The Chesapeake Community Modeling Program's

Chesapeake Modeling Symposium

May 10-11, 2010 Annapolis, MD

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Welcome to Chesapeake Community Modeling Symposium 2010 *"Community Modeling for Management, Research and Restoration Decision Support"*

Planning Committee

Raleigh Hood (CCMP Coordinator & Steering Committee Chair) – *University of Maryland Center for Environmental Science*
William Ball (CCMP Steering Committee) – *Johns Hopkins*
David Jasinski (*CCMP Program Assistant*) – *Chesapeake Research Consortium, Inc.*
Kevin McIlhany (CCMP Steering Committee) – *US Navel Academy*
Kevin Sellner – *Chesapeake Research Consortium, Inc.*
Gary Shenk (CCMP Advisory Committee) – *Chesapeake Bay Program*
Barry Stamey (CCMP Steering Committee) – *Noblis*
Doug Wilson (CCMP Advisory Committee) – *NOAA*

Scope and Aims

The Chesapeake Community Modeling Program (CCMP) seeks to improve modeling tools and related resources specific to the Chesapeake Bay, its watershed, and connected environmental systems by fostering collaborative open source research. Toward this end the CCMP is convening a modeling symposium as a venue to identify and showcase existing modeling efforts as well as communicate how models are used as decision support tools by different developer and user groups.

ChesMS '10 is the second symposium convened by CCMP. ChesMS '08 was focused on highlighting and communicating new and innovative Chesapeake ecosystem open source models and building the existing library of available models and tools. ChesMS '10 expands on this by continuing to showcase new modeling efforts while also demonstrating how new and existing models can be applied to aid in Management, Research and Restoration decision support. By bringing together the model developer and user communities at the symposium, we hope to foster greater intra group understanding and communication. This will lead to a more product focused model development and a more intelligent use of these models.

Sponsors

Plenary Speakers

Keynote – Improving Pollution Control Performance and Accountability in the Chesapeake Bay - Chuck Fox, *Senior Advisor to the Administrator, USEPA*

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.

Plenary - The Decision Support System Nest - a Key Modeling Tool for the Baltic Sea Action Plan - Christoph Humborg*, Director of the Swedish Baltic NEST Institute*.

Christoph Humborg is a biogeochemist from Stockholm University and associate professor working on issues related to coastal biogeochemistry. His research interests are: Land sea fluxes of biogenic elements (C, N, P and, Si, Man-made changes of N and P fluxes in watersheds, Biogeochemistry of enclosed seas (Baltic Sea, Black Sea), Global warming induced changes in C fluxes in taiga and tundra biomes, and Baltic Sea environmental management issues

Plenary - Chesapeake Bay water quality modeling – Is this simply intellectual game-playing, or do these models really represent reality? - Kenneth Reckhow, *Professor of Water Resources Environmental Sciences & Policy, Nicholas School, Duke University*

Kenneth H. Reckhow is a professor at Duke University with faculty appointments in the School of the Environment and the Department of Civil and Environmental Engineering. From 1996 to 2004 he served, on a part-time basis, as Director of the University of North Carolina Water Resources Research Institute. He is a past president of the National Institutes for Water Resources, past President of the North American Lake Management Society, and past Chair of the North Carolina Sedimentation Control Commission. Dr. Reckhow served as Chair of National Academy of Sciences Panel on the USEPA Total Maximum Daily Load Program (2001), as a member of the National Academy of Sciences Panel on USGS National Water Quality Assessment (2000-01), and as a member of the National Academy of Sciences Panel on Restoration of the Everglades Ecosystem (2003-05). He is currently Chair of the National Academy of Sciences Panel on the Evaluation of Chesapeake Bay Progress Implementation for Nutrient Reduction to Improve Water Quality (2009-2011). He has published two books and over 100 papers, principally on statistical and probabilistic water quality modeling, uncertainty and decision analysis, and pollutant loading assessment. In addition, Dr. Reckhow has taught several short courses on water quality modeling and monitoring design, and he has written eight technical guidance manuals on water quality modeling. He is now serving, or has previously served, on the editorial boards of Water Resources Research, Water Resources Bulletin, Lake and Reservoir Management, Journal of Environmental Statistics, Urban Ecosystems, and Risk Analysis. He received a B.S. in engineering physics from Cornell University in 1971 and a Ph.D. from Harvard University in environmental systems analysis in 1977.

Plenary - New approaches to analysis of the river inputs of nutrients to Chesapeake Bay - Robert Hirsch, *Research Hydrologist, USGS National Research Program*

Robert M. Hirsch currently serves as a Research Hydrologist at the USGS. From 1994 through May 2008, he served as the Chief Hydrologist of the U.S. Geological Survey. In this capacity, Dr. Hirsch was responsible for all U.S. Geological Survey (USGS) water science programs. These programs encompass research and monitoring of the nation's ground water and surface water resources including issues of water quantity as well as quality. Since 2003 he has served as the co-chair of the Subcommittee on Water Availability and Quality of the Committee on Environment and Natural Resources of the National Science and Technology Council, and in this role he has been instrumental in developing interagency priorities for water science and technology.

He began his USGS career in 1976 as a hydrologist and has conducted research on water supply, water quality, pollutant transport, and flood frequency analysis. He had a leading role in the development of several major USGS programs: 1) the National Water Quality Assessment (NAWQA) Program: 2) the National Streamflow Information Program (NSIP); and 3) the National Water Information System Web (NWISWeb). He has received numerous honors from the Federal Government and from non-governmental organizations, including the 2006 American Water Resources Association's William C. Ackermann Medal for Excellence in Water Management, and has twice been conferred the rank of Meritorious Senior Executive by the President of the United States. He is a recipient of the USGS "Eugene M. Shoemaker Award for Lifetime Achievement in Communications." He is co-author of the textbook "Statistical Methods in Water Resources." Dr. Hirsch is a Fellow of the American Association for the Advancement of Science and an active member of the American Geophysical Union and the American Water Resources Association. He has testified before congressional committees on many occasions and presented keynote addresses at many water-related meetings across the nation.

Since returning to a research position he has focused his efforts on methods for better documenting and understanding long-term changes in water quantity and quality in rivers. He is exploring century-scale trends in flooding nationwide and nutrient transport trends over several decades in rivers tributary to the Chesapeake Bay and the Gulf of Mexico. Clear communication of the results and their implications for policy is an integral part of this research.

Chesapeake Modeling Symposium 2010
At a Glance

Monday, May 10

Time	Mainsail				
8:15a	Breakfast (provided)				
9:00a	Introduction Introduction and charge for the meeting				
	Keynote Chuck Fox - USEPA				
10:00a	Plenary 1 Christoph Humborg - *Baltic NEST Institute*				
10:45a	*Morning Break*				
11:00a	Plenary 2 Ken Reckow - *Nicholas School, Duke University*				
11:45a	Plenary 3 Bob Hirsch - *USGS National Research Program*				
12:30p	Lunch (provided)				
	Coastal West	**Coastal Main**	**Coastal East**	**Stateroom**	**Harbour**
1:30p	Simulating the shallows: development and application of models for the Chesapeake's fringing sub-littoral zone. Brush	Modeling Hypoxia in Relation to Nutrients, Climate and Ecological Controls Kemp	Monitoring and modeling land change for hydrologic and ecosystem models: the way forward Jantz	NEST Workshop: The Baltic NEST System Humborg	UVA Baygame Plank
3:10p	*Early Afternoon Break*				
3:30p	Future Technologies of Numerical Modeling of Chesapeake Bay Aikman	(Cont.) Modeling Hypoxia in Relation to Nutrients, Climate and Ecological Controls Kemp	(Cont.) Monitoring and modeling land change for hydrologic and ecosystem models: the way forward Jantz	(Cont.) NEST Workshop: The Baltic NEST System Humborg	(Cont.) UVA Baygame Plank
6:00p	*Poster Session & Evening Reception*				

Tuesday, May 11

	Coastal West	Coastal Main	Coastal East	Stateroom	Harbour
8:00a	Breakfast (provided)				
8:30a	Chesapeake Bay Ecological Forecasting: Moving ecosystem modeling from research to operation Hood	Coping with uncertainty in modeling environmental resources: practices, pitfalls & recommendations from modelers, restoration biologists & managers Ihde	Design and Use of Environmental Observatories and Observing Systems for Estuaries Ball	Exceptional Atmospheric and Hydrodynamic Processes and Events: Observations, Models, Forecasts, Response and Communication Smith	Regional Model Comparison: Mixing/Vertical Stratification in Chesapeake Bay Long
10:10a	*Morning Break*				
10:30a	(Cont.) Chesapeake Bay Ecological Forecasting: Moving ecosystem modeling from research to operation Hood	(cont.) Coping with uncertainty in modeling environmental resources: practices, pitfalls & recommendations from modelers, restoration biologists & managers Ihde	(Cont.) Design and Use of Environmental Observatories and Observing Systems for Estuaries Ball	(Cont.) Exceptional Atmospheric and Hydrodynamic Processes and Events: Observations, Models, Forecasts, Response and Communication Smith	(Cont.) Regional Model Comparison: Mixing/Vertical Stratification in Chesapeake Bay Long
12:00p	Lunch (provided)				
1:00p	(Cont.) Chesapeake Bay Ecological Forecasting: Moving ecosystem modeling from research to operation Hood	(cont.) Coping with uncertainty in modeling environmental resources: practices, pitfalls & recommendations from modelers, restoration biologists & managers Ihde	CBEO Workshop: Cyberinfrastructure tools for Chesapeake Bay researchers and modelers Zaslavsky		CBP Model Application to Local TMDLs and Assessments of the Chesapeake Bay TMDL Water Quality Standards Linker/Wu
3:00p	*Early Afternoon Break*				
3:20p	(Cont.) Chesapeake Bay Ecological Forecasting: Moving ecosystem modeling from research to operation Hood	(cont.) Coping with uncertainty in modeling environmental resources: practices, pitfalls & recommendations from modelers, restoration biologists & managers Ihde	(Cont.) CBEO Workshop: Cyberinfrastructure tools for Chesapeake Bay researchers and modelers Zaslavsky		(Cont.) CBP Model Application to Local TMDLs and Assessments of the Chesapeake Bay TMDL Water Quality Standards Linker/Wu
5:30p	*Adjourn*				

Session Schedules

Monitoring and modeling land change for hydrologic and ecosystem models: the way forward

Session Lead: *Claire Jantz*
Session Co-Lead(s):
Date: *May 10, 2010*
Time: *1:30 pm*
Room: *Coastal East*

Abstract:
A number of efforts that loosely couple land change models with hydrologic and/or ecosystem models have been completed or are in progress in the mid-Atlantic region, many of which have direct relevancy for resource managers at local and regional scales. This session will bring together modelers working on these projects to discuss their findings, challenges and solutions. Central questions will include: how can coupled models capture feedbacks between land change processes and ecosystem or hydrologic processes; how are issues of spatial and temporal scale addressed; how can we better incorporate climate change impacts and feedbacks; how can results of these complex modeling efforts be best communicated to decision makers; what land classification schemes are most relevant for ecosystem and hydrologic modeling; what should the periodicity of monitoring of land, hydrologic and ecosystem changes; what should the 'next generation' of coupled models look like? This session will highlight the current challenges faced by this modeling community, and will pave the way for a future research for coupled modeling.

1:30 pm -	Brown de Colstoun	Exploiting The Free Landsat Archive For Operational Monitoring Of Ecosystem Condition And Change Across The Chesapeake Bay Watershed
1:45 pm -	Irani	Developing Multi-Temporal Land Cover Parameters For The Phase 5.3 Chesapeake Bay Watershed Model
2:00 pm -	Goetz	On The Relationship Between Stream Biotic Diversity And Exurbanization In The Mid-Atlantic And Northeastern USA
2:15 pm -	Sharifi	Modeling Nutrient Loadings From Ungauged Watersheds In Chesapeake Bay's Eastern Shore
2:30 pm -	Li	Flow And Nutrient Discharges From Small Coastal Watersheds Of The Chesapeake Bay's Eastern Shore
2:45 pm -	Claggett	The Potential Effects Of Differing Urban Land Classifications On Regional Land-Change And Hydrologic Models
3:10 pm -	BREAK	
3:30 pm -	Milheim	Changes In Bird Habitat Within The Chesapeake Bay Watershed, 1984-2006
3:45 pm -	Suarez-Rubio	Evaluation Of The Susceptibility Of The Maryland Green Infrastructure To Forecasted Patterns Of Land Use Change
4:00 pm -	Moglen	A Linked Modeling Approach To Predict Future Land Use And Hydrologic Consequences In The Delmarva Peninsula
4:15 pm -	Welty	Modeling Coupled Feedbacks Between The Hydrologic Cycle And Patterns Of Urban Growth

4:30 pm -	Donato	Software Developer's Perspective On Integrating Land-Change And Environmental Models
4:45 pm -		Monitoring And Modeling Land Change Discussion Session

Simulating the shallows: development and application of models for the Chesapeake's fringing sub-littoral zone.

Session Lead:	*Mark Brush*
Session Co-Lead(s):	*Lora Harris*
Date:	*May 10, 2010*
Time:	*1:30 pm*
Room:	*Coastal West*

Abstract:

Shallow, photic zones of estuaries are a dominant feature of mid-Atlantic estuaries including Chesapeake Bay, and provide a variety of ecosystem services including nutrient retention, buffering of storm energy, and habitat for important fish and shellfish. These sub-littoral zones are often subjected to high rates of nutrient loading due to their proximity to land, and are particularly vulnerable to these inputs owing to their shallow depths, relatively small volumes, and illuminated bottom. The shallow benthos can support SAV and a mixture of autotrophs, or may be dominated by an increased number of nuisance primary producers such as macroalgae and epiphytes once nutrient loading thresholds are reached and the system degrades into an alternative, undesirable state. Despite this sensitivity, the role of these systems as potential nutrient filters has been demonstrated for coastal lagoons and is likely under-valued in Chesapeake Bay. Model development for the shallows has lagged behind that for the deeper portions of estuarine systems as has data collection to support model development and calibration, yet models are essential for assessing the vulnerability of shallow systems to a variety of natural and anthropogenic stressors. This session seeks to survey existing models and methods for simulating sub-littoral water quality, biogeochemistry, and primary producer dynamics (phytoplankton, benthic microalgae, macroalgae, and seagrasses/epiphytes), the role of the sub-littoral zone in the greater Chesapeake ecosystem, the response of shallow systems to human impacts such as nutrient loading and climate change, and the potential for these models in informing local to basin-wide management. Researchers and managers are invited to present on model development and application related to sub-littoral zones around the Chesapeake Bay as well as in the seaside Delmarva lagoons. Our goal is to assess the current state of shallow water modeling in the Chesapeake, data requirements for these models, the role of these models in management, and the next steps for further sub-littoral model development and related data acquisition.

1:30 pm -	Cerco	The Shallow-Water Component Of The Chesapeake Bay Environmental Model Package
1:50 pm -	Shen	Coupling Effects Of Benthic Community And Phytoplankton On Dissolved Oxygen In The Thalia Creek: A Data Analysis And Model Diagnostic Study
2:10 pm -	Jarvis	Modeling Loss And Recovery Of Zostera Marina Beds In The Chesapeake Bay Following Repeated Disturbance Events: The Role Of Seedlings And Seed-Bank Viability
2:30 pm -	Brush	Towards An Ecosystem Model Of The Delmarva Lagoons: Formulating The Benthic Primary Producers And Results Of Initial Calibration
2:50 pm -	Harris	Improving Models Of Nitrogen Loading And Water Quality Impacts To Coastal Lagoons

Modeling Hypoxia in Relation to Nutrients, Climate and Ecological Controls

Session Lead:	*Michael Kemp*
Session Co-Lead(s):	*Ming Li, Walt Boynton and Dom DiToro*
Date:	*May 10, 2010*
Time:	*1:30 pm*
Room:	*Coastal Main*

Abstract:
The goals of this proposed session are to explore how diverse modeling approaches can help to improve understanding of how hypoxia and related dissolved oxygen distributions are controlled by variation in external nutrient loading and climatic conditions, as well as internal ecological processes. Presentations will include examples of numerical and statistical modeling studies in Chesapeake Bay and other temperate coastal ecosystems (e.g., Delaware Inland Bays, Neuse River estuary), examining system responses to key factors including nutrient management, shifts in prevailing winds and changes in stream-flow and temperature. We will also solicit presentations that illustrate interactions between bottom water oxygen, benthic animal abundance and biogeochemical processes.

1:30 pm -	North	The Influence Of Anoxia On Oyster Larval Transport: A Model-Based Hypothesis
1:50 pm -	Bierman	Revised Algal Speciation Model For The Potomac River Estuary
2:10 pm -	Brady	A Post-Audit Of The Chesapeake Bay Sediment Flux Model
2:30 pm -	Murphy	Statistical Modeling Of Spatial And Temporal Trends In Chesapeake Bay Hypoxia And Stratification
2:50 pm -	Li	Modeling Hypoxia Response To River Flow And Wind Forcing In Chesapeake Bay
3:10 pm -	BREAK	
3:30 pm -	Lee	Factors Regulating Characteristics Of Dissolved Oxygen Concentrations In Long Island Sound
3:50 pm -	Cerco	Twenty Years Of Progress In Modeling Hypoxia In Chesapeake Bay
4:10 pm -	Scully	Wind Modulation Of Hypoxia In Chesapeake Bay

NEST Workshop: The Baltic NEST System

Session Lead: *Christoph Humberg*
Session Co-Lead(s): *Oleg Savchuk, Alexander Sokolov*
Date: *May 10, 2010*
Time: *1:30 pm*
Room: *Stateroom*

Abstract:

The Baltic Nest system is being developed and maintained at the Stockholm University as a tool to support decision-making at international negotiations regarding the Baltic Sea environment. The Baltic Nest covers the entire Baltic Sea area including its catchment, and designed as a web distributed system, which has access to large amounts of diverse types of environmental data allocated in different institutions, it is capable to run different kind of models, and provides users with an easy way to evaluate different modelled scenarios and environmental data. The system has already been used as a scientific basis for eutrophication segment of the Baltic Sea Action Plan (BSAP) that was prepared by regional international environmental body (HELCOM) and signed in 2007 by all the riparian countries. Further usage of the system includes an adaptive management of BSAP, a support of the European Marine Strategy and Water Framework Directive, scenario studies of interactions between eutrophication, climate variations and fishery, etc. The decision support system Baltic Nest is publically available on-line (http://nest.su.se/nest/). The aim of the workshop is to briefly present different components of Baltic Nest and assist to participants in a "hands-on" experience of on-line usage of the system.

UVA BayGame

Session Lead:	*Jeffrey Plank*
Session Co-Lead(s):	*Gerald Learmonth and Dave Smith*
Date:	*May 10, 2010*
Time:	*1:30 pm*
Room:	*Harbour*

Abstract:

The UVA Bay Game (www.uvabaygame.org) is a large-scale agent-based simulation of the Chesapeake Bay watershed that allows players to take the roles of stakeholders, such as farmers, local policy-makers, watermen, and developers, make decisions about their livelihoods and professional expertise, and see the impacts of these decisions on the watershed and on each other over a twenty-year period. The Game is an educational tool for raising awareness about watershed stewardship; a tool for exploring and testing policy choices; and a tool for basic research in complex systems modeling. This session will provide an overview of the Bay Game including a look at the underlying model. Session attendees will then be able to play a couple rounds of the Bay Game on their own laptops.

Future Technologies of Numerical Modeling of Chesapeake Bay

Session Lead:	*Frank Aikman*
Session Co-Lead(s):	*Richard Patchen, Lyon Lanerolle, Raghu Murtugudde and Raleigh Hood*
Date:	*May 10, 2010*
Time:	*3:30 pm*
Room:	*Coastal West*

Abstract:
Presently, there are many numerical modeling efforts underway in the Chesapeake Bay. These cover a multitude of numerical ocean models (e.g. ROMS, CH3D, etc.), physical and biogeochemical/ecological model applications and both research and operational modeling set-ups. There is also a large volume of observational measurements available for the Chesapeake Bay spanning many years which have yet to be fully utilized. This session aims to discuss some future numerical modeling techniques and technologies, in particular, (I) nesting, (ii) data assimilation, (iii) watershed modeling and their integration into the hydrodynamic modeling, (iv) wetting-drying, (v) inclusion of freshwater fluxes, (vi) sediment transport and exchanges, and (vii) new bulk flux formulations (e.g. a successor to the well known TOGA-COARE formulation, etc.) which have yet to be routinely used in the Chesapeake Bay numerical models in combination with the available observations. In addition to the above physical modeling enhancements, there also exist many corresponding ecological modeling and biochemical-physical coupling enhancements. There are three aims for this session: (a) to provide researchers and investigators an opportunity to present their efforts and findings on the above physical and ecological modeling and technology advances; (b) to initiate a dialogue regarding which of the above items are the most critical to the next generation of Chesapeake Bay numerical modeling setups and how best to go about incorporating them in the currently available models; and (c) develop plans for the best options for future projections of Chesapeake Bay circulation, ecosystem health, and interactions with land use changes and other human activities.

3:30 pm -	Lanerolle	Modeling The Water Level Variability As It Effects Restoration Planning And Design At Poplar Island
3:50 pm -	Sanford	Regional Simulation Of Groundwater Transport Of Nitrate In The Delmarva Peninsula
4:10 pm -	Hoffman	Chesapeake Bay Assimilation Using Local Ensemble Transform Kalman Filter In The Presence Of Forcing Errors
4:30 pm -	Long	The Development Of The Mid-Atlantic, Chesapeake Bay, And Delaware Bay Regional Ocean Modeling System (Macroms) And Its Hydrodynamics Validation
4:50 pm -	Harris	Representation Of Mud Within A Three-Dimensional Hydrodynamic And Sediment Model For The York River
5:10 pm -	Gangai	Fema Region III Coastal Hazard Analyses And Dfirms Update

Poster Session

Session Lead: *NA*
Session Co-Lead(s):
Date: *May 10, 2010*
Time: *5:30 pm*
Room: *Coastal Main*

Abstract:
Posters will highlight a variety of modeling, monitoring and management efforts with the Chesapeake region and elsewhere.

Barnes	Chesapeake Bay Program Phase 5 Watershed Model
Bhaskar	Urban Hydrologic Modeling In The Baltimore Metropolitan Region
De Cola	Stochastic Forecasting Of Land Cover States
Donohue	West/Rhode River Nutrient Transport Model
Hong	Modeling Study Of Salinity Change Under Different Sea-Level Rise Scenarios In The Chesapeake Bay
Narvaez	Modeling The Dispersion Of Oyster Larvae: Effects Of Biological And Physical Processes
Sherwell	From The Air: Deposition And Tmdls
Steppe	Lagrangian Estimates Of Transport In Chesapeake Bay
Yactayo	Estimates Of Nitrogen And Phosphorus Input For Use In Modeling Pollutant Reduction
Bi	Ocean Conditions And Salmon Surival Off Washington And Oregon
Methratta	A Spatially-Explicit Statistical Model For Oyster Restoration In Chesapeake Bay

Coping with uncertainty in modeling environmental resources: practices, pitfalls & recommendations from modelers, restoration biologists & managers

Session Lead: *Tom Ihde*
Session Co-Lead(s): *Howard Townsend*
Date: *May 11, 2010*
Time: *8:30 am*
Room: *Coastal Main*

Abstract:

Being aware of model parameter and structure uncertainty is necessary for understanding the expected outcome of management actions. Methods of dealing with model uncertainty are disparately applied around the Chesapeake Bay research and resource management community. The communication of these concepts and study results to managers is likewise disparate. Models are important as frameworks for identifying management priorities and research needs. Models are needed to understand the populations and to simplify the complex dynamics of ecosystems that the decision-makers seek to manage. Research studies and monitoring performed can ultimately help to reduce the parameter and structure uncertainty in model outputs. Thus, the most effective use of models and their results will both help managers understand the dynamics of the resources that they manage and identify research priorities that will improve the precision of model results; ideally, this process improves the reliability of model assessments and forecasts. However, the approaches used by scientists to address uncertainty in their modeling efforts vary widely, and these methods must be communicated effectively to resource managers if managers are to be able to correctly interpret model results for effective decision making. In this session we seek to bring scientists, biologists and managers together to share how uncertainty in model parameters and structure is assessed and documented, how that information is presented to managers, and ultimately, how that information is incorporated into resource management decisions. The opportunities for questions to the panel of presenters in both the morning and afternoon sub-sessions should provide many opportunities for shared insights into possible best practices for documenting and presenting different types of model uncertainties. The goal is to capture these shared insights as a list of recommendations for scientists for how to systematically deal with model uncertainty and effectively communicate their findings to resource managers and restoration biologists.

8:30 am -	Vogt	Fishing For The Right Model: Modeling For Resource Management
8:50 am -	Townsend	Understanding Uncertainty In Modeling For Resource Management
9:10 am -	Beal	Considering Uncertainty In Fisheries Management
9:30 am -	Fegley	Managers and Uncertainty – Oil and Water, or a Match made in Heaven?
9:50 am -	Uphoff	"Just Give Me A Number" - A Fisheries Biologists Experience Communicating Uncertainty To Managers
10:10 am -	BREAK	
10:30 am -	Wilberg	Uncertainty And Precaution In Mid-Atlantic Fisheries Management
10:50 am -	Brush	Methods For Improving Confidence In Model Predictions And Incorporating Uncertainty: Lessons From Simulating Hypoxia In Narragansett Bay

11:10 am -	Ward	Ecosystems Management And Managers
11:30 am -	Ihde	An Ecosystem-Based Modeling Approach: The Chesapeake Atlantis Model
12:00 pm -	LUNCH	
1:00 pm -	Richkus	The Role Of Uncertainty In Limiting Demographic Model Application In Oyster Management In Cheapeake Bay
1:20 pm -	North	Inviting Feedback To Clarify Uncertainty
1:40 pm -		Facilitated Discussion - Round-Table 1: Best Practices/ Recommendations For Modelers (& Managers & Users)
3:00 pm -	BREAK	
3:20 pm -		Audience Question, Suggestions And Comments
3:35 pm -		Facilitated Discussion-Round-Table 2 : Best Practices/ Recommendations For Modelers (& Managers & Users)
4:50 pm -		Next Steps

Chesapeake Bay Ecological Forecasting: Moving ecosystem modeling from research to operation

Session Lead:	*Raleigh Hood*
Session Co-Lead(s):	*Robert Wood, David Green, Xinsheng Zhang*
Date:	*May 11, 2010*
Time:	*8:30 am*
Room:	*Coastal West*

Abstract:

Despite decades of ecosystem modeling efforts, ecological models are rarely taken to the operational phase. As we endeavor to move towards ecosystem management it is essential that we acknowledge that, in the words of David Fluharty, 'It is extremely important to avoid making perfect knowledge of the ecosystem the enemy of using the good knowledge we have.' Operational modeling has great potential to educate and inform not only ecosystem management, but also the outlook and opinion of the general public, for whom we manage Chesapeake Bay and other coastal ecosystems. This session will focus on existing or developing ecological or ecosystem models that have great potential to become operational in the near future. We will also explore the challenges facing both scientists and managers in moving towards model operationalization and use.

8:30 am -	Uccellini	NCEP Support for Ecological Forecasting
8:50 am -	Green	Challenges and Progress toward Integrated Environmental Services
9:30 am -	Friedrichs	The Chesapeake Focus Research Group (FRG) of the Community Surface Dynamics Modeling System (CSDMS): A Pathway to Community Operation of a Multi-Model Ecological Forecasting Test Bed
9:50 am -	Hood	CBEFS: The Chesapeake Bay Ecological Forecasting System
10:10 am -	BREAK	
10:30 am -		Ecological Forecasting Discussion Session 1
10:50 am -	Brown	Transitioning a Chesapeake Bay Ecological Prediction System Product to Operations
11:10 am -	Jacobs	Predicting the Distribution of Vibrio vulnificus in Chesapeake Bay.
11:30 am -	Zhang	Chesapeake Bay striped bass habitat suitability forecasting: moving ecosystem modeling from research to operation
12:00 pm -	LUNCH	
1:00 pm -	Wiggert	Assessment of a coupled physical-biogeochemical model developed for ecological forecast use in Chesapeake Bay
1:20 pm -	Long	ChesROMS: An NPZD-based Chesapeake Bay Biogeochemical Prediction Model Implementation and Demonstration

1:40 pm -	Evans	Simple model for uncertainty and regime shift analysis of Chesapeake Bay hypoxia
2:00 pm -		Ecological Forecasting Discussion Session 2
2:40 pm -	Bi	Copepods and salmon: forecasting salmon survival off Washington and Oregon
3:00 pm -	BREAK	
3:20 pm -	Martino	Projecting recruitment of Chesapeake Bay striped bass based on early-life habitat quality
3:40 pm -	North	Larval transport, habitat volume, and marine protected area optimization models: from development to operational use
4:00 pm -	Kaushal	Forecasting Watershed Nutrient and Contaminant Loads to Drinking Water in Baltimore, Maryland: A Pilot Application of the Chesapeake Bay Forecasting System
4:20 pm -		Ecological Forecasting Discussion Session 3

Exceptional Atmospheric and Hydrodynamic Processes and Events: Observations, Models, Forecasts, Response and Communication

Session Lead:	*Elizabeth Smith*
Session Co-Lead(s):	*Doug Wilson, Bill Boicourt, Kevin Sellner*
Date:	*May 11, 2010*
Time:	*8:30 am*
Room:	*Stateroom*

Abstract:

This session will highlight end-to-end modeling and forecasting of coastal processes that affect the Chesapeake Bay as extreme events or excursions from normal or typical processes and events. Discussions of supporting observations and observing systems, and user-driven event response and communication needs also are encouraged. Extreme event topics could include: coastal and estuarine storm driven inundation (or blow-out); waves; extreme precipitation or drought events; harmful algal blooms or toxic spills; seiches; or other similar, potentially catastrophic events. Diverse and novel approaches, especially those utilizing open-source or open-standards are welcomed. We also invite relevant presentations on observations and observing systems; atmospheric and hydrodynamic boundary conditions and forcing fields; data assimilation methods and requirements; model-data comparisons and validation studies; and model data management, visualization, and methods of communicating forecasts and results. This session builds upon recent experience in the Chesapeake Bay community in the development of the end-to-end process of the Chesapeake Inundation Prediction System (CIPS) prototype and invites perspectives on future collaborative research and development activities.

8:30 am - Zubrick	Utility of Short Range Atmospheric Model Guidance during Significant Coastal Inundation Events
8:50 am - Wnek	Multisensor Precipitation Estimates Produced By NOAA, National Weather Service River Forecast Centers
9:10 am - Boon	Storm Tide Observation, Analysis And Forecast System For Lower Chesapeake Bay
9:30 am - Wang	Numerical Modeling Of Storm Surge And Inundation For Recent Northeaster Event (November 11-14, 2009) In The Chesapeake Bay
9:50 am - Lotspeich	Monitoring Inland Storm Surge: The Usgs Mobile Storm-Surge Sensor Network And Response To The Verteran’s Day Nor’easter, November 2009
10:10 am - BREAK	
10:30 am - Stamey	Geospatial Visualization And Risk Management Methodology To Plan For Current Storm And Future Sea Level Rise Inundation Impacts On Critical Coastal Infrastructure
10:50 am - Hagan	Chesapeake Inundation Prediction System (Cips) The Value Of Cips Information To End Users: The Views Of Emergency Managers
11:10 am - Howlett	Data Management For The Chesapeake Bay Inundation System (Cips)

11:30 am -	Stamey	Implementation Of The Autonomous Sensor Network And Associated Sensor Systems To Monitor, Respond, And Communicate Real-Time, Bay-Wide Impacts On Human And Ecosystem Health

Design and Use of Environmental Observatories and Observing Systems for Estuaries

Session Lead: *Bill Ball*
Session Co-Lead(s): *Lewis Linker, Doug Wilson*
Date: *May 11, 2010*
Time: *8:30 am*
Room: *Coastal East*

Abstract:
Environmental observatories and observing systems are under continuing development as platforms for data acquisition, storage, and analysis to support a wide variety of potential users, including research scientists, resource managers, educators, commercial operations, and the public at large. A well-designed observatory enhances the opportunities for interaction between observational data and models of multiple types. This session invites a range of platform presentations and posters about on-going or planned activities related to observatories for the Chesapeake Bay and other estuarine systems. Topics could include (but are not limited to) the following: • Novel uses of observatory facilities and products for -- model development and application; -- interpretation and analysis of observational data; -- predictions and forecasting. • New approaches for handling and storing data streams in environmental observatories; • Methods for storing, documenting, and using model output in repositories; • Creation and testing of cyberinfrastructure tools for observatory use; • Lessons learned in past and current environmental observatory projects; and • Future directions for environmental observatories on the Chesapeake Bay including their potential influence on modeling applications.

8:30 am -	Perlman	Using Databases To Improve Access To Chesapeake Bay Model Data
8:50 am -	Garner	Hfradar Surface Current Observations In The Lower Chesapeake Bay
9:10 am -	Aguayo	Development Of Web-Services For CBEO Data Sources: An Overview Of Challenges When Participating In A Nationwide Network
9:30 am -	Duffy	The Age Of Recharge In Hydrologic Flow Systems: The Shale Hills Critical Zone Observatory
9:50 am -	Holmes	Use Of Real Time Data To Determine Signatures And Time Scales Of The Stable Isotope Network At The Susquehanna Shale Hills Critical Zone Observatory
10:10 am -	BREAK	
10:30 am -	Ball	The Design And Application Of A Chesapeake Bay Environmental Observatory
10:50 am -	Zaslavsky	Analytical Workflows, Data Discovery And Visualization On The Chesapeake Bay Environmental Observatory (CBEO) Data Portal

Regional Model Comparison: Mixing/Vertical Stratification in Chesapeake Bay

Session Lead: *Wen Long*
Session Co-Lead(s): *Ping Wang, Kevin Sellner*
Date: *May 11, 2010*
Time: *8:30 am*
Room: *Harbour*

Abstract:

A number of modelers from the region are currently conducting runs of multiple Chesapeake Bay hydrodynamic models using common data input for the period 2003-2005. The goal is to compare model output of vertical distributions of salinity and temperature versus field observations for specific stations/locations and times (well mixed late winter, stratified summer, and possibly mixed fall). The results will be presented at the May CheMS'10 meeting in a special 1/2 day session to identify models best approximating vertical distributions of salt and temperature, as these are critical to maximizing future biogeochemical modeling estimates of dissolved oxygen in the stratified bay, the governing factor in summer estimates of nutrient fluxes, productivity, and living resource distributions. Possible models in the suite include three versions of ROMS, CH3D, SELFE, and ELCIRC, with others possible in the future. Results will also inform future discussions of single model implementation for application in the bay or ensemble modeling to best approximate ambient conditions.

8:30 am -	Sellner	Chesapeake Bay hydrodynamic models: Needs for ecological forecasting
8:50 am -	Wang	Salinity and Temperature Simulations for the Chesapeake Bay by the CH3D Hydrodynamic Model
9:10 am -	Shen	Identifying potential problems associated with numerical simulations of hydrodynamics in the Chesapeake Bay
9:30 am -	Lanerolle	Evaluation of the NOAA/NOS Chesapeake Bay Operational Forecast System upgrade (CBOFS2) temperature and salinity predictions
9:50 am -	Long	Temperature and Salinity Predictions of the Chesapeake Bay Regional Ocean Modeling System (ChesROMS): Evaluation with In Situ Data and Intercomparison with Other Models
10:10 am -	BREAK	
10:30 am -	Long	Group Discussion

CBP Model Application to Local TMDLs and Assessments of the Chesapeake Bay TMDL Water Quality Standards

Session Lead:	*Lewis Linker*
Session Co-Lead(s):	*Jing Wu, Ping Wang, Gary Shenk, Richard Batiuk*
Date:	*May 11, 2010*
Time:	*1:00 pm*
Room:	*Harbour*

Abstract:

The TMDL of the Chesapeake Bay is the first TMDL developed for a large aquatic ecosystem and the largest TMDL yet developed. Within the regional TMDL, thousands of local TMDLs are being developed by the Bay Program States. Coordination of the Bay TMDL and the local TMDLs allows for efficient governance, cost savings, and greater environmental protection. The community models, like the Phase 5 Watershed Model, provide a tool kit for local TMDL development. In this session we'll explore all aspects of the assessment of the Chesapeake water quality standards of dissolved oxygen (DO), chlorophyll, and SAV/clarity, and the challenges and limitations of the Phase 5 application to locale TMDLs. Associated with the model application to assess numeric water quality standards is an adjustment of the model output data. Relative changes in the model scenario output are applied to observed data to create scenarios for evaluation that are more representative of the observed data. Model data correction techniques will be reviewed, along with the monitoring programs which support the models.

1:00 pm -	Woodbury	Multi-Scale Modeling Of Nutrient Loading In The Susquehanna River Basin
1:20 pm -	Dalmasy	Community Model Application To Maryland TMDLs
1:40 pm -	Boomer	The Role Of Watershed Modeling In Local Land Management Decisions In Maryland Communities
2:00 pm -	Wu	Chesapeake Bay Community Model For TMDL Development
2:20 pm -	Schultz	Enhancements Of Phase 5 To Support Water Resource Planning In The Potomac River Basin
2:40 pm -	Meng	Hydrologic & Water Quality Modeling Of Rappahannock And Potomac River Basins Using SWAT
3:00 pm -	BREAK	
3:20 pm -	Hong	A Toolbox For Calculating Net Anthropogenic Nitrogen Inputs (NANI)
3:40 pm -	Shenk	The Chesapeake Bay Program's Scenario Builder
4:00 pm -	Muller	A Tale Of Two Chesapeake Tributaries: Implications For Modeling And Restoration
4:20 pm -	Wang	Data Correction On Simulated Dissolve Oxygen With Observed Data For Water Quality Criteria Assessment
4:40 pm -	Linker	Simulation Of Atmospheric Deposition In The Chesapeake Bay And Watershed

Cyberinfrastructure tools for Chesapeake Bay researchers and modelers

Session Lead: *I. Zaslavsky*
Session Co-Lead(s): *M. Piasecki, M. Rodriguez*
Date: *May 11, 2010*
Time: *1:00 pm*
Room: *Coastal East*

Abstract:

This half-day workshop will introduce cyberinfrastructure tools and approaches that have been explored within the Chesapeake Bay Environmental Observatory (CBEO) project, and are now freely available to researchers and modelers. These tools include software for publishing, discovering and accessing hydrologic time series being developed within the NSF-supported CUAHSI Hydrologic Information System (HIS) project, and software for managing large data collections developed within the GEON project. We will communicate the basic concepts of service-oriented computing, standards for data exchange, hydrologic data services, publication and registration of water data services and their use in various desktop and online applications. Besides the standard components of the CUAHSI HIS and GEON-based nodes of the CBEO project, we will demonstrate techniques for rapid access to data summaries of the 10-year 13K Water Quality Model for the Chesapeake Bay, and techniques for efficient management of realtime observations. Participants will learn about the various Chesapeake Bay datasets that are accessible through the CBEO portal. In addition to providing heretofore unavailable public access to some previously unpublished data sets, the CBEO effort has provided a re-formatting of CIMS data which makes it accessible for use with the HIS cyberinfrastructure tools. Participants will be able to gain hands on experience working with the Chesapeake Bay data using the provided online software tools.

Abstracts

Aguayo, Miguel, *Drexel University*

DEVELOPMENT OF WEB-SERVICES FOR CBEO DATA SOURCES: AN OVERVIEW OF CHALLENGES WHEN PARTICIPATING IN A NATIONWIDE NETWORK

PRESENTATION- *The Consortium for the Advancement of Hydrologic Sciences Inc, CUAHSI, has been developing CyberInfrastructure components for deployment at environmental observatories with the aim of providing information technology that constitute the underpinning of the WATERs network. The observatories forming the network vary in size and are spatially distributed across the US. As part of the CBEO effort the network team has installed the CUAHSI CI components so the CBEO constitutes a node within the WATERs network. In contrast to the CBEO:Testbed team that aims to place all data available side by side (one DB instance for each source) into a server without emphasis or provisions for public access, querying interfaces, common standards or adherence to agreed upon metadata descriptions among the data sources the CBEO:Network team set out to integrate all data sources into the CUAHSI Observations Data Model ODM DB installation for nationwide network integration. The integration effort has posed numerous challenges to the team because of the vast differences between the data sets. These challenges concern the volume of data that needs to be ingested into the system node, the descriptions standards used, the spatial locations at where the data has been collected to semantic heterogeneities when labeling the data and also substantial syntactic differences in terms how data is stored (for example DB vs EXCEL spreadsheets) and how it can be accessed (online or via personal request as Email attachment). It also poses the need for automatic updating (or harvesting) schedules for those data sources that support and store data from continuous collection efforts. In this presentation we seek to provide an overview of what data srouces have been harvested and included ino the CBEO node, such as CIMS, MAST, RIM, but also regional cut outs from national data sets such as NADP, MPE, and Hydro_NEXRAD. We will focus on the required modifications and interpretations to include all required metadata, what it took to implement them into the ODM node, what coverage is available and how this data can accessed via web-services and web interfaces.*

Ball, Bill, *Johns Hopkins*, Randal Burns, Benjam Cuker, Dominic DiToro, Michael Kemp, Laura Murrey, Michael Piasecki, Ilya Zaslavsky, Miguel Aguayo Jennifer Bosch Damian C. Brady Rebecca R. Murphy, Eric Perlman, Matthew Rodriguez, Jeremy M Testa and Tom Whitenack

THE DESIGN AND APPLICATION OF A CHESAPEAKE BAY ENVIRONMENTAL OBSERVATORY

PRESENTATION- *The Chesapeake Bay Environmental Observatory (CBEO) is a prototypical observatory funded by the 2005 NSF program on "Cyberinfrastructure for Environmental Observatories: Prototype Systems to Address Cross-Cutting Needs (CEO:P)." For the past three years, our multi-institutional team of estuary and hydrologic scientists, environmental engineers, computer scientists, and educators has designed and built the CBEO infrastructure with an inter-disciplinary approach that integrates four parallel efforts: Network, Education, Testbed, and Science. In this project, we have used a major science question to drive cyberinfrastructure (CI) development, under the assumption that data collection, testbed structure, educational tools, and other aspects of CI can be more appropriately and efficiently designed if driven by specific science questions. The major question chosen for evaluation relates to historical hypoxia trends in the Bay. In particular, the project seeks to better understand why reduction in nutrient loads over the past few decades have apparently not resulted in reduced "hypoxic volume" (volume of Bay water with dissolved oxygen below specified criteria – e.g., 1.0 mg/L). These trends are in contrast to expectations based on decades of research that show a clear impact of excessive nutrient fluxes on algal blooms and depletion of dissolved oxygen in bottom waters. To fully investigate the reasons for this recent "regime shift" in Bay responses to management, the CBEO team required better access to multiple long-term observational datasets, new access to past modeling results (i.e., model output data from decades of calibration and simulation work), new predictive model runs, and new tools for data analysis. The breadth and depth of data and tools required has made hypoxia research in the Chesapeake Bay an ideal application for CI. In building the CBEO testbed and CI, the project team has collaborated with the Chesapeake Bay Program, multiple state environmental agencies, other academic teams doing Bay research, and the U.S. Army Corps of Engineers to obtain 60 years of observational data on the Bay as well as model output data from over 20 years of watershed, hydrodynamic and water quality modeling. We have used the combination of observational and model data sets to address a number of specific hypotheses related to the overall science question. For example, one specific project focused on better quantifying the hypoxic volume through incorporation of model output into better spatial interpolation of observations. Other projects have focused on the testing of various hypotheses for the recent observational trends, including analysis of decadal scale trends in Bay salinity and stratification as well as evaluations of benthic macrofauna and nutrient cycling in the Bay. Overall, our efforts have led to some important new findings about hypoxia in the Chesapeake Bay while also guiding the development of comprehensive, useful CI for use in environmental observatories.*

Barnes, Mike, *CRC*, Gary W. Shenk , Jing Wu and Lewis C. Linker

CHESAPEAKE BAY PROGRAM PHASE 5 WATERSHED MODEL

POSTER- *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.

Beal, Robert, *Atlantic States Marine Fisheries Commission*

CONSIDERING UNCERTAINTY IN FISHERIES MANAGEMENT

PRESENTATION- *As stock assessment models become more complex, through the incorporation of predator/prey relationships and other ecosystem considerations, fishery managers need to have a consistent and clear description of the uncertainty associated with model outputs. Management decisions implicitly or explicitly have an acceptable level of risk. Without a complete understanding of the model uncertainties, managers have a difficult time determining the risk associated with management options. The implementation of the Magnuson Stevens Reauthorization Act increases the importance of understanding uncertainty when setting annual catch limits and accountability measures for federally managed fisheries. Reducing uncertainty, through future research, will require detailed priorities in order to allocate the decreasing amounts of available funding.*

Bhaskar, Aditi, *UMBC CEE, CUERE*

URBAN HYDROLOGIC MODELING IN THE BALTIMORE METROPOLITAN REGION

POSTER- *To effectively and sustainably manage water in urban areas we need to understand the effects of urbanization on the hydrologic cycle as well as the resulting impacts of water availability on limits to development. We present results from a regional water sustainability project in the Baltimore region. We are using ParFlow, a fully-coupled three-dimensional, finite-difference watershed model with variably saturated subsurface and surface flow. Here we present applications of ParFlow to date at two scales: (1) the Gunpowder-Patapsco basin, which encompasses much of the Baltimore metropolitan region (13,200 sq km domain size, 1000-m model grid size), and (2) Dead Run, a small highly urban watershed embedded within the Gunpowder-Patapsco, at the edge of Baltimore City (72 sq km domain size, 100 m model grid size). At the smaller Dead Run scale, the model, and particularly the overland flow component, was highly sensitive to landscape form and urbanization. We found that enforcement of topographic slopes to follow channels was necessary as the topography alone was not adequate to define the drainage in this flat, urban domain. Furthermore, we found including some individual piped streams features that do not register on any Digital Elevation Model (DEM) was required for the domain to drain properly. Elevations from a DEM in an urban landscape may not be able to adequately define surface flow paths as streams may have been moved, channelized, piped underground, or otherwise modified. In future work, this watershed model will be coupled to an urban growth model (SLEUTH) of the Baltimore metropolitan region to explore the feedbacks between water availability and future development.*

Bi, Hongsheng, *UMCES/CBL*

OCEAN CONDITIONS AND SALMON SURVIVAL OFF WASHINGTON AND OREGON

PRESENTATION- *The abundance of yearling Chinook (Oncorhynchus tshawytscha) and coho salmon (O. kisutch) was sampled concurrently with physical (temperature, salinity, water depth) and biological variables (chlorophyll a concentration and copepod abundance) along Washington and Oregon coast in June 1998-2008. Copepods were divided into four different groups by their water-type affinities: cold neritic, subarctic, warm neritic and warm oceanic, and each group was used an independent environmental variable. Data collected in 1998- 2006 and 2008 were used to perform nonparametric correlation and negative binomial loglinear mixed regression with a spatial random factor, and data collected in 2007 was randomly selected to validate the models. Yearling Chinook abundance was negatively related with temperature, and positively related to the density of cold neritic copepod, chlorophyll a concentration, and salinity. Yearling coho abundance was positively related with temperature, and negatively related with warm oceanic copepods, warm neritic copepods, and water depth. The two salmon species also showed different spatial patterns in most years. Yearling Chinook abundance showed significant spatial autocorrelations in 1999, 2000, 2002, 2004, and 2005, and yearling coho abundance showed significant spatial autocorrelations in 2000- 2002. The spatial random factor in the negative binomial loglinear mixed model was positively correlated with juvenile salmon abundance and showed similar spatial cluster patterns as juvenile salmon abundance for both species. Thus the occurrence of spatial autocorrelation could be attributed to the spatial random factor. Both annual mean abundance of yearling Chinook and the spring Chinook jack counts, a measurement of local population success, were positively correlated with cold neritic copepods. The annual mean abundance of yearling coho and the ocean survival rate were negatively correlated with warm oceanic copepods. The differences in how each species mapped onto habitat variable might be explained by the fact that yearling coho has relatively wider coastal distribution, and could feed on a relatively wider range of prey items than yearling Chinook. To address the spatial autocorrelation and the difference between two species, information on other physical processes, such as large scale transports, eddies* *and fronts, and biological processes such as prey and predator may be necessary.*

Bi, Hongsheng, *UMCES/CBL*

COPEPODS AND SALMON: FORECASTING SALMON SURVIVAL OFF WASHINGTON AND OREGON

PRESENTATION- *The abundance of yearling Chinook (Oncorhynchus tshawytscha) and coho salmon (O. kisutch) was sampled concurrently with physical (temperature, salinity, water depth) and biological variables (chlorophyll a concentration and copepod abundance) along Washington and Oregon coast in June 1998-2006. Copepods were divided into four different groups by their water-type affinities: cold neritic, subarctic, warm neritic and warm oceanic, and each group was used an independent environmental variable. Data collected in 1998- 2008 were used to perform nonparametric correlation and negative binomial loglinear mixed regression with a spatial random factor, and data collected in 2006 was used to validate the models. Yearling Chinook abundance was negatively related with temperature, and positively related to the density of cold neritic copepod, chlorophyll a concentration, and salinity. Yearling coho abundance was positively related with temperature, and negatively related with warm oceanic copepods, warm neritic copepods, and water depth. The two salmon species also showed different spatial patterns in most years. Yearling Chinook abundance showed significant spatial autocorrelations in 1999, 2000, 2002, 2004, and 2005, and yearling coho abundance showed significant spatial autocorrelations in 2000- 2002. The spatial random factor in the negative binomial loglinear mixed model was positively correlated with juvenile salmon abundance and showed similar spatial cluster patterns as juvenile salmon abundance for both species. Thus the occurrence of spatial autocorrelation could be attributed to the spatial random. Both annual mean abundance of yearling Chinook and the spring Chinook jack counts, a measurement of local population success, were positively correlated with cold neritic copepods. The annual mean abundance of yearling coho and the ocean survival rate were negatively correlated with warm oceanic copepods. The differences in how each species mapped onto habitat variable might be explained by the fact that yearling coho has relatively wider coastal distribution, and could feed on a relatively wider range of prey items than yearling Chinook. To address the spatial autocorrelation and the difference between two species, information on other physical processes, such as large scale transports, eddies and fronts, and biological processes such as prey and predator may be necessary.*

Bierman, Victor, *LimnoTech, Amanda M. Flynn, Scott C. Hinz, Joseph V. DePinto, Carl F. Cerco, Tammy L. Threadgill*

REVISED ALGAL SPECIATION MODEL FOR THE POTOMAC RIVER ESTUARY

PRESENTATION- *The Potomac River Estuary is the largest tributary to Chesapeake Bay and has been plagued for decades by blooms of cyanobacteria (blue-green algae) in the tidal fresh portion. As part of the overall effort to develop an improved Water Quality and Sediment Transport Model (WQSTM) for Chesapeake Bay, a revised algal speciation model was developed for the Potomac portion and calibrated to available data for 1994-2000. To support the design of this Potomac model, an analysis was conducted of the available historical data (1984-2006) for phytoplankton biomass (carbon/liter) and abundance (cells/liter). The model represents phytoplankton biomass as carbon concentration and its principal design criteria were representation of major algal groups in both the tidal fresh and estuarine portions, computational tractability, and the ability to capture at least 95% of the observed phytoplankton biomass. For the target model calibration period, five algal groups were found to account for greater than 95% of the total phytoplankton biomass: diatoms, dinoflagellates, blue-greens, greens and cryptophytes. Diatoms, greens and blue-greens comprised 96% of the biomass in the tidal fresh portion, and diatoms and dinoflagellates comprised 82% in the lower estuary. Diatoms were important in all months but were strongly dominant in the lower estuary in winter-spring. In the tidal fresh portion, blue-greens comprised 81% of total abundance but only 32% of total biomass, although they were the dominant group in summer-fall. Microcystis, a prominent bloom-forming alga, comprised 47% of total blue-green abundance in the tidal fresh portion. There are five algal groups in the final revised model and they represent tidal freshwater diatoms, lower estuary diatoms, greens plus cryptophytes, dinoflagellates, and blue-greens. The model represents the spatial and temporal distributions of these groups as functions of temperature, light, salinity and available nutrients. This study demonstrated the feasibility of a regional-scale application of a portion of the full 57,000 cell WQSTM as well as the feasibility of developing and calibrating a multi-algal group model for a major Chesapeake Bay tributary. The calibration results from this model provided a reasonable representation of the spatial and temporal distributions of the dominant algal groups in the Potomac. They also suggested that sediment-water fluxes of dissolved inorganic phosphorus are important and that additional refinements are needed in the pH-alkalinity sub-model for the Potomac. This revised Potomac model is currently a research testbed and consideration should be given to incorporating its capabilities into other portions of the WQSTM, contingent on the need to represent water quality problems related to the occurrence of particular algal species groups and on the availability of sufficient data for model calibration.*

Boomer, Kathy, *Smithsonian Environmental Research Center*

THE ROLE OF WATERSHED MODELING IN LOCAL LAND MANAGEMENT DECISIONS IN MARYLAND COMMUNITIES

PRESENTATION- *To help meet Federal and state mandates to regulate nutrient discharges, Maryland now requires that all Maryland municipalities prepare a non-point source discharge assessment as part of a Comprehensive Growth Plan. This mandate presents an ideal opportunity to integrate watershed science and management. State guidelines currently suggest using the Maryland Department of Planning (MDP) Non-Point Source Assessment Spreadsheet to downscale annual average predictions from the Chesapeake Bay Program's HSPF Phase 4 model. The assessment tool is intended to help land managers minimize surface water quality impacts by providing nutrient load estimates under current and future land use scenarios. We implemented the MDP tool for a Maryland town, along with three watershed models, GWLF, SWAT, and the CBP-HSPF5, The differences in predicted water quality among alternative land use scenarios being considered by town planners (including a no change scenario) were small, especially compared to the variation among models in the predictions for any single scenario. In addition, all the models agreed that nutrient discharges originate primarily from outside the planning jurisdiction. Because of the dominance of external sources and the similarity among scenarios, the predicted impacts from non-point source pollution have had little influence on the Townâ€™s land management decisions.*

Boon, John, *Virginia Institute of Marine Science*

STORM TIDE OBSERVATION, ANALYSIS AND FORECAST SYSTEM FOR LOWER CHESAPEAKE BAY

PRESENTATION- *An operational system for observing, analyzing and forecasting extreme water levels (storm tides) in near-real time during tropical and extratropical storm events has been developed for lower Chesapeake Bay. Now in mid-first year of a two-year cooperative test and evaluation project between the National Weather Service (NOAA/NWS) and the Virginia Institute of Marine Science (VIMS), the system collects observations in near-real time from eight active water level stations in the lower bay, analyzes the observations to obtain the time-local astronomic tide and non-tidal residual, then extends the residual by means of an NWS storm surge forecast before combining it with the predicted astronomic tide to generate a 36-hour storm tide forecast. A storm tide forecast by this method is the sum of astronomic tide, storm surge and a sea level anomaly defined as the difference between short-term mean sea level averaged over the past 30 days (m30) and long-term mean sea level (MSL) as defined by NOAA/NOS for the current 19-year national tidal datum epoch (1983-2001). Advantages of the system include the ability to forecast "extratidal" water levels in near-real time measured above highest astronomic tide (HAT), a tidal datum derived through harmonic analysis as an offset from MSL. Adopting HAT as the storm tide reference datum accounts for differences in tidal range among the eight lower bay stations and allows comparison of peak water levels between stations using a metric that more nearly reflects the severity of flooding experienced in each locality. Encouraging test results have been obtained using historical data from past storms as well as from live forecasting during the extratropical storm event of 12-13 November, 2009.*

Brady, Damian, *University of Delaware*

A POST-AUDIT OF THE CHESAPEAKE BAY SEDIMENT FLUX MODEL

PRESENTATION- *Anthropogenic nutrient enrichment of estuaries is a problem dramatically transforming coastal ecosystems worldwide. Recently, studies have suggested that many eutrophied estuaries, such as the Chesapeake Bay, the Gulf of Mexico, and in Danish coastal waters, have exhibited an unexpected response to nutrient reduction: hypoxic volume has continued to increase while nutrient loading has plateaued or decreased. One possible explanation for this phenomenon is that internal nutrient loading from the sediments is compensating for the decrease in external nutrient loading. In order to understand how the dynamics of sediment nutrient cycles respond to changing conditions, a standalone version of the Sediment Flux Model (SFM) used in the Chesapeake Environmental Modeling Package (CBEMP) was calibrated and compared to data in the Sediment and Oxygen Nutrient Exchange (SONE) database. Originally, SFM was calibrated and developed using data collected from 1985-1988 at eight stations. Since that time, the SONE database has grown to include almost 300 stations and in some cases almost twenty years of sediment flux measurements. In order to expand the model-data comparison to new stations and years a method of approximating depositional flux of organic matter was necessary. Depositional fluxes are very difficult to measure and only one site in the Chesapeake Bay has an appreciable time series of depositional flux data from sediment traps. In this post-audit, we calculated organic matter depositional flux from surface chlorophyll, carbon:chlorophyll ratio, and seasonally varying settling velocity. This method has the dual advantages of using more data for input and outputting useful information such as what fraction of the organic matter is incorporated in the sediment. Using data from the Chesapeake Information Management System (CIMS) for overlying water column nutrient and oxygen concentrations, we demonstrate that the SFM was capable of simulating fluxes of ammonia, dissolved inorganic phosphorus, and oxygen during years and locations for which it was never calibrated, while nitrate fluxes were generally over predicted and silica fluxes largely under predicted. For example, the correlation coefficient for a mid-bay station (R-64) between modeled and observed ammonia and phosphorus flux was 0.7 and 0.8, respectively over a ten year period (1986-1996). The* *model also performed well over a 20 year time series at multiple stations in the Patuxent River estuary, where substantial changes in carbon deposition and overlying water nutrient concentrations resulted from nutrient management actions and other external changes. Model fitting on an intra-annual scale is sensitive to the choice of organic matter settling velocity as this represents the time lag between algal blooms and subsequent deposition. The identification of years, stations, and processes that were poorly simulated offers the opportunity to improve model kinetics and/or add model processes, but overall model performance more than adequately captured intra- and interannual trends as well as demonstrating that this mass balanced model is capable of accounting for sediment nutrient memory.*

Brown, Christopher, *NOAA / NESDIS*

TRANSITIONING A CHESAPEAKE BAY ECOLOGICAL PREDICTION SYSTEM PRODUCT TO OPERATIONS

PRESENTATION- *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.*

Brown de Colstoun, Eric, *UMBC/Goddard Earth Sciences and Technology Center*

EXPLOITING THE FREE LANDSAT ARCHIVE FOR OPERATIONAL MONITORING OF ECOSYSTEM CONDITION AND CHANGE ACROSS THE CHESAPEAKE BAY WATERSHED

PRESENTATION- *For the first time, all imagery acquired by the Landsat series of satellites is being made available by the USGS to users at no cost. This represents a key opportunity to use Landsat in a truly operational monitoring framework: large regions of the U.S. such as the Chesapeake Bay Watershed can now be analyzed using "wall-to-wall" imagery at timescales from ~1 month to several years. With the future launch of the Landsat Data Continuity Mission (LDCM) and Decadal Survey missions such as the hyperspectral HyspIRI, it is imperative to develop robust processing systems to perform annual ecosystem assessments over large regions such as the Chesapeake Bay. We have been working at NASA's Goddard Space Flight Center (GSFC) to develop an integrative framework for inserting 30m, annual, Landsat based data and derived products into the existing decision support system for the Bay, with a particular focus on ecosystem condition and changes over the entire watershed. The basic goal is to use a "stack" of Landsat imagery with 40% or less cloud cover to produce multi-date (2005-2009 period), cloud/shadow/gap-free composited surface reflectance products that will support the creation of watershed scale land cover/use products and the monitoring of ecosystem change across the Bay. Our scientific focus extends beyond the conventional definition of land cover (i.e. a classification of vegetation type) as we propose to monitor both changes in surface type (e.g. forest to urban), vegetation structure (e.g. forest disturbance due to logging or insect damage), as well as winter crop cover. These processes represent a continuum from large, interannual changes in land cover type, to subtler, intra-annual changes associated with short-term disturbance. The free Landsat data are being processed to surface reflectance and composited using the existing Landsat Ecosystem Disturbance Adaptive Processing System here at NASA/GSFC, and land cover products (type, tree cover, impervious cover, winter cover) are being produced using well-established decision tree and regression tree algorithms. The goal of this session is to present the data products that we have been developing to the Bay science community and to discuss potential avenues for improvements and usage of the products for decision support.*

Brush, Mark, *Virginia Institute of Marine Science*

TOWARDS AN ECOSYSTEM MODEL OF THE DELMARVA LAGOONS: FORMULATING THE BENTHIC PRIMARY PRODUCERS AND RESULTS OF INITIAL CALIBRATION

PRESENTATION- *Shallow, sub-littoral zones are a dominant feature of Chesapeake Bay as well as the nearby lagoons of the Delmarva Peninsula. These photic systems support an array of pelagic and benthic primary producers and provide a variety of ecosystem services including nutrient retention and buffering against excessive nutrient loads. However, these systems are being subjected to ever-increasing rates of nutrient loading, and are particularly susceptible to these loads due to their shallow depths, relatively small volumes, long residence times, and potential for proliferation of nuisance algae. Model development for the shallows has lagged behind that for the deeper portions of estuarine systems, yet models are increasingly needed to understand the response of the sub-littoral zone to both natural and anthropogenic stressors as well as the potential for system restoration. I will present efforts to couple a watershed, estuarine, and eelgrass model to the shallow coastal bays of the Delmarva Peninsula, with a focus on meta-analyses of literature and experimental data to develop formulations for the benthic micro- and macroalgal communities. Results of a calibration to Hog Island Bay, VA will be presented, along with efforts to simulate transitions between alternative stable states.*

Brush, Mark, *Virginia Institute of Marine Science*

METHODS FOR IMPROVING CONFIDENCE IN MODEL PREDICTIONS AND INCORPORATING UNCERTAINTY: LESSONS FROM SIMULATING HYPOXIA IN NARRAGANSETT BAY

PRESENTATION- *Numerical simulation models of estuaries and coastal systems have become critical tools for informing management decisions, particularly with regard to cultural eutrophication. Recent efforts have been focused on new methods for increasing confidence in model predictions through statistical validation, and on methods for incorporating uncertainty in model output. I will present aspects of both topics based on an ongoing NOAA Coastal Hypoxia Research Program (CHRP) project in Narragansett Bay, RI, where we have been applying an intermediate-complexity model to simulate the development and alleviation of hypoxia/anoxia. First, I will review three methods for validating model output to increase confidence in predictions, including (1) system-level validation, (2) simulation with parallel process formulations, and (3) stochastic simulation. All are proposed to complement existing statistical techniques and provide "multiple lines of evidence" in evaluating model output. The latter method is also an easily-implemented technique for incorporating uncertainty in model output. Second, I will present efforts to convert model output of daily mean dissolved oxygen (DO) concentrations to predictions of instantaneous minimum DO which reflect the actual management criteria. Analyses of Narragansett Bay buoy data have yielded consistent and well-constrained statistical relationships between mean DO and (1) daily minimum DO and (2) time spent below other DO criteria. These statistical relationships provide a critical link for managers between model output and management criteria, and through the use of error bounds they include estimates of model uncertainty.*

Cerco, Carl, *US Army ERDC*

THE SHALLOW-WATER COMPONENT OF THE CHESAPEAKE BAY ENVIRONMENTAL MODEL PACKAGE

PRESENTATION- *Restoration of submerged aquatic vegetation (SAV) is a major goal of the EPA Chesapeake Bay Program. Attainment of restoration goals is measured through SAV area and water clarity in the littoral zone. The Chesapeake Bay Environmental Model Package (CBEMP) is used to guide management actions intended to restore SAV and meet additional restoration goals. The shallow-water component of the CBEMP has been growing in complexity and capability, in response to enhanced management focus on the shallow-water environment, since its implementation more than a decade ago. The cornerstone of the shallow-water component is the SAV unit model which computes three variables: above-ground biomass (sub-divided into leaves and stems), below-ground biomass (sub-divided into roots and tubers), and attached epiphytes. These are largely determined by the surface irradiance and subsequent attenuation in the water column and by self-shading. Light attenuation is determined by an advanced optical model which computes attenuation as a function of absorption and scattering by dissolved and particulate substances. Application of an earlier version of the model indicated that resuspension of in-situ sediments may confound management efforts to limit inputs of light-attenuating particles from the watershed. Consequently a dynamic sediment resuspension component has been added to the model. Sediment resuspension is computed as a function of wave- and current-induced bottom shear stress and is attenuated by SAV. Unit values of SAV variables are combined with local bathymetry to produce computations of SAV area which are the primary model output. The model is successful at computing long-term average SAV distribution throughout the bay, which is largely determined by littoral zone area and by local light attenuation. For reasons that are not obvious, the model is less successful at computing long-term trends in SAV area. One factor may be the absence from the model of specific processes of reproduction and propagation. Or the multiplicity of environmental influences that determine SAV trends may be beyond the capability of mechanistic models. At present, the model employs a "probability of success" to help quantify otherwise unexplained trends. The presentation concludes with suggestions for next-generation models of the shallow-water environment.*

Cerco, Carl, *US Army ERDC*

TWENTY YEARS OF PROGRESS IN MODELING HYPOXIA IN CHESAPEAKE BAY

PRESENTATION- *The combined watershed, hydrodynamic, and eutrophication models currently referred to as the Chesapeake Bay Environmental Model Package (CBEMP) were originated in 1987 and have been in the process of continuous refinement since then. A fundamental purpose of the CBEMP is to represent hypoxia. This representation includes quantifying processes which create hypoxia, reproducing observations of hypoxia, and projecting the outcomes of remediation efforts. The CBEMP has passed through four major development stages. The original stage focused on processes in the water column and benthic sediments and employed tidal average hydrodynamics on a computational grid of 4,000 elements. The second stage increased resolution to 10,000 elements and employed intertidal hydrodynamics. Benthic algae and zooplankton were added to the model computational suite. In the third stage, emphasis on modeled primary production and respiration were coupled with further refined resolution. The most recent stage employs a grid of 50,000 elements and attempts to route the products of primary production on the shoals to deep channel water. Some of the improvements have been more significant than others in improving the model representation of hypoxia. We examine here basic model processes and budgets at each stage of development and compare these to observations and current paradigms regarding hypoxia. Processes which are accurately modeled are identified as well as processes which are not. The presentation paints a picture of the present model status and provides a basis for the next generation of Chesapeake Bay eutrophication models.*

Claggett, Peter, *U.S. Geological Survey*

THE POTENTIAL EFFECTS OF DIFFERING URBAN LAND CLASSIFICATIONS ON REGIONAL LAND-CHANGE AND HYDROLOGIC MODELS

PRESENTATION- *Land-use/cover datasets derived from Landsat satellite imagery have been extensively used to calibrate or parameterize several regional land change models (e.g., SLEUTH, LEAM, and L-THIA) and hydrologic models (HSPF/BASINS, SPARROW, GIS-Hydro). For such models, researchers often rely on publicly available land-use/cover data sources such as the USGS National Land Cover Dataset (NLCD) or NOAA's Coastal Change Analysis Program (CCAP) dataset. In some areas, researchers have developed sub-pixel measures of change in impervious surfaces and annual land-change products such as MacDonald Dettwiler and Associates (MDA Federal) Correlated Land Change dataset. Researchers have also used supplementary parcel or cadastral land-use datasets in their models. Interpretations of the rates, patterns, and drivers of urban change based on these datasets can differ significantly and affect both researchers interpretations of regional phenomena and the results of land-change and hydrologic models, particularly when interpreting the extent of low-density residential development because the spatial resolution (30m) of Landsat imagery is too coarse to resolve isolated dwellings and the spectral signatures of residential lawns and trees are often confused with agricultural and forest land uses respectively. This presentation explores potential interpretations of the rates, patterns, and drivers of urbanization in the greater Washington, D.C. - Baltimore region (Landsat path-row 15/33) between 1992 and 2001 using the new Chesapeake Bay Land Cover Data series, University of Maryland's impervious surface datasets, MDA Federal's Correlated Land Change product (1982- 2009), and land use data from the Maryland Department of Planning and local governments. Differing interpretations of urban land use and change derived from these data are illustrated, along with the potential affects on forecasts generated by the SLEUTH urban-growth and HSPF hydrologic models. Land-change and hydrologic modelers relying on Landsat-derived land-use/cover classifications should be aware of these modeling limitations and ramifications.*

Dalmasy, Dinorah, *Maryland Department of the Environment*

COMMUNITY MODEL APPLICATION TO MARYLAND TMDLS

PRESENTATION- *Community Model Application to Maryland Total Maximum Daily Loads (TMDLs) Dinorah Dalmasy- Senior Environmental Engineer, Maryland Department of the Environment This presentation describes how the State of Maryland has used the Chesapeake Bay Community Model as an integral part of Maryland's TMDL Program. Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and the EPA's implementing regulations direct each state to develop a TMDL for each impaired Water Quality Limited Segment (WQLS) on the Section 303(d) List. A TMDL reflects the total pollutant loading of the impairing substance a waterbody can receive and still meet water quality standards. Since the first 303(d) List in 1996, Maryland has listed hundreds of watersheds as impaired by a variety of pollutants, including nutrients, sediments, heavy metals, toxic organic substances and impacts to biological communities. The current 2008 Integrated Report identifies 134 impaired watersheds. Various combinations of waterbodies and pollutants result in over 393 potential TMDLs statewide. As of the 2008 Integrated Report, there have been 787 total impairment listings, of which 452 have been addressed. The use of the Community Model has helped Maryland's TMDL Program tremendously. Not only has it helped Maryland meet its annual TMDL goals, but it also will allow the Program to meet the federally mandated requirement of addressing all listings on the initial 1996-1998 303(d) list by 2011. It should also be known that Maryland is the only state in EPA Region 3 to complete its own TMDLs, rather than having EPA do them under a* *consent degree resulting from a lawsuit in 1997. Maryland's TMDL Program has used the Community Model in the development of TMDLs for nutrients, sediments, and PCBs, and plans to use it to address biological impairments through flow and impervious cover TMDLs.*

De Cola, Lee, *USGS*
STOCHASTIC FORECASTING OF LAND COVER STATES
POSTER- *The USGS land cover Trends project conducts detailed classification of 10- and 20-km^2 blocks based on fieldwork, 60-m satellite imagery, and ancillary data. The research provides highly accurate land cover estimates for 5 temporal "windows" in the period 1973 to 2000. I have applied stochastic methods to estimate empirical Markov chain matrices for each of 62 blocks in the 160,000-km^2 Chesapeake Bay Watershed. The matrices describe shifts among 3 land cover classes during each period and are used to estimate parameters for point forecasts of decadal 2000-2050 regional land cover. I then interpolate land cover fields for the entire region based on the estimates and error measurements. Results provide animations based on regional maps of where the landscape is changing fastest and toward what kinds of land covers. I intend to use the stochastic model both to relate simple, robust measures of land cover status and dynamics to descriptions of the drivers of landscape transformation (population growth, economic activity, climate change) and to forecast the consequences of landscape change for Chesapeake Bay water quality, habitat, and living resources.*

Donato, David, *USGS Eastern Geographic Science Center*
SOFTWARE DEVELOPER'S PERSPECTIVE ON INTEGRATING LAND-CHANGE AND ENVIRONMENTAL MODELS
PRESENTATION- *Models of land change tend to be both data-intensive and computation-intensive. For this reason, land-change models are generally and necessarily implemented with the complex computer software required to carry out millions of processing iterations over voluminous geographic rasters, over large sets of agents or geographic features, over numerous time steps, and finally over multiple Monte Carlo trials. Hydrologic models and other environmental and ecosystem models are also implemented with computer software because they often require massively repetitive computation and processing over numerous elements of time and space. Thus the problems of integrating or coupling land-change models with related environmental-resource models include the problems of model integration at the software level, and cannot be fully understood, nor solved, without due consideration of the constraints and possibilities of model integration in software. The methods, materials, tools, and concerns of the coupling and integration of land-change models with environmental-resource models will be surveyed and discussed from the perspective of the software developer. The discussion will distinguish coupling from integration and will cover modeling languages and frameworks, operating environments, inter-system and inter-process communication, points of contact among models, software-development costs and constraints, design trade-offs, and computational efficiency.*

Donohue, George, *George Mason University*
WEST/RHODE RIVER NUTRIENT TRANSPORT MODEL
POSTER- *The West and Rhode River sub-estuary has been deteriorating due to high nutrient and sediment loads. The West/Rhode Riverkeeper has tasked a Systems Engineering senior design student team to evaluate a number potential remediation measures that have been identified that could reduce nutrient and sediment runoff into the sub-estuary. The team has developed a broad-based utility function to perform this prioritization. The team has also added the enhancement of several existing oyster beds, that have been under development over the last several years, as an option to this prioritization analysis. In order to estimate the relative effects of the proposed mitigation measures, a 15 zone tidal nutrient transport model was developed. The model uses tide height as an input and predicts fluid transport into and out of the sub-estuary for up to 28 days. The poster submitted will show the final weights of the utility function and details of the fluid transport model that could be used for future studies of nutrient and sediment transport by the Riverkeeper.*

Duffy, Christopher, *Penn State*
THE AGE OF RECHARGE IN HYDROLOGIC FLOW SYSTEMS: THE SHALE HILLS CRITICAL ZONE OBSERVATORY
PRESENTATION- *This research is developing a dynamical systems model for estimating recharge and the age of recharge across in watersheds. An extensive literature has developed around the problem of direct simulation of tracer age distributions to diagnose transport in environmental systems. Theories have also been developed for estimation of tracer or isotope age in local and regional steady groundwater flow systems, and these approaches have been useful for making estimates of flow paths, flow rates, recharge, and time of travel for water resource assessment. The present paper explores theoretical and practical questions of how to interpret transient concentration-flow signals in terms of short term precipitation events and long term climate-time scale oscillations. The paper extends some earlier work (Duffy and Cusumano, WRR, 1998), where concentration-discharge phase-plane plots were shown to carry important time scales of both the flow and the environmental tracer inputs, in terms of direct simulation of "age" of water in a watershed setting. The dynamical model simulates the qualitative characteristics of climate, vegetation and*

hydrogeologic conditions. Discretization of the model is accomplished using the natural coordinates of the terrain (hypsometry). Explicit expressions are developed for transient mean age in the soil zone and recharge, and for groundwater flow across the mountain-front. Although the nonlinear dynamical model results are qualitative, the theory is easily extended to fully distributed models of concentration, age, and flow under transient conditions. The model is demonstrated at the Shale Hills/Susquehanna Critical Zone Observatory using a new stable isotope network deployed in 2009-10.

Evans, Mary Anne, *University of Michigan*

SIMPLE MODEL FOR UNCERTAINTY AND REGIME SHIFT ANALYSIS OF CHESAPEAKE BAY HYPOXIA

PRESENTATION- *Because all models are simplifications of natural systems it is desirable to use a variety of model constructs for any given natural system. More confidence can be placed in a result, such as the nutrient loading decreases needed to achieve a given reduction in hypoxic area, if this result is supported by multiple modeling approaches. We contribute to this diversity of modeling approaches with an implementation of the Streeter-Phelps river model for the bottom waters of Chesapeake Bay. This model is structurally simple, such that it can be parameterized with a minimum of field data, but retains enough mechanistic detail to allow validation against measured rate processes in the bay. Additional strengths of this model include explicit handling of parameter uncertainty and incorporation of multiple data types in parameterization and forecasting through Bayesian inference and Monte Carlo simulation. Results to date show (1) that Chesapeake Bay hypoxia is strongly influenced by total nitrogen (TN) loading but that the conversion efficiency of nitrogen to hypoxia varies from year to year, (2) specifically that this conversion efficiency has increased since 1980s, (3) that due to this increase in efficiency, TN load reductions of 35%, that previously would have returned the bay to hypoxic areas typical of the 1950s- 1970s, would now be inadequate to return the bay even to the 1980s and 1990s hypoxic areas.*

Fegley, Lynn, *Maryland Department of Natural Resources*

MANAGERS AND UNCERTAINTY – OIL AND WATER, OR A MATCH MADE IN HEAVEN?

PRESENTATION- *Weather forecasts are an excellent example of model-based uncertainty that is conveyed in a manner that allows people to assess risk and respond accordingly. There is an inherent understanding of the risk associated with a forecast of 70% chance of rain, and given this forecast, most people will adjust their behavior in some way: pack an umbrella, close up the windows in the house, or chose to wear different shoes – just in case.*

Fisheries models are highly complex and employ a language that is virtually unique to the field of stock assessment. Managers work with varying levels of understanding of stock assessments and the associated language. They listen carefully to what the assessment scientists are trying to tell them, but they will process information very differently depending on their understanding of the material; or depending on a particular agenda. Presentation of uncertainty by scientists is not done in a consistent manner, and therefore does not lend itself to consistent interpretation and action.

This talk will work from stock status summaries produced by Atlantic States Marine Fisheries Commission (ASMFC) technical committees in order to examine the different language and messaging associated with assessment uncertainty.

Friedrichs, Carl, *Virginia Institute of Marine Science, College of William & Mary*

THE CHESAPEAKE FOCUS RESEARCH GROUP (FRG) OF THE COMMUNITY SURFACE DYNAMICS MODELING SYSTEM (CSDMS): A PATHWAY TO COMMUNITY OPERATION OF A MULTI-MODEL ECOLOGICAL FORECASTING TEST BED

PRESENTATION- *The Community Surface Dynamics Modeling System (CSDMS, pronounced "Systems") is a national facility funded by the National Science Foundation to provide community access to high performance computing (HPC) facilities, model linking software, and HPC expertise for the purpose of advancing the application and evolution of freely available, open-source models of earth surface processes, including coastal and estuarine hydrology, hydrodynamics and ecosystem function. The Chesapeake FRG is CSDMS's first geographically-focused research group and has the specific goal of assembling a collection of interchangeable models and model components to address environmental processes within the Chesapeake region. The Chesapeake FRG is a partnership between CSDMS and the Chesapeake Community Modeling Program, which, in turn, is supported by the NOAA Chesapeake Bay Office, the EPA Chesapeake Bay Office, and the member institutions of the Chesapeake Research Consortium. This presentation provides additional background regarding the CSDMS Chesapeake FRG, its activities to date, and its short and long-term goals. At present, the Chesapeake FRG is seeking funding to establish a community-accessible test bed at CSDMS to link, operate and interchange existing open-source Chesapeake Bay models for (1) land-use/hydrology, (2) hydrodynamics, and (3) water quality/ecosystem function. As part of this project, multiple existing open-source models would be interchanged and assessed against existing data sets. Ideally, a process would be developed by which multiple scientifically-vetted, open-source model suites could be formally recommended for ensemble operational use.*

Gangai, Jeffrey, *Dewberry, Robin Danforth, Elena Drei-Horgan*

FEMA REGION III COASTAL HAZARD ANALYSES AND DFIRMS UPDATE

PRESENTATION- *The Federal Emergency Management Agency (FEMA) Region III encompasses Delaware, Maryland and Virginia coastal counties. As part of FEMA's Risk Map Program, an identification and assessment of the coastal flooding risks will be performed for all Region III coastal counties and will ultimately produce updated Digital Flood Insurance Rate Maps (DFIRMs). New coastal hazard analyses, initiated in the Fall of 2009, will utilize the 1% annual chance stillwater elevations obtained from the storm surge modeling of the Atlantic Ocean, Chesapeake and Delaware Bays, concurrently being performed by the USACE for FEMA Region III. A coastal flooding risk update is needed mainly because of the age of data shown on the effective FIRMs. In particular, the topographic data used for modeling and mapping shown on effective FIRMs dates back to the mid-1970s and mid-1980s from USGS contours. The stillwater elevations go back to a 1978 Virginia Institute of Marine Science study for the Chesapeake Bay and to a tidal gage analysis for the Atlantic coasts. Effective FIRMs do not account for wave setup, and the overland wave determination was computed with a methodology that dates back to the late 1970s. Dune erosion was accounted for in isolated locations only. In addition, major changes in NFIP policies and methodologies have occurred since the effective date of many FIS studies in the area, creating the need for an update that would reflect a more detailed and complete hazard determination. New guidelines for the Atlantic Coast and Gulf of Mexico, released in 2007, propose updated methods for the computation of wave setup; dune erosion should be applied following the 540 sq ft rule for dune volume criteria, and wave runup has been updated from a mean wave runup to a 2% of the highest wave runup value. Additional guidelines were released for sheltered coasts in 2008, and new policies such as the Limit of Moderate Wave Action (LiMWA) were introduced to limit wave damages to structures. Within the new coastal study for the Delaware, Maryland and Virginia coastal counties the analysis will be performed along transects located at a higher density than old studies, reducing interpolation of results, to favor more precise and detailed products. In addition to producing update DFIRMs, FEMA Region III aims at an extensive outreach program to bring to light methodologies and results through a variety of efforts. These efforts entailed identifying and engaging stakeholders within the study area through a series of announcements, mailings, web sites and public meetings to discuss results and plans for DFIRM updates.*

Garner, Teresa, *Old Dominion University*

HFRADAR SURFACE CURRENT OBSERVATIONS IN THE LOWER CHESAPEAKE BAY

PRESENTATION- *HFRADAR antennas observe surface current velocities over wide spatial areas. This unique spatial perspective on currents delivered in near real-time makes an HFRADAR velocity data set a valuable resource for the modeling community in terms of both circulation model validation and data assimilation. Old Dominion University collects hourly data in the lower Chesapeake Bay with two antenna sites and a third site operated by NOAA. The coverage area extends west from the mouth of the Bay to the mouth of the James River and north to the Back River. Total velocity vectors are computed hourly on a standard grid with nominal 2 kilometer spacing; however any user-defined grid may be used. In the Bay, comparisons of HFRADAR observations to Doppler current data have yielded average RMS differences of 6 to 13 cm/s. A recent analysis of over two years of data has revealed average sub-tidal current patterns under different wind forcing conditions. Such information on average conditions as well as observations during extreme events may serve to help validate and improve circulation models. HFRADAR data from the lower Bay are freely available to the public and to the research community. The data format and manner of data transfer may be tailored to suit the needs of individual users.*

Goetz, Scott, *Woods Hole Research Center*

ON THE RELATIONSHIP BETWEEN STREAM BIOTIC DIVERSITY AND EXURBANIZATION IN THE MID-ATLANTIC AND NORTHEASTERN USA

PRESENTATION- *Stream macroinvertebrate diversity is a commonly used indicator of aquatic health, reflecting overall ecological integrity within a watershed. We made use of two metrics of stream biota, the Hilsenhoff Biotic Index (HBI) and the diversity of Ephemeroptera, Plecoptera, and Tricoptera (nEPT) species, to develop statistical models relating land cover and urban land use information within watersheds to these metrics of stream biotic health. The study area in southern New England included over 100 small streams, which make up a substantial portion of the region's largest catchments. Land cover information derived from the National Land Cover Database (2001) included the proportion of impervious surface area and tree cover within the watersheds. Impervious cover provided an accurate measure of the amount and configuration of lands modified for urban, residential and transportation related land uses. Additional information was derived from maps of grass and agricultural crop cover types. General additive models (GAM) and step-wise multiple linear regression (MLR) models were used to explore the relationship between land cover variables and the biotic indicators. We also tested the relative importance of weighting the land cover variables as a function of distance from the stream channel. Landscape weighting of the land cover variables did systematically improve model performance, but the statistical models were both consistently reliable predictors of nEPT and HBI at the small watershed scale (tens to hundreds of square kilometers). Using the developed models we produced maps of predicted watershed nEPT* *and HBI for a larger portion of southeastern New England and the nearby Upper Delaware Scenic and Recreational River. This work indicates land cover, particularly urban land use, is a robust predictor of stream biological indicators at the small watershed scale, and judicious use of this information can be used to target streams for conservation, restoration or mitigation purposes.*

Green, David, *NOAA NWS*

CHALLENGES AND PROGRESS TOWARD INTEGRATED ENVIRONMENTAL SERVICES

PRESENTATION- *This presentation will identify the challenges and progress toward transitioning experimental model-based ecological forecasts into operational applications. NOAA has a long history of forecasting weather, tides, currents, floods, and fish stock through its various Line Offices and partnerships. In recent years the portfolio of experimental ecological models has matured and the infrastructure developed to tackle a broader suite of multidisciplinary and regional management issues. The lack of a robust framework and approach enabling transition of these models and derived forecasts, scenarios, and projections into sustained and durable environmental services limits the ability to meet user needs. The evaluation of requirements for service and operational improvement indicate that the integration of ecosystem and biogeochemistry models with existing climate, water and weather models is needed for ecosystem-based management and this shortfall 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 presentation will provide examples of marine and coastal ecosystem model development and demonstration projects at NOAA and through regional partnerships that are contributing to a strengthened ecological forecast and warning system as a contribution to a broader integrated environmental service.*

Hagan, Patrick, *UMCES*

CHESAPEAKE INUNDATION PREDICTION SYSTEM (CIPS) THE VALUE OF CIPS INFORMATION TO END USERS: THE VIEWS OF EMERGENCY MANAGERS

PRESENTATION- *CIPS is a decision support tool being developed to improve the accuracy, reliability, and timeliness of local flood forecasts for tropical cyclones and non-tropical wind systems such as nor'easters. Investigators from government, industry and academia are developing a prototype of this localized inundation forecasting system to facilitate emergency management and also planning decisions related to flooding along intricate coastlines and semi-enclosed coastal bays and estuaries where conventional inundation predictions are notoriously unreliable. The value of CIPS information, like all information depends on four factors: 1) how much better it is than the next best available information, 2) how it can be used to improve decision making, 3) what is at stake in those decisions, and 4) what the information costs. To understand the potential value of CIPS as an operational tool from the end-user perspective we interviewed local and state emergency managers in Maryland and Virginia and attempted to model how improvements in their decisions based on CIPS output would reduce various measures of flood-related costs, risks, and damage. This presentation by the CIPS economics team will include discussion of key observations made by EMs that are specific to the Chesapeake region but also have broader significance for ocean observations and modeling.*

Harris, Lora, *UMCES-CBL*

IMPROVING MODELS OF NITROGEN LOADING AND WATER QUALITY IMPACTS TO COASTAL LAGOONS

PRESENTATION- *Coastal lagoons play a critical role in the processing of land-derived nutrients on their transit from watershed to coastal ocean. However, these systems are vulnerable to rapid changes in population, land use, and associated nitrogen (N) loads. As a response to these impacts, lagoons frequently exhibit a shift in the dominant autotroph and nature of nutrient processing that may ultimately affect water quality. In light of the myriad stressors to lagoonal communities, we developed an innovative, management-focused watershed and lagoon modeling tool to understand how changing landuse affects nutrient loads, and how receiving waterbodies respond to these changing loads. Amendments to predictions of nitrogen loading budgets to include restoration and mitigation technologies will be emphasized in this presentation. Interactive stressors of increasing temperatures and sea level rise will also be explored.*

Harris, Courtney, *VIMS*

REPRESENTATION OF MUD WITHIN A THREE-DIMENSIONAL HYDRODYNAMIC AND SEDIMENT MODEL FOR THE YORK RIVER

PRESENTATION- *The MUltiDisciplinary Benthic Exchange Dynamics (MUDBED) program is exploring how both physical and biological processes influence seasonal variations in turbidity and sediment properties in muddy estuarine environments. Suspended sediment concentrations can be influenced by hydrodynamic forces, sediment settling velocity, and bed erodibility. In turn, sediment flux convergence and divergence can modify both suspended sediment and seabed properties. In estuaries, stratification and sediment trapping vary over seasonal, storm, and tidal timescales in response to tides, freshwater discharge, and winds. In the York River, VA these processes commonly produce an ephemeral Secondary* *estuarine Turbidity Maxima (STM), downstream of the main Estuarine Turbidity Maximum (ETM). A three-dimensional numerical hydrodynamic and sediment-transport model of the York River Estuary has been developed to examine feedbacks between sediment flux convergence, erodibility, and settling velocity. The model uses the Regional Ocean Modeling System (ROMS) coupled to the Community Sediment Transport Modeling System (CSTMS), and includes a bed consolidation component that represents critical shear stress for erosion as increasing with depth in the bed and with time since deposition. Specifically, the sediment bed model follows Sanford (2008) in tracking the instantaneous critical shear stress for erosion as a function of depth in the bed and time. This critical shear stress profile then is nudged toward an equilibrium value at specified rates of consolidation (for depositional cases) and swelling (for erosional cases). Multiple grain types are used in the model to represent small, medium, and large flocs. Model results will be shown that represent conditions in the York River during times that coincide with MUDBED field experiments. The model neglects both direct biological processes and flocculation dynamics, but tidal fluctuations and variations in freshwater discharge influence model estimates of bed erodibility and effective settling velocity. For example, though the model is initialized using uniform sediment bed properties, the channel quickly becomes scoured of fine-grained material, with a concomitant reduction in predicted erodibility, similar to what is seen in the actual York River. Likewise, an STM forms within the model during wet months, when erodibility increases. Challenges in using this approach include specification of model parameters such as (1) the rate parameter (often called M) used to estimate the erosion rate of sediment, (2) the equilibrium critical stress profile with depth in the sediment bed, (3) timescales for consolidation and swelling, and (3) settling velocity for the grain sizes used. Future applications of this type of bed consolidation model will need to consider appropriate ways to specify these parameters. REFERENCE: Sanford, L.P., 2008. Modeling a dynamically varying mixed sediment bed with erosion, deposition, bioturbation, consolidation, and armoring. Computers & Geosciences, 34: 1263-1283.*

Hoffman, Matthew, *Johns Hopkins Univeristy*

CHESAPEAKE BAY ASSIMILATION USING LOCAL ENSEMBLE TRANSFORM KALMAN FILTER IN THE PRESENCE OF FORCING ERRORS

PRESENTATION- *The local ensemble transform Kalman filter (LETKF) has been applied to the ChesROMS model of the Chesapeake Bay for the purpose of regional ocean prediction. Observation system simulation experiments (OSSEs) have shown that the LETKF improves the state estimate of the system using a realistic simulated observation system and errors in surface and freshwater forcing. The OSSEs explore the impact and importance of these forcing errors and show how the data assimilation improves the physical state estimate in their presence. In addition, initial steps using real data will be discussed along with future plans for the assimilation project.*

Holmes, George, *Pennsylvania State University*

USE OF REAL TIME DATA TO DETERMINE SIGNATURES AND TIME SCALES OF THE STABLE ISOTOPE NETWORK AT THE SUSQUEHANNA SHALE HILLS CRITICAL ZONE OBSERVATORY

POSTER- *An isotopic sampling network has been implemented at the Susquehanna Shale Hills Critical Zone Observatory. This site has been approved as a node in the IAEA Global Network of Isotopes in Precipitation (GNIP) database. This research is an attempt to determine oxygen-18 and deuterium signatures and time scales in all stores of the watershed. The network covers all phases of the hydrologic cycle, including precipitation sampled on an event basis with an Eigenbrodt NSA-181/S wet only collector (six-hour samples), soil water sampled weekly along four transects with suction-cup lysimeters, groundwater sampled daily at two wells with ISCO automatic samplers and weekly at 15 wells, vegetation sampled during the growing season, and stream water sampled daily with an ISCO automatic sampler. The comprehensive sampling of the network is possible because of the DLT-100 liquid water stable isotope analyzer from Los Gatos Research, with a reproducibility of ± 0.2% for oxygen-18 and ± 0.6% for deuterium, and the capability to run approximately 30 samples per day. The stable isotope data is used in conjunction with real time hydrologic data collected at fine spatial and temporal scales across the catchment. Eko nodes are installed on approximately every acre of the 20-acre catchment measuring soil moisture, temperature, humidity, electrical conductivity of the groundwater and groundwater depth every 15 minutes. There are two rain gauges, an Ott weighing type gauge that measures precipitation every 10 minutes, and a Thies Clima disdrometer that measures precipitation characteristics on intervals as small as one minute. Soil moisture, stream stage, and groundwater depth are also measured at specific locations in the catchment. The goal of the research is to identify flow paths and time scales of water from precipitation input to the watershed through stream flow output. Time series analysis and spatial principal component analysis is used to classify dominant modes and processes affecting stable isotope dynamics in the watershed. The stable isotopes and real time data are being used to quantitatively estimate the mean age and residence time of the water in the watershed.*

Hong, Bongghi, *Department of Ecology and Evolutionary Biology, Cornell University*

A TOOLBOX FOR CALCULATING NET ANTHROPOGENIC NITROGEN INPUTS (NANI)

PRESENTATION- *Net anthropogenic nitrogen inputs (NANI), composed of oxidized N deposition, fertilizer N application, agricultural N fixation, and net food and feed imports, estimate human-induced nitrogen inputs to a region and have been shown to have a strong relationship with riverine nitrogen export. Since its first introduction, it has been applied to various regions of the US, including the subbasins of the Chesapeake Bay watershed, and the world by numerous researchers. Comparison and synthesis of these studies have been somewhat problematic due to discrepancies in the data sources and assumptions applied in their calculations. To address this problem, it would be useful to have a set of tools for calculating NANI from a standardized dataset allowing the user to clearly see the assumptions behind the calculations and alter them to test their sensitivity. Here we present a prototype of such a toolbox, the NANI Calculator Toolbox. The toolbox is composed of three sets of tools: (1) a GIS tool overlaying a watershed map with various data maps to calculate overlaying proportions, (2) a set of Excel based tools extracting necessary data from various standardized datasets (Agricultural Census, Census, USGS fertilizer input estimates, and CMAQ N deposition estimates), and (3) an Excel based tool calculating the NANI budget and other related components (e.g., manure production by animals) from the extracted data. All the datasets are included in this package, allowing the user to calculate NANI anywhere in the US from the watershed map of interest. As a demonstration, we present county-scale NANI estimates for the entire continental US and also for the subbasins of the Chesapeake Bay watershed. Possible extension of the datasets to European countries and the use of the outputs for parameterizing the regional hydrology and nutrient loading model ReNuMa (Regional Nutrient Management) are discussed.*

Hong, Bo, *Virginia Institute of Marine Science*

MODELING STUDY OF SALINITY CHANGE UNDER DIFFERENT SEA-LEVEL RISE SCENARIOS IN THE CHESAPEAKE BAY

PRESENTATION- *It has been the consensus that salinity will increase in the Chesapeake Bay as sea level rises. Potential impacts of salinity change on the local ecosystem are difficult to determine. A three-dimensional hydrodynamic model using the Environmental Fluid Dynamic Code (EFDC) model is developed in this study to simulate the long-term (1998-2008) salinity field in the Bay under a decadal time scale of climate and forcing variability. The model calibration and verification demonstrate that the model is capable of reasonably reproducing the observed salinity structure and long-term trend in the Bay and can be used to study the salinity change under different sea-level rise scenarios. According to the recent U.S. Climate Change Science Program (USEPA, 2009), three future sea-level rise scenarios are selected for this study: (a) the twentieth century rate, which is generally 3 to 4 millimeters per year in the mid-Atlantic region (30 to 40 centimeters total by the year 2100); (b) the twentieth century rate plus 2 millimeters per year acceleration (up to 50 centimeters total by the year 2100); (c) the twentieth century rate plus 7 millimeters per year acceleration (up to 100 centimeters total by the year 2100). Notable changes of salinity are observed in the model simulation with different sea-level rise scenarios. The relationships between magnitude of sea-level rise and salt flux, salt water intrusion intensity, and salinity stratification are investigated. The maximum salinity variation, salinity intrusion, and potential change of accumulative salinity distribution are evaluated based on the model results.*

Hood, Raleigh, *University of Maryland Center for Environmental Science*

CBEFS: THE CHESAPEAKE BAY ECOLOGICAL FORECASTING SYSTEM

PRESENTATION- *The Chesapeake Bay is an important recreational and economic resource that has been subjected to increasing stress due to anthropogenic impacts. These impacts include eutrophication and they have contributed to increased frequency of noxious bloom events that can negatively impact human health. In this presentation we give an introductory overview of the Chesapeake Bay Ecological Forecasting System (CBEFS), which provides prototype ecological nowcasts and short-term forecasts of physical and biogeochemical properties as well as blooms of jellyfish, harmful algae and pathogenic microbes in the Bay.*

Ihde, Tom, *NOAA Chesapeake Bay Office*

AN ECOSYSTEM-BASED MODELING APPROACH: THE CHESAPEAKE ATLANTIS MODEL

PRESENTATION- *The Chesapeake Atlantis Model (CAM) is both a true ecosystem-based model for the fisheries of the Chesapeake Bay and a tool for management strategy evaluation (MSE). The model incorporates spatially-explicit information about the biological, geochemical, and physical factors that drive the ecosystem of the Bay and its estuaries. By coupling these varied data within the framework of a single model, natural variability of the system is accounted for when making model estimates. The CAM can be used to investigate the probable effects of a wide variety of change to Bay resources in an ecosystem context, whether the change concerns user groups (e.g., fisheries, land development, industry), management strategies employed (e.g., catch shares, closed areas, restoration), or climate variability. As an MSE tool, the model can also simulate changes in the important processes of assessment, decision-making and compliance. With the CAM approach, stakeholders are empowered to explore the uncertainty of policy implementation when considering different management scenarios. Use of CAM predictions (and the predictions of* *other, similar ecosystem-based models) will be somewhat different than the use of current, highly-developed single species models that managers have become accustomed to. Ecosystem models necessarily incorporate data from a variety of temporal and spatial scales and of varying magnitudes; uncertainties from all of these data sources are carried over into ecosystem models. However, the CAM offers managers important new insights to environmental and societal tradeoffs that cannot be seen with simpler approaches.*

Irani, Frederick, *US Geological Survey*

DEVELOPING MULTI-TEMPORAL LAND COVER PARAMETERS FOR THE PHASE 5.3 CHESAPEAKE BAY WATERSHED MODEL

PRESENTATION- *The procedures employed to derive multi-temporal input parameters for the Chesapeake Bay Phase 5.3 Watershed Model (Ph5.3) using the newly released USGS Chesapeake Bay Land Cover Data (CBLCD) are presented. The USGS has recently released a series of Chesapeake Bay Watershed land cover data for the years 1984, 1992, 2001 and 2006. These data were developed in such a way that land cover change trends can readily be identified over this period. The series was derived from a modified version of the 2001 USGS National Land Cover Data (NLCD), the NOAA Coastal Change Analysis Program (CCAP) land cover data and Landsat-5 reflectance data using MacDonald Dettwiler and Associates (MDA Federal) Cross Correlation Analysis (CCA). Using the CBLCD, the following Phase 5.3 input parameters were produced for each watershed modeling segment: water (acres) and proportions (percent of county total) of agriculture, cropland, and pasture. Additionally, the four CBLCD urban classes were combined with 2001 impervious surface data developed by the University of Maryland into a tabulation of high and low intensity urban pervious and impervious surface acreages for each watershed modeling segment. State-provided surface mine data were also compiled for each modeling segment and incorporated into the final land cover dataset for the Phase 5.3 model.*

Jacobs, John, *NOAA Oxford Lab*

PREDICTING THE DISTRIBUTION OF VIBRIO VULNIFICUS IN CHESAPEAKE BAY.

PRESENTATION- *Vibrio vulnificus is a gram-negative pathogenic bacterium endemic to coastal waters worldwide, and a leading cause of seafood related mortality. Because of human health concerns, understanding the ecology of the species and potentially predicting its distribution is of great importance. We evaluated and applied a previously published qPCR assay to water samples (n = 235) collected from the main-stem of the Chesapeake Bay (2007- 2008) by Maryland and Virginia State water quality monitoring programs. Results confirmed strong relationships between the likelihood of Vibrio vulnificus presence and both temperature and salinity that were used to develop a logistic regression model. The habitat model demonstrated a high degree of concordance (93%), and robustness as subsequent bootstrapping (n=1000) did not change model output (p > 0.05). We forced this empirical habitat model with temperature and salinity predictions generated by a regional hydrodynamic modeling system to demonstrate its utility in future pathogen forecasting efforts in the Chesapeake Bay.*

Jarvis, Jessie, *Army Corps of Engineers*

MODELING LOSS AND RECOVERY OF ZOSTERA MARINA BEDS IN THE CHESAPEAKE BAY FOLLOWING REPEATED DISTURBANCE EVENTS: THE ROLE OF SEEDLINGS AND SEED-BANK VIABILITY

PRESENTATION- *The loss and recovery processes following a large scale decline in Zostera marina in the York River, Virginia was modeled using a Z. marina production model with and without a sexual reproduction component. Reproductive shoot production, total seed production, density of seeds in the seed-bank, seed viability, and seed germination were factors used to determine the contribution of sexual reproduction to bed resilience. The base model was calibrated to Z. marina, water quality, and sediment data measured at a Z. marina bed located at the mouth of the York River and validated using data measured at a bed located 10 km up river. For both sites, model scenarios were run for three years (2005-2007) where the effects of (1) the presence or absence of sexual reproduction (2) projected increases in water temperature from ambient to ambient +5 º C in 1 ºC increments; and (3) the potential interactive effects of low light and high temperature conditions on bed persistence and resilience were quantified. Model projections of Z. marina production following the 2005 decline and subsequent recovery period were more comparable to in situ measurements when the sexual reproduction component was added to the production model where vegetative growth was the only component of production. Following the 2005 decline, in simulations where sexual reproduction was included, model results projected an initial period of recovery in 2006 in all temperature treatments. Without the inclusion of sexual reproduction, there was no projected recovery following the 2005 decline regardless of temperature. However, resiliency to increased water temperature provided by sexual reproduction was limited, as a 1 ºC increase in temperature resulted in a reduction of biomass to 0 g C m-2 by year three. Differences in water quality between sites also affected Z. marina above and below ground production, seed production, seed viability and seed germination. The combination of lower light and temperature stress present at the upriver site resulted in overall lower production and resiliency compared to the down river site. The results of all model scenarios highlight: the need to incorporate sexual reproduction into Z. marina ecosystem models; the projected sensitivity of established Z. marina beds to* *consecutive years of stress; and the negative effects of multiple stressors on Z. marina resiliency.*

Kaushal, Sujay, *University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory*

FORECASTING WATERSHED NUTRIENT AND CONTAMINANT LOADS TO DRINKING WATER IN BALTIMORE, MARYLAND: A PILOT APPLICATION OF THE CHESAPEAKE BAY FORECASTING SYSTEM

PRESENTATION- *There have been increasing interactive effects of land use and climate change on water resources in Maryland. These interactive disturbances may have important effects on nutrient and contaminant loads to municipal drinking water supplies. Here, we develop and test a pilot application of the Chesapeake Bay Forecasting System regarding loadings of nitrogen, phosphorus, and road salt in the North Branch of the Patapsco River. The North Branch of the Patapsco River serves as a critical source of water to Liberty Reservoir, one of 3 major reservoirs operated by Baltimore City Department of Public Works that distribute an average of 265 million gallons of water per day to 1.8 million people in the Baltimore region. Analysis of long-term trends in the North Branch of the Patapsco River and nearby watersheds show increasing salinization due to road salt use, pronounced effects of record drought and wet years on nitrogen and phosphorus loads, and rising stream and river water temperatures. The objective of the pilot application involves collaboration with Baltimore City Department of Public Works to investigate and model the effects of extreme weather events and precipitation variability on the temporal distribution and magnitude of storm discharge rates and contaminant loadings. This information may be useful for informing watershed restoration strategies to increase resilience in ecosystem nutrient retention functions in response to extremes in precipitation, and as a potential support tool for predicting the quality of water withdrawals across different weather conditions. Application of the Chesapeake Bay Forecasting System may be useful in assisting efforts to predict and protect quantity and quality of water, and preliminary challenges and/or results from the pilot application will be discussed.*

Lanerolle, Lyon, *NOAA/NOS*

MODELING THE WATER LEVEL VARIABILITY AS IT EFFECTS RESTORATION PLANNING AND DESIGN AT POPLAR ISLAND

PRESENTATION- *Poplar Island is a national showcase for the incorporation of sea level rise into wetland restoration planning and design, as undertaken by the US Army Corps of Engineers (USACE). The Poplar Island Project serves as a test bed for collaborative development of appropriate methods, protocols, and services to support ecosystem restoration and monitoring in the face of sea level rise. It is a man-made island in the mid-Chesapeake Bay region which serves as the dredge disposal site for clean sediments from the Baltimore harbor approach channels. The site is managed by Maryland Environmental Services (MES), for the Maryland Port Administration (MPA) and the USACE-Baltimore District. Over 730 acres of wetlands are being built and further expansions to the island are planned. Permit agreements with the NOAA/National Marine Fisheries Service (NMFS) call for 80% of the wetlands to be classified as low marsh and 20% to be high marsh. Low marshes are inundated more regularly and for longer periods than high marshes and represent valuable fish habitats. Given the low tidal range of the Bay and the small elevation difference between low marshes and high marshes, this marsh construction project requires very accurate and precise elevation and water level data to ensure that it achieves the appropriate habitat ratios. To support this need for accurate water levels at the boundaries of the land/Bay interface during the restoration effort, a modeling study was conducted to quantify water lever variability over synoptic, seasonal, and decadal time scales and to evaluate changes in the circulation in the vicinity of the island as restoration efforts are being conducted. The computational tool of choice for this modeling effort was NOAA/National Ocean Service (NOS)'s new Chesapeake Bay Operational Forecast System (CBOFS2). In order to address the specific issues pertaining to Poplar Island, a finely resolved model that encompasses the environs of Poplar Island was seamlessly coupled to/nested within the larger CBOFS2 computational domain. A series of hindcast studies were conducted which included : (i) examination of the extent of inundation under a series of synoptic events, such as hurricanes and extra-tropical events, and high and low river discharge events employing the existing morphology of Poplar Island, (ii) a downscaling of the IPCC projections at the entrance to Chesapeake Bay to evaluate its impacts at Poplar Island and, (iii) quantifying of the impact of island accretion as the result of restoration activities on the circulation near the island. The results of these hindcasts will provide accurate water levels at the shoreline encompassing Poplar Island to support future inundation studies within its intertidal zone and marshes.*

Lee, Younjoo, *Chesapeake Biological Laboratory*

FACTORS REGULATING CHARACTERISTICS OF DISSOLVED OXYGEN CONCENTRATIONS IN LONG ISLAND SOUND

PRESENTATION- *The factors controlling bottom dissolved oxygen (DO) in Long Island Sound (LIS) were examined using observational data collected by the Connecticut Department of Environmental Protection. The analysis focused on the temporal and spatial characteristics of DO in LIS. For non-summer seasons, bottom water DO concentration is mainly regulated by temperature and salinity influences on DO solubility. During summer, however, intensified stratification under weak wind conditions leads to the depletion of bottom water DO from saturation. The results show that density stratification plays a role in the variability of the bottom* *water DO for the westernmost and shallow (<15 m) stations, but its importance diminishes at deep stations (>20 m). Bottom water DO concentrations tend to reach a minimum when bottom water temperature is 19~20 °C, although temperature can rise to 23 °C during summer. In most cases the recovery to DO saturation is rapid at the beginning of fall. Hypoxic volume was weakly related to summer wind speed, spring total nitrogen concentration, spring total chlorophyll a, maximum spring river discharge, and winter precipitation. When all variables were combined in a multiple regression, the coefficient of determination (r^2) becomes 0.96. When total nitrogen concentration was removed, the coefficient of determination decreased slightly (r^2 = 0.87). This indicates that the duration and severity of hypoxia in the future, in addition to nitrogen loadings, will depend on climate-induced changes influencing DO dynamics in coastal waters.*

Li, Xulong, *State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-environmental Sciences, Chinese Academy of Sciences*

FLOW AND NUTRIENT DISCHARGES FROM SMALL COASTAL WATERSHEDS OF THE CHESAPEAKE BAY'S EASTERN SHORE

PRESENTATION- *We applied three watershed models (SWAT, GWLF and L-THIA) to predict flow and nutrient discharges from six small watersheds on the eastern shore of the Chesapeake coastal plain, in Queen Anne's County, MD. We used three watersheds for calibrations and three for model validations. The SWAT and GWLF models performed best for predicting flow, then total nitrogen (TN), and worst for total phosphorus (TP). The GWLF slightly outperformed SWAT for the calibration watersheds but performances were similar for the validation watersheds. Based on a comparison with monthly data from the validation watersheds, the GWLF model had Nash-Sutcliffe efficiencies of 0.60~0.68 for streamflow, 0.50~0.55 for TN and -0.05~0.36 for TP; the SWAT model had Nash-Sutcliffe efficiencies of 0.54-0.73 for streamflow, 0.44~0.59 for TN and 0.21~0.38 for TP. When compared on annual observed discharges, both SWAT and GWLF performed better than L-THIA for predicting flow and TN, but L-THIA did better job of predicting TP. We conclude that no one model is superior to others and all models are suitable for further analyses with current and future climate and land use scenarios. Applying several models will help quantify the uncertainty in the model predictions.*

Li, Yun, *Horn Point Lab, University of Maryland Center for Environmental Science*

MODELING HYPOXIA RESPONSE TO RIVER FLOW AND WIND FORCING IN CHESAPEAKE BAY

PRESENTATION- *Anthropogenic nutrient enrichment has contributed to the depletion of oxygen from bottom waters in coastal systems worldwide. A major impediment to developing successful strategy to reduce hypoxia is the lack of adequate understanding of complicating effects due to climate variability. Previous hypoxia research has centered on the effects of nutrient loading and relied on statistical approaches. In order to predict hypoxia under changing climate and nutrient-loading conditions, a mechanistic model that resolves important physical and biogeochemical processes is required. In this work we present modeling studies of Chesapeake Bay hypoxia using a 3D coupled hydrodynamic-biogeochemical model with varying degrees of sophistication in representing biogeochemical processes. In this first model, we coupled the ROMS hydrodynamic model with a simple biogeochemical model in which the sediment oxygen demand and water column respiration rate are parameterized via temperature- and depth-dependent functions derived from observational data. We find that both vertical mixing and landward advection are equally important in supplying dissolved oxygen to the bottom layer in Chesapeake Bay. The model predicts a hypoxic region located in the deeper mesohaline region of Chesapeake Bay and shows a seasonal progression of hypoxia from May to October. The model also shows significant modulation and movement of hypoxia water at synoptic weather time scales. The downestuary and upestuary winds not only cause longitudinal movement of the hypoxic water but also cause lateral seiching that exposes hypoxic water to aeration at shallow shoals. In order to understand how climate variability affects hypoxia, we conduct model runs with different combinations of river flow and wind forcing. Increasing river flow leads to stronger stratification, weaker mixing to replenish the bottom layer with high oxygenated surface water, but increases the landward oxygen import from the lower Bay. Wind mixing is found to exert a surprisingly strong effect on hypoxia in the bottom water: the hypoxic volume is highly sensitive to the strength of vertical mixing. In the second model, we couple the ROMS hydrodynamic model with a sophisticated water quality model (RCA) that includes compartments such as dissolved oxygen, multiple forms of algae, carbon, nitrogen, phosphorus and silica, and a sediment diagnesis model. This model allows us to explore biochemical controls of bottom-water hypoxia and investigate processes such as the nitrification-denitrification cycle and the loss of sediment-buffering capacity resulting from the consumption of electron acceptors.*

Linker, Lewis, *U.S. EPA Chesapeake Bay Program Office*

SIMULATION OF ATMOSPHERIC DEPOSITION IN THE CHESAPEAKE BAY AND WATERSHED

PRESENTATION- *Between 1985 and 2005, the simulation period of the Phase 5 Watershed Model, atmospheric deposition loads of nitrate have tended to decrease overall in the in the Chesapeake watershed. Over this 20 year period, nitrate loads have decreased by about 30%, however, there is considerable variability across the Phase 5 domain with the greatest reductions occurring in the northern and western portions. Much of* *the reduction has been due to point source air emission reductions, particularly from Electric Generating Units (EGUs). More rapid declines are expected in 2010 as the Clean Air Interstate Rule (CAIR) controls on power plant emissions and the air quality standards for ozone and particulate matter come into their enforcement deadlines. Reductions from mobile sources are another contributor to the downward trend. Reductions from mobile sources will continue past the year 2020 as large off-road diesel and marine diesel fleets are replaced. Simulating the past and future projected nitrogen deposition is the Chesapeake Bay Program's Airshed Model, which is a combination of a regression model of wet deposition developed by Penn State, and a continental-scale air quality model of North America called the Community Multiscale Air Quality Model (CMAQ) for estimates of dry deposition. The CMAQ Model provides estimates of nitrogen deposition resulting from changes in emissions from utility, mobile, and industrial sources due to management actions or growth. The CMAQ Model scenarios include estimated nitrogen deposition in 2010, 2020, and 2030. The future year scenarios reflect emissions reductions from national control programs for both stationary and mobile sources, including the Clean Air Interstate Rule, the Tier-2 Vehicle Rule, the Nonroad Engine Rule, the Heavy-Duty Diesel Engine Rule, and the Locomotive/Marine Engine Rule. Atmospheric deposition inputs from the current and future Airshed Model scenarios are maintained in the CCMP data library for the Phase 5 Model. Inputs include daily inputs of oxidized and reduced nitrogen, and sulfate. These inputs are available for any model practitioner and may be useful in TMDLs for nitrogen or acidity. Another deposition input to be added to the data library is mercury deposition, which will be available once the CMAC Model completes development of the mercury simulation in 2011.*

Long, Wen, *UMCES/HPL*

CHESROMS: AN NPZD-BASED CHESAPEAKE BAY BIOGEOCHEMICAL PREDICTION MODEL IMPLEMENTATION AND DEMONSTRATION

PRESENTATION- *The presentation will provide an introduction to ChesROMS v1.2, an open source prediction model of the Chesapeake Bay that is based on the 3-D primitive equation numerical ocean circulation model ROMS (Regional Ocean Modeling System). The initial hydrodynamic implementation of ChesROMS has been employed to provide input to empirical harmful algal bloom (HAB) predictive models. Recently, ChesROMS has been extended to include a fully coupled Nitrogen-Phytoplankton-Zooplankton-Detritus (NPZD) type dynamic lower trophic level ecological component that simulates the Bay's biogeochemical cycles. The model framework provides necessary components for retrospective and near real time data acquisition and pre- and post- processing, which make it suitable for hindcasting, nowcasting and short term forecasting of bay-wide physical, ecological and water quality conditions. A web based GIS visualization system has also been developed for dissemination. Key aspects of the biogeochemical model include point and non-point (diffusive) nutrient inputs, atmospheric nutrient deposition, light attenuation by particulate and dissolved components, and mechanistic implementation of water column and benthic denitrification. The Bay's open boundary is relaxed to climatological nutrient and biomass concentrations and physical properties. The simulated biogeochemical state variables include nitrate, ammonia, phytoplankton, chlorophyll a, zooplankton, dissolved organic nitrogen, detritus, dissolved oxygen and inorganic suspended solids. An overview of the model components, strategies and implementation specifics will be presented. The system is initially deployed at the NOAA Chesapeake Bay Office for nowcasting and three-day forecasting with a daily updating cycle. An initial assessment of results from re-forecasting years 2008 and 2009 will be presented. Keywords: ChesROMS, Chesapeake Bay, circulation, ecological forecasting, open source community modeling*

Long, Wen, *UMCES/HPL*

THE DEVELOPMENT OF THE MID-ATLANTIC, CHESAPEAKE BAY, AND DELAWARE BAY REGIONAL OCEAN MODELING SYSTEM (MACROMS) AND ITS HYDRODYNAMICS VALIDATION

PRESENTATION- *We will introduce a newly developed open source community model called Mid-Atlantic, Chesapeake Bay, and Delaware Bay Regional Ocean Modeling System (MACROMS), which is based on the Rutgers University Regional Ocean Modeling System (ROMS). The research is primarily focused on studying detailed features of hydrodynamic circulation near the estuary mouths including fresh water plumes and exchange flow between the estuaries and the ocean waters. By coupling MACROMS with the LTRANS particle tracking model, we also will identify the influence of physical variability on the transport of blue crab and fish larvae into these estuaries. MACROMS is driven by discharge from all major rivers in the region, with surface heat fluxes and wind speed from the NCEP NARR (North American Regional Reanalysis) dataset. On the open boundary, tidal water levels are prescribed using the ADCIRC East Coast tidal database with 9 constituents. For sub-tidal water level, temperature, salinity and 3D-velocities, they are nudged to the MABGOM (Mid-Atlantic Bight and Gulf Of Maine) model developed by He et al. at The North Carolina State University and the global HYCOM predictions from The Florida State University. The nesting of MACROMS within a larger domain model such as HYCOM and MABGOM is through an advanced model-interoperability tool . In this presentation, we will show hindcast results and skill assessment of years 2005 and 2006 based on in-situ measurements. Future research applications and development of this system, such as coupling with a watershed model, the role of CnD canal, and new approaches for visualization will be discussed. Keywords: MACROMS, LTRANS, Mid-Atlantic Bight, Chesapeake Bay, Delaware Bay, coastal ocean circulation, larval transport, open source ocean modeling*

Lotspeich, R. Russell, *USGS*

MONITORING INLAND STORM SURGE: THE USGS MOBILE STORM-SURGE SENSOR NETWORK AND RESPONSE TO THE VERTERAN'S DAY NOR'EASTER, NOVEMBER 2009

PRESENTATION- *Historically, hurricane-induced storm tides have been documented through analysis of structural or vegetative damage and high-water marks. However, these sources rarely provided quantitative information about the timing of the flooding, the sequencing of multiple paths by which the storm-surge waters arrived, or the magnitude of waves and wave run-up comprising floodwaters. The United States Geological Survey has developed and deployed water-level and barometric pressure sensor networks to record the magnitude, extent, and timing of inland storm surge and coastal flooding. The deployed sensors continuously measure changes in pressure and the sensor data are corrected for salinity (water density) and barometric pressure to calculate the height of water above the sensor. That height is corrected to provide the elevation of the water above the land surface at the sensor location, which has been referenced to a known vertical datum, such as North American Vertical Datum of 1988. Deployments of storm-surge sensor networks have included Hurricanes Rita (2005, 34 sensors), Wilma (2005, 30 sensors), Gustav (2008, 80 sensors), and Ike (2008, 65 sensors), Tropical Storm Ernesto (2006, 40 sensors), and the Veteran's Day Nor'Easter (2009, 11 sensors). For each deployment, sensors were distributed along and near the coast, at distances ranging from a few hundred feet to approximately 30 miles inland. Each sensor is encased in a 2-inch metal pipe and strapped to existing piers, power poles, bridge supports, or other structures (figure 1). Generally, sensors were located opportunistically and not in grids or transects. Examining hydrographs of sensors located along principal flow paths, can provide insight into the rate of surge penetration and reduction (or amplification) of the height of the surge. Although inland sensors initially can record a rise in water level from runoff generated by upstream rainfall, they also can indicate how far and fast the storm surge likely traveled inland. Locally, the Chesapeake Inundation Prediction System (CIPS) was developed to improve the accuracy, reliability, and capability of flood forecasts for tropical cyclones and non-tropical wind systems such as nor'easters. The United States Geological Survey has been working with the Chesapeake Bay Observing System and its partners to cooperatively collect storm surge data that will be used to verify the CIPS output. Data collected during the 2009 Veteran's Day Nor'Easter along the western shore of the Chesapeake Bay will be used to demonstrate how predictive outputs of the inundation modeling compare with observed data. During this event, the highest observed water elevation occurred in downtown Norfolk, VA on November 12, 2009 at an elevation of 6.51 feet above NAVD88.*

Martino, Edward, *JHT Inc. Contractor for NOAA,* Bob Wood, Xinsheng Zhang, Edward Houde, Michael Roman, and Bahner Lowell

PROJECTING RECRUITMENT OF CHESAPEAKE BAY STRIPED BASS BASED ON EARLY-LIFE HABITAT QUALITY

PRESENTATION- *Ecosystem-based approaches to fishery management require improved understanding of habitat requirements and how environmental variability affects stock dynamics. High variability (>20 fold) in age-0 juvenile recruitment is a common feature of Chesapeake Bay striped bass population dynamics. Spatio-temporal variability in zooplankton prey for striped bass larvae, controlled by synoptic-scale climatology and hydrological conditions, explains strong environmental controls of recruitment. In two spawning-nursery locations, Ricker stock-recruitment models were fit using stock biomass (SSB) alone and with freshwater flow to partition effects of SSB and hydrology on age-0 recruitments for years 1989-2008. Models including flow explained more variability in recruitments than models with SSB alone (AIC=507 to AIC=273). Regression models including freshwater flow and temperature explain a high proportion of variability (r2=0.63) in age-0 recruitment. Modeling results indicate that environmental variability controls larval survival and the level of age-0 recruitment. Estimates of zooplankton abundance and distribution based on net and acoustic sampling coarsely depicts annual differences in prey availability, and indicates feeding conditions and potential survival of striped bass larvae. We also develop indicators of habitat quality and quantity based on isohaline location, and assess their ability to predict recruitment. After the larval stage, regulation occurs via density-dependent growth and size-selective overwintering mortality of age-0 juveniles. Age-1 juvenile abundance can be predicted in a regression model (r2=0.82, p<0.001) using age-0 juvenile abundance, age-0 length attained, and winter temperature. Requirements of ecosystem-based fishery management are addressed by evaluating the potential to apply these findings to determine indicators and reference points of habitat suitability and reproductive success.*

Mathukumalli, Bala Krishna Prasad, *Earth System Science Interdisciplinary Center, University of Maryland*

ECOLOGICAL PREDICTION OF DISSOLVED OXYGEN IN THE CHESAPEAKE BAY

PRESENTATION- *The structure and dynamics of aquatic ecosystem are a function of set of biogeochemical properties and forecast of these biogeochemical properties is a critical step in the sustainable management of the aquatic ecosystems. Dissolved oxygen (DO) is a key parameter in the aquatic science research which not only controls the biological productivity but also regulated by the biological productivity. Nutrient pollution resulted from the increasing human activities alters the oxygen dynamics by reducing its concentrations to a critical level where the ecosystem cannot support the biological systems. The Chesapeake Bay is a largest estuary in the North America and is experiencing summer hypoxia/anoxia events due to* *the cultural eutrophication. Statistical step-wise multiple regression approach is applied to develop an empirical model to predict DO in Chesapeake Bay by using a long-term data (1990-2006) of water temperature, salinity, dissolved nutrients (N and P). The predicted DO concentrations correlated well with the observed values. The predicted DO values depict the current status of the Bay and are useful to develop several linked products by integrating results from other hydrodynamic physical models for the ecosystem conservation and management.*

Meng, Huan, *National Oceanic and Atmospheric Administration*

HYDROLOGIC AND WATER QUALITY MODELING OF RAPPAHANNOCK AND POTOMAC RIVER BASINS USING SWAT

PRESENTATION- *The Chesapeake Bay (CB) is the largest estuary in North America, and has been listed as impaired under the Clean Water Act since 2000. Deteriorating water conditions are largely due to contaminants carried into the Bay by the many tributaries in the CB watershed. The Earth System Science Interdisciplinary Center of the University of Maryland at College Park is developing a Chesapeake Bay Forecast System (CBFS) to provide regional Earth System predictions for the Chesapeake Bay watershed. SWAT is adopted for the land module of CBFS to simulate the hydrology and water quality of the prominent tributaries in the CB watershed. This paper reports the model configuration as well as calibration and validation results for Rappahannock and Potomac River basins. The complete configuration of the model involves the following steps: watershed delineation and the establishment of hydrologic response units, sensitivity analysis, balancing water budget, adjusting crop yields, balancing flow partition, manual and auto-calibration, and validation. The simulated quantities include daily average streamflow and daily loadings of sediment, nitrate and phosphate. The calibration results for Rappahannock show satisfactory model simulations of the four variables with the exception of large uncertainty in phosphate. Validation of streamflow and nitrate load also satisfies a set of stringent evaluation criteria. The validation results for sediment and phosphate loads do not meet the criteria but are close enough to be considered acceptable. The Rappahannock SWAT model currently produces routine 14-day 20-member ensemble forecasts of daily flow and loadings of sediment, nitrate and phosphate in an automated system. More advanced strategies are adopted for modeling the Potomac River basin compared to Rappahannock. These include smaller sub-basin sizes for better spatial representation and for facilitating future scenario studies, dynamic land use, and multiple calibration stations etc. The calibration and validation results of the Potomac SWAT model will also be presented.*

Methratta, Elizabeth, *Versar Ecological Sciences & Applications*

A SPATIALLY-EXPLICIT STATISTICAL MODEL FOR OYSTER RESTORATION IN CHESAPEAKE BAY

PRESENTATION- *Native oysters in Chesapeake Bay are nearing extinction due to a combination of disease, over-fishing, habitat loss, and declines in water quality. While numerous disparate datasets have been compiled over the years for various projects related to this species, little attempt has been made to compile these datasets and use them to develop a spatially-resolved model for oyster restoration. Here we present a spatially-explicit statistical model that relates known oyster densities with multiple key habitat characteristics to predict where oysters are most likely to occur in relatively high densities for two regions of the Bay. Geographically-weighted regression (GWR) was used in which the dependent variable was live oyster density from a recent patent tong survey, and the independent variables were bathymetry, water quality, and available oyster habitat. GWR is similar to weighted least squares regression (WLS) except that a set of weights which depends upon the location of a sample point relative to other sample points in the data set are applied to the parameter estimates. After construction, the model was validated using a validation dataset generated by overlaying a 500m X 500m grid over the rasters for each independent variable and extracting values for each variable to include in the model. The results of this model predict with a high degree of spatial resolution locations in the Chester and Choptank Rivers where oysters are likely to occur in relatively high densities and where resources should be concentrated to restore the native oyster. This modeling effort illustrates how existing large, long term datasets can be compiled and utilized to inform spatial planning and management for one of Chesapeake Bay's most valued natural resources.*

Milheim, Lesley, *United States Geological Survey*

CHANGES IN BIRD HABITAT WITHIN THE CHESAPEAKE BAY WATERSHED, 1984-2006

PRESENTATION- *Research has shown clear evidence that land cover changes have significant impacts on a variety of environmental and ecological conditions and processes. Land cover change modifies the structure and functioning of ecosystems, which in turn have consequences for the biodiversity of native flora and fauna. Understanding social-environmental interactions through the consequences of land cover change requires the modeling of ecosystem impacts over time at a variety of spatial scales. Landscape indicators are models that indicate the potential fitness of a landscape to support a particular ecosystem condition such as providing favorable habitat for native birds. The models are based on measures of species diversity and/or indices of biotic integrity, and metrics of land cover and landscape pattern. This presentation explores the effect of land cover change on native bird habitat within the Chesapeake Bay watershed. Four land cover data sets derived from satellite imagery of the Chesapeake Bay watershed for 1984, 1992,* *2001, and 2006 are analyzed at the county, watershed (HUC 11), and moderate-resolution grid scales. Bird habitat is calculated as the percent forest within the 3 x 3 neighborhood around each pixel of the land cover dataset and visualized at each resolution over the entire watershed. The moderate-scale resolution grid analysis visualizes the distribution of good, moderate and poor bird habitat, which comprise approximately 30, 30, and 40 percent of the watershed area respectively. Small increases (< one percent) in poor habitat are observed within each time period. Keywords: land cover change, landscape indicators, habitat impacts, Chesapeake Bay*

Moglen, Glenn, *Virginia Tech*

A LINKED MODELING APPROACH TO PREDICT FUTURE LAND USE AND HYDROLOGIC CONSEQUENCES IN THE DELMARVA PENINSULA

PRESENTATION- *Land use and changes in land use can have a profound effect on water quality and water quantity. Urban growth, sea level rise, and other drivers of change are anticipated on the Delaware/Maryland/Virginia (DelMarVa) peninsula over the coming decades. Here we present a modeling approach that links demographic models, spatially explicit models of land use change, and models of nutrient loading and runoff to ultimately provide estimates of future hydrologic change on the DelMarVa peninsula. A challenge for our research team has been the coordination of information flow between individual models and team members in our efforts to make these estimates. The models involved in this project are called SLEUTH (version 3r), GAMe, and GISHydro. SLEUTH is a spatially explicit land use change model that uses inputs of historic urban land cover change, a transportation network, slope, and a weighted map indicating areas that are more or less likely to experience development. SLEUTH ultimately produces spatial and tabular outputs of probable future urban land cover change. GAMe consists of a demographic model that estimates the number of houses (county scale), which need to be constructed at horizon years, and a suite of statistical models that estimate how the county scale housing and job growth will be distributed to minor civil divisions (MCDs, equivalent to small municipalities) within the county. Finally, GAME estimates the impervious surface footprint of this new growth for each MCD. GISHydro is a GIS-based tool that melds the data needed by hydrologic models of water quality and quantity with the algorithms needed to interpret and prepare this data for input into the hydrologic models. In this modeling approach SLEUTH output in the form of anticipated future land use across the DelMarVa peninsula serves as the driving input for two distinct types of hydrologic models. The first type of these hydrologic models is the EPA Chesapeake Bay Program nutrient loading model already embedded within GISHydro. This hydrologic model produces estimates of nitrogen, phosphorus, and sediment loadings from user-defined locations within the DelMarVa peninsula. The second type of hydrologic models supported by GISHydro are flood models. These models predict floods (e.g. the 100-year flood) as a function of watershed size, slope, soils, location, and land use. The SLEUTH land use informs the flood models as to the relative quantities and intensities of urban, agricultural, and forest lands present in the watershed area being studied. The emphasis of this presentation is on the structure of linkages, feedbacks, and interpretation of information flowing between the SLEUTH, GAMe, and GISHydro models. Outputs from one model were not always precisely suited as input to another model. Creativity, critical thinking, and an appreciation of model sensitivity and uncertainty were crucial for our project team to attain the goal of linking these disparate tools for the purpose of estimating hydrologic change on the DelMarVa peninsula. Examples of how information was shaped and reformed as it flowed from one model to the next will be provided in this presentation.*

Muller, Andrew, *U.S. Naval Academy*

A TALE OF TWO CHESAPEAKE TRIBUTARIES: IMPLICATIONS FOR MODELING AND RESTORATION

PRESENTATION- *The Severn and South Rivers are in many respects very similar tributaries of the Chesapeake Bay. Both reside on the Western Shore, are aligned in approximately the same orientation, are fairly shallow and have low tidal ranges. Low fresh water input, combined with high nutrient loading and ephemeral summer stratification have led to well known hypoxic events in both tributaries. Despite the many similarities, the Severn and South Rivers' hypoxia and anoxia appear very different spatially and temporarally. While the South River experiences hypoxia in mid to upper tributary regions in July and late fall, the Severn has wide spread continuous hypoxia and anoxia throughout the river. Observations of these events have led to the construction of a conceptual model for each of these tributaries, which will provide insight for mathematical modeling and restoration efforts.*

Mullinix, Cassandra, *USGS*

THE CHESAPEAKE ONLINE ADAPTIVE SUPPORT TOOLKIT: DELIVERING MODEL RESULTS AND INFORMATION TO CHESAPEAKE BAY STAKEHOLDERS IN AN ADAPTIVE-MANAGEMENT CONTEXT

PRESENTATION- *In the Chesapeake Bay region, stakeholders are required to meet Federal mandates and make management decisions that will improve the water quality and health of the Bay ecosystem. These decisions are commonly made on criteria such as economic cost and opportunities to implement management actions. Often, actions are not targeted in areas that would provide the greatest environmental benefit. To help facilitate stakeholders in making decisions based on environmental improvement, the Chesapeake Online Adaptive Support Toolkit (COAST) was developed by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency's Chesapeake Bay Program Office (CBPO). The*

COAST website design uses an adaptive-management framework to provide access to a diverse suite of model results, monitoring data, and supporting information to help managers better target, implement, and assess the effectiveness of their activities. By utilizing an adaptive-management framework, COAST emphasizes the opportunity for improved management as more is learned about the ecosystem over time. Informational content and web map decision support tools on water quality have been organized and grouped on the COAST website into customized adaptive-management steps, based on structured decision making, to help stakeholders better utilize scientific information in their decision- making process. Thus far, COAST has been used in at least one instance to better focus actions to improve water quality in the Bay. The U.S. Department of Agriculture (USDA), the USGS, and the U.S. Environmental Protection Agency (USEPA) used COAST to focus 2008 Farm Bill funding in areas delivering the highest nutrient loads to the Chesapeake Bay. COAST is also being applied to identify forested areas that should be conserved in the Bay watershed because of their water-quality benefits. This talk will discuss COAST and its adaptive-management structure and summarize the successes and challenges encountered during its development and application.

Murphy, Rebecca, *Johns Hopkins University, Dept. of Geography and Environmental Engineering*

STATISTICAL MODELING OF SPATIAL AND TEMPORAL TRENDS IN CHESAPEAKE BAY HYPOXIA AND STRATIFICATION

PRESENTATION- *Recent results have shown that the extent of summertime hypoxia in the Chesapeake Bay has not responded as expected to decreased nutrient loads from the watershed. In this study, we use a combination of spatial and temporal statistical models to explore the hypothesis that changes in the stratification of the Chesapeake Bay are a major factor in the unexpected patterns of Bay hypoxia. Strong stratification has the potential to impact hypoxic conditions by causing decreased water column mixing and thereby reducing the replenishment of oxygen to bottom waters. Through a related team effort called the Chesapeake Bay Environmental Observatory (CBEO), we have compiled data from multiple agencies and researchers collected since 1950. We make full use of this rich data resource to develop, test, and compare statistical models for evaluation of hypoxia and stratification. Specifically, we implemented a kriging technique to calculate the hypoxic volume of the Bay for each summertime data collection cruise from 1949 to 2009 and implemented a calculation of vertical stratification strength that uses density data collected along the main channel of the Chesapeake Bay. Time series analysis of these results revealed some interesting findings: that the observed increase in hypoxia volume in recent decades is actually only occurring in the early summer, and that the early summer stratification strength of the Chesapeake Bay has been increasing. We will present results that demonstrate a significant relationship between the increasing early summer hypoxia and stratification of the Bay and explore the spatial extent of these changes. Finally, we will describe some of our on-going modeling efforts including linear multi-regression, non-linear regression, and data mining techniques designed to evaluate possible climatic factors for their relative impacts on the increasing stratification. Overall, this study demonstrates how comprehensive spatial and temporal statistical modeling of the Chesapeake Bay monitoring data can reveal previously unnoticed trends and suggest relationships that can be tested further with targeted monitoring and modeling.*

Narvaez, Diego, *Center for Coastal Physical Oceanography, Old Dominion University*

MODELING THE DISPERSION OF OYSTER LARVAE: EFFECTS OF BIOLOGICAL AND PHYSICAL PROCESSES

PRESENTATION- *The multidisciplinary nature of larval dispersion constitutes a challenge for management and restoration efforts of many commercially important estuarine species. In this study we address these challenges using a combination of numerical models that allow us to study the relative importance of biotic and abiotic factors in the dispersion of eastern oyster. A numerical model (ROMS) was configured for Delaware Bay to determine the estuarine circulation in response to winds and river discharge. Water-following Lagrangian floats in the model were modified to include larval growth and vertical migration in response to temperature and salinity. Model simulations follow larvae from a number of release points (reefs) and release times over a span of 2 to 4 weeks which is sufficient for them to mature (attain a length of 330 micron) at which point they sink and attach to the bottom. The results show that variations in temperature and salinity have a large impact in the larval survival, dispersal and settlement. An along estuary survival gradient is related to the salinity gradient observed for the Bay, long development times are associated with areas having low salinity or low temperature. Simulations show that behavior is important and favors settlement of larvae within the Bay; particles without behavior are mostly exported to the shelf. A recirculation in the lower Bay seems to be important for the retention of larvae, increasing the settlement in this area. River discharge also affects the settlement pattern, causing a shift between middle and lower Bay settlement. These results present new evidence of how climate variability might affect the exchange of individuals among oyster populations, and therefore the structure of marine ecosystem.*

North, Elizabeth, *UMCES HPL*

LARVAL TRANSPORT, HABITAT VOLUME, AND MARINE PROTECTED AREA OPTIMIZATION MODELS: FROM DEVELOPMENT TO OPERATIONAL USE

PRESENTATION- *Coupled bio-physical models are increasingly being used to inform fisheries and ecosystem management and restoration programs. We describe three types of coupled biophysical models and present case studies for three Chesapeake Bay species: 1) a larval transport model for blue crab (Callinectes sapidus), 2) a habitat volume model for juvenile Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus), and 3) a marine protected area optimization model for oysters (Crassostrea virginica). The differences and similarities in these modeling approaches will be highlighted and used to illustrate the information needs and challenges in moving these types of models towards operational use.*

North, Elizabeth, *UMD Center for Environmental Science Horn Point Laboratory*

THE INFLUENCE OF ANOXIA ON OYSTER LARVAL TRANSPORT: A MODEL-BASED HYPOTHESIS

PRESENTATION- *Larvae of the eastern oyster (Crassostrea virginica) in Chesapeake Bay spend 2-3 weeks in the plankton and require hard substrate, preferably oyster shell, for settlement. Results of larval transport model simulations suggest that transport of larvae between oyster reefs is an important component of oyster population dynamics in Chesapeake Bay and that the vertical swimming behavior of larvae influence spatial patterns in transport between reefs. We hypothesize that anoxia could influence the transport and survival of oyster larvae in Chesapeake Bay, either by causing direct mortality or, if larvae swim to avoid anoxia, by cutting off access to transport pathways that could be created by lateral circulation. We used measurements of anoxic volume coupled with numerical simulations of a larval transport model to assess the feasibility of this hypothesis and to identify where and when anoxia could influence the survival of oyster larvae or the spatial patterns in connectivity between reefs. Model results will be discussed and field methods for testing this hypothesis will be proposed.*

North, Elizabeth, *UMCES Horn Point Laboratory*

INVITING FEEDBACK TO CLARIFY UNCERTAINTY

PRESENTATION- *Exchange of ideas and vocabulary between scientists and managers is critical for sound interpretation and application of models. Scientists and managers use conceptual and numerical models to enhance our knowledge of species, ecosystems, and their interactions as well as to manage human activities and guide public investments. Even our most well-informed models are necessarily simplified versions of reality. The appropriate use of these models depends upon how well their limitations are understood and communicated. In this presentation, managers and scientists will be invited to provide feedback on multiple techniques for presenting model uncertainty. Several case studies will be used to frame the discussion with the objective of developing agreement on effective methods for communicating uncertainty in model formulations and predictions.*

Perlman, Eric, *Johns Hopkins University*

USING DATABASES TO IMPROVE ACCESS TO CHESAPEAKE BAY MODEL DATA

PRESENTATION- *We present our experiences in using a database to improve access to output from large simulations. Specifically, we have incorporated 20 years of output from multiple versions of the Chesapeake Bay Program and Army Corps of Engineers' hydrodynamics, water quality, and watershed models into the Chesapeake Bay Environmental Observatory (CBEO) testbed. We use the CBEO database environment to provide efficient analysis between both simulated and measured data. First, we will discuss our data ingest process and effort needed to create usable database tables from raw model output. Next, we will give examples of research and new analysis techniques from our project made possible by the colocation of these model data with Bay-wide observational data sets. Finally, we will offer our views on how access to large data models should work in the future.*

Richkus, William, *Versar, Inc.*

THE ROLE OF UNCERTAINTY IN LIMITING DEMOGRAPHIC MODEL APPLICATION IN OYSTER MANAGEMENT IN CHEAPEAKE BAY

PRESENTATION- *An oyster demographic model was developed for the purpose of comparing potential oyster population outcomes from several Chesapeake Bay oyster management alternatives evaluated in a Programmatic Environmental Impact Statement (PEIS) issued in June 2009. Model parameters for the native Eastern oyster were derived from management data and research findings collected over many decades. The intent was to use findings from a series of more current research studies of the Asian oyster to revise model parameters to be representative of that species and run the model for non-native species alternatives. A peer review panel critiqued the modeling effort throughout its development. An Oyster Advisory Panel (OAP) conducted a subsequent peer review of the use of model outcomes in the draft PEIS. The OAP concluded that the level of uncertainty associated with model projections was so great that it would be inadvisable to rely on the outcomes in making management decisions, even for native oyster alternatives. In particular, levels of uncertainty about benefits and risks associated with the Asian oyster were found to be unacceptable. Sources of uncertainty regarding native oyster outcomes included basic data inputs that had to be derived from disparate data sources and numerous* *assumptions required to construct the basic life history architecture of the model. The primary source of uncertainty regarding the Asian oyster was the absence of reliable life history data that would characterize a reproducing population of the species within the Chesapeake Bay environment. While the model has proven to be a useful scientific tool for investigating potential relationships among various life history and environmental factors influencing oyster populations in the Bay, unresolvable uncertainties precluded its use in making management decisions, particularly when being applied to highly controversial management alternatives. As a result, only very limited applications of demographic model outcomes were included the anlyses included in the Final PEIS.*

Sanford, Ward, *USGS*

REGIONAL SIMULATION OF GROUNDWATER TRANSPORT OF NITRATE IN THE DELMARVA PENINSULA

PRESENTATION- *The Chesapeake Bay has been suffering from degraded water quality for a number of decades. One large cause of the problem has been increased delivery of nitrogen to the bay by groundwater and surface water. The nitrogen originates at the land surface throughout the watershed from a variety of locations that include point sources of wastewater discharge and diffuse sources of fertilizer and wastes from agriculture and suburbia. To date much of the efforts to simulate the loading of nitrogen to the bay have focused around the HSPF watershed model. Studies, however, indicate that much of the nitrate being delivered to the bay is via groundwater, and the associated groundwater lag time is not accounted for by the HSPF model. A major effort is now underway at the USGS to simulate the groundwater transport of nitrate to the bay. These simulations will cover several large sections of the watershed, will be used to estimate the magnitude and distribution of groundwater lag times, and will help land managers target areas to adjust nitrogen loading. Four MODFLOW models of regions of the bay watershed are being constructed. The first of these covers the Maryland and Delaware sections of the Delmarva Peninsula. The Delmarva model is of the shallow unconfined aquifer (<300 ft deep) and has been calibrated for steady-state conditions. The grid has a 500-ft horizontal resolution and the entire model has more than 6 million cells. The model was calibrated using 48 groundwater levels and 24 ages. Processing GIS-based datasets comprised a substantial amount of the effort in this modeling project. Digital elevation models (including LIDAR), land cover, percent impervious surface, percent soil clay content, temperature and precipitation were all used, with the latter four being used to estimate evapotranspiration and recharge. MODPATH was used on the MODFLOW results to estimate the distribution of groundwater ages that contribute to several smaller watersheds within the peninsula. The distribution of ages is being used to help forecast changes in nitrate levels in the streams for various best management practice scenarios. The history of fertilizer and poultry sales across the peninsula has been used to recreate temporal input functions of the nitrogen loading. A nitrate transport-and-fate, mass-balance model was calibrated using 728 nitrate values from wells and 7 temporal nitrate datasets from streams. The delivery of nitrate by submarine groundwater discharge to the bay is also being quantified. Initial results indicate that 75 and 85 percent of nitrate is lost (by plant uptake and denitrification) above the water table from fertilizer and manure, respectively. Also, denitrification occurs during groundwater transport with an average first order rate loss constant of 0.033 per year. Finally, 10 to 20 percent of the remaining nitrate is lost in the stream-riparian corridor. The median age of water reaching the streams in the various smaller watersheds ranges between 10 and 40 years. Simulated forecasts of future nitrate levels in the streams indicate that levels should take years to decades to respond substantially to changes in loadings at the land surface.*

Schultz, Cherie, *Interstate Commission on the Potomac River Basin*

ENHANCEMENTS OF PHASE 5 TO SUPPORT WATER RESOURCE PLANNING IN THE POTOMAC RIVER BASIN

PRESENTATION- *Watershed modeling has historically placed more emphasis on the simulation of high stream flows, in order to predict flooding events or to model the transport of pollutant loads to receiving waters. Recently, a number of organizations have begun investigating possible use of the Chesapeake Bay Program's Phase 5 Watershed Model to support water supply and water resource management, where the focus is often on low flows. We report on several modifications we have made to the Phase 5 model to enhance its ability to serve as a water resource planning tool in the Potomac River basin. The Phase 5 model, designed to provide estimates of tributary loads to the Bay, has been successfully calibrated to accurately simulate the full range of stream flows. However, because of the reliance of HSPF, like other popular watershed modeling frameworks, on a simple linear storage-discharge algorithm to simulate the ground water contribution to stream flow, Phase 5 tends to under-predict very low flows. To improve the model's ability to simulate low flow periods that occur during drought, we have implemented a nonlinear storage-discharge algorithm in HSPF. We have also added a number of Potomac basin reservoirs not previously represented in the model to increase the model's spatial resolution and to aid in the development of management scenarios. We report on the status of our recalibration of this enhanced version of the Phase 5 model.*

Scully, Malcolm, *Old Dominion University*

WIND MODULATION OF HYPOXIA IN CHESAPEAKE BAY

PRESENTATION- *A numerical circulation model with a simplified dissolved oxygen module is used to examine the importance of wind-driven ventilation of hypoxic waters in Chesapeake Bay. The model demonstrates that the interaction between wind-driven lateral circulation and enhanced vertical mixing over shoal regions is a dominant mechanism for providing oxygen to hypoxic sub-pycnocline waters. The effectiveness of this mechanism is strongly influenced by the direction of the wind forcing. Winds from the south are most effective at supplying oxygen to hypoxic regions and winds from the west are shown to be least effective. Simple numerical simulations suggest that the total hypoxic volume in the Bay increases by over a factor of 2 when the mean wind direction switches from southeast to southwest. These results are supported by an analysis of a 58-year time-series of summer hypoxia, which shows that a significant fraction of the inter-annual variability in observed hypoxia is correlated to changes in summertime wind direction. Beginning around 1980, the surface pressure associated with the summer Bermuda High has weakened, favoring winds from a more westerly direction - the direction most correlated with observed hypoxia. Regression analysis suggests that the long-term increase in hypoxic volume observed in this data set is only accounted for when both changes in wind direction and nitrogen loading are considered.*

Sharifi, Amir, *Auburn University*

MODELING NUTRIENT LOADINGS FROM UNGAUGED WATERSHEDS IN CHESAPEAKE'S EASTERN SHORE

PRESENTATION- *Modeling Nutrient Loadings from Ungauged Watersheds in Chesapeake Bay's Eastern Shore Watershed models are extremely valuable tools for exploring human interactions with the landscape and predicting effects of different management options. Models often need to be calibrated and validated for improved performance, which require some sort of observed data available from the watershed. When there is insufficient or no data in a study watershed, one can build and calibrate the model in a nearby watershed having observed data, and then transfer the calibrated model parameters to the study watershed. In this study we used the SWAT model to predict flow and nutrient loadings (N, and P) from several small watersheds of the Chesapeake Bay coastal community of Queenstown, MD, where the Town Planning Commission is in the early phases of developing a comprehensive land use plan. Since neither flow nor nutrients data was available, SWAT model was calibrated with hydrologic and water quality data collected from three drainage basins on the Chesapeake Bay's Eastern Shore (SERC 304, SERC 310 and USGS Greensboro). The calibrated SWAT model had a relatively high Nash-Sutcliffe Efficiency (ENS) and R2 (over 0.67 and 0.7 respectively) for all three watersheds in flow prediction. The Model's performance for N was acceptable with ENS and R2 values around 0.6 and 0.4 respectively. The model did not predict P well with lower R2 and ENS values compared to flow and N. The calibrated SWAT model was independently tested on three additional watersheds close to the study area (SERC 305, SERC 306 and USGS Ruthsburg). The performance statistics R2 and ENS for Flow, Nitrogen and Phosphorus were quite similar to the results from calibration, verifying the reliability of the SWAT model. The calibrated parameters were used to build up the Queenstown watershed model.*

Shen, Jian, *Virginia Institute of Marine Science, College of William and Mary*

COUPLING EFFECTS OF BENTHIC COMMUNITY AND PHYTOPLANKTON ON DISSOLVED OXYGEN IN THE THALIA CREEK: A DATA ANALYSIS AND MODEL DIAGNOSTIC STUDY

PRESENTATION- *The Thalia Creek (TC) system, a tidal tributary connecting to the Western Branch of the Lynnhaven River in the City of Virginia Beach, VA, has consistently failed State dissolved oxygen criteria. The TC system commonly exhibits high concentrations of chlorophyll a (>100 ug/l) and chronic severe hypoxia (< 2 mg/L) during the summer. It is anticipated that additional development pressures within the region will further exacerbate the degradation of water quality in TB-TC and the downstream Western Branch of the Lynnhaven River ecosystem. Because of its failure to meet State dissolved oxygen criteria, the City of Virginia Beach and US Army Corps of Engineers (Norfolk District) are currently assessing eutrophication related processes and seeking an ecosystem-based approach to improve the water quality conditions within the TB-TC system. An intensive field survey was conducted in summer 2009 using high-frequency observations of DO, Chl fluorescence, and turbidity in conjunction with multiple-site in-stream synoptic grab sample surveys. In situ sediment oxygen demand (SOD) studies were also conducted to determine the benthic impacts on the oxygen budget. Observations showed large diurnal DO oscillations resulting in severe hypoxia at night during fair weather, whereas phytoplankton exhibited semi-diurnal as well as diurnal fluctuations during the study period. Estimates of net ecosystem metabolism suggest the TC system is heterotrophic and characterized by elevated primary production and community respiration. High respiration rates often results in a hypoxic conditions that can increase in severity and duration following rainfall events. The DO variation is predominated by benthic community with diurnal swings but it is strongly influenced by phytoplankton through competitions of light and nutrients. The influence of physical processes on associated biological process is visible and varies along the salinity gradient. Biological processes are more dominant in the upstream regions whereas the influence of the physical processes increases downstream. A diagnostic model has been developed to study the coupling effects between phytoplankton and benthic community and between biological and physical processes in the TC system. The model results show that a strong coupling and competition between the benthic* *community and the water column exist in the system resulting in phase shifting between DO and phytoplankton. The findings of data analysis and diagnostic model study are being used to guide the development of 3D numerical model to simulate eutrophication processes and will be used for designing a management plan to improve the water quality conditions in the TC system.*

Shenk, Gary, *EPA / CBPO*

THE CHESAPEAKE BAY PROGRAM'S SCENARIO BUILDER

PRESENTATION- *Coincident with the development of a Chesapeake-wide TMDL, the Chesapeake Bay Program is developing a free, on-line decision-support tool known as the Scenario Builder. This tool is designed for both in-house and on-line use. The Chesapeake Bay Program staff use Scenario Builder to generate calibration and scenario data for the Chesapeake Bay Program's watershed model. It is anticipated that state and local governments will use it to assist in generating management plans to meet load allocations associated with the TMDL. The combination of Scenario Builder and the watershed model allows CBP staff, state and local governments, and watershed organizations to translate land use and land management decisions into changes in pounds of nitrogen, phosphorus, and sediment originating from a particular county, region, or watershed. The underlying model to the Nutrient and Sediment Scenario Builder is process-based. Source data such as animal counts, human population, land cover, crop types, cropping practices, fertilizer rates, and BMPs are converted to watershed model inputs of land use, manure and fertilizer applications, land disturbance effects, crop uptake potential, and sewer and septic loads.*

Sherwell, John, *Maryland Power Plant Research Program*

FROM THE AIR: DEPOSITION AND TMDLS

POSTER- *Air emissions of nitrogen dioxide (NOx) from coal-fired power plants and mobile sources can contribute to nutrient loading in the Bay. A methodology has been developed, using the CALPUFF atmospheric model, coupled with the USGS Spatially Referenced Regression on Watershed Attributes (SPARROW) methodology for the Chesapeake Bay Watershed, to estimate this contribution on a seasonal, annual, and event basis. The methodology is easily adaptable to both large and small watersheds and tributary areas, and can provide estimates of single source, source sector (e.g. power plants in Ohio) and total contributions. Results can be scaled to estimate improvements that would occur based on the application of emissions controls. This poster will present an overview of the methodology and results to-date, including updates to air emissions inventories.*

Stamey, Barry, *Noblis*

GEOSPATIAL VISUALIZATION AND RISK MANAGEMENT METHODOLOGY TO PLAN FOR CURRENT STORM AND FUTURE SEA LEVEL RISE INUNDATION IMPACTS ON CRITICAL COASTAL INFRASTRUCTURE

PRESENTATION- *The Chesapeake Inundation Prediction System (CIPS) has developed a prototype capability to model and visualize on-land flooding inundation at high-resolution spatial and temporal scales that will support current and future planning across a spectrum of Chesapeake Bay region activities and missions. This is the result of a multi-year collaborative project by a team of colleagues operating within the Chesapeake Bay Observing System. The initial objective was to develop a forecasting capability for the NOAA National Weather Service to better support local emergency managers during real-time storm events. That initial capability has been further developed to model and visualize the combined effects of tropical storms and nor'easters with sea level rise from climate change through the Chesapeake Sea Level Rise and Storm Surge: Public Awareness and Response project. With this prototype system now in hand, Noblis and the Virginia Institute of Marine Science developed an initial set of scenarios that combined storms, e.g. Hurricane Isabel, with incremental increases in sea level rise to model and visualize projected inundation. Noblis would now broaden its focus to implementation of this emerging geospatial visualization capability through a risk assessment process that would support risk-informed decision making. Risk assessment would develop scenario-based analysis methodologies about the nature and magnitude of the inundation threat to critical infrastructure assets and operations, vulnerabilities to the threat of current and sea level related inundation, and the consequences that could result. This process would enable the determination of a course of action predicated on the assessment of the risk of inundation, the expected impact of an intended course of action on that risk, and other relevant factors. Noblis will outline and describe this approach and methodology that could provide an analytical tool to integrate this emerging CIPS capability in planning, response, and recovery from projected impacts of the combined effects of storms and sea level rise. A prototype system developed in the Chesapeake Bay region could be replicated to support coastal communities around our nation.*

Stamey, Barry, *Noblis*

IMPLEMENTATION OF THE AUTONOMOUS SENSOR NETWORK AND ASSOCIATED SENSOR SYSTEMS TO MONITOR, RESPOND, AND COMMUNICATE REAL-TIME, BAY-WIDE IMPACTS ON HUMAN AND ECOSYSTEM HEALTH

PRESENTATION- *Maritime observation systems currently are insufficient in spatial distribution, sensor type availability, interoperability, cost, and deployment utility to adequately support coastal marine and estuarine decision-*

makers and event responders. This is a significant problem for current and needed monitoring and response across a broad spectrum of activities throughout the Chesapeake Bay region. The goal of the Autonomous Sensor Network (ASN) project is twofold. First is to develop the rapidly deployable Noblis Autonomous Marine Sensor System (NAMSS) as a prototype to demonstrate that more affordable and capable small sensor systems can be developed to significantly augment the currently expensive and limited number of systems in use. This is being accomplished in parallel with several other sensor system development programs of other organizations that will be described and that also provide innovative capabilities to monitor effects on human and ecosystem health. Second is to integrate NAMSS (and other existing and emerging operational and developmental sensor systems, both satellite and in situ) with emerging capabilities in the Noblis Sensor Service Oriented Architecture (SOA) along with geospatial analysis and visualization services to demonstrate the value of this enhanced capability. The ASN will be an automated observation, detection, alert, tasking, deployment, and product delivery system designed to allow domain users to react quickly and efficiently to a variety of emergent incidents, as well as improve the efficacy of longer-term monitoring, in estuarine and coastal marine waters. Noblis is working with partners in the Chesapeake Bay Observing System (CBOS) and other organizations to build upon the initial work of the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center on the NASA Earth Observing (EO)-1 Sensor Web. The ASN will expand current EO-1 Sensor Web capabilities and extend them into the logistically and operationally challenging coastal marine and estuarine environment of the Chesapeake Bay, U.S. national marine sanctuaries, and other vitally important marine ecosystems. The ASN is intended to be a demonstration of the benefit of a rapid prototyping approach to exemplify the potential of CBOS and the Integrated Ocean Observing System (IOOS). While initial efforts focus on a few select marine environments, this project is adaptable and scalable to national use for IOOS.

Steppe, Cecily, *Department of Oceanography; U.S. Naval Academy*

LAGRANGIAN ESTIMATES OF TRANSPORT IN CHESAPEAKE BAY

PRESENTATION- *A number of physical models (e.g., Regional Ocean Modeling System (ROMS), Advanced Circulation Model (ADCIRC), have been used to describe the circulation within Chesapeake Bay and its tributaries. One goal of these models is to predict the transport and fate of particles introduced to the bay, including planktonic larvae of fish and invertebrates. While ROMS and ADCIRC may be driven by observed parameters (i.e., wind, buoyant discharge, sea surface height, tides), relatively few studies have been conducted to ground-truth the models simulated particle trajectories with Lagrangian field observations. Lagrangian observations can provide key information for understanding dispersal of larvae among habitats. Advection may be initially assessed with repeated releases of single drifters under varying environmental conditions, but quantifying dispersion of plankton patches requires deploying multiple drifters, and tracking them over time-scales of hours to weeks. Therefore, one goal of this study was to begin to quantify both advection and dispersion of a cluster of surface drifters in a Chesapeake Bay tributary. To this end, deployments of 2-4 drifters were made from the mouth of Weems Creek (Severn River, Annapolis, Maryland) in late summer and fall 2008. Drifters drogued from 0-1 m or from 1-3 m were deployed in an initial square-shaped pattern (diameter ~100m). The drifters were tracked via the ARGOS satellite system or by radio transmission for periods of hours to days. Two advection regimes were observed: rapid export (hours) to Chesapeake Bay, or retention within the Severn for the duration of the deployments (days). The short deployment periods precluded estimates of diffusion, but divergence, stretching, and changes in the aspect ratio of the cluster were calculated. Trajectories of the drifters deployed from 13-15 August, 2008 were then compared to output from an ADCIRC model forced by observed sea level and tides throughout the same period. The model simulation reflected a similar pattern of transport (retention within the Severn River) as was observed in the drifter trajectories, yet the model underestimated the magnitude of transport. This discrepancy is likely due to forcing factors missing from the model, in particular, vertical current shear and winds. Ground-truthing models with Lagrangian observations at the mouths of tributaries will ultimately refine current models of Chesapeake Bay circulation, and provide the tools for managers to make well-informed decisions about coastal resources. Relevance of this work to current efforts to effectively place oyster restoration bars in the Severn River is discussed.*

Suarez-Rubio, Marcela, *University of Maryland Center for Environmental Science*

EVALUATION OF THE SUSCEPTIBILITY OF THE MARYLAND GREEN INFRASTRUCTURE TO FORECASTED PATTERNS OF LAND USE CHANGE

PRESENTATION- *Green infrastructure is a unique approach to promote strategic land conservation and restoration. One of the primary goals of green infrastructure is to maintain natural ecological processes and services by preserving ecological connectivity. However, current trends of land conversion to urban, surburban, and exurban development challenge green infrastructure planning and implementation. We evaluated the Maryland Green Infrastructure by converting it to a network representation, forecasting land conversion using the SLEUTH modeling framework, and assessing potential changes in connectivity to the green infrastructure network. The importance of each hub and corridor in the network was assessed by systematically removing them individually and re-assessing network metrics assuming the loss of that specific link or hub. To forecast land use change, we used* *the SLEUTH urban growth model and evaluated 3 scenarios: one based on current trends, a "reasonable effort" scenario, and a best case scenario. Spatial patterns of forecasted land-use change were evaluated for each scenario to determine if such land-use change could potentially break green infrastructure links or threaten the integrity of hubs. These results were then incorporated into the network analysis, to ascertain if any of the critical hubs or links corresponded to those expected to be threatened under one of the three land use change scenarios. We show how network models can be combined with forecasting models of land-use change to guide management priorities for the green infrastructure by identifying potential threats to the network due to land use change.*

Townsend, Howard, *NOAA Chesapeake Bay Office - Oxford Lab*

UNDERSTANDING UNCERTAINTY IN MODELING FOR RESOURCE MANAGEMENT

PRESENTATION- *Modelers attempt to synthesize data and knowledge about natural systems in a meaningful way to support policy decision-making for resource managers. Thus, our overarching goal is to turn data into meaningful, actionable information. Throughout this process, modelers and managers must deal with uncertainty- limited knowledge where it is not possible to describe exactly the current state or future state of a system- and risks of undesired effects or losses. The authors illustrate a generalized flow of how data about the natural system are converted into estimates and predictions of quantities of interest to managers (via modeling and analysis) and how those quantities are used for decision-making and for developing natural resource policy. We discuss where uncertainties and risks arise in this flow and suggest some ways to deal with the risks. This symposium session is designed to initiate an ongoing conversation between modelers, resource managers, and other users of model assessment and predictions about how to best communicate and deal with uncertainty and risks for more effective modeling and decision-making. This presentation will develop a taxonomy a risk and uncertainty for framing the discussion that follows during the session and in the future, as well.*

Uccellini, Louis, *NOAA NWS NCEP*

NCEP SUPPORT FOR ECOLOGICAL FORECASTING

PRESENTATION- *This presentation will highlight how the National Centers for Environmental Prediction (NCEP) supply backbone capabilities for an operational ecological forecasting system. This includes support for applied research, technology transfer and implementation of a common modeling infrastructure. The NCEP is a recognized global leader delivering a seamless suite of operational environmental analysis, diagnostics and forecasts for a domain that now ranges from the sun to the sea, including weather, ocean, climate, water, and space weather prediction services. In order to address evolving user needs the NCEP is capitalizing on emerging scientific and technological advances and partnering with other agencies and institutions promoting ecosystem-based management. Recent efforts are targeting the transition of regional models and prototype ecological forecasts for the Chesapeake Bay and its tidal tributaries. The models rely on variables, including air temperature, wind speed, sea surface temperature, salinity, and solar radiation from NOAA forecasted data. The operational concept is to apply relevant observations and partner models to NCEP infrastructure and increase data availability, access and distribution of integrated environmental services through Weather Forecast Offices and other operational centers to state and local authorities. Specific challenges include scalability, data assimilation, and verification for short term forecasts, seasonal outlooks and climate projections. Shared development, improvement in ocean and coastal models, hydrologic and land use models, and linkage with marine ecological and biogeochemical science are being advanced with an Earth System Modeling view. This presentation will focus on the continuing NCEP support for multidisciplinary activities required to transition ecosystem modeling from research to applications.*

Uphoff, Jim, *MD DNR, Fisheries Service*

"JUST GIVE ME A NUMBER" - A FISHERIES BIOLOGISTS EXPERIENCE COMMUNICATING UNCERTAINTY TO MANAGERS

PRESENTATION- *Fisheries management has become highly reliant on models fitted to time-series of landings and relative abundance indices, often with additional detail on age-structure, to determine abundance and mortality rates. These results are compared to targets and thresholds developed in a model framework to determine stock status. I have experience five categories of uncertainty in these models: data, precision, bias, surprises, and cultural. Often data series are not screened and conflicting signals in time-series influences estimation of status. Managers may prefer a comparison of point estimates to targets and limits rather than consider the spread about the estimates that minimally depicts the risk that something bad could happen. Some standard models exhibit substantial bias that makes the depiction of stock status overly optimistic in the most recent years. Surprises result when assumptions used to make models tractable (constancy of underlying biological or ecological processes) are not met. Finally, the cultural differences of management and modeling tribes can lead to substantial uncertainty about successful communication. The author offers examples of communicating uncertainty, but no pathway to enlightenment. Understanding the needs of managers, patience, and persistence are offered as means for better communication of uncertainy.*

Vogt, Bruce, *NCBO*

FISHING FOR THE RIGHT MODEL: MODELING FOR RESOURCE MANAGEMENT

-PRESENTATION *To effectively manage the vulnerability of coastal and estuarine ecosystems to human activities and the value of the ecosystem services they provide new tools and management approaches are required. In the Chesapeake Bay, we are further challenged by the fact the resources we are managing do not recognize political boundaries and require multiple jurisdictions collaborate to address management problems. We must understand how actions in one part of the bay might affect the bay ecosystem as a whole and communicate these effects between jurisdictions. Ecosystem modeling provides the tool to test scenarios and consider the implications of management decisions. However, for models to be most useful they need to be honed to address certain questions. Current efforts in the Chesapeake Bay such as Executive Order 13508 Chesapeake Bay Protection and Restoration, bay-wide oyster restoration, and inter-jurisdictional fisheries management provide an opportunity to focus modeling on specific problems. This paired with greater communication between modelers and the management community through forums such as the Chesapeake Bay Program Fisheries Goal Implementation Team will begin to ensure modeling products are aimed at helping decision makers address real problems.*

Wang, Ping, *UMCES*

DATA CORRECTION ON SIMULATED DISSOLVE OXYGEN WITH OBSERVED DATA FOR WATER QUALITY CRITERIA ASSESSMENT

PRESENTATION- *Observed data provide information on the attainability of water quality criteria in the time and space of the measurements. However, observations are usually in discrete time and locations, therefore, cannot provide enough spatial and temporal information, nor predict water quality conditions under management scenarios. On the other hand, computer models compensate the shortages of observations. However, all models have certain deviations from the actual. The model error in model calibration will propagate in model scenario predictions. When comparing a modeled value with a numerical water quality standard, the deviated model value may lead to a wrong conclusion on whether the water quality standard is attained or not. We developed data correction on model scenario based on observations and relative changes between model calibration and scenarios, yielding more likely observed values under the scenario conditions. This approach allows us to evaluate water quality attainability relaying on observations which are the only data to demonstrate if the water quality standards are achieved. This talk will discuss two approaches in dissolved oxygen data corrections and the application in the assessment of dissolved oxygen criteria attainment.*

Wang, Harry, *VIMS*

NUMERICAL MODELING OF STORM SURGE AND INUNDATION FOR RECENT NORTHEASTER EVENT (NOVEMBER 11-14, 2009) IN THE CHESAPEAKE BAY

PRESENTATION- *The storm surge and inundation caused by hurricanes and northeasters in the Chesapeake Bay are a major concern in terms of natural-induced hazard. It has cost lost of life and major property damage in the past events. The recent northeaster occurred in November 12, 2009 produced 7.75 feet water level rise above MLLW (mean low low water) which was the third highest on record in the lower Chesapeake Bay, only slightly less than those caused by the 1933 and 2003 Hurricanes. As part of CIPS (Chesapeake Bay Inundation Prediction System) project, the hydrodynamic model ELCIRC (Eulerian-Lagrangian Circulation) model was coupled with a suite of atmospheric models including WRF, RAMS and GFS to produce ensemble forecast for the tide and storm surge prediction. Due to northeaster's extensive spatial coverage, a large model domain spanning from Nova Scotia to Florida Key in the north-south direction and 1200 km offshore from US east coast in the east-west direction were chosen to implement the model simulation. At the same time, a very high resolution model grid for the Chesapeake Bay region coupled with the large domain was executed in order to simulate the inundation in the local area of the Bay. The high resolution model grid places its boundary condition along the margin of adjacent continental shelf, which was in turn provided by the large domain model results. Quasi-3D mode of the ELCREC framework was used in order to capture the Ekman dynamics-controlled exchange in the coast rather than the traditional 2-D vertical average mode. Seven tidal constituents were considered from the outer boundary in the ocean and six wind ensembles were used for the entire domain during the simulation period from 11/11/2001 through 11/16/2001. The storm and tide predictions by the model compares favorably with the NOAA tidal gauge measurement with errors within the range of 5-10% in the lower Chesapeake Bay. Unique for the November 11-14, 2009 event was the installation of state-of-art inundation gauge by USGS in the cities of Poquoson, Hampton Road, and Norfolk during the event. The modeled inundation results compared exceptionally well with the inundation measurement after the gauges were retrieved and went through QA/QC. For accurate inundation predictions, the quality of LIDAR, capable of resolving the landform including the small creek and streams, plays a pivotal role and should be further improved.*

Ward, John,

ECOSYSTEMS MANAGEMENT AND MANAGERS

-PRESENTATION *The world can be considered to be a complex organism with direct and indirect interactions and dependencies. In their systematic assessment of this organism, the physical sciences normally exempt the effect of mankind from their analyses while the social sciences* *rarely incorporate the natural sciences into their models of human behavior as motivating forces. One exception, natural resource economics, integrates renewable and nonrenewable natural resources into the economic allocation problem as a set of constraints limiting economic opportunities in a dynamic setting. Even these models, whose mathematical complexity implies accuracy and sophistication, are naïve in their implications for actual world ecosystems because of their narrow focus and perspective. Even in a deterministic framework, dynamic interactions can introduce variable and uncertainty in future outcomes. When stochastic effects are formally modeled outcomes can become both counter-intuitive and paradoxical. Dealing with this uncertainty and associated risk requires the adoption of a different methodological approach. From an anthropocentric perspective, the ecosystem model should provide information that can be used by the manager to balance the different stakeholder demands as communities whether virtual or geopolitical vie for access to the natural resources in the an uncertain and risky ecosystem. Science for science sake is insufficient to achieve this goal, physical and social scientists can only provide this information through an integrated management framework that makes a concerted effort to focus on the community.*

Welty, Claire, *UMBC, Center for Urban Environmental Research and Education, M.L. Baeck, A. Bhaskar, E. Doheny, S. Drzyzga, B.Hanlon, C. Jantz, P.Larson, G. Lindner, R.Maxwell, M. McGuire, A. Miller, J. Smith*

MODELING COUPLED FEEDBACKS BETWEEN THE HYDROLOGIC CYCLE AND PATTERNS OF URBAN GROWTH

PRESENTATION- *We seek to quantify the coupled feedbacks between urban growth and the urban water cycle to evaluate the impacts of development on water availability and limits to water supply, using the Baltimore metropolitan area as a case study. The six-county Baltimore metropolitan area presents a particularly interesting case for water supply when surface water systems and groundwater systems are considered as a whole, because there is a mixture of municipal surface water supply, municipal groundwater supply, and an extensive network of private wells outside of designated service areas. Our work involves linking three types of mathematical models -- an urban growth model (SLEUTH); a three-dimensional, physically-based groundwater-surface water model (ParFlow); and an empirical water demand model -- and capturing feedbacks among model components in a spatially explicit manner. Here we present the conceptual framework that describes the model coupling and feedbacks. SLEUTH is a cellular urban model that is calibrated with an historic time series of land cover information to simulate contemporary (validation to 2000) and future (prediction to 2030) urban development rates and patterns. We developed a geospatial sub-model that generates an input layer to SLEUTH to indicate areas more or less likely to experience development. The primary inputs to the sub-model are water service areas and population and employment estimates (both at the Regional Planning District (RPD) scale). SLEUTH generates a geospatial probabilistic prediction surface of urban land cover for 2030, which is aggregated to a 500m x 500m array. Population and employment forecasts at the RPD scale are also allocated to the 500m x 500m array, but using dasymetric mapping techniques. These data feed directly into the water demand model, which requires population and employment data, and the hydrologic model, which requires land surface permeability data. Inputs to the hydrologic model include spatial-distributed precipitation, evapotranspiration, topography, land surface permeability, soil/rock permeability, watershed imports/exports from piped flow, pipe leakage, and return flow from septic systems; model outputs are streamflow and aquifer water levels. Regulatory policies for in-stream flow requirements, reservoir operations, and aquifer safe yield are superimposed on hydrologic model outputs to determine source water availability, since it cannot be assumed that all existing water can be utilized. Empirically estimated water demand is compared to water availability. If source water is predicted to be available, infrastructure is installed (municipal supply or private wells), new groundwater or surface water withdrawal rates are fed back to the hydrologic model, and this land is no longer available to be developed in SLEUTH. If source water is not available, then this also feeds back to SLEUTH to exclude this area from development, forcing the model to look elsewhere for adequate water supply. This work represents collaboration among researchers in the fields of geography, hydrology, civil engineering, public policy, and information systems. Clear and frequent communication is required to move the coupling aspects of the modeling forward. Challenges and opportunities in carrying out such collaborations will be highlighted as part of this presentation.*

Wiggert, Jerry, *University of Southern Mississippi*

ASSESSMENT OF A COUPLED PHYSICAL-BIOGEOCHEMICAL MODEL DEVELOPED FOR ECOLOGICAL FORECAST USE IN CHESAPEAKE BAY

PRESENTATION- *The Chesapeake Bay is a valuable recreational, ecological and economic resource that is commonly subject to harmful algal bloom (HAB) outbreaks that threaten its continued viability. With expanding knowledge of the conditions likely to promote HAB occurrence, forecasting these events is becoming ever more tenable. HAB triggers include both physical and biogeochemical environmental properties; therefore a fully coupled physical-biogeochemical numerical model that accurately simulates, and forecasts, the Bay's environment is well-suited for application as a means of generating nowcasts or forecasts of HAB occurrence. Attaining this technological capability has been a primary motivation for the development of the biogeochemical version of the Chesapeake Bay Regional Ocean Modeling System (ChesROMS), which incorporates Rutgers University's Regional Ocean Modeling System (ROMS) as the physical modeling engine. The ecosystem model has been* *modified from the standard Fasham-type formulation incorporated within the ROMS distribution to include components that explicitly accommodate the impact of river borne sediments, inorganic nutrients and dissolved organic matter. Nutrient inputs from diffuse land sources as well as those from atmospheric deposition are also taken into account. In addition, dynamic simulation of dissolved oxygen has been implemented, with the intent of resolving seasonally developing hypoxic conditions within the Bay and the accompanying transition to denitrification within the water column and underlying benthos. Here, simulations for the year 1999 will be presented and characterized with respect to in situ observations made available by the Chesapeake Bay Program. These results will highlight and assess the realism of model simulated phytoplankton bloom dynamics and the seasonal evolution of dissolved oxygen distributions in the Bay.*

Wilberg, Michael, *Chesapeake Biological Laboratory University of Maryland Center for Environmental Science*

UNCERTAINTY AND PRECAUTION IN MID-ATLANTIC FISHERIES MANAGEMENT

PRESENTATION- *Federal fisheries management has recently changed to require that scientific and management uncertainty are used in setting precautionary annual catch limits under the revised Magnuson-Stevens Act. Within this process, the Scientific and Statistical Committee (SSC) develops an Acceptable Biological Catch limit (ABC), which incorporates scientific uncertainty on level of sustainable harvest, and the Council set an Annual Catch Limit, which incorporates management uncertainty. The Mid-Atlantic SSC is currently developing a tiered approach for setting ABCs based on the uncertainty in fishing mortality reference points and uncertainty in current stock biomass. This information is combined with a Council risk policy that identifies the acceptable probability of overfishing for each stock. As uncertainty and risk are difficult topics to communicate, the SSC has had several interactions with the Council to help them develop a risk policy. In this presentation, I will discuss methods the SSC is developing to incorporate uncertainty in ABC recommendations and how this uncertainty is communicated to the Council.*

Wilcox, Kyle, *Applied Science Associates*

DATA MANAGEMENT FOR THE CHESAPEAKE BAY INUNDATION SYSTEM (CIPS)

PRESENTATION- *The Chesapeake Inundation Prediction System (CIPS) is designed to facilitate emergency management decision-making in the challenging case of predicting flood inundation in an area of intricate coastlines and semi-enclosed coastal bays and estuaries. CIPS is an ideal testbed to evaluate end-to-end data management to support an inundation forecasting system. The data infrastructure must integrate data from a wide variety of ocean and meteorological observations and numerous numerical models and then deliver scientific results in a manner that supports emergency managers and the public. In 2009, CIPS enhanced its data management strategy to leverage a number of open data standards and protocols endorsed by NOAA's Integrated Ocean Observing System (IOOS). The data management project focused on practical implementation of these protocols to promote interoperability between data providers including universities, a number of government agencies, and industry. By using open standards, the system is a prototype for a relocatable system that can be deployed in many regions where providers use these open data standards. This paper discusses the standards that were implemented including the Sensor Observation Service (SOS), Web Map Service (WMS), KML (Keyhole Markup Language), and the Thredds (Thematic Realtime Environmental Distributed Data Services), and the challenges faced in integrating a wide variety of ocean observation data and different numerical models.*

Wnek, Patricia, *NOAA, NWS, Middle Atlantic River Forecast Center*

MULTISENSOR PRECIPITATION ESTIMATES PRODUCED BY NOAA, NATIONAL WEATHER SERVICE RIVER FORECAST CENTERS

PRESENTATION- *Quality, high resolution precipitation estimates are produced hourly over the United States by NOAA's National Weather Service River Forecast Centers. These estimates are created through combining precipitation gage data with RADAR data, and applying automated and manual quality control. The data is presented graphically and can be summed over any desired time period. This presentation will provide an overview of multi-sensor precipitation data, showing how it is created and how accurate it is in the Chesapeake Bay region. The use of the data in the National Weather Service forecast process will be described through a case study example.*

Woodbury, Peter, *Cornell University*

MULTI-SCALE MODELING OF NUTRIENT LOADING IN THE SUSQUEHANNA RIVER BASIN

PRESENTATION- *The Agricultural Ecosystems Program is a multi-disciplinary research program of Cornell University designed to increase our knowledge of the sources and sinks of nutrients and sediments in the New York portion of the Susquehanna watershed. At the whole-basin scale we are using the ReNuMa and SCOPE-NANI models. The SCOPE-NANI model performs a mass-balance for four categories of net anthropogenic nitrogen (N) inputs: atmospheric deposition, fertilizer, nitrogen fixation by vegetation, and food and feed imports. Deposition was estimated based on data from CASTNet and NADP monitoring stations and modeled estimates for regions and species that are not monitored. Fertilizer application rates within counties were obtained from the* *literature. Nitrogen fixation was derived from crop area data from the Census of Agriculture multiplied by N fixation rates from the literature. Net N import in food and feed were derived from crop and animal data from the Census of Agriculture and data from the literature on crop and feed N contents and animal and human N requirements. Total net anthropogenic N inputs were 4,707 kg N km-2 y-1, partitioned as follows: atmospheric deposition 28%, fertilizer 14%, N-fixation 17%, and food and feed import 41%. Only 21% of N inputs are exported in rivers. Trend analysis indicates that there was a slight decrease in N export from 1980 to present. At the farm scale, we use a detailed daily model of nitrogen cycling and crop growth: Precision Nitrogen Management (PNM). We simulated N losses from silage maize on dairy farms under current management practices (manure and N fertilizer), and reduced fertilizer practice (manure only) on both valley farms (with manure storage, 3 soil types) and hill farms (daily manure spreading, 2 soil types). The model was driven with 20 to 40 years of historical weather data for 10 locations. Results were up-scaled to the basin using geospatial data on soils, land cover, and climate. Nitrogen leaching below the rooting zone averaged 73 kg N ha-1 y-1 for current practices but only 55 kg N ha-1 y-1 for the reduced fertilizer practice. Total N loss from fields (leaching, volatilization and denitrification) averaged 162 kg N ha-1y-1 for current practices but only 114 kg N ha-1y-1 for the reduced fertilizer practice. For valley soils, N leaching below the rooting zone averaged 143 kg N ha-1y-1 for current practices and 113 kg N ha-1y-1 for the reduced fertilizer practice. For hill soils, N leaching below the rooting zone averaged 32 kg N ha-1y-1 for current practice and 29 kg N ha-1 y-1 for the reduced fertilizer practice. Average above-ground biomass yield decreased with reduced fertilizer by only 1% in valley soils, but 14% on hill soils. Nitrogen leaching below the rooting zone varied among sub-basins, ranging from 56 kg N ha-1y-1 (Tioga) up to 96 kg N ha-1y-1 (Upper Susquehanna). These results indicate that fertilizer use can be decreased in valley soils without decreasing yield, and that such a reduction would substantially reduce total N loss and N leaching loss from maize fields.*

Wu, Jing, *University of Maryland Center for Environmental Science*

CHESAPEAKE BAY COMMUNITY MODEL FOR TMDL DEVELOPMENT

PRESENTATION- *The Chesapeake Bay Watershed Model has been used to simulate nutrient and sediment loads delivered to the Bay for more than two decades. Over time, the Model has increased in complexity commensurate with the management challenges in Chesapeake restoration. The current development, Phase 5 Community Watershed Model, is a new generation of the watershed model in response to the needs of developing Chesapeake Bay TMDL as well as supporting small scale local TMDLs. The Phase 5 Model simulates 308 land segments, 25 land uses, 930 rivers, and 45,000 land use/river connections over a 22-year period (1984-2005). The Phase 5 Model enhances the existing HSPF model structure with a complementary software system to address unique spatial and temporal scale issues inherent in a large-scale watershed modeling. The software system, consisting of preprocessors, an External Transfer Module, and postprocessors, was devised to conveniently generate and update input files essential to model operations and to implement land use and management changes over time. An automatic model calibration method, designed to iteratively adjust model parameters based on the sensitivity of the parameters to particular model outputs, is utilized to calibrate the Phase 5 Model for hydrology, nutrients, and sediment. Through CCMP support, model code, preprocessors, postprocessors, a data library of model input data, and documentation are available for the Phase 5 applications at county or more local scales.*

Yactayo, Guido, *UMCES, Jeff Sweeney, Jessica Rigelman, Olivia Devereux, Mark Dubin, Gary W. Shenk, Lewis C. Linker*

ESTIMATES OF NITROGEN AND PHOSPHORUS INPUT FOR USE IN MODELING POLLUTANT REDUCTION

POSTER- *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.*

Zaslavsky, Ilya, *San Diego Supercomputer Center, U. Cal., San Diego*

ANALYTICAL WORKFLOWS, DATA DISCOVERY AND VISUALIZATION ON THE CHESAPEAKE BAY ENVIRONMENTAL OBSERVATORY (CBEO) DATA PORTAL

PRESENTATION- *Chesapeake Bay Environmental Observatory (CBEO) is an NSF-supported project focused on studying hypoxia in Chesapeake Bay using advanced cyberinfrastructure (CI) technologies. The project is organized around four concurrent and interacting activities: 1) CBEO:S provides science and management context for the use of CI technologies, focusing on hypoxia and its non-linear dynamics as affected by management and climate; 2) CBEO:T constructs a locally-accessible CBEO test bed prototype centered on spatio-temporal interpolation and advanced querying of model runs; 3) CBEO:N incorporates the test bed CI into national environmental observation networks, and 4) CBEO:E develops education and outreach components of the project that translate observational science for public consumption. CBEO:N activities, which are the focus of this presentation, include: - constructing an online project portal to enable researchers to publish, discover, query, visualize and integrate project-related datasets of different types. The portal is based on the technologies developed within the GEON (the Geosciences Network) project; developing a CBEO node within the WATERS network, taking advantage of the CUAHSI Hydrologic Information System (HIS) Server technology that supports online publication of observational data as web services, and ontology-assisted data discovery; developing new data structures and metadata in order to describe water quality observational data, and model run output, obtained for the Chesapeake Bay area, using data structures adopted and modified from the Observations Data Model of CUAHSI HIS; prototyping CBEO tools that can be re-used through the portal. These tools include a collection of analytical workflows for studying hypoxia in the bay, OLAP-based visualization and animation tools for rapid aggregation of results from a 10-year run of the Chesapeake Bay Program's 13k Water Quality Model, and map-based applications for finding, aggregating and interpolating observational data. The paper describes recent accomplishments in these four development areas, and demonstrates how CI approaches transform research and data sharing in environmental observing systems.*

Zhang, Xinsheng, *NOAA Cooperative Oxford Laboratory,* Wood, Robert J., and Bahner, Lowell

CHESAPEAKE BAY STRIPED BASS HABITAT SUITABILITY FORECASTING: MOVING ECOSYSTEM MODELING FROM RESEARCH TO OPERATION

PRESENTATION- *Operational modeling offers the potential to educate and inform ecosystem management and the outlook and opinion of the general public for whom we manage coastal ecosystems. Striped bass (Morone saxatilis) supports important commercial and recreational fisheries in Chesapeake Bay. Improved understanding and forecasting of striped bass habitat suitability, and the interactions of striped bass and its prey are important from both scientific and resource management perspectives. We have developed a suite of life-stage-specific, striped bass habitat suitability models that can be used to evaluate and forecast how hydro-climate variability drives variability in habitat quality and quantity. Particular emphasis was placed on summer conditions, when the striped bass population is vulnerable to stress from warm temperatures and low dissolved oxygen. Model results suggest that Coutant's temperature-oxygen "squeeze" could affect striped bass in Chesapeake Bay through predator-prey habitat overlap/separation and encounter rates, and vulnerability to pathogens. These models have been integrated into the Chesapeake Bay Ecological Forecasting Modeling System, a joint NOAA-University of Maryland Earth System Science Interdisciplinary Center effort that links atmospheric, hydrodynamic, water quality, and living resources sub-models to produce operational and accessible models relevant to Bay restoration efforts. One ultimate objective is to provide managers with decision support tools for planning ecosystem-based fisheries management.*

Zubrick, Steven M., *National Weather Service, Weather Forecast Office,* and John Billet

UTILITY OF SHORT RANGE ATMOSPHERIC MODEL GUIDANCE DURING SIGNIFICANT COASTAL INUNDATION EVENTS.

PRESENTATION- *Weather forecasters in the National Weather Service (NWS) at its Weather Forecast Offices (WFOs) routinely assess future atmospheric predictions of variables like surface winds, rainfall, temperatures, etc., derived from numerical weather prediction model guidance. Predictions of surface winds are play an important role in forcing water levels in coastal areas. Atmospheric predictions are derived from numerical atmospheric models having a variety of horizontal and vertical grid resolutions. Horizontal grid spacing ranges from so-called "high resolution" models having spacings of less than 10 km down to as fine as 4 km, to courser resolution models with grid spacings of 10 to 50 km.*

This presentation will focus on the quality of model predictions of salient atmospheric parameters (like winds) that resulted in significant coastal inundation 11-13

November 2009 across coastal section of the Mid-Atlantic Region, particularly in Southeastern Virginia in the Hampton Roads area. This event featured the interaction of the circulation remnants of former Tropical Storm Ida with an upper level disturbance. An intense surface low pressure storm system resulted from this interaction that peaked just east of the Southeast Virginia coast. This storm featured copious amounts of rainfall coupled with a prolonged period of strong onshore winds that created ideal conditions for widespread coastal flooding in the Hampton Roads area. Examples will be provided.