Chesapeake Community Research Symposium 2024

Session 23: General: Estuarine and Watershed Processes

Sarah Preheim

Major trends, gene-gene relationships, and environmental correlates of spatiotemporal shifts in the distribution of genes in Chesapeake Bay

Although microorganisms play critical roles in these models, the evolution of microbial biomass apart from photosynthesizers is not typically simulated, in part because data to constrain such representation is lacking . Although metagenomic information could provide useful constraints for these models it is not clear how best to use it. Here we compare the abundance of a subset of metabolic genes identified in Chesapeake Bay during the summer of 2017 with rates predicted by a numerical model. We focus on genes associated with photosynthetic primary production , nitrification, denitrification, and sulfur cycling. Certain modeled rates are significantly correlated with associated genes or genes subset by key taxa . However, we also find interesting discrepancies such as an overabundance of photosynthesis and denitrification genes in the deep waters in the spring when the model expects rates of both processes to be small. Our work demonstrates that metagenomics could serve as a useful indicator for some, but not all rates. Future work to advance this field should focus on improving the detection and proper classification of genes encoding key enzymes for modeled processes and when adding taxonomically-resolved representations of key processes informed by metagenomics is warranted

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Gabrielle Ripa

Non-native plant invasion of stream restoration projects on the Chesapeake Bay watershed

Stream restoration is increasingly used within the Chesapeake Bay watershed to comply with total maximum daily load regulations and achieve goals set forth by the Chesapeake Bay Program related to forest buffers and tree canopy cover. However, in highly urbanized areas, such as in Maryland's Chesapeake Bay watershed, invasive plants can interfere with stream health and compromise restoration goals. Of greater concern, stream restoration practices may be promoting invasion by creating suitable microsites for establishment through soil disturbance and the release of necessary resources (e.g., increased light availability, reduced competition). To assess the potential for stream restoration to promote invasive species, we compared the vegetation composition of 25 stream reaches restored between 1999 and 2015 with a paired unrestored stream reach, usually either immediately upstream or downstream of the restored reach. For each stream reach, we sampled 100-m with 6 systematic sampling points oriented around the midpoint of the reach. At each sampling point, we determined species composition with two 5-m point-intercept transects (n=12/reach) and measured the basal area in the middle of the two transects using a fixed-radius plot (n=6/reach). We found that restoration was associated with a greater proportion of non-native species and reduced coverage of native species ($p=0.03$, $F_{1,48}=4.79$). Through canonical correspondence analysis, we determined the majority of stream reach pairs shifted from lower non-native species importance in the unrestored reach towards greater non-native species importance in the restored reach. Because the majority of restored streams were more invaded than their paired unrestored stream, current restoration methods seem to not be limiting invasion and may even be promoting it. Stream restoration practices in the Chesapeake Bay watershed need to be evaluated in terms of limiting invasive species.

Nicole Cai

Linkage between Estuarine Saltwater Intrusion and Marsh Evolution under Sea-level Rise

Saltwater intrusion resulting from sea-level rise due to climate change is a significant outcome, and its impacts on coastal ecosystems are substantial. However, a complete understanding of its complex interactions with marsh evolution remains unknown. Our research reveals that the progression of the intrusion front has caused the estuarine turbidity maximum zone to shift upstream, accompanied by a trend of tidal marsh evolution. Satellite observations have also indicated forest loss associated with increased salinity. Furthermore, increased salinity tends to strengthen salt marsh soil and make it less erodible. Predictive hydrodynamics models of sea-level rise suggest that saltwater intrusion and tidal range will increase if tidal marshes can keep pace with rising sea levels. The observed consequences of increased saltwater intrusion, including changes in turbidity, forest retreat, and reduced erosion, along with the projected increase in the tidal range under future sea-level rise, contribute to the enhanced survival of tidal marshes.

Jeffrey Cornwell, Michael Owens, Lorie Staver, J. Court Stevenson

Provision of Nutrient Ecosystem Services By Maryland Tidal Wetlands

Tidal wetlands provide a myriad of ecosystem services, including sequestration and transformation of nutrients from adjacent waters. Nitrogen and phosphorus can be deposited in wetlands through trapping of solids from tidal waters, or the burial of organic matter derived from wetland macrophytes. Phosphorus burial can occur as either inorganic or organic forms, with fluvial inputs increasing the proportion of inorganic P. Nitrogen is generally buried as organic N. Microbial denitrification, the conversion of fixed N to di-nitrogen gas, is an important N removal process of a similar magnitude as N burial. Using available data from tidal fresh, oligohaline and brackish wetlands, estimates of N and P burial may be compared to nutrient inputs; on a bay-wide scale, a modest proportion of N inputs into the northern (Maryland) Chesapeake Bay is removed by tidal wetlands. In subestuaries such as the Patuxent and Choptank Rivers, the proportional removal of N and P inputs in freshwater tidal wetlands is much higher. With wetland losses due to relative sea level rise, wetland creation and restoration could be of value to the bay for nutrient removal. The tidal wetlands of Poplar Island, created using dredged materials from upper Chesapeake Bay navigation channels, appear to rapidly achieve areal nutrient removal rates similar to “natural” wetlands. This presentation will thus identify both the current nutrient removal value of tidal wetlands, as well as examine if wetland creation may at least partially recover some ecosystem functions that may be lost to erosion.

Carl Cerco

The Influence of Submerged Aquatic Vegetation on Chesapeake Bay Dissolved Oxygen Concentration

The interface between estuaries and the adjacent shore encompasses a range of environments including intra-tidal wetlands, inter-tidal wetlands, and submerged aquatic vegetation (SAV) beds. The relationship between SAV and Chesapeake Bay water quality is examined by employing the 2015 version of the Chesapeake Bay Water Quality and Sediment Transport Model. The model indicates SAV enhances nutrient transfer from bottom sediments to overlying water. The enhanced transfer is equivalent to 1.67% of the watershed nitrogen load and 4.72% of the watershed phosphorus load under 1991-2000 conditions. The recycled nutrients stimulate phytoplankton production and concurrent dissolved oxygen (DO) production in surface waters. Enhanced algal biomass settles to the deep water and the deep channel of the Bay, stimulating respiration in the water and bottom sediments and subsequently diminishing DO. The DO diminishment varies in magnitude but is primarily less than 0.05 g m-3.

Amanda Small

Strategies and resource needs for adapting Maryland’s fisheries management structure to climate change

Sustainable fisheries are supported by the relationships between ecological, socioeconomic, and governance components. Maryland’s fishing industry is critical to the economy and culture of the state, yet climate change is already altering fish physiology, behavior, and habitat. These changes are expected to shift how Maryland’s management system operates. This project aimed to develop adaptation strategies that will support climate-resilient fisheries in Maryland. While focus was centered on governance and the fisheries management process, opportunities for coordination with ecological and socioeconomic entities were identified. The Maryland Department of Natural Resources Chesapeake and Coastal Services unit and Fishing and Boating Services unit collaborated to assess individual processes within fisheries management, identify climate impacts, then work with managers to develop tailored adaptive management strategies. Fishermen are an essential partner in the management process and were engaged throughout the project. The project team identified fishery management plans, monitoring and assessing fish stocks, writing regulations, encouraging industry diversification, and expanding partnerships as key management processes. Additionally, the project team identified the importance of encouraging new industry opportunities that may arise from climate change to support the socioeconomic component of fisheries. To support the ecological component of fisheries, the project team acknowledged that fish habitat conservation, restoration, and protection strategies are often outside the jurisdiction of fisheries authorities. Creative partnership with state staff, land managers, and landowners will facilitate integration of fisheries data and priorities into the greater scope of land management. Fisheries management is a complex system that relies on collaboration between fishermen, governing bodies, partners, industry members, and consumers. These recommended strategies will increase the state's adaptive capacity to take climate-informed management actions in the case that fish species and their environment continue to change.

Jiangtao Xu

Update on NOAA's New Operational Forecast System for the Northeast US

NOAA's National Ocean Service (NOS) is collaborating with the University of Massachusetts - Dartmouth (UMASS) to develop and implement a new Operational Forecast System (OFS) for US Northeast coastal waters to provide short-term (3-5 days) forecast guidance of water level, 3D currents, water temperature, and salinity to better support the needs of this regional coastal community. Bipartisan Infrastructure Law (BIL) funding is supporting the accelerated development of the Northeast Coastal Ocean OFS. This system is based on the Finite Volume Community Ocean Model (FVCOM) and is being developed by the UMASS-WHOI research team in collaboration with the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS). Guided by requirements collected from navigation, emergency response, coastal resource management and other users, the model grid has been refined to use newly-available, high-quality shoreline and bathymetry data, especially in the New York Harbor, Delaware Bay, and Chesapeake Bay regions. The model domain extends from Bald Head Island, North Carolina northeastward to Nova Scotia, Canada. NOS plans to replace NOAA's existing New York and New Jersey OFS (NYOFS) and potentially the existing Chesapeake Bay OFS (CBOFS), Delaware Bay OFS (DBOFS), and Gulf of Maine OFS (GOMOFS) with this new regional OFS. Presently, a one-year hindcast simulation for 2017 is being conducted to evaluate the performance of the overall forecast system before it is transitioned to NOAA for further evaluation by the impacted user community prior to implementation into operations. NOS welcomes feedback from potential impacted users in anticipation of the upcoming changes in the OFS products, and strongly encourages the community to become more involved in the current and future development of this regional model.