## Assessing the Relative Success of Multiple Interventions at Onondaga Lake to Reduce Mercury Bioaccumulation

B. Henry (bhenry@anchorqea.com), Anchor QEA, LLC Saratoga Springs, NY; A. Burnham and M. Arrigo, Parsons, NY; and J. McAuliffe, Honeywell, NY

Mercury concentrations in fish in Onondaga Lake (Syracuse New York, USA) have declined over the past 10 years contemporaneous with a combination of interventions by Honeywell and Onondaga County to, respectively, reduce contaminant concentrations and improve water quality. For mercury, interventions involved control of inputs to the lake via groundwater and tributaries, dredging and capping of contaminated nearshore sediment, and redox control of lake water to prevent methylmercury release from profundal sediment. These interventions along with natural recovery in profundal sediment have addressed the major external and internal sources of mercury and methylmercury. Redox control by nitrate injection to the hypolimnion supplements nitrate discharged from the Onondaga County Metropolitan Sewage Treatment Plant (Metro). Metro supplies 20 percent of annual water flow to the lake and underwent significant upgrades to limit phosphorus and ammonia discharges. Now, the lake is experiencing improvements in diversity and abundance of fish and plant communities. Methylmercury concentrations in water and zooplankton are similar to concentrations in lakes lacking point source mercury contamination.

Control of mercury sources to Onondaga Lake and reductions in mercury concentrations in sediment and water have contributed to reductions in mercury concentrations in fish with their relative importance differing by species. Nearshore sediment remediation has had a marked impact on concentrations in small prey fish while interventions that limit methylmercury concentrations in water (primarily redox control) are more important to fish such as walleye that consume plankton and planktivorous fish. Evidence to date indicates that lower trophic levels of the food web (including prey fish and plankton) respond relatively quickly to changes in water and sediment concentrations, while responses in upper trophic levels require longer monitoring periods due to greater age/size and high “within year” variability as concentrations are influenced by body size and growth rate as well as movement and migration patterns.

Application of causal analyses to evaluating ecological changes in a river and estuarine system associated with changes in freshwater flows

Charles A. Menzie, Exponent Inc.

camenzie@exponent.com

Over the past decade, causal analysis has been increasingly used to diagnose environmental impairments within water bodies. Much of this work is guided by the USEPA CADDIS program. These tools have been adapted to a variety of environmental issues involving observed or presumed stressors on terrestrial environments, air, coastal systems, deserts, and wetlands. Causal analyses have examined biological, chemical, and physical stressors in these domains. This paper describes a tiered causal analysis approach for a river system where stress has occurred as a result of changes in river flows. The central questions relate to the nexus between flow alterations and their causes and the observed and/or alleged changes in the ecosystems of the river and adjacent coastal areas. The alterations include changes in primary and secondary production, presence of aquatic vegetation, quality of fish nursery areas, and viability of biota in adjacent floodplains. The presentation will focus on the structure of the analyses. The tiered causal method has been used to support evaluations designed to achieve appropriate interventions and have also been presented in court proceedings including before the U.S. Supreme Court and International Court of Justice.

**Modeling the environmental fate and transport of nanocopper in surface waters**

Bianca Ross and Chris Knightes, USEPA, Narragansett, RI

The use and production of engineered nanomaterials have grown exponentially over the past few decades due to their unique properties and versatility. As a result of widespread industrial applications, nanomaterials have evolved into their own unique class of emerging contaminants ranging from metallic to carbonaceous forms. However, the full extent of nanomaterials' impact on the environment is currently unknown. In this study, we use the Water Quality Analysis Simulation Program (WASP8) to investigate the fate, transport, and transformations of nanocopper in surface waters. Surface treatments used in aquatic environments, such as boat-bottom paints and lumber preservatives, frequently rely on nanocopper for its antifouling properties. Despite its frequent use and ionic copper's well-known toxic effects on aquatic/benthic organisms, few studies have modelled the behavior of nanocopper in the environment. WASP8 serves as a powerful modeling framework that allows users to create dynamic, mechanistic water quality models. Using WASP8, we aim to model the variables, including dissolved organic carbon and suspended particulate matter, and processes and that govern nanocopper behavior once it is released to freshwater environments from boats coated with nanocopper bottom paint. Although we are initially targeting freshwater environments, we plan to create models that can be applied to a wide variety of aquatic environments. Results from this study may benefit research efforts to predict the toxicity of nanocopper used widely in coastal systems.

# Development and Testing of Two Polymers for *in situ* Passive Sampling of Munitions Compounds

Emma R. Shipley[1,2], Penny Vlahos[2], Robert M. Burgess[3]

[1]ORISE Program c/o U.S. EPA, ORD/CEMM, Atlantic Coastal Environmental Sciences Division, Narragansett, RI, USA

[2]University of Connecticut Avery Point, Department of Marine Sciences, Groton, CT, USA

[3]U.S. EPA, ORD/CEMM, Atlantic Coastal Environmental Sciences Division, Narragansett, RI, USA

Unregulated dumping of unexploded ordnance into coastal waters over the last century has raised questions about the identification and quantification of munitions compounds such as 2,4,6-trinitrotoluene (TNT) and its derivatives in various environmental mediums. Though typically present at low concentrations in seawater and sediment, many of these compounds have known human health risks and potential ecological impacts. Given the low concentrations, passive sampling is a promising avenue of research providing new data on these compounds in an economical and low maintenance way. This work examines two promising polymers, ethylene vinyl acetate (EVA) and polyoxymethylene (POM), for their utility toward detection and quantification of munition freely dissolved concentrations ($C_{free}$s). The $C_{free}$ was selected as it provides a good surrogate for the bioavailable concentration of the munitions in marine systems. Experiments use natural seawater and sediments retrieved from coastal areas affected by munition usage and disposal to determine munition $C_{free}$ in sediment porewater. These samplers will provide a low-cost technique to inform environmental remediation and monitoring programs at military sites and any facility where munitions compounds may be of concern.

# Sorption and removal kinetics of 2,4-dinitroanisole and 3-nitro-1,2,4-triazol-5-one in contrasting fresh-water sediments: Batch studies

Thivanka Ariyarathna, Sydney Twarz, and Craig Tobias
University of Connecticut, Department of Marine Sciences, 1080 Shennecossett Road, Groton, Connecticut, USA

Insensitive high explosive (IHE) constituents like 2,4-dinitroanisole (DNAN) and 3-nitro-1,2,4-triazol-5-one (NTO) are used alongside or in replacement of conventional energetics. Environmental release of these compounds is of great concern due to their high polarity and associated higher potential for offsite migration in surface water environments. The objective of this study is to evaluate adsorption and microbially-mediated removal kinetics of dissolved DNAN and NTO in freshwater sediment systems. Here we conducted bench-top sediment slurry experiments using six geochemically and texturally contrasting freshwater sediment types: low organic carbon (OC) sand, high OC silt, high OC clay, iron containing clay, carbonate sand, and high OC wetland sediment. Separate abiotic and biotic sediment incubations were carried out at $23^0$C, $14^0$C and $4^0$C by adding DNAN and NTO solutions into the sediment slurries. Experiments were conducted over three weeks, and time series aqueous samples and sediment samples that were taken at the end of the experiment were measured for DNAN and NTO concentrations. Dissolved IHE compounds were equilibrated with sediment within the first two hours after spike and sorption kinetics in different sediments were analyzed and compared. Sediment-type and temperature effects were observed. DNAN has higher sorption to sediments while sorption of NTO was not observed in any of the sediment type. Biotic removal rates, calculated as the difference in loss between sterile and unsterile sediments, were higher than abiotic sorption rates for DNAN, regardless of sediment type. DNAN biotic removal rates are higher than NTO rates in all sediment slurries. Smaller grain size coupled with higher OC content in sediment is more important for biotic NTO and DNAN removal. The influence of sediment geochemical parameters such as OC, grain size, cation exchange capacity, total iron, total sulfur, carbonate content etc. on adsorption and biotic removal of these IHE compounds were evaluated. Resulting comparative estimates of sorption and removal kinetics of DNAN and NTO from our study have the potential to aid in parameterization of fate and transport models and contaminant management schemes.

SETAC North Atlantic Chapter 27th Annual Meeting

Abstract

*Photochemical Degradation of Short-Chain Chlorinated Paraffins in Aqueous Solution*

Brian DiMento, Cristina Tusei, Elizabeth Westbrook, Christoph Aeppli
Bigelow Laboratory for Ocean Sciences

Chlorinated paraffins are anthropogenically produced complex mixtures of straight-chain hydrocarbons with varying degrees of chlorination. They have been used as high-pressure lubricants and cutting fluids for metalworking, as well as a flame retardants and plasticizers in a variety of products such as paints and textiles. Short-chain chlorinated paraffins (SCCPs), comprised of 10-13 carbon atoms and 40 to 70% chlorine by mass, were added to the Stockholm Convention on Persistent Organic Pollutants (POPs) in 2017; however, their fate in the aquatic environment is poorly understood. The goal of this project was to investigate the importance of photochemical degradation in their removal from natural waters. Because industrial SCCPs exist as mixtures of thousands of congeners, individual compounds were synthesized to study the importance of carbon chain length and degree of chlorination. Laboratory irradiation experiments indicated that both hydrated electrons and hydroxyl radicals are capable of degrading SCCPs. Higher chlorine content resulted in higher rate constants for hydrated electrons and lower for hydroxyl radicals, in agreement with trends found in literature data. In the environment, this degradation is expected to occur within the dissolved organic matter (DOM) phase where reactive intermediates produced photochemically have higher concentrations and longer lifetimes. The affinity of SCCPs for this hydrophobic micro-environment was both modeled computationally and confirmed in the lab, and these partition coefficients will ultimately be used to predict their fate in the environment.

Shannon Hogan-University of Massachusetts Boston
NACSETAC Abstract

**Microplastic Pollution on Nantucket Island**

The study of microplastics in the environment is crucial to understanding further impacts of plastic pollution. It is known that microplastic pollution is widespread in the marine ecosystem from two main contributors: primary sources those of which produce polymers as the building blocks of other materials (clothing, exfoliators, etc.), and secondary sources which result from the breakdown of large plastic debris (Guerranti et al., 2019). Once broken down these microplastics disperse throughout the oceans by surface transport or bottom water transport. While these microplastics are carried to deeper waters or other regions of the ocean, they interact with environmental pollutants which have the potential to bind to plastic polymers (Hartmann et al., 2017). These microplastics are then ingested by marine organisms from all different trophic levels including zooplankton, suspension feeders and marine mammals. Once digested, the bound pollutants become bioavailable in the organism leading to harmful impacts (Botterell et al., 2019).

My specific research will study microplastic pollution in the marine environment of Nantucket Island, located off the coast of Cape Cod, Massachusetts. Microplastic levels will be determined in sand, seawater and suspension feeder samples from Nantucket Harbor, Madaket Beach, and Surfside beach. Additionally, microplastic levels will be studied in seal scat collected from Great Point in the Coskata-Coatue Wildlife Refuge. The data discovered will be used to create a baseline of microplastic pollution levels on Nantucket Island to be utilized for future analysis. Furthermore, this knowledge and information will be shared through public outreach and education.

Botterell, Z. L. R., Beaumont, N., Dorrington, T., Steinke, M., Thompson, R. C., & Lindeque, P. K. (2019). Bioavailability and effects of microplastics on marine plankton: A review. *Environmental Pollution*, *245*, 98–110.

Guerranti, C., Martellini, T., Perra, G., Scopetani, C., & Cincinelli, A. (2019). Microplastics in cosmetics: Environmental issues and need for global bans. *Environmental Toxicology and Pharmacology*, *68*, 75–79. https://doi.org/https://doi.org/10.1016/j.etap.2019.03.007

Hartmann, N. B., Rist, S., Bodin, J., Jensen, L. H., Schmidt, S. N., Mayer, P., … Baun, A. (2017). Microplastics as Vectors for Environmental Contaminants Exploring Sorption, Desorption, and Transfer to Biota. *Integrated Environmental Assessment and Management*, *13*(3), 488–493.

# A SPATIAL ANALYSIS OF MICROPLASTICS AND SORBED POLYBROMINATED DIPHENYL ETHERS IN THE PENOBSCOT BAY ESTUARY, MAINE.

Conner H, Friedman C (huxleyconner@gmail.com), Maine Maritime Academy, Castine, Maine 04420.

This study was a survey of microplastic concentrations in the Penboscot Bay estuary, a generally rural body of water on the central Maine coast. Microplastics are pieces of plastic ranging in size from 300 to 5000 microns that enter the environment as byproducts of plastic manufacture. Dispersal of microplastics throughout the marine environment is mediated by biological, physical, and chemical variables. Microplastics are detrimental to all marine trophic levels: previous studies have shown that microplastics can cause false satiation in plankton, impact the digestive systems of seabirds, and potentially deliver persistent organic pollutants (POPs) to small fish when ingested. The primary objective of this study was to survey surface microplastic densities at four sites (A-D) throughout upper Penobscot Bay, Maine, to see if there was a spatial trend correlated with distance from two major cities just north of station A: Orono and Bangor. Surface particulates were collected by a Tucker trawl net towed along vertical transects at each site. Microplastics were then isolated through wet peroxide oxidation to remove biofilms, and then through density separation, causing the less dense plastic to float and separate. The plastics collected for each tow were massed and divided by the volume of water towed through the net. It was hypothesized that sample sites further upriver (i.e., stations A and B) and closest to these cities' wastewater treatment outfall sites would contain greater microplastic densities. However, it was found that Station A had the lowest plastic densities, while Station C contained the highest. Station C, in the mid-upper region of

Penobscot Bay, was located just west of the Bagaduce River, which is smaller than the Penobscot River but also feeds into the Penobscot Bay. It is likely that the Bagaduce River is a source of microplastic to Penobscot Bay, potentially due to runoff from the small but dense town of Castine, which has a small pollution control facility and the active working waterfront of Maine Maritime Academy, but more work needs to be done in that area to locate specific sources. A secondary objective of this study was to determine whether polybrominated diphenyl ether (PBDE) flame retardants could be detected in microplastics from Penobscot Bay. Microplastics were again collected from Station B, near the town of Bucksport, Maine, then extracted with hexane and methylene chloride. Extracts were analyzed for PBDEs using an Agilent 5973 GC/MS operating in the negative chemical ionization SIM mode with a reagent gas of methane. A 15m DB5-MS capillary column was used for separation. Extracts had detectable concentrations of BDEs 47 and 99, but concentrations were orders of magnitude higher than those found in microplastics in similar studies. Additional studies should be done to clarify whether PBDE concentrations are actually anomalously high or if there was a contamination issue.

# Reconstructed trends of PFAS in sediment cores in Narragansett Bay, Rhode Island, USA

Michaela A. Cashman, Mark Cantwell, Julia Sullivan, Anna Robuck, David Katz, USEPA

Poly- and perfluoroalkyl substances (PFAS) have been used extensively in commercial and industrial applications for decades. Their demonstrated persistence and bioaccumulative properties have resulted in widespread environmental distribution. Our current understanding of PFAS fate in the marine environment is significantly limited by analytical techniques that identify a discreet subset of PFAS compounds. A dated sediment core collected from Narragansett Bay, RI, was analyzed for 24 terminal PFAS compounds. After initial PFAS quantification, a modified Total Oxidizable Precursor (TOP) assay was used to transform PFAS precursors into quantifiable PFAS compounds. PFAS sediment concentrations were compared pre- and post-TOP assay to better understand temporal PFAS distribution in Narragansett Bay. Data showed temporal trends of PFAS accumulation preserved within the sediment record ranging from <1–17.76 ng/g sediment. Compounds including PFOS, PFOA, PFHxA, and PFHpA showed significantly higher concentrations post-TOP assay. These data show that environmental PFAS concentrations are well preserved in the sediment record, and that many PFAS precursors present in the environment are undetected in initial sediment analysis. This suggests that existing PFAS detection methods for marine sediments may underestimate total PFAS concentrations.

Opportunities and Pitfalls for Addressing PFAS in Surface Waters: a New England Perspective.

Jonathan Ali, Ph.D., Toxicologist
New Hampshire Department of Environmental Services

Regulatory actions on per- and polyfluoroalkyl substances (PFAS) are a growing area of risk assessment science, environmental management and public interest. Initial efforts to regulate PFAS have been focused reducing exposure from drinking water sources, but there is growing attention towards the need to protect aquatic resources with surface water standards for certain PFAS. In 2019, environmental agencies from two New England states, New Hampshire and Vermont, developed a plan, budget and time for generating surface water quality standards for multiple PFAS including: perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), and perfluorononanoic acid (PFNA). This effort found that there are significant challenges for establishing criteria at this time, but also found a number of opportunities for important scientific questions related to PFAS. This presentation will provide an overview of problem formulation and potential challenges related to regulation of PFAS within regional surface waters. We will highlight uncertainties and data needs for deriving human health criteria, the existing limitations of aquatic toxicity databases and sampling needs for evidence-based standards. Additionally, other on-going regional collaborations will be highlighted as they relate to interstate and interagency efforts to address PFAS in surface waters.

Lisa McIntosh

Woodard & Curran

Understanding PFAS Ecotoxicity: Where We are Now and Where We Need to Go

Our current knowledge of PFAS ecological toxicity is limited to only a relatively few of the thousands of PFAS compounds known, which poses a significant data gap for assessing ecological risk as part of the site investigation process. We compiled the available ecotoxicological data and identified key knowledge gaps that are critical in understanding the potential for ecological risk and, ultimately, developing accurate and reasonable cleanup objectives. PFAS releases have contaminated multiple environmental media, including biota, on a global scale. The chemical characteristics of many of the shorter-chain compounds suggest a high propensity for solubilizing in surface water, whereas longer-chain constituents may deposit in soils and sediments. While the focus of recent PFAS investigations has largely been on human exposures, the chemical characteristics of PFAS, combined with the ubiquity of PFAS sources, create exposure pathways not only for humans but also for fish, wildlife and other ecological receptors. Indeed, there is an abundance of documentation of PFAS bioaccumulation in a variety of aquatic and terrestrial organisms, demonstrating widespread ecological exposure is occurring across the globe. However, within the large class of PFAS compounds, information on ecological toxicity is limited to only a relatively few PFAS, with the focus of studies mostly on PFOS and PFOA, and on relatively few organisms (mainly aquatic species). The limited information available presents challenges in assessing ecological risk of PFAS, which in turn may significantly impact the outcome of cleanup actions at hazardous waste sites. This talk summarizes the available aquatic and terrestrial ecological toxicity information currently available in the literature, presents ranges of concentrations associated with various adverse effects, discusses the potential application of these data in ecological risk assessment and implications for setting remedial goals, and highlights areas where additional ecotoxicity research is needed.

*PFAS and Human Health Toxicity Complexities*

Amy Rosenstein, US Army Corps of Engineers, New England District, Concord, MA

There have been many obstacles in determining the toxicity of PFAS compounds. We are currently using a 70 parts per trillion standard for groundwater, however this standard is based on several assumptions and uncertainties. This presentation will address how we currently evaluate risk based on what we know, and will highlight uncertainties (such as assessing risks for dermal and inhalation exposures). It will also summarize emerging toxicity evaluation approaches that may come into play in the future.

Greg Drozd
Colby College
Abstract
NAC-SETAC 2021
*The Surprising Sources of Pollution in Today's Air, From Car Exhaust to Personal Care Products.*

Ozone and fine particulate matter ($PM_{2.5}$) are air pollutants of concern for human exposure, with secondary organic aerosol (SOA) typically being the dominant component of $PM_{2.5}$. Combustion sources, such as vehicle exhaust, are typically considered major sources of emissions that lead to ozone and SOA formation, but as stricter regulations continue to reduce vehicular emissions, other sources such as evaporative emissions have become more important in overall pollutant forming emissions in many urban areas of the United States. A significant fraction of these emissions are categorized as volatile consumer products (VCP), ranging from paints, to household cleaners, to personal care products (even deodorant). SOA- and ozone-forming emissions from VCP sources are now estimated to be similar in magnitude to highway vehicle emissions. Questions remain as to how the science of air quality and new regulations should best address the ever-changing sources of air pollution to the air we breathe. In this presentation I will discuss the recent history and near future of key strategies to improve air quality, focusing on the magnitude and potency of pollutant forming emissions

# Effects of 17α-Ethinylestradiol (EE2) and Ketoconazole (KZ) on *Mytilus edulis* Sex Differentiation Gene Expression

Garrett Evensen, Emily Rusin, Bonnie Blalock, William Robinson, Helen Poynton
School for the Environment, University of Massachusetts Boston

*Mytilus edulis,* the common blue mussel native to the north Atlantic Ocean, is a keystone species in intertidal shore communities. Blue mussels are utilized world-wide for monitoring environmental quality of coastal waters including pollutant bioaccumulation and potentially effects from endocrine disrupting compounds (EDCs). Previous work suggests that sexual development and natural sex ratios of *M. edulis* are being perturbed due to EDCs. Estrogen is an important hormone for vertebrate sex differentiation, specifically the female pathway, and possibly for mollusk sex differentiation. Using a gene expression analysis assay, we showed the estrogen, 17α-ethinylestradiol (EE2), causes male mussels to become feminized. The sex ratio of mussels from New York Harbor, a site polluted with EDCs, was skewed towards females. In these mussels, we found that genes involved in female gonad development were significantly upregulated. Furthermore, genes involved in detoxification were also significantly upregulated. In addition, ketoconazole (KZ), a steroidogenesis inhibitor and fungicide, has been shown to reduce aromatase activity (i.e., estrogen production) in a closely related species (*Mytilus trossulus*), which may reduce estrogen production. Therefore, we chose EE2 and KZ to further investigate the effects of EDC pollution on sex differentiation in bivalves. Mussels were collected, and sex was identified using gene expression of a male (VCL) and a female (VERL) gene from hemolymph samples. Males were then exposed to 50 ng/L of EE2, and females were exposed to 30 μg/L of KZ for 26 days. Mantle tissue samples were taken for gene expression analysis of sex determining genes. In males exposed to EE2, *DMRT1L*, a gene involved in male development, was downregulated, while *FoxL2,* a gene involved in female development, was upregulated. This study aims to confirm the feminization of male mussels and further investigate which genes are necessary for sex differentiation in *M. edulis* and how they are affected by pollutants.

**Using Environmental DNA and RNA to Evaluate the Impacts of Nanoplastics on Benthic Invertebrate Communities**

[1] Marissa Giroux (giroux.marissa@epa.gov), [2] Jay R. Reichman, [1] Troy Langknecht, [2] Bonnie M. Smith, [3] Robert M. Burgess, [3] Kay T. Ho

[1]ORISE c/o U.S. EPA ORD/CEMM Atlantic Coastal Environmental Sciences Division

[2]U.S. EPA, Office of Research and Development, Pacific Ecological Systems Division, Corvallis, OR

[3]U.S. EPA, Office of Research and Development, Atlantic Coastal Environmental Sciences Division, Narragansett, RI

Plastic particles are ubiquitous in marine systems and the effects of nanoplastic particles on marine organisms are of growing concern. Nanoplastics enter marine systems primarily through the fragmentation of larger plastics present in the environment, often ultimately accumulating in sediments. Marine sediments act as a sink for many contaminants and are rich habitats for benthic micro- and meiofauna which form the base of the marine food web. However, little is known about the sensitivities of specific species to nanoplastics or the effects on community diversity. Utilizing molecular methods, such as metabarcoding of environmental DNA/RNA, allows for rapid and comprehensive detection of microscopic organisms via high-throughput sequencing and the ability to assess community diversity and structure. The objective of this study was to use an RNA metabarcoding approach to investigate the effects of two different sizes of nanoplastic particles on benthic micro- and meiofaunal community diversity. Sediment cores (mesocosms) were collected from the Narrow River estuary in Rhode Island (USA) and exposed to 200 and 900 nm polystyrene beads at concentrations of 0, 0.1, 1, 10, or 100 mg/kg dry weight in sediment for two weeks. Following exposure, RNA and DNA were co-extracted from the top 1 cm sediment layer, RNA was reverse-transcribed, 18S and CO1 markers were PCR-amplified, and amplicons were sequenced on an Illumina platform. Key differences in the value of environmental DNA compared to environmental RNA for ecotoxicological applications were identified. Significant reductions to α-diversity and β-diversity were observed in 900 nm nanoplastic exposures relative to the other treatments. To our knowledge, this is the first comparison of the effect of different sizes of nanoplastics at the community level, and it highlights the utility of using community endpoints to assess nanomaterial impacts.

Poster

# Spatial and Temporal Variations in the Mercury Content of Narragansett Bay Sediments (RI, USA)

Authors: Colby Peters[1], David L. Taylor[1], Rebecca Robinson[2], John King[2], Brice Loose[2]

[1] Roger Williams University, Dept of Marine Biology, Bristol, RI

[2] University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

Marine and estuarine sediments can provide a historical record of heavy metal contamination in the environment. In this study, stratigraphic profiles of sediment mercury concentrations were examined at four sites in the Narragansett Bay Estuary (Rhode Island, USA). Sediment cores were collected in May and June 2019 using a push piston corer, and in the laboratory, cores were sectioned at 2-cm increments. Sediments were then lyophilized and analyzed for total mercury content (Hg; ppm dry weight) and total organic carbon (TOC; % dry weight) using atomic absorption spectroscopy and loss-on-ignition, respectively. Overall sediment Hg concentrations and depth profiles varied across sites. The highest Hg concentrations were observed in the Providence River near Fields Point (maximum Hg = 2.02 ppm), followed by Greenwich Bay (0.85 ppm), Mt. Hope Bay (0.65 ppm), and mid-Bay, north of Conanicut Island (0.06 ppm). These patterns likely reflect each site's proximity to anthropogenic sources of Hg, as well as spatial variations in sediment TOC levels (range = 1.3 to 5.5%), i.e., Hg was observed to have a high affinity for organic material ($R^2$ = 0.574; $p < 0.0001$). The depth of maximum Hg content also differed across sites (range = 1 to 51 cm), and this is attributed to site-specific sedimentation rates. Finally, sediment Hg concentrations were generally lowest in the deepest portions of the cores, coinciding with the pre-industrial period (< 1820s). In conclusion, the stratigraphic analysis of Hg and TOC in this study provided spatio-temporal insights into the history of Hg contamination in Rhode Island and surrounding waters.

Poster

# Validating the Hot Needle Method for Determining the Presence of Microplastics

Sandra B Robinson (Robinson.sandra@epa.gov), Kay Ho, Michaela A. Cashman, and Robert M. Burgess, US EPA, Atlantic Coastal Environmental Sciences Division, Narragansett, RI 02882

Microplastics are ubiquitous in the marine environment. To study their fate and effects in the environment, researchers need to isolate, extract, and identify plastics from environmental (e.g., water, sediment or tissue) samples. Differentiating a plastic fragment from natural materials such as chitin, wood, silica, or feather can be challenging. Although sophisticated analytical techniques are available for identifying microplastics, they are expensive, time-consuming, and require advanced training. This method determines plastics based on their melting and distortion after a hot needle is applied to its surface. This study documents the method and the responses of many plastics and natural materials to a heated needle. For this study, we weathered seven commercial microplastics (e.g. polyethylene, polyvinylchloride, polypropylene), and applied a heated needle to weathered, non-weathered, and beach-collected samples. We observed changes in the appearance of a variety of plastic and non-plastic materials (e.g., melted, not melted, burned) after being treated with the Hot Needle Method. We captured the response of each sample photographically and assessed the utility of the Hot Needle Method. We observed that this method melted commercial plastic samples (> 40 µm), regardless of weathering. Our findings and photographic documentation of these physical changes strengthen the applicability of the Hot Needle Method to confirm plastics found in environmental matrices.

Poster

# Communication breakdown: The endocrine disruptors, BDE-47 and BPS, alter long term gene expression in mouse brain hormone feedback control when exposed developmentally.

Joshua P. Mogus, Asha Ajmani, Gurpal Singh, Vanessa Harripersaud, Marjorie Pereira Marin, Audrey McAfee, Ryan Paxton, Victoria Salemme, Sudhir Sharma, Amy Stankiewicz, Karen Yip, Laura N. Vandenberg and Alexander Suvorov

Department of Environmental Health Sciences, School of Public Health and Health Sciences, University of Massachusetts, Amherst, MA, USA

Environmental contaminants are ubiquitous, and many structurally different chemicals are known to be endocrine disrupting chemicals (EDCs). When exposures occur during critical stages of development, these chemicals can alter normal hormone signaling, and induce permanent changes in gene expression, leading to endocrine disease. Many EDCs have been studied for their direct effects on endocrine organ development and function. However, few studies address how EDCs can perturb endocrine feedback loops at the level of the pituitary and hypothalamus. Yet, disturbances in either organ may alter hormonal control for axes affecting the gonads, the thyroid, the adrenal, and others. Here we evaluate long-term changes in gene expression in mouse hypothalamus and pituitaries following exposures to BDE-47 or BPS, two EDCs routinely found in the human exposome and shown to have disruptive effects on endocrine organs. Pregnant CD-1 mice were treated daily with environmentally relevant doses of either EDC from pregnancy day eight to the end of nursing. Pituitaries and hypothalamus were collected from offspring at 20 weeks of age and analyzed for global gene expression via RNA sequencing or targeted gene expression via qRT-PCR. Bioinformatic and gene expression analysis revealed that developmental exposure to BDE-47 suppressed adult pituitary thyroid hormone signaling pathways, while BPS treatment reduced activity of growth hormone and gonadal axis signaling hormones. BDE-47 and BPS also had convergent disruption of innate and adaptive immune cell signaling, inhibition of NF-kB pathways, and reduction of intracellular signal transduction molecules associated with G-protein–coupled receptors. Importantly, the effects of BPS and BDE-47 on hormone regulating genes were seen in both the pituitary and hypothalamus. This study reveals both unique and shared disruption of two structurally different EDCs on long term endocrine feedback regulation.

Poster

# Using killifish (*Fundulus heteroclitus*) early life stage assessment to connect mechanisms of toxicity to adverse outcomes

Tara Burke[1]*(burke.tara@epa.gov), Madison Francoeur[2]*(francoeur.madison@epa.gov), Hannah Schrader[2]*(schrader.hannah@epa.gov), Bryan Clark[1], Bushra Khan[2], Lesley Mills[1], Nicole McNabb[3], and Diane Nacci[1]

[1] U.S. Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Atlantic Coastal Environmental Sciences Division, Narragansett, Rhode Island
[2] ORISE Fellow, U.S. Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Atlantic Coastal Environmental Sciences Division, Narragansett, Rhode Island
[3] Department of Environmental Toxicology, UC Davis, California

Environmental contaminants adversely impact fish on the organismal level through a variety of pathways that may affect their development, survival, and ability to reproduce. The early life stages of fish are useful to assess the effects of pollutants because they are often more sensitive than adult stages and have the potential for later life impacts that together can affect population persistence. Moreover, linking developmental endpoints to underlying genetic alterations can provide insights into the molecular mechanisms by which pollutants produce adverse biological outcomes, which can serve as a basis for extrapolation of risk to diverse species and pollutants. To assess the risks associated with chemical exposures, early developmental stages of Atlantic killifish (*Fundulus heteroclitus*), an ecologically important species with a well-annotated genome, were exposed via maternal transfer or directly by aquatic exposures in standardized embryo larval assays (ELAs). In ELAs, non-destructive measurements of growth and development are monitored in individuals after exposure until 16 days post-hatching (dph). A subset of embryos were sacrificed for 'omics analyses to reveal molecular mechanisms affected by pollutant exposures. In the presented ELAs, a variety of biological endpoints were measured including embryonic survival, development, phenotypic abnormalities, heart rate and swim bladder size, as well as larval survival and growth. In addition to daily observations, detailed microscopic phenotyping is conducted 10 days-post-fertilization (10 dpf) and was used to examine embryos for developmental abnormalities including, but not limited to abnormal head or body size, hemorrhages of the tail, head, and pericardial area, and heart features such as offset heart chambers and an elongated sinus venosus. Images were taken using a mounted Nikon camera and analyzed with ImageJ processing software. To assess heart function, video analysis of 10 dph killifish embryos was performed with DanioScope software to determine average heart rate in beats per minute by individual embryo. Swim bladder measurements were taken to discern possible treatment effects on inflation. Larval length measurements were taken at 0 (dph), 7 dph, and 16 dph to determine larval growth rates. Our results provide examples showing that the concentration and type of chemical exposures had varying effects on the frequency and severity of each developmental endpoint. The evaluation of developmental endpoints at the organismal level is an important component in the risk assessment of chemical exposures. These data can be used directly to inform ecological models, including Individual Based Models, under development for killifish that predict adverse chemical outcomes at the population level, which often cannot be measured directly. Furthermore, by connecting molecular mechanisms to developmental endpoints, adverse outcomes measured in killifish for specific chemical exposures can be extrapolated to untested species and chemical pollutants.