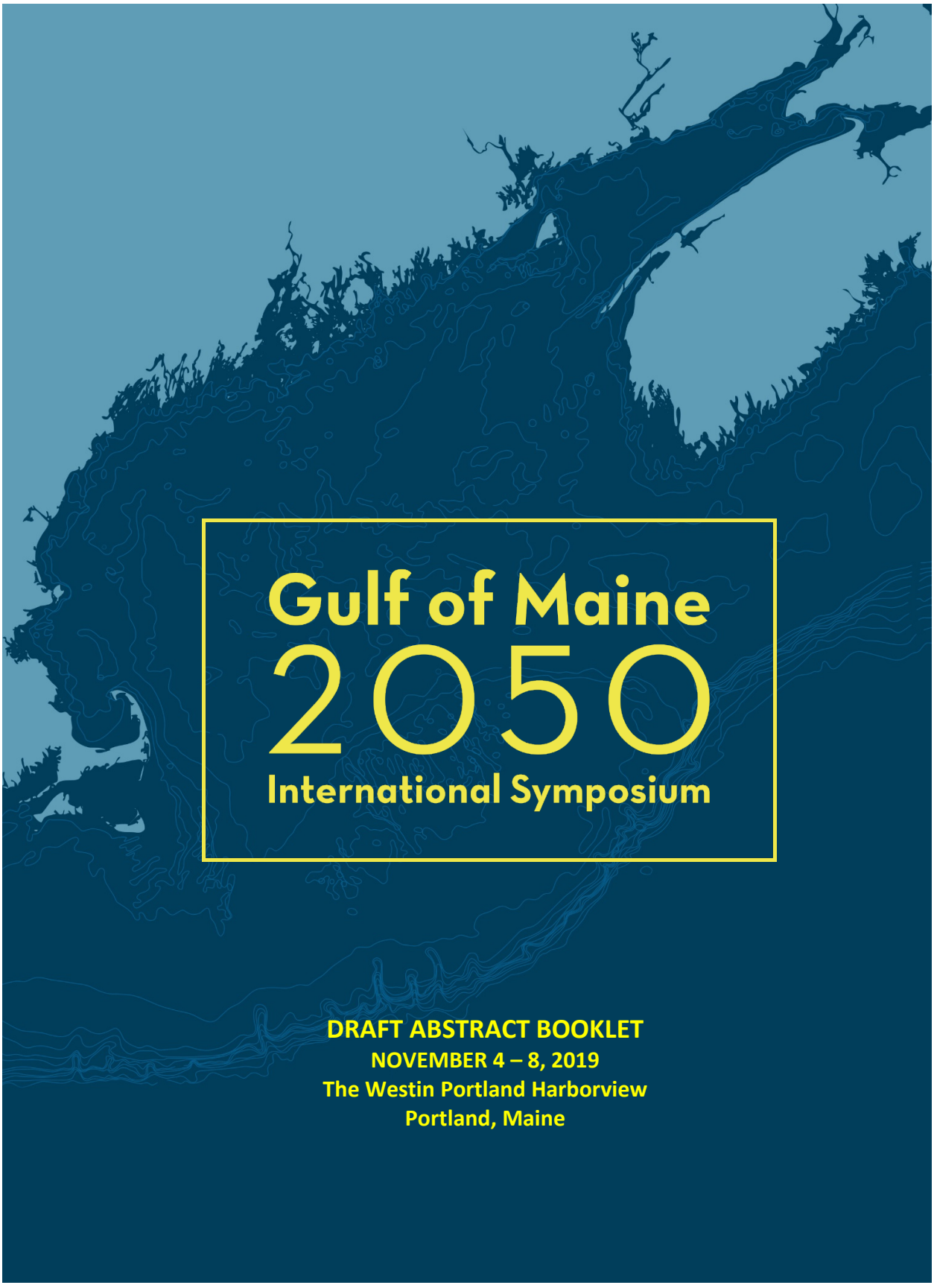

DRAFT ABSTRACT BOOKLET

NOVEMBER 4 – 8, 2019

The Westin Portland Harborview

Portland, Maine

This booklet provides abstracts for oral presentations, lightning talks and posters to be presented during the Gulf of Maine 2050 International Symposium. Abstracts are listed in alphabetical order by presenter.

Day 2 Poster

Coastal Massachusetts StoryMap: Compilation of reports and data from the USGS-CZM Sea-floor Mapping Program

Authors: Seth D. Ackerman and Elizabeth A. Pendleton (U.S. Geological Survey, Woods Hole Coastal and Marine Science Center, Woods Hole, MA 02543)

Presenter: Seth D. Ackerman, sackerman@usgs.gov

Data and interpretive reports from the 16+ year U.S. Geological Survey (USGS) - Massachusetts Office of Coastal Zone Management (CZM) cooperative Sea-Floor Mapping Program have been compiled into a StoryMap narrative, providing quick and easy access to the various data releases and descriptive reports in a creative and innovative format. Since 2003, this USGS-CZM cooperative has published more than 20 reports and data releases including geophysical and geologic survey data, interpretive maps and descriptive reports. Data from this mapping program cover 2,400 square kilometers of Massachusetts state waters are complemented by data from other USGS collaborations in Massachusetts Bay and Stellwagen Bank, and are available online. Recently, composite datasets, including regional mapping products, geologic interpretations, and a statewide digital elevation model have been produced and are available online and through web services. The StoryMap showcased here presents vignettes from several of the survey areas and includes descriptions, images, and new interactive maps made from published datasets. This StoryMap can also serve as a landing page for publications from the USGS-CZM mapping cooperative, for links to related resources such as links to USGS data portals, and to other products from similar collaborations. These mapping data, as well as the various products derived from them, provide valuable information about seafloor composition and morphology, marine resources, benthic ecosystems, and coastal processes and resiliency. Data from the mapping program will continue to inform coastal management and policy decisions in coastal Massachusetts. This Coastal Massachusetts StoryMap will increase discoverability of the data and science, serve as an outreach tool for USGS and collaborators, and provide a project overview site for the USGS-CZM Sea-Floor Mapping Collaboration.

Day 3 Lightning talk, Poster

Presenting the Northeast Ocean Health Index dashboard

Authors: Jamie Afflerbach, (National Center for Ecological Analysis & Synthesis, UC Santa Barbara, Santa Barbara, CA 93101) Courtney Scarborough (National Center for Ecological Analysis & Synthesis, UC Santa Barbara, Santa Barbara, CA 93101)

Presenter: Jamie Afflerbach, afflerbach@nceas.ucsb.edu

The Northeast Ocean Health Index (OHI) measures what people in the US Northeast value about their ocean and provides a holistic picture on how to manage ocean benefits sustainably for future generations. The Index uses best-available data to measure progress toward target conditions for benefits provided by the marine ecosystem such as Biodiversity, Food Provision, Tourism & Recreation, Clean Waters and more. Using the Northeast Ocean Plan as a starting point, eight distinct benefits (also termed 'goals') were identified and measured on a scale from 0 to 100 for 11 sub-regions in the Northeast from New York to Maine. The OHI also incorporates regional pressures on ocean health (e.g. climate change, habitat destruction) as well as resilience measures meant to boost and maintain future ocean health. OHI scores and data layers are displayed in an interactive web-based dashboard allowing managers, stakeholders, and the general public to dive into the data and understand how Ocean Health is changing in the Northeast over time. The OHI can serve regional ocean planning by providing a big picture perspective on ocean health based on data and priorities specific to the Northeast. We hope to present our dashboard in an interactive manner at the GOM2050 symposium.

Day 2 Poster

New high-resolution continuous bathymetry and topography for the Southern Gulf of Maine.

Authors: Brian D. Andrews (U.S. Geological Survey, Woods Hole, MA), Wayne E. Baldwin (U.S. Geological Survey, Woods Hole, MA), Daniel W. Sampson (Massachusetts Office of Coastal Zone Management, Boston, MA)

Presenter: Brian D. Andrews, bandrews@usgs.gov

A new terrain model covering the Massachusetts Coastal Zone provides the first continuous state-wide framework to support the Massachusetts Ocean Management Plan and visualize the State's near coastal and submerged landscape. This dataset, published in 2018 under a collaborative effort between the U.S. Geological Survey and the Massachusetts Office of Coastal Zone Management, makes available both an inventory of the highest-resolution source datasets available, and a 10-m resolution grid divided into four contiguous geographic areas. These data are currently used to inform state managers tasked with making decisions, such as identifying zones of potential inundation from floods, hurricanes, and sea-level rise, and guide the permitting of submerged cables, pipelines and other offshore infrastructure projects. In addition, the data inventory highlights seafloor areas covered by older survey data (lead-line soundings, single beam sonar), or data gaps, that should be updated with new high-resolution multibeam and lidar surveys. Data are available for download at: https://doi.org/10.5066/F72806T7 .

Day 3 Poster

Holding on to Historic Managers: Providing a Forum for River Herring Wardens in Massachusetts and Using Citizen Science to Support State Management

Authors: Abigail Franklin Archer, Cape Cod Cooperative Extension & Woods Hole Sea Grant, Jo Ann Muramoto, Association to Preserve Cape Cod & MassBays Cape Cod, Sara Grady, North & South Rivers Watershed Association & MassBays South Shore, John Sheppard, Massachusetts Division of Marine Fisheries

Presenter: Abigail Franklin Archer, aarcher@barnstablecounty.org

Anadromous river herring (Alosa pseudoharengus & Alosa aestivalis) migrate through Gulf of Maine marine waters, estuaries, and rivers and provide forage for many fish, bird, and mammal species. Humans utilize river herring as well for subsistence, commercial, and recreational fishing. Most coastal towns in Massachusetts have employed 'herring wardens' since the 1700s to regulate harvest and keep the rivers free of barriers to upstream and downstream passage. In the 1940s formal agreements between towns and Massachusetts Division of Marine Fisheries (DMF) were created to jointly manage local river herring fisheries. Beginning in the 1990s river herring populations experienced sharp declines which prompted DMF to institute a moratorium in 2006 prohibiting harvest, possession, and sale. To support efforts to restore populations, the MassBays National Estuary Program through its regional coordinators organized volunteers to observe and count upstream migrating river herring using a methodology developed by DMF to estimate run sizes using visual counts. At the same time, management of these species was being discussed by federal, regional, and state entities but few comments were being received from town-based herring wardens. In 2011 a group called the 'River Herring Network' was formed to provide a forum for these historic managers to discuss their intensely local knowledge and observations of their particular 'runs', and for herring count volunteers to learn about how the data they were collecting was being used by fisheries managers. Funding from a variety of sources was received to develop and maintain a website and hold annual meetings. Participation remains strong and in 2018 the eighth annual meeting was held with 69 people in attendance. The experience of the River Herring Network provides an example of how local stewards and citizen science volunteers can inform state, regional, and federal fisheries management & protection efforts.

Day 3 Poster

Maintaining the Collection of Long-Term Monitoring Data on Water Quality, Shellfish Growth, and Shellfish Disease in Cape Cod Bay

Authors: Abigail Franklin Archer, Cape Cod Cooperative Extension & Woods Hole Sea Grant, Joshua Reitsma, Cape Cod Cooperative Extension & Woods Hole Sea Grant

Presenter: Abigail Franklin Archer, aarcher@barnstablecounty.org

In Cape Cod Bay annual monitoring is carried out by the Barnstable County Cape Cod Cooperative Extension Marine Program & the Woods Hole Sea Grant Extension Program for nine water quality parameters, for American oyster (Crassostrea virginica) and quahog (Mercenaria mercenaria) growth rates, and for the incidence of oyster disease. These data sets are made available to anyone, but especially aquaculture growers, shellfish harvesters, and to town and state natural resource managers via a website and by request. Starting in 2004 at two important shellfish aquaculture growing areas (Wellfleet Harbor and Barnstable Harbor) Yellow Springs Instruments sondes have been collecting data on temperature, salinity, conductivity, total dissolved solids, depth, pH, dissolved oxygen, chlorophyll, and turbidity. In 2013 a third site was added in Duxbury Bay. Every year since 2003 small oysters & quahogs are deployed in aquaculture gear in Wellfleet Harbor, Cape Cod Bay in Brewster, and Barnstable Harbor. They are left in location for two months and then retrieved, counted, and measured to determine growth rate and percent survival. In 2012 a disease monitoring network was initiated to provide routine testing in aquaculture growing areas and in non-harvested areas. This monitoring has helped provide a better understanding of disease dynamics in the region and helped identify pending outbreaks, giving shellfish growers and resource managers an opportunity to make better-informed management decisions to reduce oyster losses from disease(s). These monitoring programs were begun in response to requests by these stakeholders because the information can be used to make harvest and management decisions. These data sets are also useful as a way to track whether conditions are stable or changing.

Day 3 Lightning talk, Poster

Kelp Farming as a Potential Strategy for Remediating Ocean Acidification and Improving Shellfish Cultivation

Authors: Suzanne N. Arnold (Island Institute, 386 Main Street, Rockland, ME 04841 USA), Nichole N. Price (Bigelow Laboratory for Ocean Sciences, 60 Bigelow Drive, East Boothbay, ME 04544 USA), Paul Dobbins (World Wildlife Fund, 1250 24th Street, NW, Washington, DC 20008), Sabrina L. Groves (Mount Holyoke College, 50 College Street, South Hadley, MA 01075 USA), Brittney L. Honisch (Bigelow Laboratory for Ocean Sciences, 60 Bigelow Drive, East Boothbay, ME 04544 USA), Christopher Hunt (Ocean Process Analysis Laboratory, University of New Hampshire, 8 College Road, Durham, NH 03824 USA), Melissa Melendez (Ocean Process Analysis Laboratory, University of New Hampshire, 8 College Road, Durham, NH 03824 USA), Matthew Moretti (Wild Ocean Aquaculture, LLC / Bangs Island Mussels, 72 Commercial St #15, Portland, ME 04101), Joseph Salisbury (Ocean Process Analysis Laboratory, University of New Hampshire, 8 College Road, Durham, NH 03824 USA), Shawn Shellito (Ocean Process Analysis Laboratory, University of New Hampshire, 8 College Road, Durham, NH 03824 USA)

Presenter: Suzanne N. Arnold, sarnold@islandinstitute.org

Maine is uniquely vulnerable to ocean acidification from both an environmental and socio-economic perspective. To address this vulnerability, Maine was the first east coast state to convene a legislatively established commission to address acidification in its waters and potential impacts on commercially important species. Commission recommendations included research to better understand the carbon capturing role of growing and harvesting macroalgae and determining potential benefits of co-culturing macrophytes, such as kelp, with shellfish. Cultivated seaweed may remove sufficient amounts of CO2 to mitigate acidification at small spatial scales, creating a 'halo' of improved growing conditions for nearby shellfish. We investigated this concept at an Ocean Approved kelp farm in Casco Bay, Maine from 2016-2018. For three growing seasons, instruments moored inside and outside of the kelp farm measured salinity, temperature, dissolved oxygen, pH, and pCO2. During certain time periods, CO2 was lower inside the farm, and as a result, pH was 13% higher and Ω was 23% higher. To determine the spatial extent of the halo, cruises equipped with flow-through sensors operating underway were used to map biogeochemical conditions at high resolution. Although the 'halo' effect can be detected, the strength of this effect is inconsistent over time and space and is likely impacted by a variety of biological and physical factors. To investigate whether the halo can translate to enhanced mussel production, year-old mussel lines were deployed in predator exclusion cages inside the farm and at increasing distances away from the farm for two months. Mussels grown within the kelp farm exhibited shells with significantly greater acute pressure resistance, higher force tolerances to breakage, and greater shell thickness, shell density, and meat mass. This study provides evidence that co-cultivation can provide a strategy for reducing marine calcifier stress and increasing mussel quality.

Day 4 Poster

Do small female lobsters produce low quality eggs?

Authors: Alex Ascher (Darling Marine Center, University of Maine), Grace Andrews (Colby College), Donaven Baughman (Wichita State university), Maura Niemisto (Bigelow Laboratory for Ocean Sciences), David Fields (Bigelow Laboratory for Ocean Sciences), Richard Wahle (Darling Marine Center, University of Maine)

Presenter: Alexander James Ascher, ascher.alex@gmail.com

Recent research reveals that as the Gulf of Maine warms, female American lobster (Homarus americanus) are maturing at significantly smaller sizes. Aside from the lower fecundity associated with smaller adult size, we hypothesize that small females may not invest as much energy per larva as large females, thereby compromising post-hatch performance and survival. Alternatively, reproductive output could be greater if smaller mothers have more opportunities to spawn over their life time, as long as they produce larvae of a similar quality to those of larger mothers. In a two-factor experimental design, we evaluated maternal size effects under two feeding regimes, one with and the other without planktonic food. In the starved treatment we measured larval weight change and respiration rate over 5 days. We found that larvae from large mothers lost weight significantly faster, yet maintained significantly higher mass-adjusted respiration rates after 5 days. In the food saturated treatment larval stages I and II from large mothers weighed significantly more than those from small mothers, and were also significantly longer. Larvae from small mothers developed significantly more slowly, and did not develop beyond stage II during the course of this experiment. These preliminary results suggest that larvae from smaller lobsters are less likely to survive to settlement. Our results may have long-term implications for the reproductive performance of this iconic species in a warming ocean, and in turn broader importance to many Gulf of Maine coastal communities that depend on the fishery.

Day 3 Oral presentation

A Multi-Fidelity Framework and Uncertainty Quantification for Ocean Acidification in the Massachusetts and Cape Cod Bays

Authors: Hessam Babaee (University of Pittsburgh, Pittsburgh PA, 15261 USA), Carolina Bastidas, Micheal Deflippo, Chrys Chryssostomidis, Benjamin W. Bray (MIT Sea Grant, Massachusetts Institute of Technology, Cambridge, MA, 02139 USA) and George Karniadakis (Division of Applied Mathematics, Brown University, RI 02906 USA)

Presenter: Hessam Babaee, h.babaee@pitt.edu

We present a transformative framework to analyze and forecast various quantities of interest (QoI) of acidification in the Massachusetts Bay area and also in the Stellwagen Bank National Marine Sanctuary, which are critical regions for the fishery industry, tourism, for a wide range of ecological and environmental studies, and the blue economy in general. There is a lack of ocean acidification relevant data for the Mass Bay due to the high cost of collecting the samples (cost of buoys, maintenance, etc.). To this end we will present a multi-fidelity framework that systematically exploit all correlations between data from multiple heterogeneous spatio-temporal sources with various degrees of fidelity. We will use data from all available sources: multi-resolution satellite images, in-situ measurements (e.g. buoys, drifters) and opportunistic measurements such as cruises. We will present multi-fidelity models for several QoIs for ocean acidification.

Day 3 Poster

Temperature and ocean acidification changes along the 21-year GNATS transect across the Gulf of Maine

Authors: William Balch (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544 USA), Dave Drapeau (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544 USA), Bruce Bowler (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544 USA), and Nicolas Bates (Bermuda Inst. Of Ocean Sciences, St. George, Bermuda)

Presenter: William M. Balch, bbalch@bigelow.org

The Gulf of Maine North Atlantic Time Series (GNATS) has been running since 1998 with over 200 cruises performed across the gulf, each sampling a wide variety of physical, biological, chemical and bio-optical measurements, taken from ships of opportunity. Slocum glider missions have also been performed since 2008 at approximately a seasonal frequency. The focus of GNATS is the line between Portland, Maine and Yarmouth, Nova Scotia, the widest section across the Gulf. Because one of the goals of this NASA-sponsored program is to validate ocean color satellite measurements, the focus of GNATS is primarily on surface properties that are visible to ocean color sensors. However, one variable consistently sampled over the water column for the entire duration of the GNATS program, is temperature, using expendable bathythermograph measurements (XBT), Moving Vessel Profiler and glider measurements. We will present results of this temperature time series over two decades, stratifying the data by depth and time. The results show extensive recent warm water intrusions into the eastern side of the Gulf at depths of 50-150m depth. We also have sampled the surface seawater carbonate system parameters since 2012. The second half of the talk will address these results, which demonstrate specific periods where the aragonite solubility term (omega) has dropped to values close to 1, with low pH excursions observed across much of the Gulf. We will discuss the factors driving both the temperature and carbonate system variability and put them into perspective of the overall variability in primary productivity of the Gulf of Maine.

Day 2 Poster

Science-Based Ocean Management in Massachusetts: A State-Federal Collaboration

Authors: Walter Barnhardt (U.S. Geological Survey, Woods Hole, MA 02543 USA), Daniel Sampson and Todd Callaghan (Massachusetts Office of Coastal Zone Management, Boston, MA 02114 USA)

Presenter: Walter Barnhardt, wbarnhardt@usgs.gov

The Gulf of Maine faces many challenges from changing coastal and marine environments. For more than 20 years, the U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM) have collaborated to develop scientific information and decision-support tools to ensure that Massachusetts is resilient and can continue to prosper as oceans and coasts change. The primary components of the collaboration are 1. high-resolution seafloor mapping to define offshore hazards, sediment processes, and benthic resources and habitats, and 2. delineation of historical, ocean-facing shorelines to quantify short- and long-term rates of shoreline change. The Massachusetts Oceans Act of 2008 requires that offshore development in the State's coastal ocean - a large (>6500 km2) and complex region of diverse seafloor environments - conforms to a science-based plan that protects 'special, sensitive, or unique resources' such as critical fish habitats. To determine the distribution of these and other resources, a collaborative USGS-CZM program of seafloor mapping began in 2003 and has, to date, covered 2400 km2 or 34% of Massachusetts waters. The maps and data products provide a rational basis for quickly evaluating proposed locations for offshore development, thereby simplifying the permitting process for new pipelines, cables, and energy facilities. In this rapidly transforming region, effective management of coastal resources and climate change adaptation require current data on trends and rates of shoreline movement. Statistical analyses by USGS of historical shoreline data (mid-1800s to 2018) are used to document erosion-prone areas of the coast and improve scientific understanding of the causes of the erosion. The data support efforts by CZM to minimize the impact of erosion on coastal communities and environments, and are publicly accessible through the USGS Coastal Change Hazards Portal (https://marine.usgs.gov/coastalchangehazardsportal/).

Day 2 Lightning talk, Poster

Tools for Action: Addressing Sea Level Rise and its impact on Maine communities

Authors: Sam Belknap, Sea Level Resilience Project Lead, Island Institute, Jeremy Bell, River and Coastal Restoration Director, The Nature Conservancy, Judy Colby-George, GISP, Spatial Alternatives, Elizabeth Hertz, Blue Sky Planning Solutions

Presenter: Sam Belknap, sbelknap@islandinstitute.org

Maine's coastal communities face distinct challenges associated with the impacts of climate change, specifically sea level rise and coastal flooding. Rising seas and more frequent strong coastal storms impact Maine's coastal municipalities in many ways. In this session, you will be introduced to two new Maine-specific web tools designed to help communities plan for those challenges. As sea levels rise, there will be impacts to the assessed values of properties in the inundation zone with ramifications to a town's overall assess value. Based on municipal assessing data, the Island Institute's Cost of Inaction tool allows the user to 'flood' the landscape to determine the impact to individual properties and to the town wide commercial and residential values from different flood scenarios. This allows municipalities to weigh the cost of 'doing nothing' against any proposed infrastructure investment addressing sea level rise. The Coastal Risk Explorer, developed by The Nature Conservancy, includes a customized social vulnerability index and an analysis of the impacts of sea level rise on road networks as lifelines critical for residents to access health and emergency response services. Using this tool, a municipality will be able to assess how sea level rise impacts the transportation network and the vulnerable populations within its boundaries. Taken together these two tools provide a community with the ability to examine how future sea level rise and coastal flooding will impact their infrastructure and their finances.

Day 3 Poster

Persistent Organic Pollutants and Climate Change: Assessing Global Risks to Marine Mammals Across Three Oceans

Authors: Susan D. Shaw, Michelle L. Berger (Shaw Institute, 55 Main Street, Blue Hill, ME 04614); Da Chen (Southern Illinois University Carbondale, 1263 Lincoln Drive, Carbondale, IL 62901); Aqqalu Rosing-Asvid (Greenland Institute of Natural Resources, Box 570 3900 Nuuk, Greenland); Sandra Magdalena Granquist (The Icelandic Seal Center, Brekkugata 2, 530 Hvammstangi, Iceland); Anna Roos (Swedish Museum of Natural History, FrescativÃ¤gen 52, 114 18 Stockholm, Sweden & Greenland Institute of Natural Resources, Box 570 3900 Nuuk, Greenland)

Presenter: Michelle L. Berger, mberger@shawinstitute.org

Marine mammals suffer from complex, concomitant stresses including pollution, climate change, and food web depletion. Except for 'signal' mass die-offs, the extent of these combined effects on their resilience and ultimate survival is unknown. Scientists from the Shaw Institute, Southern Illinois University, Swedish Museum of Natural History, Greenland Institute of Natural Resources, and Icelandic Seal Center are collaborating on a multi-year international study to assess the combined impacts of climate change and pollutants such as emerging, novel flame retardants (NFRs) on cetaceans and pinnipeds from the Gulf of Maine, Baltic, and Arctic regions. Samples (blubber and liver) were collected from nine species inhabiting the Northeast US, Sweden, Greenland and Iceland coasts, including harbor, grey, and ringed seals; harbor porpoises; white-sided and white-beaked dolphins; long-finned pilot, minke, and humpback whales. A total of 43 compounds were analyzed including 19 PBDEs and 24 NFRs: Dechloranes, TBPX (2,3,5,6-tetrabromo-p-xylene), TBOCT (tetrabromo-o-chlorotoluene), PBT (pentabromotoluene), PBEB (pentabromoethylbenzene), HBBZ (hexabromobenzene), BB-101 (2,2',4,5,5'-pentabromobiphenyl), FiremasterÂ® 550 - EHTBB (2-ethylhexyl-2,3,4,5-tetrabromobenzoate) and TBPH (Bis(2-ethyl-1-hexyl)tetrabromophthalate), BTBPE (1,2-bis-(2,4,6-tribromophenoxy)ethane), and others. Concentrations are examined by species, region, age class, and tissue distribution across a 10-year time span. Where possible, the toxic potential of NFRs in tissue and implications for reproductive status and future population health are assessed. This innovative, multi-regional study generates critical, new information about emerging pollutants in marine mammals inhabiting the northern hemisphere. Findings will help determine which species are likely to survive in a radically warming environment and will drive conservation efforts and global policy to curb pollution and warming trends.

Day 3 Poster

Bringing Research to Implementation (working title)

Authors: Pam DiBona (Massachusetts Bays National Estuary Program, Boston MA), Rachel Rouillard (Piscataqua Region Estuary Partnership, Durham NH), Curtis Bohlen (Casco Bay Estuary Partnership, Portland ME)

Presenter: Curtis Bohlen, Curtis.bohlen@maine.edu

(placeholder, more detail on PREP case study forthcoming) Across the U.S., 28 National Estuary Programs (NEPs) implement Â§320 of the Clean Water Act to improve habitats and conditions in nearshore waters, estuaries, and their watersheds. The Gulf of Maine hosts three NEPs centered on 'estuaries of national significance:' Casco Bay, the Piscataqua Region, Massachusetts Bays. The NEPs have no regulatory authority, despite our status as an EPA-funded program. We don't have large endowments - we offer only mini-grants and in-kind support to local partners. We don't bring large stables of lawyers or scientists to the table - our three programs have an average of 3 in-house staff. Instead, we develop partnerships with local decisionmakers and institutions, including nonprofits and schools. We leverage our small funds to support future, more substantial investments. We convene management conferences made up of scientists, planners, business people, communications experts, and community members. In short, NEPs align stakeholders and resources to identify complex problems, and employ local data and scientific research to identify and implement innovative and positive solutions to those problems. Three case studies will provide insights into how data and research can be brought to the table to benefit local efforts: MassBays will describe work with EPA's Office of Research and Development to apply the Biological Condition Gradient approach to set ecosystem targets while gathering historical and contemporary data about habitat and water quality conditions, and applying research findings to set out trajectories for improvement. PREP will describe work in the upper watershed to Casco Bay has been advancing understanding of nutrients in Casco Bay - summarizing available science, facilitating conversations, testing out novel technologies, and supporting research. Finally, we will describe the system for cross-collaboration and shared learning among the NEPs.

Day 4 Lightning talk, Poster

Climate Change Communication Using Strategic Framing

Authors: Aimee Bonanno, Billy Spitzer, Hannah Pickard, and Sylvia Scharf; New England Aquarium, Boston, MA 02110

Presenter: Aimee Bonanno, abonanno@neaq.org

In order to achieve regional resilience to changes expected over the next 30 years in the Gulf of Maine, people need to understand climate change on a systems level. They need to know why it matters, how it works, and what we can do. Yet, communicating climate change research to the public can be tough. Linguistic and framing research has shown that communication differs in comprehension, 'stickiness' (or how well the message is remembered), and transferability (or how well a listener can relay a lesson to others). The National Network for Ocean and Climate Change Interpretation (NNOCCI) has developed a series of tested metaphors and communication tactics based on social science research that rely on shared societal values. We will show how these methods can be applied to extreme weather, ocean acidification, and sea-level rise using tested metaphors and visualizations. This work was made possible by funding from NSF, NOAA, and others.

Day 4 Lightning talk

Scenario planning: a tool to identify management and science needs in a changing climate- Atlantic Salmon and North Atlantic Right Whale Case Studies

Authors: Diane Borggaard (NOAA Fisheries, Greater Atlantic Region, Gloucester, MA, USA), Dori Dick (Ocean Associates Inc., Arlington, VA, USA in support of NOAA Fisheries, Office of Protected Resources, Silver Spring, MD, USA)

Presenter: Diane Borggaard, Diane.Borggaard@noaa.gov

The scenario planning process can inform marine conservation and science needs in a changing climate through the identification and exploration of key drivers and their uncertainty to help prepare for the future. Scenario planning can be informed by vulnerability assessments, but the outcomes can also contribute to vulnerability assessments. The framework has been used by many organizations and was recently piloted by NOAA Fisheries to explore what the agency can do to improve the remnant U.S. Atlantic salmon population resilience to changing conditions in both riverine and marine environments across its current range. Based on the pilot's success, NOAA Fisheries also used scenario planning to explore future conditions for North Atlantic right whales throughout their range and identify possible options to address those conditions to improve recovery. Drivers of change that were common between these scenario planning exercises included warming ocean temperatures, especially in the Gulf of Maine. We will highlight the scenario planning process, multi-disciplinary approach, key drivers considered, and example outcomes to demonstrate its applicability to conservation challenges under a changing climate in the Gulf of Maine.

Day 2 Poster

Implementation of Managed Realignment & Salt Marsh Restoration to Enhance Resilience of Dykeland Communities to Climate Change in the Bay of Fundy

Authors: Tony Bowron (CBWES Inc., Halifax, NS. tony.bowron@cbwes.com), Dr. Danika van Proosdij (Department of Geography and Environmental Studies, Saint Mary's University, Halifax NS. dvanproo@smu.ca), Jennie Graham (CBWES Inc., Halifax, NS. Jen.m.graham@cbwes.com, Chris Ross Bekkers (Nova Scotia Department of Agriculture, Agriculture and Food Advisory Services, Land Protection, Truro, NS. Chris.ross@novascotia.ca), Kevin Bekkers (Nova Scotia Department of Agriculture, Agriculture and Food Advisory Services, Land Protection, Truro, NS. Kevin.Bekkers@novascotia.ca), Bob Pett (Nova Scotia Department of Transportation and Infrastructure Renewal. Halifax, NS. bob.pett@novascotia.ca)

Presenter: Tony Bowron, tony.bowron@cbwes.com

Globally, the practice of re-introducing, where feasible, tidal flow to former agricultural dykelands and the restoration of tidal wetland habitat, has been identified as a viable adaptation method to current and future hazards associated with climate change. While previous efforts to restore coastal wetlands in Atlantic Canada focused primarily on the restoration of resilient and self-sufficient habitats, the increasingly tangible impacts of climate change combined with changing economic landscapes, regulations, and land use practices have shifted and broadened the objectives of these projects. With limited resources available, guidance is required to determine where and how dykes should be re-aligned to optimize ecosystem services, maximize adaptation benefits, minimize economic costs and maintain fertile agricultural land and social, cultural and historic activities. The Making Room for Wetlands project is building resilience to climate change impacts of dykelands in the Bay of Fundy, Canada by developing a framework for implementing managed dyke realignment and demonstrating the success of these strategies. Demonstration sites were selected in collaboration with the Provincial body responsible for dyke maintenance, after a comprehensive dyke vulnerability assessment and builds upon over a decade of collaboration and experience in tidal wetland restoration. Completed and on-going managed realignment projects in Nova Scotia are used as a framework for a discussion on the challenges and opportunities presented for coastal habitat restoration for climate change adaptation. The design, implementation and monitored restoration trajectory at multiple sites in the Bay of Fundy will be presented to inform feasibility and design of future projects.

Day 2 Poster

New Geological Observations of the Seafloor and Subbottom of Cape Cod Bay, MA

Authors: Laura L. Brothers, David S. Foster, Seth D. Ackerman, Wayne E. Baldwin, Brian D. Andrews, Daniel Kennedy, William Danforth, Walter A. Barnhardt (US Geological Survey, Woods Hole Coastal & Marine Science Center, Woods Hole, MA)

Presenter: Laura Brothers, lbrothers@usgs.gov

The southern Gulf of Maine contains many resources and is subject to a multitude of competing uses. Managers and scientists often lack the high-resolution data needed to determine sediment abundance and movement, shoreline change, seafloor or shallow geohazards (e.g. scour, natural gas), substrate heterogeneity and other seabed characteristics that impact the use of this region. To address these needs, in 2019 the United States Geological Survey (USGS) Woods Hole Science Center and Massachusetts Office of Coastal Zone Management (CZM) conducted a high-resolution geophysical investigation of Cape Cod Bay, MA. These surveys are the first systematic mapping of the southern-most Gulf of Maine since the 1940s. Geophysical data collected include swath bathymetry, backscatter, and seismic reflection profile data. Groundtruth data, including sediment samples, underwater video, and bottom photographs were also collected. These 2019 data offer an unprecedented view of the Bay's seafloor and subseafloor, and will help define the region's geologic framework. This effort is part of a long-term collaboration between the USGS and the State of Massachusetts to map the State's waters. These seafloor mapping data support both scientific research and resource management objectives.

Day 3 Poster

Exploring the effects of dam removals on zooplankton communities in the Penobscot River estuary

Authors: Erin Bucci Ambrose (University of Southern Maine, Portland 04103 USA), Karen A. Wilson (University of Southern Maine, Gorham, ME 04062 USA), Damian C. Brady (University of Maine, Walpole, ME 04573 USA), Rachel Lasley-Rasher (University of Southern Maine, Portland, ME 04103 USA)

Presenter: Erin Bucci Ambrose, erin.bucci@maine.edu

Estuaries provide many ecosystem services such as buffering the negative impacts of storms, offering recreation and commercial fishing opportunities, and they serve as a critical habitat corridor for migratory fish. In New England, estuarine habitats have been dramatically altered over the last 200 years due to dam construction; migratory fish such as Atlantic salmon and alewives have suffered. There are approximately seven thousand dams in New England, many of which will be up for relicensing in the next few decades. Recently, there have been several dam removal projects in Maine aimed at restoring fish populations - the largest of these efforts being the Penobscot River Restoration Project. In 2013, two dams were removed from the Penobscot River, opening more than 2,000 miles of rivers and streams to sea-run fish. Since 2013, migratory fish such as blueback herring and alewives have dramatically increased in number. While the beneficial effects of dam removal on migratory fish is well documented, less information exists on how dam removal and fish restoration affect nearshore prey communities. Here we present data on the seasonal and annual abundance and diversity of zooplankton in the Penobscot estuary following two dam removals. We couple this information with results from fish diet analysis to better understand the importance of fish predation on estuarine zooplankton communities. Our field surveys reveal a six-fold decrease in zooplankton abundance and notable changes in species composition. Zooplankton, such as copepods, are abundant in the diets of juvenile alewives, and there appears to be distinct preferences for certain species. Whether or not fish predation is driving changes in zooplankton communities remains an open question. These findings contribute to the understanding of trophic dynamics in a coastal system following habitat restoration.

Day 4 Poster

Implications of climate change to the blooms of Alexandrium catenella in the Gulf of Maine.

Authors: Andre F. Bucci (School of Marine Sciences, University of Maine, Orono, ME, 04469 USA), Andrew C. Thomas (School of Marine Sciences, University of Maine, Orono, ME, 04469 USA).

Presenter: Andre F. Bucci, andre.bucci@maine.edu

Gulf of Maine surface waters are warming faster than the global average and at an increased rate over the last decade. The implications of these rapid changes in temperature on the biota, especially Harmful Algal Bloom species, are still a topic of current research. Our goal is to assess the changes in phenology of HABs of Alexandrium catenella associated with variations in temperature in the Gulf of Maine (GoM). We used Sea Surface Temperature anomalies (SSTa - OISST) from 1984 to 2018 focused in 3 regions in the GoM (Bay of Fundy, Eastern and Western Maine Coastal Currents). These SSTa were compared to variations in timing, duration and magnitude of A. catenella blooms in the Bay of Fundy from a 27-year (1988-2014) time series and to shellfish toxicity data (1985-2005) along the Maine coast. The current average start, peak and end dates of A. catenella blooms in the Bay of Fundy are, respectively, days 166 (mid-June), 198 (mid-July) and 213 (early August). A significant regression shows warmer SSTa years result in blooms of A. catenella shifting earlier in the year. Projecting SSTa to the year of 2050 by the current rate of +0.7ËšC to +0.5ËšC/decade (max/min) (see Thomas et al., this meeting), we can expect the average start, peak and end date of blooms to be as early as days 125/133, 151/160 and 170/178, respectively. If the SSTa and bloom date regression holds true for the Eastern Maine Coast, we could expect blooms to start, on average, in late May (day 143) based on SSTa trends of the region. Other bloom metrics (duration and magnitude) do not have a significant relationship to SSTa. For the coastal shellfish toxicity, no clear relationship with SSTa is observed. The long-term increase in SST and associated changes in stratification are likely to impact the development of HABs in the GoM. The shift in timing of the blooms associated with increased global warming must be taken into account when planning water quality and shellfish closures monitoring strategies.

Day 2 Poster

Incorporating marsh migration into traditional river and wetland restoration efforts

Authors: Mike Burke, Nick Nelson, Caitlin Alcott all with Inter-Fluve, Inc.

Presenter: Mike Burke, mburke@interfluve.com

Ecological restoration of tidal and lowland areas is occurring throughout the country for a variety of reasons, including flood attenuation, supporting species habitats, ecosystem resilience, levee/barrier retirement or upgrades, improved public access to natural areas, and more. Recent years have seen marsh migration strategies, including landscape assessments, site-level modeling, risk assessment, and species habitat needs, incorporated into the existing techniques for restoration of river and wetland habitats that are becoming threatened by sea level rise. Here we present some of the opportunities and complexities of incorporating marsh migration efforts into the restoration of two different types of historical agricultural lands: peatlands in the Northeastern US, and endangered salmon habitat in the Pacific Northwest.

Day 4 Poster

Modeling Subsurface Lagrangian Pathways in a Changing Gulf of Maine

Authors: John Irving (Florida State University, Tallahassee, FL 32306 and Stonehill College, Easton, MA, 02357) Elaina McDowell (Stonehill College, Easton, MA, 02357), Anna Pinckney (Stonehill College, Easton, MA, 02357), Taylor Ladue (Stonehill College, Easton, MA, 02357) , Ruoying He (North Carolina State University, Raleigh, NC 27695), Kristin Burkholder (Stonehill College, Easton, MA, 02357)

Presenter: Kristin C. Burkholder, kburkholder@stonehill.edu

The amazingly productive waters of the Gulf of Maine (GOM) support one of the most biodiverse and economically important marine habitats in the world. This productivity relies on adequate concentrations of nutrients being transported into the photic zone during times of the year when significant amounts of sunlight are present. As such, an understanding of the nature and variability of the pathways that deliver nutrients to the photic zone is desirable. Here, we use output from a high resolution ocean circulation model and a particle tracking code to investigate the Lagrangian pathways by which the nutrients entering the Northeast Channel at depth move around the GOM and enter the photic zone. Furthermore, we investigate the changes in those deep water circulation pathways as the composition of the incoming waters change.

Day 3 Poster

A Video Trawl Survey for Atlantic Cod (Gadus morhua) in the Gulf of Maine.

Authors: Travis Lowery (University of Massachusetts Dartmouth, School for Marine Science and Technology, 836 South Rodney French Blvd, New Bedford, MA 02744), Kevin D.E. Stokesbury (University of Massachusetts Dartmouth, School for Marine Science and Technology, 836 South Rodney French Blvd, New Bedford, MA 02744),

Presenter: Nicholas M. Calabrese, ncalabrese@umassd.edu

Increasing water temperatures in the Gulf of Maine are beginning to cause shifts in the distribution of many fish species and will negatively impact the Gulf of Maine Atlantic cod (Gadus morhua) stock (Planque and Fredou 1999; Drinkwater 2005; Fogarty et al. 2008; Hare et al. 2015), which is already considered overfished. We have developed a survey system that utilizes a live feed video camera mounted inside the codend of a demersal trawl to monitor changes in fish populations and distribution, while reducing the mortality associated with surveying. This system is primarily used with an open codend, allowing fish to be recorded, identified, and quantified as they pass through unharmed, and periodically with a closed codend to collect biological information and verify video observations. Towing with an open codend increases the area of sea floor that can be covered because the net never fills with fish. This increased sampling intensity enables us to more accurately survey lower densities of cod with the population in decline. Seven field trials (2016-2019) have surveyed Stellwagen Bank collecting 261 hours of video, and cod density has decreased from 1.28 MT/Km2 in 2016 to 0.02 MT/Km2 in 2019. We tested the hypotheses that cod counts from the catch and video were similar, and that the distribution of cod along the tow path is homogenous; we accepted the first but rejected the second. The next step involves incorporating a mark-recapture experiment into the survey, using the resulting to cod abundance estimate to quantify the catchability of the net. With a catchability estimate it will be possible to calculate accurate abundance estimates of cod with a known precision. This approach provides a non-invasive method of monitoring the cod population and distribution in the changing environment of the Gulf of Maine.

Day 3 Poster

Evaluating the effect of planktonic foods on larval lobster survival and performance

Authors: Jessica Capista (Darling Marine Center, University of Maine, Walpole, ME 04573), Alex Ascher (Darling Marine Center, University of Maine, Walpole, ME 04573), David Fields (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544), Richard Wahle (Darling Marine Center, University of Maine, Walpole, ME 04573)

Presenter: Jessica Capista, jc824947@wcupa.edu

In the Gulf of Maine, larval settlement of the American lobster (Homarus americanus) to coastal nurseries has been on the decline despite record high levels of broodstock. Recent evidence suggests a potential source of this disparity may be food limitation at the larval stage, prior to settlement, possibly linked to a warming ocean. Few studies have been performed on larval lobster feeding habits, specifically early instar phases. Our study aims to identify how diet affects mortality and molt rates in stage I larvae. We are rearing larvae in the laboratory and exposing them to four different diet treatments: brine shrimp-only (Artemia sp.), phytoplankton-only (Tetraselmis sp.), both foods combined, and a starved control group. Results of this study will help determine the importance of planktonic foods as constituents of the larval lobster diet and the impact of different feeding regimes on survival.

Day 4 Poster

Impacts of climatically-induced environmental variabilities on egg mortality of northern shrimp (Pandalus borealis) in a changing Gulf of Maine

Authors: Hsiao-Yun Chang (University of Maine, Orono, ME 04469 USA), Yong Chen (University of Maine, Orono, ME 04469 USA)

Presenter: Hsiao-Yun Chang, hsiaoyun.chang@maine.edu

The Gulf of Maine northern shrimp (Pandalus borealis) population is at the southern end of their distribution, which makes them very sensitive and vulnerable to climatically-induced environmental variabilities. The shrimp population once supported a significant commercial winter fishery for the New England states. However, the fishery has been on moratorium since 2014 due to recruitment failures in several consecutive years. The issue of parasites infected eggs, the so-called 'white eggs', has long been identified for the Gulf of Maine northern shrimp, which makes eggs nonviable and subsequently hamper the recruitment potential. Furthermore, the infection rates of white eggs were observed to increase with water temperature. However, the impacts of white eggs on the biological productivity and its relation to environmental variabilities have never been quantified for the shrimp population. This study identifies the infection rates of white eggs and examines the effects of biotic and abiotic factors on infection rates and the impacts on shrimp population productivity. Biological samples have been collected by Northeast Fishery Sciences Center bottom trawl surveys for the quantification of parasite-induced egg mortality since 2012. Proportion of white eggs for each female sample is examined. The results are used to account for egg quality and provide information on potential impacts of possible climatically-inducted variability on fish population dynamics.

Day 2 Oral presentation

Assessing the Threat to Gulf of Maine Salt Marsh Ecosystem Services with Rising Sea Level

Authors: Gail L. Chmura (McGill University, Dept. of Geography, Montreal, QC Canada), Dante D. Torio (University of New Hampshire, Jackson Estuarine Laboratory, 85 Adams Point Road, Durham, NH USA), Lee B. van Ardenne (McGill University, Dept. of Geography, Montreal, QC Canada)

Presenter: Gail L. Chmura, gail.chmura@mcgill.ca

Salt marshes are recognized for their provision of many ecosystem services, as: habitat for fish and wildlife, their soils as sinks for nutrients and toxins, buffers for storm energy and most recently as extremely efficient sinks for organic carbon (referred to as blue carbon). Preservation of their ecosystem services requires that marshes maintain their surface elevation in relation to sea level, which on the Gulf of Maine, has been rising for >3,000 yrs. Belowground plant production plays a critical role in expanding marsh volume, thus increasing its surface elevation and its carbon stock. The duration of submergence from accelerated rates of sea level rise associated with climate warming may exceed the endurance of plants on the seaward boundary of marshes, causing loss of vegetation, marsh area, and its carbon sink. To some extent, ecosystem services can be maintained if marshes are allowed to migrate inland a process that requires gentle slopes and absence of constructed barriers (e.g. seawalls and roads). If barriers are present, marshes are put in a 'coastal squeeze'. Carbon stored through restoration (and soon conservation) of salt marshes can be sold on carbon offset markets, helping to fund these efforts. Because markets require that carbon storage be maintained for 100 yrs., we need to assess the potential of coastal squeeze for project approval. We have developed a 'coastal squeeze index' which uses remotely sensed imagery and Lidar to assess the threat of coastal squeeze around marsh borders. The index can be employed on the Gulf of Maine to rank potential marsh restoration sites, identifying those with the most promising future, and marshes that will be the most resilient in the face of sea level rise. With enough data on regional rates of marsh soil and carbon accretion we can also apply the index to predict future carbon stocks as will be demonstrated at Wells, Maine.

Day 2 Oral presentation

Integrated Wind and Wave Stresses Reveal Long-Term Increases in Gulf of Maine Storminess

Authors: Daniel L. Codiga (Massachusetts Water Resources Authority, Boston, MA 02129 USA), P. Soupy Dalyander (The Water Institute of the Gulf, Baton Rouge, LA 70802 USA), and Kenneth E. Keay (Massachusetts Water Resources Authority, Boston, MA 02129 USA)

Presenter: Daniel L. Codiga, dan.codiga@mwra.com

We identify and quantify long-term trends in storm intensity and frequency using 35 years (1985-2019) of wind and wave observations from six stations spanning the Gulf of Maine. The trends became apparent during analysis of winds and waves to help understand inter-annual variability in benthic conditions (infaunal community; depth of apparent redox potential discontinuity) observed by the Massachusetts Water Resources Authority monitoring program in Boston Harbor and Massachusetts Bay. We computed the wind stress using established methods, identified storms as periods when its magnitude exceeded 0.2 Pa for at least 6 hours, and quantified storm intensities using the 'Integrated Wind Stress' (IWindS). IWindS is the area (units Pa-hr) under the wind stress magnitude time series during the storm. Storms with higher average stress magnitude, and/or longer duration, have higher IWindS. We used an annual metric, the cumulative IWindS of all storms from October 1 through May 31, to examine trends. Long-term increases in the annual metric occur at all sites, indicating the regional nature of the trend, and the rates generally increase southwestward. The highest rate is in Massachusetts Bay, where a linear regression through the annual results increased by 112% over the entire period (an increase of 32% per decade, on average) as a result of both increasing storm frequency and increasing storm-average IWindS, the latter mainly due to increasing storm durations. Parallel analysis of wave observations using Integrated Wave Stress demonstrates similar long-term increases in its October through May cumulative annual metric. This work determines trends in observed regional storminess on decadal scales in the Gulf of Maine. Increased storminess may drive associated large-scale changes in, for example, coastal inundation, benthic habitat distribution, water quality, bottom sediment resuspension, precipitation, and river flow.

Day 3 Lightning talk, Poster

Inserting Science into Management: Tales from the trenches

Authors: Dr. Brian Beal (University of Maine at Machias, 116 O' Brien Ave., Machias, ME; Downeast Institute, 39 Wildflower Lane, Beals, ME 04611), Sara Randall (Downeast Institute, 39 Wildflower Lane, Beals, ME 04611), Clint Goodenow (Maine Clammers Association, PO Box 26, Freeport, ME 04032)

Presenter: Chad Coffin, friendsoftheclammers@comcast.net

Large-scale field research conducted by the Downeast Institute and Maine Clammers Association from 2013-2018 overwhelmingly shows that predation, driven by invasive green crabs and warming ocean temperatures, is the cause of the soft-shell clam decline. However, actually putting this information to use in clam management has proven difficult. Adaptation measures have faced resistance from managers and clammers themselves. People that advocate for using science are ostracized and belittled. What do we do when the science isn't enough to convince people to take action?

Day 2 Lightning talk

Are Small Coastal Businesses Thinking About Disaster Preparedness?

Authors: Anne Cox, Wells National Estuarine Research Reserve, Chris Feurt, Wells National Estuarine Research Reserve, Lynne Vachon, Wells National Estuarine Research Reserve, Laura Dolce, Kennebunk-Kennebunkport-Arundel Chamber of Commerce, Werner Gilliam, Town of Kennbunkport

Presenter: Anne Cox, acox@wellsnerr.org

Coastal businesses, a powerful economic engine for Maine, are generally little prepared for storm surge and coastal flooding. Yet lessons learned from previous disasters underscore how important the recovery of businesses is to the overall recovery of a region's economy. The Wells National Estuarine Research Reserve collaborated with the Kennebunk-Kennebunkport-Arundel Chamber of Commerce and the Town of Kennebunkport to help business owners assess their vulnerability to the impacts of a natural disaster using the Tourism Resilience Index. The Index was developed by Mississippi-Alabama Sea Grant and adapted for New England. Best practices identified by businesses and lessons-learned from the project will be shared.

Day 4 Oral presentation

The role of oceanography in the North Atlantic right whale mortality crisis and ensuing policy response

Authors: Sean Brillant (Canadian Wildlife Federation, Halifax NS, Canada), Erin Meyer-Gutbrod (UC Santa Barbara, Santa Barbara CA, USA), Charles Greene (Cornell University, Ithaca NY, USA)

Presenter: Kimberley Davies, kim.davies@unb.ca

Changes in the Gulf of Maine ecosystem have reduced regional food supply for North Atlantic right whales, causing widespread changes in their migratory patterns and habitat use. Driven into new foraging areas in the Gulf of St. Lawrence, Canada, right whales encountered unforeseen risks and 24 animals have died in this region since 2015 due at least partly to ship strikes and fishing gear entanglements. The objectives of our work are to characterize the impact of a changing climate on right whales and their food supply, and discuss the capacity of current regulations to respond to these impacts. In 2010, right whales responded to warming conditions and reduced food supply in the Gulf of Maine within 1 year by shifting their distribution hundreds of kilometers northward where they encountered lethal threats. This demonstrates the need, under the current right whale management paradigm, for rapid regulatory response to changing ocean conditions over extraordinarily large spatial scales. The future of right whales appears to be critically dependent on the adaptability of regulatory response mechanisms at the time scales of less than 1 year. We discuss the feasibility of the current management paradigm to achieve this goal, and review emerging alternate strategies that are more resilient to oceanographic variability as a path toward securing the right whale's future.

Day 4 Poster

Identifying New England's "underutilized species" with a quantitative approach and assessing their availability to consumers in Boston, Massachusetts

Authors: Amanda Davis (DOI Northeast Climate Adaptation Science Center, University of Massachusetts, Amherst; Department of Environmental Conservation, University of Massachusetts, Amherst; Our Wicked Fish, Inc, Deerfield, Massachusetts), Michelle Staudinger (DOI Northeast Climate Adaptation Science Center, University of Massachusetts, Amherst)

Presenter: Amanda Davis, amandad@umass.edu

Climate change is challenging the socio-economic and environmental sustainability of New England's seafood industry by increasing costs for fishers, redistributing fish species, and enhancing the imbalance between consumer demand and nature's supply. This multifaceted challenge highlights a need for innovative solutions that bring together ecological, economic, and social science knowledge to improve decision-making. One initiative that could build resilience is increasing demand for underutilized species. This strategy appears promising since culinary networks are advocating for lesser-known species and consumers are willing to pay a premium for local food. However, since the term underutilized species lacks a specific quantitative definition, regions are limited in their ability to identify - let alone market - their own unique underutilized species during this eat local movement. To ensure underutilized species are consistently characterized, we propose a quantitative definition that includes science-based sustainable fishing metrics that can be consistently calculated within each region. Under our definition, the Northwestern Atlantic region in the United States currently has six underutilized species: 1) Acadian redfish (Sebastes fasciatus), 2) Atlantic pollock (Pollachius virens), 3) butterfish (Peprilus triacanthus), 4) haddock (Melanogrammus aeglefinus), 5) scup (Stenotomus chrysops), and 6) white hake (Urophycis tenuis). Using this definition, we cross-checked information on each species climate vulnerability and seafood sustainability guides. In addition, we assessed over 160 restaurant menus in Boston to determine local capacity and demand for underutilized species. Our project aims to support climate-smart decision-making and purchasing by exploring if consumers and industry are ready for new seafood products to be made with underutilized species and species that are emerging in the New England region due to warming ocean temperatures.

Day 3 Poster

Distribution of emerging contaminants in Massachusetts Bay surface water and biota

Authors: Anna R. Robuck (University of Rhode Island Graduate School of Oceanography, Narragansett, RI 02840), David N. Wiley (Stellwagen Bank National Marine Sanctuary, Scituate, MA 02066), Ben Haskell (Stellwagen Bank National Marine Sanctuary, Scituate, MA 02066), Rainer Lohmann (University of Rhode Island Graduate School of Oceanography, Narragansett, RI 02840)

Presenter: Captain Peter DeCola, US Coast Guard (ret), pete.decola@noaa.gov

Per- and polyfluoroalkyl substances (PFASs) have been produced since the 1940s for use in commercial and industrial applications, including water repellant coatings, surfactants, and vinyl polymerization. The unique, amphiphilic tendencies of PFASs contribute to unique environmental distributions unlike the distribution of legacy organic pollutants such as polychlorinated biphenyls (PCBs). PFASs demonstrate remarkable environmental persistence and bioaccumulative capacity, and have been found globally in drinking water, surface water, and biota, including birds from diverse habitats. Seabirds are particularly useful as indicators of marine ecosystem health and contamination, as their upper trophic level position allows them to assimilate resources and related biological, physical, and chemical conditions across multiple ecosystems and temporal scales. Here we offer preliminary results describing PFASs concentrations in seabirds and surface water from Massachusetts Bay. Samples were cleaned up appropriately and analyzed for 25 ionic and neutral PFASs using liquid chromatography/tandem mass spectrometry in electrospray ionization mode. Perfluorooctanesulfonic acid (PFOS) dominated seabird liver tissue, while perfluoroalkyl carboxylic acids dominated concentration profiles in surface water. Concentration differences and variability in compound dominance could not be attributed to seabird trophic level as approximated by nitrogen stable isotopes. Concentrations observed in both tissue and surface water suggest pervasive PFASs occurrence across the continuum of surface water environments and coastal--pelagic trophic webs supporting seabirds in Massachusetts Bay.

Day 2 Poster

Maine Silver Jackets High Water Mark Initiative

Authors: Project Team Members: Kevin Deneault - City of Portland, ME; William Needelman - City of Portland, ME; Amber Harrison - Town of York, ME; Leslie Hinz -Town of York, ME; Nathan Robbins - Maine DEP; Sue Baker - State of , Maine; Peter Slovinsky - State of Maine; Brian Balukonis - USACOE; Jamie Carter - NOAA; Thomas Hawley - NOAA

Presenter: Kevin J. Deneault, KDeneault@portlandmaine.gov

The story map dashboard provides the ideal platform to combine project processes and final results in a usable and useful format for the public. In this presentation, we will discuss how we publicized and summarized a unique and critical coastal resilience inter-agency project in the State of Maine, and how all levels of government came together to establish the Maine Silver Jackets High Water Mark Initiative for the City of Portland and the Town of York. With the right tools, collaboration, and planning both municipalities were able to select the most cost-effective, and community-enhancing adaptation alternative. The main objective of this project was to resurvey coastal Maine's historic High Water Marks from the 'Blizzard of 78,' and to identify critical High Water Mark sign locations across the City of Portland and the Town of York that will provide essential educational opportunities and outreach, but most importantly, enhance the public's awareness surrounding historic flood events and Sea Level Rise. This key component will further achieve the overall goal in becoming a safer, more resilient Maine.

Day 3 Poster

Monitoring Coastal Carbonate Chemistry in Casco Bay, ME

Authors: R. Michael Doan (Friends of Casco Bay, South Portland, ME 04106

Presenter: R. Michael Doan, mdoan@cascobay.org

Hourly, year-round, measurements of temperature, salinity, dissolved oxygen, chlorophyll fluorescence, pH, and the partial pressure of carbon dioxide are collected at our monitoring station on Cousins Island, Yarmouth, ME. In addition, dissolved inorganic carbon, total alkalinity and the saturation state of aragonite are calculated from these measurements. Results from the first three years of deployment of this station are presented, and we begin to better understand the current baseline for these parameters in Casco Bay, and attempt to characterize the carbonate system over several different time scales. Strong daily and seasonal variability exists and appears to be driven by temperature and the balance between primary productivity and respiration. These first three years of monitoring represent only the beginning of a long-term program that will expand to three stations across Casco Bay, including a new station in heavily nutrient-loaded Portland Harbor and another new station at the other end of the bay in the freshwater influenced New Meadows system.

Day 4 Poster

Overwinter Distribution and Movement of Adult Razorbills (Alca torda) Breeding in Atlantic Canada.

Authors: Mark D. Dodds (University of New Brunswick, Saint John, New Brunswick, E2K 5E2, Canada), Heather L. Major (University of New Brunswick, Saint John, New Brunswick, E2K 5E2, Canada), Antony W. Diamond (University of New Brunswick, Fredericton, New Brunswick, E3B 5A3, Canada), Robert A. Ronconi (Environment and Climate Change Canada, Dartmouth, Nova Scotia, B2Y 2N6, Canada)

Presenter: Mark D. Dodds, mdodds@unb.ca

Winter conditions have significant carry-over effects on seabird breeding performance, recruitment rates, and adult survival, influencing lifetime reproductive success of individuals and populations. However, gaps in information on seabird overwinter distribution are frequent and often the result of technical and logistical limitations created by the size of the areas over which they disperse and uncertainty in source populations for birds observed at sea. This has been particularly discernible in studies of Razorbills (Alca torda) breeding in Atlantic Canada. Our primary objective was to refine the current understanding of overwinter movements of Razorbills breeding in Atlantic Canada. Using geolocators, we obtained position estimates of complete nonbreeding season movement for 34 individuals from four colonies (Machias Seal Island, New Brunswick; Bicquette Island, Quebec; James and Gull Islands, Newfoundland) from 2011-2018. Core overwintering areas (50% kernel home range) were concentrated in the Gulf of Maine and Bay of Fundy, Nantucket Shoals and Georges Bank, and Cape Hatteras. Core areas of Newfoundland breeding populations overlapped throughout the entire nonbreeding period, however breeding populations from each province remained separate during the post-breeding period until December. Overlap among breeding populations was highest in January, February, and April and occurred within the Gulf of Maine. 38% of tagged individuals breeding on Machias Seal Island did not leave the Gulf of Maine for the duration of the nonbreeding season. This study is the first to describe the overwinter movements of Razorbills breeding in Atlantic Canada and emphasizes the importance of the Gulf of Maine as an overwintering area.

Day 4 Lightning talk, Poster

The New England Arctic Network

Authors: Katharine A. Duderstadt (The University of New Hampshire, Durham, NH 03284 USA), Robin Alden (Maine Center for Coastal Fisheries, Retired, Stonington, ME 04681 USA), Robyn A. Barbato (Cold Regions Research and Engineering Lab, Hanover, NH 03755 USA), Paul A. Berkman (Tufts University, Somerville, MA 02144 USA), Jennifer F. Brewer (The University of New Hampshire, Durham, NH 03284 USA), Cara J. Condit (U.S. Coast Guard Academy, New London, CT 06320 USA), Jack E. Dibb (The University of New Hampshire, Durham, NH 03284 USA), Jessica Ernakovich (The University of New Hampshire, Durham, NH 03284 USA), Christopher Gerbi (University of Maine, Orono, ME 04469 USA), Lawrence C. Hamilton (The University of New Hampshire, Durham, NH 03284 USA), Susan A. Kaplan (Bowdoin College, Brunswick, ME 04011 USA), Larry A. Mayer (The University of New Hampshire, Durham, NH 03284 USA), Erich C. Osterberg (Dartmouth, Hanover, NH 03755 USA), Donald K. Perovich (Dartmouth, Hanover, NH 03755 USA), Rebecca Pincus (U.S. Naval War College, Newport, RI 02841 USA), Terry Shehata (The University of Southern Maine, Portland, ME 04104 USA), Ruth K. Varner (The University of New Hampshire, Durham, NH 03284 USA), Cameron P. Wake (The University of New Hampshire, Durham, NH 03284 USA), Simone S. Whitecloud (Cold Regions Research and Engineering Lab, Hanover, NH 03755 USA).

Presenter: Katharine A. Duderstadt, katharine.duderstadt@unh.edu

The Arctic is warming twice as fast as the rest of the globe, with some models predicting a summertime ice-free Arctic by 2050. Ice-free shipping routes combined with shifts in ocean circulation and regional climate patterns linked to Arctic ice melt will affect trade, transportation, coastal ecology, and many other aspects of the natural, socioeconomic, and built environment: not only in the Arctic but also in mid-latitude coastal regions such as New England. With profound changes on the horizon, this is a critical opportunity for communities surrounding the Gulf of Maine to prepare for the uncertain yet inevitable economic and environmental impacts of Arctic change. The nascent New England Arctic Network (NEAN) is a regional, multi-institutional, and inclusive collaboration that promotes resilience in the Gulf of Maine region by uniquely addressing links between Arctic change and natural, social, and built systems. NEAN strives to combine the wealth of academic expertise in Arctic research across New England with researchers, stakeholders, and external partners concerned with environmental, economic, and social domains, providing an ideal community for anticipating and responding to Arctic change and its implications for the eastern coast of North America. There is an urgent need to expand our nation's focus in Arctic research beyond Alaska and the Pacific Arctic in order to study and respond to changes in the North Atlantic Arctic, including links with the Gulf of Maine and New England. This regional network in affiliation with other nascent networks in Canada and Europe will foster connections and research collaborations among people living and working throughout the greater North Atlantic Arctic region.

Day 4 Oral presentation

Embracing Ecosystem Change and Creating Resilience: Lessons Learned from CFRF's Lobster and Jonah Crab Research Fleet

Authors: Aubrey Ellertson (Commercial Fisheries Research Foundation, Saunderstown, RI 02874 USA), Christopher Glass, PhD (Commercial Fisheries Research Foundation, Saunderstown, RI 02874 USA)

Presenter: Aubrey Ellertson, aellertson@cfrfoundation.org

Over the past several decades, southern New England waters have experienced dramatic and widespread warming. This has had profound impacts on key fisheries resources, such as American lobster. Southern species are increasingly appearing off the coast of southern New England, new species and markets are emerging, and the fishing community must adapt. Increases in water temperature have likely resulted in changes to American lobster size at maturity and growth patterns, given temperature has a strong influence on these vital processes. In addition, Jonah crab is an emerging fishery of volume and value that has provided lobstermen recently with an opportunity to diversify in response to a decline in the southern New England lobster fishery. Here we focus on changes to southern New England marine ecosystems, how lobstermen have adapted their businesses to the emergence of Jonah Crab, and explore future implications for the Gulf of Maine. Since 2004, the Commercial Fisheries Research Foundation (CFRF) has focused on working collaboratively to build relationships among scientists, managers, and members of the fishing industry to solve problems facing fisheries resources and fishing communities across southern New England. Among the CFRF's greatest accomplishments are the fishermen-led Research Fleets developed in particular for lobster, Jonah crab, and black sea bass, which involve over 40 fishermen collecting biological and environmental data while conducting their normal fishing operations for these valuable resource species. We will review data from CFRF's Lobster and Jonah Crab Research Fleet, and share lessons learned from the Southern New England lobster industry.

Day 4 Poster

U.S. fisheries and climate change: legal and management implications

Authors: None

Presenter: Susan Farady, sfarady@une.edu

Many marine fish species are reacting to the impacts of climate change. Species are moving outside their historical ranges in response to changing ecosystem conditions, such as warmer temperatures and acidification, and experiences related impacts, such as changes to predator-prey interactions and ecosystem function. Changes in fish behavior has direct implications for fishery management. U.S. marine fisheries in federal waters are governed primarily by the Magnuson-Stevens Act that determines, among other things, who is responsible for managing a fish stock, how much fish can be caught, and who is eligible to participate in a fishery. Applying the law to dynamic ecosystems presents significant challenges, as previous geographic definitions become obsolete, and historical stock conditions less relevant. How will the regulatory system react when species move between fishery management council areas? What defensible 'triggers' can declare one fishery obsolete as a species moves out of an area, and another fishery open as another species moves in? How will participation be managed when fishermen may have legal access to a species no longer present where they fish, and not be allowed to catch new species moving in? This presentation will explore how our current fishery management system is being tested by climate change impacts, the scientific and management efforts underway to adapt, the constraints of current law, and ideas for how law and policy could be revised for fishery management in climate-changed conditions.

Day 3 Lightning talk, Poster

Development of a vulnerability assessment for climate effects on the habitats of living marine resources in the Northeast U.S.

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Lightning Talk Presenter: Emily Farr, emily.farr@noaa.gov
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Vulnerability assessments have become an important tool in climate change science. As the Gulf of Maine continues to experience rapid change, it will be important to understand the relative vulnerability of its species, habitats, and communities to that change. In the United States, NOAA Fisheries has developed and implemented a framework for assessing the vulnerability of marine fish and invertebrate species, marine mammals, and sea turtles in a changing climate. This framework has been linked to social vulnerability of human communities through the vulnerability of fisheries. NOAA Fisheries is also responsible for conserving habitats that support fisheries and protected species. Here we describe the development of a trait-based climate vulnerability assessment framework to consider climate impacts on tidal freshwater, coastal, and marine habitats in the Northeast U.S. region. The framework incorporates the key environmental drivers of change and the sensitivity of habitats to those changes, and asks experts to score the sensitivity and exposure of each habitat using available literature and relying on expert opinion. The goal of this project is to provide regional managers and scientists with a practical tool to efficiently assess the relative vulnerability of habitats to climate change. The results of the assessment will contribute to: i) an understanding of the long-term effects of climate change, ii) the identification of particularly vulnerable habitats, iii) decisions regarding the allocation of effort and resources, iv) discussions of adaptation measures for specific habitats, fisheries, or communities and v) link into an expanding set of tools to broadly assess the effects of climate change on aquatic ecosystems - including human communities.

Day 2 Poster

Advances in remote monitoring of salt marshes and their application in the Plum Island Estuary, Massachusetts

Authors: Zafer Defne

Presenter: Amy S. Farris, afarris@usgs.gov

Salt marshes are valuable ecosystems that provide habitat, attenuate waves, cycle nutrients and sequester carbon; unfortunately, they are under threat from many forces, including sea level rise and sediment deficits. One of the largest salt marshes in the Gulf of Maine is the Plum Island Estuary and Parker River salt marsh complex in Massachusetts. The US Geological Survey has applied two new methods for monitoring salt marshes to this important salt marsh. The first method is the calculation of the areal unvegetated/vegetated marsh ratio (UVVR) metric. The UVVR is the ratio of the unvegetated marsh area to the vegetated marsh area; it is calculated using high-resolution elevation data and imagery. This metric has been shown to correlate well with sediment budgets and can be an indicator of marsh vulnerability. The second method is a novel technique to delineate marsh shorelines using remotely sensed elevation data. This method calculates the abrupt change in elevation that usually characterizes the seaward edge of a salt marsh, designated the 'marsh scarp.' The marsh scarp is defined as the maximum slope along a cross-shore transect between mean high water and mean tide level. The calculated marsh scarp closely follows the edge of vegetation seen in imagery. As more data are collected, shoreline change can be calculated along these transects. Consequently, the UVVR (or change in the UVVR) can be used to predict which parts of the marsh complex are most vulnerable while the recurring shoreline measurements can monitor any erosion at the edge of the marsh.

Day 3 Lightning talk

A future-looking bi-national Integrated Ocean Observing System for the Gulf of Maine

Authors: J. Ruairidh Morrison (Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), United States Integrated Ocean Observing System (U.S. IOOS)), Shayla Fitzsimmons (Atlantic Region, Canadian Integrated Ocean Observing System (CIOOS-Atlantic)

Presenter: Shayla Fitzsimmons, Shayla.fitzsimmons@dal.ca

Oceans have no boundaries, no borders. Events in the Atlantic Ocean often affect ecosystems and economies in both Canada and the United States. For example, the rapid warming observed over the past several years in the Gulf of Maine, which has impacted ecosystems and economies in both countries. This cross-border effect emphasizes why international collaboration is essential to understanding our changing oceans. To this end, NERACOOS of the US IOOS and the Atlantic Regional Association of CIOOS (CIOOS-Atlantic) are working to build a strong and forward-looking partnership for ocean observation in the Gulf of Maine. We envision a bi-national system which builds upon the work completed to date: a system which encompasses both ocean observation and data management best practices; a system which eases data discovery across borders through harmonization of data formats, metadata profiles and QA/QC processes; and a system which emphasizes meaningful and ongoing communication and consultation with stakeholders, so as to ensure regional coordination and a strategy which addresses the needs of the local oceanographic community. NERACOOS and CIOOS-Atlantic were formed approximately a decade apart, but with a shared vision: providing high-quality ocean information that, by 2050, will be indispensable in protecting lives and property, empowering coastal economies and improving the health of our oceans. This presentation will expand upon the envisioned bi-national system, which will ultimately provide a platform essential to understanding and progressing on issues such as sea-level rise and precipitation, ocean (and coastal) acidification, and warming waters.

Day 4 Poster

The changing intertidal zone: invasive species influence on hard substrate communities in a fast warming climate

Authors: Caroline E. Foy, Heather L. Richard, Mary E. Stack, Dr. Susan D. Shaw (Shaw Institute, Blue Hill ME 04614 USA)

Presenter: Caroline Foy, cfoy@shawinstitute.org

The coast of Maine, made up of roughly sixty percent rocky shoreline, is one of the fastest warming bodies of water in the world and is particularly vulnerable to coastal acidification. Marine hard substrate communities play a vital role in coastal Maine economy and ecosystems. The increasing population of the invasive green crab (Carcinus maenas) has altered community structure, biodiversity, and predator-prey interactions. Green crabs can have both direct and indirect effects on intertidal communities. Recruitment boxes have previously been used on soft sediment environments; with the addition of boxes containing hard substrate, the two environments, their stressors, and the subtle interactions between organisms can be better understood and compared. This study investigated the effects of predator and grazer species on biomass and biodiversity in hard substrate communities. Two organism recruitment boxes were installed in the mid tide region of Peters Cove, Blue Hill, Maine. One box was open to predators and grazers (such as Carcinus Maenas and Littorina littorea), while the second box was closed. Twelve porcelain settlement tiles were suspended vertically within both boxes, removed approximately once a month, and analyzed for biomass and diversity. Zooplankton tows were used to verify the presence of bivalve juveniles in the water column. Sediment and overlying water pH, as well as salinity, were collected at the sample site. Due to isolation from C. maenas and L. littorea, it is expected that the tiles in the closed box will have more biomass and biodiversity than those in the open box. Organism recruitment boxes will be removed and analyzed for results in October 2019. Investigating the green crab's effect on the rocky intertidal can provide a better understanding of what drives the changes observed along Maine's coast. The results will help determine the most efficient management and mitigation strategies for the Gulf of Maine.

Day 4 Poster

Assessing vessel traffic threats to right whales in the Gulf of Maine: A framework for assessing risk given anthropogenic and climatic factors.

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Presenter: Laura Ganley, laura.ganley@gmail.com

The Gulf of Maine contains important seasonal feeding grounds for endangered North Atlantic right whales (Eubalaena glacialis). The region has experienced rapid warming over the past decade due to climate change. Over the last eight years, multiple survey teams have recorded substantial changes in sighting rates of right whales, with lower rates in some feeding habitats (e.g., Bay of Fundy) and higher rates in others (e.g., Cape Cod Bay). The time of year during which right whales and other Regional Species of Greatest Conservation Need occupy these key habitats will impact the effectiveness of conservation and management actions designed to protect them from human activities, such as fishing and shipping. The present work focuses on developing spatiotemporally dynamic maps characterizing the threat posed by vessel traffic to right whales in the Gulf of Maine. Our approach overlays right whale habitat maps, derived from marine mammal survey data and remotely sensed environmental data, with automatic identification system (AIS) vessel traffic data to generate dynamic threat maps. We will highlight general results from our work including: 1) Seasonal dynamics of vessel traffic in the Gulf of Maine and 2) space- and time-resolved risk maps showing co-occurrence of vessel traffic and right whale habitat-use patterns. Our approach is intended to be generalizable to additional anthropogenic stressors, such as trap-pot fishing activity. Results will provide information on the vulnerability and adaptive capacity of right whales and other marine mammals to changing environmental conditions, and can aid long-term resource management planning efforts seeking to reduce anthropogenic causes of marine mammal injury and mortality.

Day 3 Poster

Informational assessments and needs to help forecast ocean chemistry in coastal waters of the northeast

Authors: J. Ruairidh Morrison (Northeastern Regional Association of Coastal Ocean Observing Systems, NERACOOS), Changsheng Chen (University of Massachusetts Dartmouth, UMassD), Joseph Salisbury (University of New Hampshire, UNH), Jennifer Brewer (UNH), Aaron Strong (Hamilton College), Jason Goldstein (Wells National Estuarine Research Reserve, NERR), Erik Chapman (NH Sea Grant), Meredith White (Mook Sea Farm), Riley Young-Morse (Gulf of Maine Research Institute, GMRI), and Jackie Motyka (NERACOOS)

Presenter: Parker Gassett, jackie@neracoos.org

In recent years, Ocean and Coastal Acidification (OCA) has become an issue of significant concern for coastal communities in the Northeast United States. To address this problem, decision-makers including state and local resource and environmental managers and stakeholders including shellfish growers and wild harvest fishers need to understand how the impacts of OCA will affect their livelihoods and their work (Mathis et al., 2015; Weisberg et al., 2016). A newly funded research effort is working to address this need by creating a regional OCA forecast model that aims to provide outputs that can lead to actionable information on OCA impact thresholds for stakeholders and managers. This project will expand the Northeast Coastal Ocean Forecast System (NECOFS) to include carbonate system parameters critical for assessing OCA impacts. A critical component of this effort is garnering input from members of the stakeholder and management community to help define threshold detection and warning capabilities. To ensure that the forecasts and decision-support products that ultimately result from this modeling effort are useful to individuals and businesses in the region, we desire input from the community of coastal stakeholders in the Northeast. Specifically, recognizing that OCA is one concern out of many in our changing coastal ocean, we want to hear how model-based forecasts of OCA impacts can be incorporated into the daily work of coastal businesses and managers. Are people concerned about certain conditions, changes or impacts; would alerts be helpful? Please visit our poster to learn more about this project and to let us know what matters most to you when it comes to the future of the Gulf of Maine.

Day 2 Poster

Environmental DNA (eDNA) Ecosystem Monitoring in the Gulf of Maine

Authors: Jason Goldstein (Wells National Estuarine Research Reserve, Maine Coastal Ecology Center, Wells, ME USA), Chris Peter (Great Bay National Estuarine Research Reserve, Great Bay Discovery Center, Greenland, NH USA), Laura Crane (Wells National Estuarine Research Reserve, Maine Coastal Ecology Center, Wells, ME USA), Devin Thomas (University of New Hampshire, Hubbard Genomics Center, Durham, NH USA), Briana Fischella (Great Bay National Estuarine Research Reserve, Great Bay Discovery Center, Greenland, NH USA), Alison Watts (University of New Hampshire, Dept. Civil & Environmental Engineering, Durham, NH USA)

Presenter: Jason S. Goldstein, jsgoldstein2@gmail.com

Environmental monitoring programs are essential foundations for assessing estuarine condition and response to key drivers of change. Advances in DNA methods and rapid reductions in analytical costs present an opportunity to harness this new technology and fundamentally improve our capacity to monitor biological communities and individual species. In Gulf of Maine coastal and estuarine waters both Wells (ME) and Great Bay (NH) National Estuarine Research Reserves are evaluating the use of eDNA analysis within their ongoing estuarine monitoring framework. eDNA samples are collected with standard water quality monitoring at both sites, in coordination with fish seine sampling in Great Bay, and with larval trawls at Wells. These results will be used to a) develop baseline eukaryote biodiversity profiles at established long-term monitoring locations; b) evaluate the value of eDNA for both adult and larval fish community surveys, and c) provide initial guidance on challenges associated with the use of eDNA for invasive crab detection.

Day 4 Poster

The brighter side of climate change: How local oceanography amplified a lobster boom in the Gulf of Maine

Authors: Robert Steneck, Richard Wahle, Damian Brady

Presenter: Andrew Goode, andrew.goode@maine.edu

Ocean warming can drive poleward shifts of commercially important species with potentially significant economic impacts. Nowhere are those impacts greater than in the Gulf of Maine where North America's most valuable marine species, the American lobster (Homarus americanus), has thrived for decades. However, concerns are growing as monitored shallow water young-of-year lobsters decline and landings shift to the northeast that the regional maritime economies will suffer. We examine how the interplay of ocean warming, tidal mixing, and larval behavior results in a brighter side of climate change. Since the 1980s lobster stocks have increased fivefold. We suggest this increase resulted from a complex interplay between lobster larvae settlement behavior, climate change, and local oceanographic conditions. Specifically, postlarval sounding behavior is confined to a thermal envelope above 12ºC and below 20ºC. Summer thermally-stratified surface water in southwestern regions have historically been well within the settlement thermal envelope. Although surface layers are warming fastest in this region, the steep depth-wise temperature gradient caused thermally-suitable areas for larval settlement to expand only modestly. This contrasts with the northeast where strong tidal mixing prevents thermal stratification and recent ocean warming has made an expansive area of seabed more favorable for larval settlement. Recent declines in lobster settlement densities observed at shallow monitoring sites correlate with the expanded area of thermally-suitable habitat associated with warmer summers. This leads us to hypothesize that the expanded area of suitable habitat may help explain strong lobster population increases in this region over the last decade and offset potential future declines. It also suggests that the fate of fisheries in a changing climate requires understanding local interaction between life-stage-specific biological thresholds and finer scale oceanographic processes.

Day 2 Poster

Looking Back over 20 Years of Tidal Wetland Restoration Projects in Nova Scotia, Canada

Authors:

Presenter: Jennie Graham (CBWES Inc., Halifax, NS. Jen.m.graham@cbwes.com)
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Tidal wetlands play a key role in our environment, particularly in the face of the increasing risks associated with climate change and rising sea levels. Since 2000, efforts have been underway throughout Nova Scotia to stem the tide of coastal habitat loss, and to restore, were feasible, some of the 80% of salt marshes previously lost due to the construction of dykes, tidal barriers (causeways), and coastal development. As our awareness of the impacts and implications of climate change for our coastal infrastructure and communities grows, so to is the recognition that new ideas and new ways of managing our shorelines are going to be needed. Although the solutions of the past maybe woefully inadequate for the challenges of the future, the two decades of collaboration and experience in coastal wetland restoration can inform and guide the nature-based approaches to climate change adaptation. This poster will showcase the 19 completed, or in progress, projects restoring almost 500 ha that the collaborative team of CBWES-SMU has worked on in partnership with the NS Department of Transportation and Infrastructure Renewal and the NS Department of Agriculture.

Day 3 Poster

The Eastern Maine Coastal Current Collaborative: Building a Regional Network and Research Framework to Support EBFM

Authors: Jon Hare (Northeast Fisheries Science Center Woods Hole ME USA 02543), Carl Wilson (Maine Department of Marine Resources Boothbay ME USA 04575)

Presenter: Carla Guenther, cguenther@coastalfisheries.org

The Eastern Maine Coastal Current Collaborative (EM3C is a project between Maine Center for Coastal Fisheries, NOAA Fisheries, and the Maine Department of Marine Resources to develop a research framework that supports ecosystem-based fisheries management in the Eastern Maine Coastal Current and its associated watersheds. An ecosystem-based approach provides a comprehensive and collaborative mechanism with the goal of improving the resiliency of coastal communities and the sustainability of fisheries. This approach provides an opportunity for adaptive processes by which we can learn and evolve approaches to management. Active participation from tribal and local stakeholders is essential. To this end, EM3C hosted a State of the Science conference in June 2019 to bring together experts from local governments, fishing, science, and academic communities. The conference is the first step toward producing a comprehensive understanding of our current knowledge of Eastern Maine's watersheds, intertidal, nearshore, and offshore ecosystems. Through a unique mix of local community and fishing industry, academic, state, and federal speakers we have sparked a rich dialogue toward producing a deep understanding of a local community fisheries vision and building the human network necessary to support it.

Day 3 Poster

Ocean acidification impairs the ability of American lobsters (Homarus americanus) to respond to food odors

Authors: Benjamin C. Gutzler (University of New Hampshire, Durham, NH 03824 USA), Winsor H. Watson III (University of New Hampshire, Durham, NH 03824 USA), Jason S. Goldstein (Wells National Estuarine Research Reserve, Wells, ME 04090)

Presenter: Benjamin C. Gutzler, bg1067@wildcats.unh.edu

Lobsters are perhaps the most iconic species in the Gulf of Maine, and consequently a great deal of research has been devoted to their responses to climate change, including ocean acidification (OA). Most of the work examining the effects of OA on lobsters has been focused on physiological impacts, especially on larval stages. However, OA can also alter the behavior of juvenile and adult lobsters in ways that are as yet poorly understood. We conducted a series of raceway trials and found that despite no change in overall activity levels relative to ambient conditions, lowering the pH causes lobsters to take longer to react to and locate a food item placed in the tank. This is likely indicative of an impaired olfactory ability, which may alter lobster foraging success and social behaviors, as well efficacy of baited traps in the fishery. An improved understanding of the full suite of effects that OA has on lobsters throughout all stages of their life history will be important to ensure we are able to predict what the implications of climate change are for this economically and culturally significant species.

Day 3 Oral presentation

Preliminary results from a study of deepwater ocean acidification in Stellwagen Bank National Marine Sanctuary

Authors: Joseph Salisbury (University of New Hampshire), Cynthia Pilskaln (University of Massachusetts, SMAST), Benjamin Haskell (NOAA Stellwagen Bank National Marine Sanctuary)

Presenter: Benjamin Haskell, ben.haskell@noaa.gov

Deepwater carbonate dynamics in the Gulf of Maine are not well-understood yet it is increasingly important to reveal this missing piece of the carbonate dynamics puzzle. In late 2011, we deployed a suite of sensors as a pilot project to study acid dynamics near the ocean floor, and to evaluate the feasibility of incorporating ocean acidification monitoring sensors on passive acoustic monitoring moorings already in place in Stellwagen Bank National Marine Sanctuary (SBNMS). Two deployments were conducted between December 2011 and October 2013 to capture all seasons. The calibrated instrument package was mounted at a depth of 83 m on an existing mooring and was designed to measure CO2, pH, oxygen, temperature, salinity and beam attenuation. Our results revealed high CO2 and correspondingly low aragonite saturation throughout much of the deployment period. We also observed an apparent coupling in time between surface and near-bottom CO2 implying that dynamics driving acidification near the ocean bottom may be closely coupled to the downward flux of particulate organic matter from phytoplankton blooms at the surface. These results and the leveraged measurement approach used to obtain them, help to solidify the scientific need and methodologies that can be applied to ocean acidification monitoring in the Northeast region. This study highlights the need for several sentinel sites in the GoM, such as SBNMS, where intensive monitoring can fill current gaps in our understanding of the complex chemical and physical dynamics of the GoM particularly in the deep waters. In a rapidly changing environment such as the Gulf of Maine monitoring results from sentinel sites are needed to provide early warning indicators for the many ocean-dependent businesses in the region.

Day 4 Lightning talk

Warming Waters Create Opportunity for Diversification and Collaboration: Addressing the Rise of Black Sea Bass in Southern New England

Authors: Thomas Heimann (Commercial Fisheries Research Foundation, Kingston RI 02881), Christopher Glass (Commercial Fisheries Research Foundation, Kingston RI 02881), Jason McNamee (Rhode Island Department of Environmental Management Division of Marine Fisheries, Jamestown RI 02835)

Presenter: Thomas Heimann, theimann@cfrfoundation.org

Black sea bass is an ecologically and economically important species, but assessment and management efforts have not been reflective of the shifting distribution and growing abundance of this species, in part due to a dearth of data throughout the species range and the northward shift in the range of black sea bass likely in response to warming waters. As a result, thousands of pounds of black sea bass are discarded and economic opportunities are lost. To address this issue, a Black Sea Bass Research Fleet was constructed to engage fishermen from a multitude of gear types to collect critical biological black sea bass data. Further, this model for fisheries dependent data collection allows for catch and discard characterizations to begin understanding the extent fishermen are interacting with the northward shifting black sea bass. Black sea bass are also retained for analysis of sexual maturity, diet, and age to investigate any biological changes in the species as it shifts northward. To date, the Research Fleet has sampled over 15,000 black sea bass at sea and collected over 1,500 black sea bass for laboratory analysis. Black sea bass have already established a transient seasonal presence in the Gulf of Maine and will likely continue to expand in the coming decades as waters continue warming. The Research Fleet will be assessed as a case study of effective industry collaboration to increase trust in management and assessment of a species. Further, this project can serve as a model to apply in the Gulf of Maine to proactively address the shifting range of black sea bass and reduce potential conflicts.

Day 4 Poster

How do species-specific thermal niches affect predator-prey overlap?

Authors: M. Elisabeth Henderson (Stony Brook University, Stony Brook, NY 11790 USA), Andrew J. Pershing (Gulf of Maine Research Institute, Portland, ME 04101 USA), Janet A. Nye (Stony Brook University, Stony Brook, NY 11790 USA)

Presenter: M. Elisabeth Henderson, mehenderson11@gmail.com

Temperature is a key driver in animal distributions and abundances globally. Species-specific spatio-temporal responses to temperature changes may result in potential mismatch between predator and prey species as well as new community compositions. Recent declines in Northwest Atlantic herring recruitment have driven dramatic cuts in fishery quotas. The mechanisms of this decline are not certain but potential match-mismatch between herring and preferred prey species during larval and/or adult life stages is a theory. Habitat models for herring adults and larvae and their preferred zooplankton prey species were calculated from trawl survey observations. Metrics of annual predator-prey overlaps in time and space were modeled using high-resolution simulated bottom temperatures. We found that the overlap of the thermal habitat of Atlantic herring with their prey at both the larval and adult stage is decreasing in the spring and increasing in the fall. Favorable predator-prey overlap during the fall season may explain the transition to more summer and fall spawning in western Atlantic herring populations and/or low recent low recruitment.

Day 2 Poster

Lunar cycle and haul-out abundance of harbor seals and gray seals at Duck Island, Maine and surrounding ledges

Authors: Holly Hoag (University of New Hampshire), Andrea Bogomolni (Woods Hole Oceanographic Institute), Lisa Settee (Center for Coastal Studies), Nadine Lysiak (Suffolk University)

Presenter: Holly Hoag, david.buck@unh.edu

There is a suspected relationship between the lunar cycle and seal haul-out abundance at low tide. Determining if these factors are related could have implications for when surveys are conducted in order to obtain a more accurate population estimate of Phoca vitulina vitulina (harbor seal) and Halichoerus grypus atlantica (gray seal). An accurate population estimate allows for conservation and management strategies. Photographic surveys are a method of obtaining a minimum count for pinniped populations. The surveys for this study are conducted during daylight hours within a certain time frame surrounding low tide as this is when pinnipeds, such as harbor seals, are more likely to be hauled out. Haul-out abundance of gray seals in relation to low tide is more variable. This study utilized data collected from long-term survey effort on Duck Island and the surrounding ledges from 2011-2019. Statistical analysis involved running an effects test with moon phase, as well as other abiotic factors in order to attribute variance to other sources. The abiotic factors were weather, low tide of the day (first, second, or only) and the year. It was found that moon phase does not have an effect on haul-out abundance. However, year, and weather have an effect on both harbor and gray seal haul-out abundance. In addition, it was found that the first low tide of the day had a greater gray seal haul-out abundance. This study found that timing of surveys should not be adjusted for moon phase during the day. Surveys should take place during weather conditions found to have greater haul-out abundances such as when precipitating or overcast, and at the first low tide of the day for maximum gray seal counts.

Day 4 Poster

Spatiotemporal Differences in Atlantic Sea Scallop Growth in the Northern Gulf of Maine & Influence of Environmental Factors

Authors: Cameron T. Hodgdon (University of Maine, Orono, ME 04469 USA), Yong Chen (University of Maine, Orono, ME 04469 USA)

Presenter: Cameron T. Hodgdon, cameron.hodgdon@maine.edu

Simulation-based assessment tools coupled with large-scale and consistent monitoring efforts contribute to the overall success of the Atlantic sea scallop (Placopecten magellanicus; ASC) fishery on the North American east coast. However, data from the northern Gulf of Maine (NGOM) are usually excluded from the assessment because limited monitoring effort and an overall lack of information regarding the growth of ASCs in this region have led to large uncertainty of fine-scale dynamics. The objectives of this study are to determine if ASC growth varies spatially and/or temporally across the NGOM and if the variation in growth can be explained in part by variability in bottom temperature and bottom salinity. To achieve these objectives, ASC shells have been continually collected through a partnership between the University of Maine and Maine Department of Marine Resources since 2006. Individualistic ASC length-at-age curves are developed to evaluate small and large scale spatio-temporal variabilities. In comparison to ASC growth on Georges Bank and in Southern New England, it appears that ASCs in the Northern Gulf of Maine are growing at a similar rate yet have the potential to grow to a larger size. No clear spatio-temporal trends in ASC growth are identified in the NGOM. However, the generalized additive models reveal that bottom temperature and bottom salinity may be influencing inter-annual variabilities by proxy. This may imply changes in ASC growth in the future with increasing warming in the Gulf of Maine.

Day 3 Poster

Public health effects of fecal indicator bacteria pollution at beaches on the Blue Hill Peninsula

Authors: Michelle L. Berger, Mackenzie Hulme, Kendall Billig, Mary E. Stack (Shaw Institute, 55 Main Street, Blue Hill, ME 04614); Michael G. Murnik (Northern Light Blue Hill Hospital, 57 Water Street, Blue Hill, ME 04614); Susan D. Shaw (Shaw Institute, 55 Main Street, Blue Hill, ME 04614)

Presenter: Mackenzie Hulme, mhulme@shawinstitute.org

The public health risk of polluted swimming beaches is a nationwide concern and is a significant issue in Maine because of its long coastline and many lakes. The U.S. Environmental Protection Agency (EPA) has established that Enterococcus bacteria, one of many microorganisms in feces, are good 'indicators' of the presence of pathogens known to cause gastrointestinal illness. The EPA has set recommended water quality criteria based on these fecal indicator bacteria to minimize risk of illness in swimmers. This project focused on the Blue Hill Peninsula, an area with rocky and muddy beaches that are not currently included in the state's bacteria monitoring program, Maine Healthy Beaches (MHB). For the past 10 years, the Shaw Institute (SI) has been using MHB and EPA protocols to monitor local beaches with weekly or bi-weekly measurements of enterococci as indicators of fecal contamination in Blue Hill Bay. Last year, a collaboration developed between SI and Northern Light Blue Hill Hospital with the purpose to explore links between swimming beach water quality and public health on a local scale. During the summer of 2019, SI monitored bacteria 1-2 times per week at four local beaches with additional sampling following bacterial spikes to obtain a detailed picture of seasonal patterns. Additionally, beach-goers were surveyed about their water exposure and recent illness history on days corresponding with bacteria sampling. Interviewers then followed up with participants regarding new and ongoing illness symptoms 7-10 days after the initial beach survey. By the end of the summer, this study will yield detailed bacteria monitoring data as well as health outcome data from at least 100 family groups including a range of swimmer ages. The results of this project will be applicable to many communities throughout northeast Maine where small, locally popular rocky beaches are common, and will provide useful information for local management and monitoring agencies.

Day 2 Lightning talk

Case Study: Cape Cod's Regional Floodplain Specialist Position Promotes Resilience

Authors: Shannon Hulst Jarbeau (Woods Hole Sea Grant / Cape Cod Cooperative Extension, Barnstable County, MA)

Presenter: Shannon Hulst Jarbeau, shannon.jarbeau@barnstablecounty.org

Barnstable County, MA (Cape Cod) and Woods Hole Sea Grant are working to improve resilience to flooding, storms, and sea level rise through the creation of a county-wide Floodplain Specialist and Community Rating System Coordinator. The position, the first of its kind in the country, assists Cape Cod towns with participation in the Community Rating System (CRS), a federal program offering discounts on flood insurance in exchange for actions that reduce flood risk. The program promotes resilience by providing an incentive to communities to improve flood safety and by encouraging the uptake of flood insurance for residents, thereby bolstering a community's best resource for fast recovery after a storm. Many communities, particularly in New England, opt not to participate in the CRS because the program requires documentation levels that are difficult for towns with limited resources to meet. The Barnstable County CRS Coordinator reduces this burden by managing the CRS program on a regional basis, streamlining the process for participating towns. In addition, the regional Coordinator provides guidance on actions that communities can take to improve their flood resilience. In addition to CRS support, the Floodplain Specialist/CRS Coordinator also provides technical assistance to communities, residents, and businesses on basic floodplain compliance, flood insurance, and flood mitigation. This assistance, combined with the CRS work, helps improve flood resilience overall through expanded risk awareness, new actions taken to reduce flood risk, and better enforcement of flood-related regulations. The Barnstable County floodplain program was awarded the James Lee Witt Award for Excellence in Local Floodplain Management in 2017 by the Association of State Floodplain Managers, and served as the model for a federal bill in the National Flood Insurance Program reauthorization to create more of these positions through the country.

Day 3 Poster

Comparing Independent Approaches to Estimate Age of the Jonah Crab (Cancer borealis): Corroborating Gastric Mill Band Counts as a Direct Aging Method

Authors: Carl Huntsberger (School of Marine Sciences, University of Maine), Richard Wahle (School of Marine Sciences, University of Maine), Yong Chen (School of Marine Sciences, University of Maine), Raouf Kilada, (OceAge)

Presenter: Carl Huntsberger, carlton.huntsberger@maine.edu

Age determination is essential to understanding key life history parameters for fisheries management. Direct aging methods for fishes and mollusks typically rely on counting annual growth bands preserved in calcified structures. Crustaceans pose a unique challenge in this respect since all calcified structures are lost with each molt. Recent evidence from several taxa of decapod crustaceans suggests that the bands present in thin sections of the gastric mill, a gizzard like structure of the foregut, may accumulate with age. The current project describes the application of this method to the Jonah crab (Cancer borealis), an ecologically important species and a newly managed fishery in New England, for which no direct aging method has yet been established. The gastric mill band counts correlate with size, suggesting they may be a promising indicator of age. Existing growth data are sparse and only available for larger crabs. To corroborate the band count method, a probabilistic molt model has been produced from a laboratory growth study and a length frequency analysis, including young of year crabs. The independent aging methods have been compared corroborating the use of gastric mill band count method, providing the first direct method for aging Jonah crabs.

Day 3 Poster

Comparing Chemical and Physical Properties of Prehistoric and Modern Samples of Mya arenaria in Saco Bay

Authors: Danielle Jolie (University of New England), Dr. Joseph Kunkel (Marine Science Department, University of New England), Dr. Arthur Anderson (Department of Society, Culture, and Language, University of New England), Dr. Ali N. Bahadur (Bruker Labs, Billerica MA)

Presenter: Danielle Jolie, djolie@une.edu

This is an interdisciplinary research project that utilizes archeology and marine biology to study the effect of Climate Change on Mya arenaria. Climate Change has been increasing ocean carbon dioxide levels, which causes an increase in acidity. Mya arenaria are Mollusks with calcium carbonate exoskeletons. A lower ocean pH, lowers the concentration of calcium carbonate because carbonate ions are less abundant. A decrease in carbonate ions makes building shells much more difficult. Ancient Mya arenaria were collected from Archaeological dig site ME 5.06 on Saco Bay, dating from c. 1000 BC to AD 1500. Current samples were retrieved from Saco Bay, ME during spring of 2018. Samples were then sent out to Dr. Ali Bahadur at Bruker Corporation in Billerica, MA to scan through a microCT. Two density standards were included, Calcium Fluoride or Aragonite, due to similar penetration by X-rays. Standards are needed to translate relative density into actual density. The standards and shells were sent through a microCT machine and the sample density was returned to UNE as 3000 bmp file slices of voxel density. ImageJ was used to calculate the mean, standard deviation, minimum, maximum, and mode for selected areas of voxel X-ray density. R was then used to fit a linear regression line for the standards of known density to their X-ray density. Density calculated with R shows that the density of Midden samples are ranging higher than the density of Modern samples. Statistical analysis will be run on the density calculations to determine if there is a significant difference between shell densities from modern and ancient samples. Previous studies have been conducted to show that ocean acidification is a global issue, but no studies have been done yet to determine the damage it is doing to current Mya arenaria off the coast of Maine. This study will help determine if there is a need to protect Mya arenaria from ocean acidification as climate change progresses.

Day 3 Poster

Contaminants of emerging concern in the Gulf of Maine: An assessment by the NCCOS Mussel Watch Program and the Gulf of Maine Gulfwatch Program

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Presenter: Steve Jones, stephen.jones@unh.edu

Since 1986, the National Centers for Coastal Ocean Science (NCCOS) Mussel Watch Program (MWP) has monitored the nation's coastal waters for legacy chemical contaminants and biological indicators of water quality. Due to the decreasing trend in legacy contaminant concentrations, and in order to meet current monitoring needs, the MWP began a rotational regional sampling model to analyze contaminants of emerging concern (CECs). CECs such as pharmaceuticals and personal care products (PPCPs), perfluorinated compounds (PFCs), alkyl phenol compounds (APs), polybrominated diphenyl ethers (PBDEs), polybrominated biphenyls (PBBs), alternative flame retardants (AFRs), and multi-residue pesticides (MRES) are finding their way into aquatic environments and resources. In 2015 and 2016, the MWP and the Gulf of Maine Gulfwatch Program worked together to sample 41 sites across the Gulf of Maine to characterize the magnitude and distribution of a suite of more than 200 CECs being monitored by the MWP in coastal environments nationally. This study, which included sites in Massachusetts (17), New Hampshire (7), Maine (14) and Nova Scotia (3), showed that CECs in six of the seven contaminant groups (all except PBBs) are being bioaccumulated in bivalves at varying degrees in the Gulf of Maine. Contaminants were detected at all 41 sites with PBDEs and PPCPs being the most detected groups followed by PFCs and APs. Detections were typically compound driven, with a small subset of contaminants representing the majority of detections within each group. This regional monitoring data, combined with other CEC data collected by the MWP from California, the Chesapeake Bay, Charleston Harbor, and the Gulf of Mexico, will provide a unique national perspective to local results and serves as baseline tool for directing more targeted management and monitoring actions at state and regional levels.

Day 4 Poster

Climate Challenges to Fisheries Management in a Rapidly Changing Ecosystem

Authors: Andrew Pershing (Gulf of Maine Research Institute, Portland ME 04101 USA), Katherine Mills (Gulf of Maine Research Institute, Portland ME 04101 USA), Samuel Truesdell (Gulf of Maine Research Institute, Portland ME 04101 USA), Gavin Fay (School for Marine Science & Technology, UMass Dartmouth, New Bedford MA 02744), Steve Cadrin (School for Marine Science & Technology, UMass Dartmouth, New Bedford MA 02744), Jonathan Cummings (School for Marine Science & Technology, UMass Dartmouth, New Bedford MA 02744), Sarah Gaichas (Northeast Fisheries Science Center, Woods Hole, MA 02543), Min-Yang Lee (Northeast Fisheries Science Center, Falmouth, MA 02540), Anna Birkenbach (University of Delaware, Newark, DE 19716).

Presenter: Lisa Kerr, lkerr@gmri.org

The Northeast U.S. shelf ecosystem has warmed rapidly, with a long-term warming trend that is four times the global average rate and recent decadal warming that is faster than most of the global ocean. Climate-mediated change in this region is unprecedented, and the impacts of climate change on marine fisheries resources, such as changes in productivity and shifts in distribution, are increasing. These changes are challenging the U.S. fishery management system and as the effects of climate change become more apparent, acknowledging the realities of non-stationarity and developing methods to integrate climate information into the fishery management process will be essential for sustainable fisheries management in this century. The goal of this research is to review the U.S. fishery management process and consider how climate change impacts different components of the system. We evaluate the following aspects of the management process: 1) scientific components (system observations and understanding, and stock assessment), 2) policy and governance components (risk tolerance, setting catch advice, and allocation of quota), and 3) regulatory components (monitoring, enforcement, fishing behavior and catch/bycatch). We focus on how changes in species distribution and productivity impact the different components of the fishery management system. We identify short-term solutions that could be implemented within current management or fishery decisions and highlight longer-term solutions that may require more systematic changes or adjustments to major policies. Our analysis is focused on commercial fisheries and the federal fisheries management system in the Northeast U. S., but the conclusions apply broadly to fisheries around the world.

Day 4 Lightning Talk

Are Recent Declines in Whale Sightings in Midcoast Maine Related to Climate Change and Decreased Productivity?

Presenter: Zack Klyver, Bar Harbor Whale Watch

In 2017, The success rate for sighting at least one large whale per trip dropped to 34% for Bar Harbor Whale Watch. The sightings per trip over the previous thirty years had ranged from a high of 95% and low of 80%. Likewise, sightings of finback whales declined: in 2000 and 2007, over 150 tours saw at least one finback whale, while in 2017, only five tours saw at least one finback whale. Historically, most whale sightings took place in areas of high upwelling along the 50 fathom curve stretching between Mount Dessert Rock and the Schoodic Ridges. In 2017, the lowest figures for salinity were recorded at the northeast channel NERACOOS buoy, with Greenland freshwater melt being the most likely cause and the eastern Maine shelf current continued to show a speeding up by 20% (pers. comm. Dr. Neal Pettigrew). Changes in primary productivity due to climate change and changing currents have recently been described showing a decline in calanus copepods and therefore feeding right whales in the eastern Gulf of Maine Record, et. al., 2019). Bar Harbor Whale Watch changed the whale watch trip schedule in 2019 from 3 hour tours going out 20-25 miles to 5 hour tours going out 50 miles. Whale watching tours are now conducted on the Grand Manan Banks in Canada, where sightings of humpback, finback and minke whale remain both high and consistent. During 2019, four tours saw right whales: two in Canadian waters just over the Hague line and two in us waters off Maine.

Day 2 Poster

Applying Living Shoreline Approaches to Increase Resilience and Reduce Risk in New England

Authors: David Burdick (Jackson Estuarine Lab, UNH, Durham, NH 03824), Janet Freedman (Rhode Island Coastal Resources Management Council, Wakefield, RI 02879), Kirsten Howard (New Hampshire Department of Environmental Services, Coastal Program, Portsmouth, NH 03801), Julia Knisel (Massachusetts Coastal Zone Management, Boston, MA 02114), Eric Roberts (The Nature Conservancy, Boston, MA 02111), Pete Slovinsky (Maine Geological Survey, Augusta, ME 04333). Additional Partners: Tom Ballestero (College of Engineering and Physical Sciences, UNH, NH 03824), Curtis Bohlen (Casco Bay Estuary Partnership at University of Southern Maine, Portland, ME 04101), Jennifer Mattei (Sacred Heart University, Fairfield, CT 06825), James O'Donnell (University of Connecticut, CIRCA, Groton, CT 06340),

Presenter: Julia Knisel, Julia.knisel@mass.gov

Higher sea levels, reduced sediment supplies, and coastal storms cause widespread coastal erosion and flooding in New England and compel landowners to request hardened shoreline stabilization projects. Regionally, the erosion is also reducing fringing salt marsh habitat. Providing alternatives to hardened solutions is more urgent than ever. Collaborating via the Northeast Regional Ocean Council on two NOAA-funded coastal resilience projects, coastal zone management programs and their partners are assessing the effectiveness of living shoreline projects (e.g. bioengineering coastal banks or restoring marshes) to build resilience and reduce risk to people, infrastructure, and natural resources. Variable levels of development and environmental conditions along the shoreline require the use of different living shoreline approaches. Partners are implementing projects across a range of coastal habitats and applying a standardized suite of monitoring metrics. The effort is advancing proper siting, design, construction, and maintenance of these practices in New England. Data analysis will elucidate the positive contributions or lack thereof that living shorelines have on shoreline stabilization, storm damage reduction, and ecological processes and inform local, state and federal regulatory guidance and policies influencing the use of these approaches. State coastal managers and scientists from Maine to Connecticut will discuss successes and challenges of efforts to design, permit, construct, and monitor and maintain living shorelines throughout the region. Panelists will share lessons learned and insights on working with existing site conditions, decision support tools, beneficial reuse of natural materials in low-cost shoreline treatments, models to characterize wave and water level fluctuations, permitting hurdles and opportunities, regional collaboration, use of professional and trained volunteers for monitoring, and public and stakeholder outreach and education.

Day 2 Lightning talk, Poster

Community Coastal Resilience Planning and Action - Massachusetts Case Studies

Authors: Steven Roy, LEED AP (Weston and Sampson, Portsmouth, NH 03801), Amanda Kohn (Weston and Sampson, Reading, MA 01867)

Presenter: Amanda Kohn, kohn.amanda@wseinc.com

Massachusetts communities are taking action to improve their climate resilience from sea level rise, intense precipitation events, and other climate threats. Often, the first step is to prepare a climate adaptation plan that includes actions such as designing elevated roadways, improving undersized culverts, and constructing flood control parks. Next, communities begin to secure funding to implement their highest priority action. This presentation will examine the climate adaptation planning and implementation process by using several case studies. The case studies will cover municipalities that are working regionally, using nature-based solutions, and updating their planning tools to address the projected impacts of climate change at the local level. The presentation will begin with an overview of state programs that provides funding for coastal resilience projects, with an emphasis on the Commonwealth of Massachusetts Municipal Vulnerability Preparedness (MVP) Program. The audience will then hear about the Town of Salisbury, Massachusetts and its journey from becoming a certified MVP community to being awarded funding for elevated roadways and culvert replacements. Chelsea and Everett, Massachusetts will be used as an example to showcase the importance of working in a regional context to ensure integrated shoreline protection along the coast. The Climate Ready Boston Initiative will be highlighted to show the importance of green space by exemplifying the climate adaptation designs at Moakley Park and Langone & Puopolo Park for promoting both coastal resilience and equitable access to the ocean. Boston has also developed a series of plans and actions, including the creation of the Climate Resilience Infrastructure Design Guidelines, which encompasses resilient roads and new waterfront barrier designs and standards.

Day 4 Poster

Comparing Subsurface Property Fields Within High Resolution Models of the Gulf of Maine

Authors: Taylor N. Ladue (Stonehill College, Easton, MA 02357), Kristin Burkholder (Stonehill College, Easton, MA 02357), Ruoying He (North Carolina State University, Raleigh, NC 27695)

Presenter: Taylor N. Ladue, tladue@students.stonehill.edu

The waters of the Gulf of Maine (GOM) has been experiencing dramatic warming in recent years. Though much of this warming has been attributed to a change in the composition of the waters flowing into the GOM, little is known about the impact of this warming on circulation within the GOM itself. Ocean circulation models allow for the opportunity to examine such circulation changes, particularly at depth where observational measurements are sparse. The fate of the currents carrying inorganic nutrients at depth into the GOM through the Northeast Channel are of particular interest. However, prior to any analysis of the subsurface circulation pathways, a model must first be shown to be in reasonable agreement with the observed property fields. Here, we compare the output of two regional ocean circulation models, the Gulf of Maine Regional Ocean Modeling System (GOMROMS) and the East Regional Ocean Modeling System (EASTROMS) with observational records. Specifically, we compare property fields from the model with data from the NERACOOS observational arrays (particularly Buoy M in the Jordan Basin and Buoy N in the Northeast Channel). Finally, we evaluate the skills and restrictions of each model as well as the feasibility of using each for future studies of pathway variability in the GOM.

Day 3 Poster

Monitoring Chemical Contaminants in the Gulf of Maine using Sediments and Mussels: An Evaluation

Authors: James S. Latimer (US EPA, Office of Research and Development, Narragansett, RI 02882 USA), Adria A. Elskus (USGS, Leetown Science Center, S.O. Conte Anadromous Fish Research Laboratory, Turners Falls, MA 01376 USA), Lawrence A. LeBlanc (Lawrence LeBlanc Consulting, Conway MA 01341 USA), David Page (Bowdoin College, Brunswick, ME 04011 USA), Gareth C.H. Harding (Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, NS B2Y 4A2 CAN) Peter G. Wells (International Ocean Institute Canada, Dalhousie University, Halifax, NS B3H 4R2 CAN)

Presenter: James S. Latimer, latimer.jim@epa.gov

Sediments and mussels have been used for decades to assess the ecological and human health risks associated with concentrations of organic and metal contaminants through monitoring programs. Mussels (Mytilus edulis) can selectively bioaccumulate certain organic and metal contaminants from water, food, and resuspended sediment; whereas sediments in locations of relatively low turbulence can serve as repositories for particle-active contaminants. The objective of the present paper is to examine the correspondence of contaminant levels in mussel tissues and sediment samples collected from similar locations. Mussel and sediment databases for a suite of organic and metal analytes were retrieved from monitoring programs in the Gulf of Maine. Mussel Watch (National Oceanic and Atmospheric Agency) and Gulfwatch (Gulf of Maine Council) were used for mussel tissue levels; the National Coastal and National Coastal Condition Assessments (US Environmental Protection Agency), and the Ecosystem Indicator Partnership (ESIP) were used for intertidal sediments. A strong correspondence was found between sediment and mussel concentrations of polycyclic aromatic hydrocarbons, moderate correspondence was observed for polychlorinated biphenyls, and except for mercury and zinc, little to no correspondence was found for metals. We conclude that mussels may be a more reliable indicator of exposure to some contaminants than sediments at sites where contaminant concentrations are low. Sediments may provide a more complete picture than mussels for a broader range of contaminants at sites with moderate or higher levels. In dynamic environments, resuspension could reduce the utility of sediments for distinguishing contaminant sources and gradients. The present study demonstrates that combining data from multiple monitoring programs provides robust information that can be exploited to gain additional insights into the coastal condition, such as the response of contaminants to climate change.

Day 2 Poster

Updating Coastal Landscape Change Projections for the Northeast

Authors: Erika E. Lentz (Woods Hole Coastal and Marine Science Center, 384 Woods Hole Rd., Woods Hole, MA 02543), William Condon (Woods Hole Coastal and Marine Science Center, 384 Woods Hole Rd., Woods Hole, MA 02543), Elizabeth Pendleton (Woods Hole Coastal and Marine Science Center, 384 Woods Hole Rd., Woods Hole, MA 02543)

Presenter: Erika E. Lentz, elentz@usgs.gov

The likelihood of the coastal landscape to dynamically change or adapt to sea-level rise (SLR) is directly governed by the geology, landforms, built environment, and ecosystems that comprise it. In 2016, USGS researchers produced a probabilistic framework, or Bayesian network, that considered the likelihood of dynamic coastal response across Northeastern U.S. to future sea-level rise scenarios based on elevation and land cover variation. Results were produced at 30 m by 30 m resolution from Maine to Virginia for the 2020s, 2030s, 2050s, and 2080s at elevation contours between 10 m inland to -10 m offshore. An advantage in using a Bayesian approach is that the framework is both adaptable and flexible; new data and knowledge can be readily incorporated as they become available. To further streamline updates, we have invested time in converting our model from proprietary software to an open-source framework. Here, we present new predictions, including: 1) a high resolution and seamless topographic and bathymetric dataset (Coastal National Elevation Dataset, CoNED); 2) probabilistic relative sea-level rise scenarios from the 4th National Climate Assessment; and 3) new understanding and insights on inundation thresholds for different land cover types. The updates in both data and model components enable an expanded spatial and temporal footprint, more confident dynamic response predictions, and establish model infrastructure critical both for future decision-support tool development and real-time updates via cloud computing.

Day 2 Lightning talk, Poster

Facilitating municipal use of climate information in adaptation actions

Authors: Vanessa Levesque (University of New Hampshire, Durham, NH, 03824 USA), Cameron Wake (University of New Hampshire, Durham, NH 03824 USA), Julia Peterson (New Hampshire Sea Grant, Durham, NH 03824 USA)

Presenter: Vanessa R. Levesque, vanessa.levesque@unh.edu

Rising sea level and more intense storms associated with climate change are projected to increase coastal flooding along the U.S. east coast, including in the Gulf of Maine. While flooding impacts to infrastructure, homes, natural areas and transportation corridors threatens economic and social well being of individuals and communities, coastal municipalities can act to improve community resilience through a range of adaptation measures. Whether they use available climate change data to do so, however, remains tenuous. Existing research suggests that climate information is more likely to lead to adaptation actions when (1) the content of information is credible, salient and legitimate, (2) the process used to produce climate information engenders dialogue and trust and (3) the decision-making context facilitates action. In this study, we explored how these factors facilitated or hindered use of information from two climate adaptation projects in coastal New Hampshire. Based on 16 interviews and document review, we found that, contrary to expectations, highly engaged co-production of knowledge was not necessary due, in part, to pre-existing trust between New Hampshire coastal municipalities, boundary spanners and researchers. However, we found a fourth essential factor for municipal action to occur: translating usable climate data into specific adaptation actions geared to the priorities and context of each municipality. This research suggests that in areas with pre-existing trust networks, less effort might be required to build trust and ensure content meets user needs in early stages of producing knowledge, but that much more effort is needed to help municipalities implement actions at the final stages of adaptation projects.

Day 3 Oral presentation

Coastal acidification drivers in the largest Maine oyster aquaculture growing area

Authors: Kate Liberti (University of Maine, Darling Marine Center), Damian Brady (University of Maine, Darling Marine Center), Lawrence Mayer (University of Maine, Darling Marine Center)

Presenter: Kate Liberti, Kate.Liberti@maine.edu

Shellfish fisheries and aquaculture is an important economic driver for nearshore coastal communities in Maine. However, acidification processes threaten the growth of many of these species. The Gulf of Maine has naturally low calcium carbonate saturation due to its relative freshness and cold temperatures, making shellfish more susceptible to locally driven acidification. However, many of the shellfish species, particularly aquacultured oysters, are grown in estuaries that can have very different conditions than the open Gulf of Maine. We examined the drivers of coastal carbonate chemistry within the largest oyster aquaculture growing area in Maine; the Damariscotta River Estuary. pH was collected hourly by a SeaFET pH sensor from a buoy in the oyster growing area, along with dissolved oxygen, temperature, salinity, chlorophyll a, nitrate, and turbidity. Dissolved inorganic carbon and total alkalinity samples were collected biweekly at the buoy from May - October 2018. Net community metabolism was the largest driver of carbonate chemistry change within the oyster aquaculture growing area. pH and dissolved oxygen co-varied on a diel cycle, with an average change of about 0.2 pH units and 1.5 ml/l (~25%) oxygen. Aragonite and calcite saturation states vary around 1.7 and 2.6 (~0.25 and 0.5 units daily change), respectively, throughout the 2018 growing season. Freshwater runoff is the second largest driver of acidification in the growing area but preliminary results indicate that freshwater may only acidify the growing area when respiration is high. Our results show that despite the DRE being an 'incubation' area for Gulf of Maine water, it does have elevated rates of metabolism and higher connectivity to land which increases the number of times it experiences higher acidity during the growing season.

Day 3 Oral presentation

Ocean acidification and the Gulf of Maine: Advances in attribution science

Authors: Brenda Ekwurzel, Peter Frumhoff, and Roger Stephenson (Union of Concerned Scientists)

Presenter: Rachel Licker, rlicker@ucsusa.org

The ability to tease apart the drivers of adverse changes in our ocean ecosystems - whether it be human-caused climate change, nutrient pollution, or overfishing - is critical for developing appropriate solutions. Attribution science is a growing field that largely examines the contribution of anthropogenic greenhouse gas emissions to global-scale changes in climate or, increasingly, individual extreme weather events. Ocean acidification has emerged as a top threat to marine resources. The consequences of ocean acidification are clear in some regions that are subject to multiple threats, including the Arctic, the California Current, and the Bering Sea and Gulf of Alaska. In the Gulf of Maine, several factors including ocean warming, acidification, and regional ocean circulation are influencing the region's physical, chemical, and biological processes, making it a particularly complex region to conduct attribution science. Given the importance of the region's fishery stocks, research that can disentangle the impacts of different stressors is critical. This talk will review advances made in attributing changes in global ocean chemistry to not only human-caused greenhouse gas emissions, but individual, major industrial carbon producers, and the application of this research to identifying the risks to important fisheries like those in the Gulf of Maine.

Day 3 Poster

Continuous monitoring for coastal acidification in Casco Bay

Authors: Matthew Liebman (US EPA Region 1), Curtis Bohlen (Casco Bay Estuary Partnership), Chris Hunt (University of New Hampshire), Joe Salisbury (University of New Hampshire), Larry Mayer (University of Maine)

Presenter: Matthew Liebman, liebman.matt@epa.gov

The Gulf of Maine is vulnerable to the impacts of ocean and coastal acidification (OCA), and new technology has allowed scientists to monitor carbonate chemistry parameters on a continuous basis. Since 2015, the Casco Bay Estuary Partnership, in partnership with the University of New Hampshire, has collected hourly measurements of pCO2, pH, dissolved oxygen, salinity and temperature. The site is at the Southern Maine Community College pier in the Portland Channel near outlets of the Fore and Presumpscot rivers in a relatively urban area of Casco Bay. The purpose of these sensors is to observe seasonal changes in OCA parameters, and to estimate aragonite (or calcite) saturation state, and to evaluate drivers of these changes. Despite technological issues that prevented collection of year-round data at the site, the system operated for five years. Patterns in the data reveal signals of seasonality, riverine sources, biological processes related to nutrient enrichment, and tidal exchange at this site. This system is one of eight other sites across the country, funded by the EPA National Estuary Program. Results from this site will contrasted with observations at some of the other sites in the Northeast and at other sites in Maine.

Day 2 Oral presentation

Effects of Sea Level Rise on Modeled Storm Surge and Current Speeds in New Hampshire Estuaries

Authors: Thomas C. Lippmann (University of New Hampshire, Dept. of Earth Sciences, Center for Coastal and Ocean Mapping, 24 Colovos Rd., Durham, NH 03824), Anna E. Simpson (Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, Corvallis, OR 97331), Salme E. Cook (University of New Hampshire, Center for Coastal and Ocean Mapping, 24 Colovos Rd., Durham, NH 03824), Paul Kirshen (University of Massachusetts Boston, School for the Environment, Boston, MA 02125),

Presenter: Thomas C. Lippmann, lippmann@ccom.unh.edu

The effects of sea level rise on storm surge energy transformation and flood and ebb current magnitudes are examined in two distinctly different New Hampshire estuarine systems using FVCOM. Simulations are computed for 0.01 annual exceedance probability storm surge with and without sea level rise. Results for the Great Bay Estuary show that although the maximum sea surface elevation is much higher during storm events, upstream energy decay is similar (50%) with and without storm surge or sea level rise. Corresponding depth-integrated currents increase by 10-30% with sea level rise, 23-52% with the storm surge, and 32-97% for the combined event. However, results from the Hampton/Seabrook Estuary show that energy loss through the inlet increases from 2-4% for no storm and present day sea level to 30-40% for storm surge with sea level rise, partially mitigating inland inundation. Depth-integrated current magnitudes in Hampton/Seabrook inlet increase by a factor of 4 under sea level rise and storm surge. Model results suggest that sea level rise will have significant impacts on storm surge inundation and current speeds.

Day 2 Poster

Preparing for offshore wind: a collaborative approach to environmental monitoring

Authors: Jeremy Collie (University of Rhode Island Graduate School of Oceanography, Narragansett, RI 02882 USA), Christopher Glass (Commercial Fisheries Research Foundation, Kingston, RI 02881 USA), Michael Long (Commercial Fisheries Research Foundation, Kingston, RI 02881 USA), Joseph Langan (University of Rhode Island Graduate School of Oceanography, Narragansett, RI 02882 USA)

Presenter: Michael Long, mlong@cfrfoundation.org

Over 2,000 square miles of ocean have been leased for offshore wind energy development in the northeastern United States; however, there is uncertainty surrounding how fisheries resources will be impacted by the installation, operation, and decommissioning of offshore wind turbines and power cables. To address these uncertainties, the University of Rhode Island and Commercial Fisheries Research Foundation, in partnership with commercial lobstermen, conducted the Southern New England Cooperative Ventless Trap Survey (SNECVTS) from 2014 - 2018. This baseline survey aimed to assess the seasonal abundance, distribution, movement, and habitat use of American lobster and Jonah crab in one of the first offshore wind energy lease sites off the coast of New England. Twenty-four lease blocks within the Cox's Ledge Wind Energy Area were selected for the survey based upon their importance to the lobster and Jonah crab fisheries and wind energy development timeline. Survey components consisted of at-sea biological sampling, mark-recapture tagging, and habitat characterization, all conducted by teams of commercial lobstermen and scientific samplers. Overall, SNECVTS has provided a multi-year record of pre-construction conditions at one of the first offshore wind energy lease sites in the United States. Further, the survey was designed to be replicable during all phases of wind energy development, as well as at other offshore wind energy sites, which will enable site specific and regional assessment and potential mitigation of the impacts of offshore wind energy development on fisheries resources. With recent legislation and movement towards offshore wind energy development in the Gulf of Maine, a proactive approach to environmental monitoring is necessary to establish pre-existing conditions at any potential offshore wind energy development sites.

Day 4 Lightning talk

Strengthening relationships through coastal environmental baseline data collection: a case study in the Port of Saint John, New Brunswick, Canada.

Authors: Claire Mussells (DFO St. Andrews Biological Station, St. Andrews NB E5B 0E4 Canada, Casey O'Laughlin (DFO St. Andrews Biological Station, St. Andrews NB E5B 0E4 Canada

Presenter: Rachel Long, rachel.long@dfo-mpo.gc.ca

Ecosystem characterization and evidence-based decision making are crucial to the effective management and preservation of marine ecosystems in Canada's busiest and most industrial ports. The collection of comprehensive baseline data, will provide a snapshot in time, and allow for changes in the environment to be better detected over time. Over 5 years, the Coastal Environmental Baseline program, an initiative under Canada's Ocean Protection Plan, will be piloted in 6 sites across Canada - the Port of Saint John being one of the pilots. The Port of Saint John is located in the Bay of Fundy, which has the highest tidal ranges in the world, and is home to industries such as fisheries, aquaculture, oil and gas, mining and ecotourism. Fisheries and Oceans Canada is working with local Indigenous organizations and stakeholder groups to collaboratively identify key ecosystem components and study site boundaries; compile current and historical environmental datasets to identify outstanding data needs; prioritize, plan and carry out data collection; as well as data management and visualization. The data sets will be available to participating organizations as well as Fisheries and Oceans Canada and other federal departments to inform management decisions in areas such as fisheries management and protection, species at risk and aquatic invasive species and Transport Canada's Cumulative Effects of Shipping program etc. This Program sets out to strengthen relationships with local indigenous and stakeholder organizations by helping to increase local capacity to collect ecological, social and culturally important ecosystem indicators to better reflect their needs in decision making and to allow for changes in the environment to be better detected over time.

Day 4 Oral presentation

Demographic changes in seabirds at Machias Seal Island over 25 years

Authors: Heather L. Major (Department of Biological Sciences, University of New Brunswick, Saint John, NB E2L 4L5, Canada), Antony W. Diamond (Department of Biology, University of New Brunswick, Fredericton, NB E3B 5A3, Canada)

Presenter: Heather L. Major, hmajor@unb.ca

Seabirds have been used for many decades as bioindicators as they have a position at the top of the food chain, feed on a variety of levels, and are sensitive to changes involving all levels of the marine ecosystem. The impacts of climate change on seabirds range from large obvious events, such as die-offs, to indirect impacts on demographic variables such as annual survival and reproductive success. One common account of the impact of climate change on ecosystems is the mismatch of seasonal timing with the phenology of different species. Research has shown that over the last three decades, breeding phenology of many species has advanced as an effect of climate change, specifically warming sea surface temperatures (SST) and related changes in prey availability during egg production. At the Machias Seal Island migratory bird sanctuary, 2019 marked the 25th consecutive year of concentrated monitoring of the island's nesting seabird populations. The primary goal of this monitoring program is to understand how changes in the marine environment are driving changes in seabird ecology. Specifically, we are interested in how changes in the marine environment (e.g., SST) relate to measures of seabird phenology, productivity, and chick growth and provisioning rates. Given that the waters around Machias Seal Island (i.e., Bay of Fundy and Gulf of Maine) are warming at a rapid rate and our focal seabird species are nesting at the southern extent of their range, our monitoring program offers a unique glimpse into how seabird populations might react to ocean warming. Our monitoring program has found variability in species responses to a warming ocean, many likely caused by changed in prey species availability and quality.

Day 4 Poster

The effect of warming waters on cod in the western Gulf of Maine

Authors: James Churchill (Woods Hole Oceanographic Institution, Woods Hole MA 02543 USA), Micah Dean (MA Div. Mar. Fisheries, Gloucester MA 01930), Steve Cadrin (U. Mass. Dartmouth/Sch. for Mar. Sci. & Technol., New Bedford MA 02744 USA), Douglas Zemeckis (Rutgers U. NJ Agricultural Experiment Station, Toms River, NJ 08755 USA), Michael Armstrong (MA Div. Mar. Fisheries, Gloucester MA 01930 USA)

Presenter: James Manning, james.manning@noaa.gov

The degree to which a marine fish stock grows or declines is often strongly dependent on early stage recruitment success, typically defined as the ratio of the number of settled juveniles to the stock's spawning biomass. Recruitment success, in turn, depends on three principal elements: 1) the success of spawning, 2) the degree to which the spawned larvae survive and are carried by ocean currents to habitat suitable for juvenile settlement and 3) the success of colonizing such habitat. The study described here focuses on the manner in which ocean temperatures impact elements 1 and 3 of the cod stock that spawns in the western Gulf of Maine during spring. Analysis of data from various sources indicates that both spawning and juvenile settlement of this stock are sensitive to water temperature. In particular, spawning is not observed at temperatures higher than 9 ºC, while settlement appears to be precluded in waters warmer than 16 ºC. Numerical modeling of the transport of cod larvae spawned during spring reveals the importance of these apparent thermal limitations on spawning and settlement. The simulations require imposition of temperature caps on spawning and settlement at the levels indicated above to produce results consistent with the observed timing and areas of spawning and the observed regions of juvenile settlement. The larval transport modeling further indicates that the projected warming of Gulf of Maine waters may seriously impact early stage recruitment of spring-spawned cod by restricting the areas available for spawning and juvenile settlement. The overall reduction in early stage recruitment success associated with rising temperatures is estimated to be as high as 65 % in 45 years and 94 % in 90 years (with the RCP8.5 unabated emissions scenario). The projected warming of the Gulf of Maine may thus imperil the Gulf's spring-spawning cod stock by compromising the stock's early stage recruitment.

Day 4 Poster

Maintaining the Environmental Monitors on Lobster Traps and Large Trawlers (eMOLT) Program for decades to come

Authors: James Manning, Northeast Fisheries Science Center, Woods Hole, MA, Erin Pelletier Gulf of Maine Lobster Foundation, Kennebunk, ME

Presenter: James Manning, erin@gomlf.org

Beginning in 2001, more than one hundred commercial fishing vessel captains have installed temperature sensors on their fixed or mobile gear in continental shelf waters off the New England coast. Given their help to deploy instrumentation and our effort to process, document, archive, and serve the data, there is now a well-documented web-served record of bottom temperatures at many sites around the Gulf of Maine. This data is being used to evaluate numerical ocean models and is now assimilated into models. While there have been some experiments with salinity monitors, cameras, pressure sensors, acoustic listening devices, and current meters, the primary variable of interest is bottom temperature and the hope is that this effort will be sustained for decades to come. In recent years, there has been an effort to telemeter the data in real-time. At the time of this writing, thirty-two vessels (mostly mobile gear trawlers from the Northeast Cooperative Research Program's 'Study Fleet') are fitted with satellite transmitters and have automatically reported well over 7000 haul-averaged bottom temperatures. With funding available for a few dozen vessels and three different local ocean model groups now starting to assimilate this data in forecast runs, we hope the fishing industry will be able to target regions based on improved bottom temperature forecasts. A variety of processes are affecting the bottom temperatures at different time scales. The dominant processes at a particular site differ depending on water depth and proximity to geographic features. In some areas, the wind, for example, drives the largest variation while areas near the shelf-edge are affected by intrusions of the deep ocean. In general, however, the eMOLT time series document the upward trend in water temperatures throughout the region with 2002, 2006, 2012, 2016, 2018, and 2019 being relatively warm.

Day 4 Poster

Dynamics of American lobster thermal habitat availability and productivity in the inshore Gulf of Maine

Authors: Mackenzie D. Mazur (University of Maine, Orono, ME 04469 USA), Kisei R. Tanaka (Princeton University, Princeton, NJ 08544 USA), and Yong Chen (University of Maine, Orono, ME 04469 USA)

Presenter: Mackenzie D. Mazur, mackenzie.mazur@maine.edu

The Gulf of Maine (GOM) American lobster supports the most valuable fishery in the United States as a result of substantially increased recruitment over the past few decades. However, a functional stock-recruitment relationship has not been defined due to (1) recruitment processes occurring at a spatial scale smaller than the whole GOM and (2) large environmental variability in the ecosystem. As the GOM water temperatures increase, inshore thermal habitat for juvenile lobsters expands, adding to the complexity of understanding recruitment dynamics. In this study, we evaluate the effect of bottom water temperature on American lobster recruitment dynamics. We fit Ricker models to estimated recruitment and spawning stock biomass in the inshore GOM. We then investigated the relationship between bottom water temperature and recruitment dynamics, specifically productivity. The results showed that recruitment productivity significantly increased with bottom water temperature ($p < 0.05$). Results indicate that lobster in the GOM has experienced a shift in recruitment dynamics over time and space related to thermal habitat availability. Our study showed that climate-driven stock-recruitment relationships should be considered for American lobster, which would impact biological reference points and fishery projections.

Day 4 Oral presentation

Views from the dock: Warming waters, adaptation, and the future of Maine's lobster fishery

Authors: Steven Scyphers (Northeastern University), Jon Grabowski (Northeastern University)

Presenter: Loren McClenachan, lemcclen@colby.edu

The ability of resource-dependent communities to adapt to climate change depends in part on their perceptions and prioritization of specific climate-related threats. In the Maine lobster fishery, which is highly vulnerable to warming water associated with climate change, we found a strong majority (84%) of fishers viewed warming water as a threat, but rank its impacts lower than other drivers of change (e.g., pollution). Two-thirds believed they will be personally affected by warming waters, but only half had plans to adapt. Those with adaptation plans demonstrated fundamentally different views of human agency in this system, observing greater anthropogenic threats, but also a greater ability to control the fishery through their own actions on the water and fisheries management processes. Lack of adaptation planning was linked to the view that warming waters result from natural cycles, and the expectation that technological advancements will help buffer the industry from warming waters.

Day 3 Poster

Response of soft-shell clams (Mya arenaria) and mud shrimp (Corophium volutator) to decreased and variable water column pH

Authors: Melanie Bishops (University of New Brunswick, Saint John, NB CAN), Heather Hunt (University of New Brunswick, Saint John, NB CAN)

Presenter: Samantha McGarrigle, samantha.a.mcgarrigle@gmail.com

Ocean acidification is a growing threat to marine life as CO2 concentrations increase in the ocean influencing pH and carbonate chemistry. Models estimate that pH will decrease an additional 0.22 pH units by 2050. When combined with natural variability, the expected decrease in pH could result in water conditions that push tolerance levels for many species of invertebrates. Variability in pH is a part of the natural environment in coastal regions, so it is critical to integrate variability into laboratory experiments on ocean acidification to better simulate natural conditions and make better predictions about the effects of decreasing pH on coastal species. Effects of pH on soft-shell clams (Mya arenaria) and mud shrimp (Corophium volutator), two ecologically and economically important species in the Bay of Fundy and Gulf of Maine, were examined in two laboratory experiments. In 2018, mud shrimp were exposed to two different water treatments, ambient (~pH 7.85) and constant acidified (average pH 7.6). In 2019, we exposed soft-shell clams and mud shrimp to three different water conditions, ambient (~pH 7.85), constant acidified (average pH 7.7) and variable acidified (average pH 7.7). These values were chosen to simulate expected future declines in pH in this region. The variable acidified treatment was set to mimic diurnal patterns in pH, with two periods each of lower pH and higher pH per day. Morphological measurements were taken before and after the experiment on both to determine the impacts of the differing pH treatments on growth and mortality. It is essential to understand how benthic infaunal invertebrates will respond to ocean acidification as well as present-day variability in pH. Due to the complexity and variability of the processes driving pH and carbonate chemistry in the coastal ocean, laboratory experiments that integrate variability are required to deepen our understanding of the impacts of ocean acidification on coastal marine species.

Day 3 Oral presentation

Empirical models for estimating the carbonate system off the northeastern US from basic hydrographic data: An MLR approach

Authors: Kelly McGarry (University of Connecticut, Department of Marine Sciences), Samantha Siedlecki (University of Connecticut, Department of Marine Sciences), Simone Alin (NOAA Pacific Marine Environmental Laboratory), Joseph Salisbury (University of New Hampshire, Institute for the Study of Earth, Oceans, and Space)

Presenter: Kelly McGarry, kelly.m.mcgarry@uconn.edu

Upward trends in atmospheric carbon dioxide concentration are largely matched in the carbonate chemistry of the global ocean, but in some coastal environments, this trend is modulated by local processes. To understand the present state of ocean acidification and its future trend in coastal waters, it is vital to determine the extent to which local processes modulate global trends. Local carbonate chemistry is controlled by a balance between physical and biological mechanisms which can be inferred to some degree from measurements of temperature, salinity, oxygen, and nitrate. It is possible to identify the relative importance of physical and biological processes using multiple linear regression (MLR) models, which have been developed for other regions. Here, we develop an MLR to estimate total alkalinity (TA), dissolved inorganic carbon (DIC), pH, and aragonite saturation state (Ω_{AR}) from measured temperature, salinity, oxygen, and nitrate off the northeastern coast of the US. Calibration data included measurements of TA and DIC collected during Gulf of Mexico and East Coast Carbon cruises in July-August 2007 and 2012 and during the East Coast Ocean Acidification cruise in June-July 2015. Resulting empirical relationships for TA, DIC, and Ω_{AR}) are robust with $R^2 > 0.96$, but the variability in pH is not as well captured by the MLR ($R^2 = 0.89$), which is unlike the MLRs developed for other regions. A data set collected in the East Coast Ocean Acidification cruise in June-July 2018 was used to test the performance of the MLR. Comparing estimated and measured carbonate chemistry values indicates the MLR performs well with $R^2 > 0.9$ for TA, DIC, and Ω_{AR}), and $R^2 > 0.7$ for pH. These newly developed empirical models can be used to extend records in space and time, and reveal dominant mechanisms controlling local carbonate chemistry off the northeastern coast of the US.

Day 3 Poster

Aggression and Assortative Mating in the Great Black-backed Gulls

Authors: Brielle Michener (University of Rhode Island), Sarah J Courchesne (Northern Essex Community College), Kristen Covino (Loyola Marymount University), Mary Elizabeth Everett (Northern Essex Community College)

Presenter: Brielle Michener, david.buck@unh.edu

Appledore Island in the Isles of Shoals is home to the great black-backed gull (Larus marinus). There is currently an ongoing monitoring project that was established, due to the gap in knowledge about the black-backed gulls found off the north American coasts. Additionally, assortative mating, which is a form of sexual selection in which a mate is chosen based off of some phenotypic characteristic, has been extensively studied in a variety of bird species including sparrows. However, aggression driven assortative mating has not been studied in sea birds. To test whether the great black-backed gulls were negatively assortative mating, we documented aggression behaviors of nesting 'target' gulls and their mates (N = 44 gulls in N = 22 nests). Tests were conducted every 3 days starting May 27 until 3 to 5 days after the last chick was hatched, which varied between nests, to ensure that the chick mortality rate was not inflated by colony disruptions. Overall, it became clear that the gulls are very aggressive and that their aggression increases leading up to and following the hatch of their chicks. Our data did not support the hypothesis that gulls were negatively assortative mating.

Day 4 Poster

Ichthyoplankton community structure, abundance, and diversity in the GOM: Ongoing time-series of larval fish ingress and environmental drivers

Authors: Jeremy Miller (Wells National Estuarine Research Reserve, Maine Coastal Ecology Center, Wells, ME USA), Eric Bjorkstedt (NOAA-SWFSC, Humboldt State University, Arcata, CA USA), Laura Crane (Wells National Estuarine Research Reserve, Maine Coastal Ecology Center, Wells, ME USA), Jason Goldstein (Wells National Estuarine Research Reserve, Maine Coastal Ecology Center, Wells, ME USA)

Presenter: Jeremy Miller, jsgoldstein2@gmail.com

Understanding larval fish population dynamics is important for determining recruitment availability, dispersal distances, and changes in species distribution and abundance within a rapidly changing Gulf of Maine (GoM). Most larval fish studies in the GoM sample sub-tidal and pelagic habitats, with poor temporal replication. This ongoing study examines the community structure, diversity, and abundance of larval fishes in the Webhannet River Estuary in Wells, ME, USA. Ichthyoplankton were sampled 2-6 times monthly at a single location (1-m depth) during incoming high tides from January 2009 to present. Additionally, environmental variables have been collected continuously, every 15 minutes, at the site since 1995 as part of NOAA's System Wide Monitoring Program (SWMP). A total of 469 sampling events has produced 7,570 individuals representing 35 species of fish, more than any other comparable study in the GoM. The three dominant species by number were Tautogolabrus adsperus (cunner), Ammodytes americanus (sand lance), and Clupea harengus (Atlantic herring). Because peaks in larval fish abundances typically correspond with major plankton blooms in the GoM, rapid changes in water temperature and other environmental drivers could have influential impacts on the timing and success of spawning events. The occurrence of Centropristis striata (black sea bass) in 2013 and 2014, and Sphyraena borealis (northern sennet) in 2017, coupled with increasing water temperatures in the GoM, may be a sign of range expansions of more southerly species. These two years were also concurrent with peaks in larval abundances for several species, particularly T. adsperus. We are collaborating with researchers from NOAA Northeast Fisheries Science Center (NEFSC), Gulf of Maine Research Institute (GMRI, and Rutgers Marine Field Station to compare similar time series from a Mid-Atlantic estuary, and offshore trawls

Day 4 Oral presentation

Vulnerabilities and adaptation of Northeast U. S. fishing communities in the context of shifting species

Authors: Katherine E. Mills (Gulf of Maine Research Institute, Portland, ME, USA), Michael Alexander (NOAA Earth System Research Laboratory, Boulder, CO, USA), Andrew Allyn (Gulf of Maine Research Institute, Portland, ME, USA), Lisa L. Colburn (NOAA Fisheries, Northeast Fisheries Science Center, Narragansett, RI, USA), Steve Eayrs (Gulf of Maine Research Institute, Portland, ME, USA), Bradley Franklin (Gulf of Maine Research Institute, Portland, ME, USA), Troy Hartley (Virginia Sea Grant College, Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA, USA), Brian Kennedy (Gulf of Maine Research Institute, Portland, ME, USA), Jonathan Labaree (Gulf of Maine Research Institute, Portland, ME, USA), Andrew Pershing (Gulf of Maine Research Institute, Portland, ME, USA), James Scott (NOAA Earth System Research Laboratory, Boulder, CO, USA)

Presenter: Katherine E. Mills, kmills@gmri.org

Ocean waters on the Northeast U. S. continental shelf have warmed rapidly in recent years, and climate models project this warming to continue. Associated changes in species distributions and productivity are already affecting fishing communities, as they face declines in traditionally-fished species and the appearance of emerging species in their fishing areas. The local impacts of these changes depend on the nature and rate of ecosystem change, patterns of dependence on marine resources, and adaptation capacity and choices. We use climate projections to drive species models as a basis for conducting port-scale assessments of social-ecological vulnerabilities to climate-related species changes. Results of this assessment provide insights into relative vulnerability of fishing communities from Maine to Virginia and help identify key risks in specific ports. For four focus communities, we integrate projected species changes into economic models of the fishing sector to quantify their impacts to landed value and profits. We also consider a suite of adaptation scenarios within the economic models to assess the extent to which different adaptation approaches would buffer the impact of species changes and create new opportunities for fisheries in the community. Interviews with fishermen and municipal officials enable us to evaluate factors that facilitate or constrain implementation of specific adaptation strategies. Ultimately, this information provides a foundation for decision-making and climate adaptation planning at community and regional scales as well as insights into policy and institutional needs to support the resilience of fishing communities in the context of climate change.

Day 3 Poster

A predictive model for ocean and coastal acidification thresholds from Long Island Sound to the Nova Scotian Shelf

Authors: Changsheng Chen (University of Massachusetts Dartmouth, UMassD), Joseph Salisbury (University of New Hampshire, UNH), Jennifer Brewer (UNH), Aaron Strong (Hamilton College), Jason Goldstein (Wells National Estuarine Research Reserve, NERR), Erik Chapman (NH Sea Grant), Meredith White (Mook Sea Farm), Riley Young-Morse (Gulf of Maine Research Institute, GMRI), Jackie Motyka (NERACOOS) and Parker Gassett (University of Maine)

Presenter: Dr. J. Ruairidh Morrison, jackie@neracoos.org

Waters of the Northeastern U.S. are among the most vulnerable to ocean and coastal acidification (OCA). Successful adaptation and mitigation options to address these impacts depend strongly on the availability of real-time predictions and short-term forecasts to inform decision-making. While understanding the multiple drivers of carbonate system variability continues to advance, the threshold detection and model-based forecasting system being developed in this project will provide the first-ever set of products and guidance, co-developed with end-users, to address this need. This effort will develop two closely-linked products to support outcome-based actions by coastal managers. The first component of this work will develop a generic and flexible threshold detection and warning capability for OCA in concert with other stressors. These efforts will generate actionable information and products that range from real time predictions and short-term forecasts to multi-decadal predictions of climate effects. This will be accomplished by combining advanced circulation, hydrological and ecological models within the context of the Northeast Coastal Ocean Forecast System (NECOFS). In addition to physical parameters, the model suite will have the capability to fully resolve the carbonate system in three dimensions over time. The second part of this project will develop guidance for coastal water quality and marine resource managers through workshops and direct engagement on how to balance the risks associated with multiple interacting factors, including OCA, that contribute to thresholds, how actions can affect thresholds, and reactions scenarios to potential tipping points. The findings of these engagements will feed-back to the modeling team for reiteration, such that the threshold detection and forecast products can be specifically tailored to the needs of the user.

Day 3 Poster

Responding to Ocean and Coastal Acidification Through a Regional Network

Authors: J. Ru Morrison, PhD (NECAN Chair, 195 New Hampshire Ave, Suite 240, Portsmouth, NH 03801)

Presenter: J. Ru Morrison, Ru.morrison@neracoos.org

The Northeast Coastal Acidification Network (NECAN) is a group of scientists, resource managers, and marine industry partners dedicated to providing information to decision makers and stakeholders regarding ocean and coastal acidification (OCA) and its potential environmental and socio-economic impacts. NECAN's role is to review, synthesize, and communicate the most recent OCA science and identify regional priorities for monitoring, modeling, and research. NECAN then communicates critical knowledge gaps, coordinates research, and educates the public and stakeholders on regional OCA issues. NECAN has served as a model for other regional OCA networks and helped to inform state commissions working to address impacts to commercially important species and local resources. Through webinars, workshops, surveys, and other activities, NECAN has reached a wide audience, getting feedback on stakeholder and regional needs. The NECAN Steering Committee maintains an Implementation Plan which includes work plans and goals for upcoming years and has four working groups through which most projects and activities are coordinated. In 2018 NECAN hosted a series of webinars and workshops for citizen science water quality monitoring groups. Following these workshops, a single-day monitoring event was planned for August 22, 2019 along the New England coast from Downeast Maine to Long Island Sound and including over 50 monitoring organizations and laboratories. These educational outreach and stakeholder feedback opportunities are critical to fulfilling NECAN's mission. This presentation aims to review the evolution of NECAN over the last six years, highlight how NECAN has helped to identify research priorities and coordinate modeling and monitoring efforts, and discuss recent and upcoming projects, stakeholder outreach plans, and opportunities for collaboration.

Day 3 Lightning talk, Poster

The Ocean Acidification Information Exchange: Using online communities to affect offline change

Authors: Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS)

Presenter: Julianna E. Mullen, julianna@neracoos.org

Ocean and coastal acidification (OCA) are impacting communities around the world, with some of the most radical changes being observed in the Gulf of Maine. The field of OCA research is, relatively speaking, new; advances in understanding and rapidly changing conditions make the sharing of resources vital if we want to create resilient coastal communities. Recognition of the importance of information sharing led to the creation of the Ocean Acidification Information Exchange (OAIE), an online community for professionals involved with or interested in OCA. Launched in February 2018, the community's mission is to respond and adapt to OCA by promoting the collegial exchange of information across disciplines and geographical boundaries, with the ultimate goal of facilitating the creation of more holistic, more effective response strategies. Considering the broad representation of sectors at GOM2050 and the OAIE's transdisciplinary, collaborative approach to problem-solving, attendees may be interested in learning more about the community or seeing a demonstration of the site's capabilities. The OAIE demonstrates a new way of tackling the problem of OCA by creating informed, empowered networks that can translate knowledge into action. Because of the success of the OAIE and the strong representation of Northeastern stakeholders within the member base, we believe this project is a model for how to build online communities that affect real-world change.

Day 2 Poster

Next-generation monitoring and research for sustaining ecosystems and managing natural resources

Authors: Peter S. Murdoch (US Geological Survey, Troy, NY), Joel Blomquist (USGS, Catonsville, MD), John Brakebill (USGS, Catonsville, MD), Brian Pellerin (USGS, Reston, VA)

Presenter: Peter S. Murdoch, pmurdoch@usgs.gov

Efforts to establish baseline monitoring of natural and socio-economic systems in the Northeast Coast have accelerated during the past 10 years. Optimizing new scientific information for supporting resource management decisions will need to include improvement and integration of existing monitoring capabilities that can enhance the frequency and type of data collected, in addition to extending data records into the past for enabling early detection of trends. The USGS is developing a “next-generation water observing system" (NGWOS) designed to provide high-fidelity, real-time data on water quantity and quality necessary to address daily water operations and water emergencies using modern water prediction and decision support systems. An NGWOS pilot the Delaware River Basin is applying innovative strategies for network design with the express goal of tracking change in whole river basins, by implementing monitoring at locations representing the range of physical, chemical, and biological conditions observed. This somewhat novel, multi-scale, inter-disciplinary approach to observing network design could enable data integration among multiple networks in the Gulf of Maine region, with the goal of detecting, understanding, and addressing changes in complex socio-ecological systems.

Day 4 Poster

Modeling the spread of the invasive red alga Dasysiphonia japonica in the Gulf of Maine

Authors: Brandon S. O'Brien (University of New Hampshire, Durham, NH 03823 USA), Christopher D. Neefus (University of New Hampshire, Durham, NH 03823 USA), Jennifer A. Dijkstra (University of New Hampshire, Durham, NH 03823 USA)

Presenter: Brandon S. O'Brien, bso1002@wildcats.unh.edu

The invasive red alga Dasysiphonia japonica was first reported in the Northwest Atlantic in 2011. Since then, it has spread rapidly along the coast, from New York to Maine, becoming a common and locally dominant member of the subtidal community. In the present study, a series of correlative species distribution models for Dasysiphonia were constructed using presence-only occurrence records, regional environmental datasets, and the MaxEnt software package. The first model describes the suitable habitat within the Gulf of Maine and nearby regions for this species based on present-day environmental conditions, including areas in which Dasysiphonia could inhabit but has not yet been recorded. The second set of models describe the suitability of habitats for Dasysiphonia under projected climate change scenarios. Given that the expected range limits of Dasysiphonia are largely controlled by trends in sea surface temperature, we predict that this invasive species will continue to spread northwards into new parts of the Gulf of Maine. With warming ocean temperatures expected to have negative impacts on the success of native canopy-forming kelps, it is likely that the subtidal ecosystem of the Gulf of Maine will become increasingly dominated by the fast-growing red turf alga Dasysiphonia. This has severe implications for other organisms which rely on kelp beds.

Day 3 Poster

Shell Game for Price Gain: Does Feeding Regime Make a Difference to Post-molt Shell Hardening in the American Lobster?

Authors: Nicole D. Orminski (University of Maine, Orono, ME 04469 USA), Curt Brown (Ready Seafood Co., Portland, ME 04101 USA), Dr. Richard Wahle (University of Maine, Orono, ME 04469 USA), Dr. Steve Jury (St. Joseph's College, Standish, ME 04084 USA)

Presenter: Nicole D. Orminski, nicole.orminski@maine.edu

The Maine lobster industry contributes significantly to the state's economy: the distribution supply chain generated nearly $1 billion in 2016 alone. Fulfilling growing overseas demand requires that lobsters endure up to two days of shipping. During the summer months Maine lobstermen mostly harvest low value soft-shelled lobsters that do not survive shipping. This study seeks to evaluate whether differences in feeding regime influence the rate of shell hardening. Our experimental protocol compares unfed lobsters to those fed daily with Zeigler shrimp broodstock pellets over 5-day trials. At the end of each trial, lobsters will be tested for weight gain and shell hardness via a durometer. If we observe the hypothesized increase in weight and shell grade in fed lobsters, including hold-over days with a feeding regime could become a profitable way to add value to live lobsters after accounting for costs.

Day 3 Poster

Collaborative research to help assess flatfish stocks in changing oceans

Authors: Tyler Pavlowich (Integrated Statistics, Narragansett Lab of the Northeast Fisheries Science Center, Narragansett, RI 02882 USA), David Richardson (Northeast Fisheries Science Center, Narragansett, RI 02882 USA), Greg DeCelles (Massachusetts Division of Marine Fisheries, New Bedford, MA 02740 USA), John Manderson (OpenOcean Research, Philadelphia, PA 19118 USA)

Presenter: Tyler Pavlowich, tyler.pavlowich@noaa.gov

With the Gulf of Maine marine ecosystem changing rapidly, fishery stakeholders should work together to achieve the best estimate possible of the condition of fish stocks. Scientists can benefit from fishermen's observations of the ocean and their catch, day after day, year after year. Fishermen also gain from scientists' analyses and often-times wider perspective, assuming scientists' work and conclusions are abundantly disseminated and not obscured by jargon. A team of scientists at NOAA's Northeast Fisheries Science Center and the Massachusetts Division of Marine Fisheries are working with fishermen to understand and utilize fishermen's social-ecological knowledge about American plaice, Hippoglossoides platessoides. The project seeks to gather fishermen's observations related to plaice, determine whether the observations are supported by data and can be illustrated with scientific analysis, and create analytical tools useful for improving the stock assessment of this species. To take in the industry's perspective, the team has had one-on-one conversations, group workshops, and regular dialog with fishermen. For scientists, each interaction leads to new analyses and fills in details not easily seen in the raw data. It also helps fishermen understand the ways scientists' view of the system differs from their own and sparks ideas for what to pay attention to while on the water. To date, the project has generated hypotheses about plaice related to their abundance, changes in the timing of seasonal migrations, shifts in presence related to depth and bottom temperature, and the distribution of plaice as a function of population size. This project has the potential to make real improvements in the accuracy of the next benchmark stock assessment for plaice in 2022. It also serves as an example of the type of boundary-spanning work that will be an important strategy for dealing with environmental and social change.

Day 4 Poster

Student-built, fishermen-deployed, satellite-tracked drifters

Authors: Erin Pelletier, Gulf of Maine Lobster Foundation, Kennebunk, ME, James Manning, NOAA's Northeast Fisheries Science Center, Woods Hole, MA

Presenter: Erin Pelletier, erin@gomlf.org

Nearly 1500 student-built drifters have been deployed in the last 15 years off the New England coast in an attempt to resolve transport pathways and provide surface current information to numerical modelers. Well over a million kilometers of tracks have been logged, archived, and now served according to Integrated Ocean Observing System standards. This program has provided students from over 100 schools a hands-on introduction to physical oceanographic principles by engaging them in the entire process of building the instruments, connecting with local fishermen and other mariners (who deploy the units offshore), and following their tracks through time in the classroom. In addition to being a hands-on educational tool, these drifters have provided oceanographers at federal, state, and academic labs a source of low-cost instrumentation for a variety of applications. In particular, they provide circulation modellers data they need for validation. While both surface and drogued drifters are built with easy-to-find, eco-friendly materials, they are configured according to oceanographic standards.

Day 4 Poster

Changing phenology of large whales in Cape Cod Bay and its implications for management

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Presenter: Daniel E. Pendleton, dpendleton@neaq.org

Marine species are responding to climate change through spatio-temporal changes in distribution. Such changes have the potential to negate the effectiveness of static protective measures, such as time and area restrictions on fishing and vessel speed limits related to marine mammal conservation. The distribution of North Atlantic right whales (Eubalaena glacialis) has shifted dramatically over the past 10 years. While right whales have decreased their use of habitats in the eastern Gulf of Maine, they have increased their use of western Gulf of Maine habitats, especially Cape Cod Bay (CCB). These broad distribution shifts have been linked to large-scale, climate-induced changes in temperature and circulation. However, we lack an understanding of how changing distributions within specific habitats may change the effectiveness of established regulations. The objective of our research was to measure changes in the timing of habitat use by large whales in CCB, where fishing gear and vessel speed regulations are based upon the historic timing of habitat use. Toward this end, we used multi-season occupancy models that considered date, sea surface temperature, chlorophyll, depth, and sighting conditions such as Beaufort sea state, to measure shifts in the timing of habitat use by right, fin (Balaenoptera physalus), and humpback (Megaptera novaeangliae) whales between 1998 and 2018. We found that the springtime peak in right whale occupancy of CCB has moved forward in time by over 4 weeks. The springtime peak in fin whale occupancy in CCB moved backward in time 1-2 weeks, and the springtime peak for humpback whales moved forward 1-2 weeks. Shifts in arrival, peak use, and departure of large whales have implications for the fixed-gear fishery and shipping regulations. Model results will be discussed in the context of current measures designed to protect large whales in CCB and potential actions for reducing adverse interactions with human activities.

Day 2 Poster

Re-envisioning the USGS Coastal Vulnerability Index (CVI) assessment

Authors: Elizabeth A. Pendleton (U.S. Geological Survey, Woods Hole, MA 02543 USA) and Erika E. Lentz (U.S. Geological Survey, Woods Hole, MA 02543 USA)

Presenter: Elizabeth Pendleton, ependleton@usgs.gov

The U.S. Geological Survey is improving its coastal vulnerability to sea-level rise assessment that was conducted 20 years ago. Our update seeks to preserve the strengths of the original study, which include the graphical color-coded vulnerability scale, analysis of geologic factors that influence coastal change, and the national-scale coverage, while applying recent advances in machine learning, input datasets and resolution, and timescales of anticipated coastal change. The original CVI focused on longer term vulnerability (50 to 100 years) using expected accelerated sea-level rise as the primary driver of coastal change, however, this iteration will integrate additional coastal change drivers (e.g. storms and flooding) on a timescale of 0 to 10 years. The updated assessment will focus on classifying coastal exposure and hazards, which include slope and elevation, onshore and offshore substrate type, storm and flood intensity and frequency, relative sea-level rise rates, wave energy, and erosion, to predict the likelihood of change in landform or coastal system function. A machine learning decision tree framework is used to analyze existing coastal geospatial datasets and determine a probability of change that could include damage, destruction, and/or loss of resources in the coming decade. The northeastern U.S. has been selected as a feasibility test area for the updated CVI assessment, as part of a natural Resource Preservation Program (NRPP) collaboration with the National Park Service.

Day 2 Poster

A Team Approach to Comprehensive Resiliency and Global Improvement and Restoration to the Great Marsh, Massachusetts

Authors: Peter Phippen (Massachusetts Bays National Estuary Program), Gregg Moore (University of New Hampshire), Alyssa Novak (Boston University), Nancy Pau U.S. Fish and Wildlife Service), Elizabeth Duff (Mass Audubon), Geffrey Walker (Town of Newbury, MA), Roger Warner (Green Crab R&D)

Presenter: Peter D. Phippen, pphippen@mvpc.org

An ad hoc, select Team of university, government, and nonprofit individuals have been partnering with stakeholders to comprehensively restore and improve the resiliency of the Great Marsh, Massachusetts. The Great Marsh, located in the northeast corner of the state, is in relatively healthy condition, however over the last couple of decades it has been showing signs of degradation at an increasing rate in the face of expected sea level rise and storm surge. The Great Marsh is the largest contiguous coastal marsh in New England and is an important natural protection for vulnerable man-made coastal infrastructure in several communities and for tens of thousands of people. It is also a significant recreational asset for the region, an important commercial and recreational fin and shellfishery, a valuable migratory stop-over on the North Atlantic Flyway, and provides a host of environmental services on a grand scale. The Team has been working together (with partners) on various projects for over five years with many successes and occasional frustrations; however, each action has helped to move the resiliency needle forward in Massachusetts. Working on the scale of tens and even hundreds of acres per project, has its challenges, which the team has addressed successfully. Projects include: researching and modifying marsh hydrology, invasive marsh plant management, dune creation and restoration, marsh edge erosion investigations for living shorelines, thin-layer placement of repurposed dredge material assessment, eelgrass restoration, invasive green crab, monitoring, management and repurposing, and a number of other projects. The greatest challenge of all is keeping the partners in concert as old projects end and new ones begin, especially when funding lapses and project direction changes. The Great Marsh Partnership has been extremely successful coordinating the varying interests, and at protecting, restoring and improving the attributes of the Great Marsh.

Day 2 Poster

Stonington, ME Coastal Flood Vulnerability and Adaptation Study

Authors: Leila A. Pike, P.E. (GEI Consultants, Inc.)

Presenter: Leila Pike, lpike@geiconsultants.com

The presentation will be an overview of a coastal flood vulnerability and adaptation study being conducted for the Town of Stonington. The purpose of the work is to perform a vulnerability study on municipally owned infrastructure in Stonington, specifically the road network and wastewater infrastructure, to determine critical infrastructure that is vulnerable to coastal flooding due to storms and sea level rise and to provide adaptation solutions to increase Stonington's resiliency in the face of coastal storms and changing sea levels. The vulnerability study incorporates increased future sea level rise into an STWAVE model to simulate the transmission of offshore storm conditions to nearshore wave conditions to see worst-case-scenario flooding. From there, eight other scenarios of a combination of sea level rise and date (2030, 2050, or 2100) are simulated to provide the client with information as to if and when particular municipal assets will expect flooding. The work is funded in part by a Maine Coastal Program Coastal Communities Grant and is expected to be completed by December 2020. The study provides a robust framework for conducting thorough vulnerability studies, including incorporating community, stakeholder, and asset manager engagement, and assessing various adaptation options to increase the community's resiliency. One project goal is for this same framework to be easily implemented in any community to address flood vulnerability and adaptation options, and audience members can leave the presentation knowing that there is a path forward when dealing with the threat of coastal flooding due to storm surge and sea level rise.

Day 2 Poster

The Manifestation of Resource Acquisition Preference of Pagurus Acadianus in its Determination of Shell Refuge Quality

Authors: Meghan Poth (Dartmouth College), Mark Laidre (Dartmouth College)

Presenter: Meghan Poth, david.buck@unh.edu

In the pursuit of rare resources, subtidal hermit crabs face a plurality of challenges, both temporally and spatially. Such resources include the emptied shells of deceased marine gastropods, in which subtidal hermit crabs take refuge. Subtidal hermit crabs exploit long-distance chemical cues to overcome these challenges and to determine the availability of nearby gastropod shells that have been recently emptied or abandoned. Here, we utilized the Acadian hermit crab (Pagurus acadianus) to assess and identify the gastropod shell characteristics that marine hermit crabs use to determine the overall quality of a shell refuge, whether those be shell diameter, wall thickness, aperture size, or weight. We conducted this assessment in a two-fold manner. First, we released long-distance chemical cues, simulative of nondestructive predation, predation in which the predator consumes the flesh of the gastropod but leaves the shell itself intact. Such cues arising from nondestructive predation are indicative to P. acadianus of the availability of an emptied gastropod shell. Using this method, we determined a preference for a specific gastropod species shell: that of the common periwinkle (Littorina littorea). Then, by a series of shell preference trials performed and analyzed in laboratory water tables, we determined which specific characteristics of shell architecture of both the dog whelk and the common periwinkle P. acadianus manipulates to determine the quality of available housing provided by deceased mollusks. Broadly, this sequence of studies provides an indication as to how, within the context of the ecological challenge of locating resources that are limited in nature, preference manifests, specifically for P. acadianus.

Day 3 Oral presentation

The effects of sediment buffering and predator exclusion on Soft-shell clams

Authors: Dr. Brian Beal (Division of Environmental and Biological Sciences, University of Maine at Machias, 116 O'Brien Avenue, Machias, ME 04654 and Downeast Institute, 39 Wildflower Lane, PO Box 83, Beals, ME 04611),Chad Coffin (Maine Clammers Association, PO Box 26, Freeport, ME 04032),Clint Goodenow Jr. (Maine Clammers Association, PO Box 26, Freeport, ME 04032),

Presenter: Sara Randall, Srandall@downeastinstitute.org

Soft-shell clam (Mya arenaria) landings in Casco Bay communities have declined dramatically over the past decade by nearly 70%, and this has coincided with unprecedented increases in Gulf of Maine sea surface temperatures. In 2014, we initiated a three-year field study at four intertidal flats in Freeport to investigate simultaneously two of the purported causes of the decline: ocean acidification and predation. Sites had low sediment pH (< 7.4) and few juvenile clams. We attempted to buffer those sediments by adding crushed shells to plots. Success was measured as the density of wild recruits of Mya. The presence of crushed shell material did not result in a significant enhancement of clam recruits. However, when we applied predator netting (aperture = 4.2 mm) to plots with or without crushed shell, we found significantly more clams compared to the unprotected plots. In 2016, we continued field testing sediment buffering as a way to enhance clam populations. At two intertidal sites we deployed 12 treatments: small clam shells (1mm), medium clam shells (5-10mm), large clam shell (15- 20mm), oyster shell (1mm), granite and then none and added nets to each of the treatments for a total of 12 treatments replicated ten times at each sites (n=240). The pH was measured throughout the field season by Friends of Casco Bay. We found that overall netted units have lower (more acidic) sediments. Despite this, overall, we found more clams under nets than in the sediment buffering. The P values for one of the sites (Recompence) was statistically significant for protection. Over the course of these experiments (2014-2016) we sampled and processed 4.65 tons of intertidal sediments, counting and measuring every single soft-shell clam in those sediments. We conclude that buffering sediments to combat low sediment pH is not effective compared with applying netting to deter predators.

Day 4 Oral presentation

Recovery, range contraction, and the fate of kelp forests in the Gulf of Maine

Authors: Douglas B. Rasher (Bigelow Laboratory, East Boothbay, ME 04544), Thew S. Suskiewicz (Bigelow Laboratory, East Boothbay, ME 04544), Robert S. Steneck (University of Maine, Walpole, ME 04573), Jarrett E.K. Byrnes (University of Massachusetts, Boston, MA 02125)

Presenter: Douglas B. Rasher, drasher@bigelow.org

Kelp forests are the foundational habitat of temperate seas around the world and have defined the coast of Maine for millennia. Yet, a century of industrial overfishing has rearranged the Gulf of Maine kelp forest food web, triggering abrupt ecosystem changes. When large predatory fish were hunted to functional extinction in the twentieth century, herbivorous sea urchins proliferated and grazed kelp forests into barren reefs. A sea urchin fishery then emerged in the 1990's, driving urchin populations to functional extinction and allowing kelp forests to rapidly return to much of the region. It remains unclear, however, whether kelp forests continue to recover, given that the Gulf of Maine is now rapidly warming and some forests reside at the warm edge of their geographic range in the Northwest Atlantic. Using the first comprehensive survey of kelp forests in nearly 20 years, we show here that while forests have strongly returned to much of the region in the wake of the sea urchin fishery, those once found in the southern portion of the region have entirely collapsed. Using environmental data, we go on to demonstrate that the southern Gulf of Maine now regularly experiences summer seawater temperatures that surpass the thermal limits of kelp, indicating these areas are no longer conducive to forest development. Our results suggest that top-down forcing will retain kelp forests within much of region over the coming decades, but eventually central and northern forests will succumb to the same fate as their southern counterparts (unless global carbon emissions are curbed). They also suggest that ecosystem-based management will be needed in the near-term to build ecological resilience against rapid warming and associated species range shifts.

Day 4 Lightning talk, Poster

Ecosystem forecasting can be a valuable climate adaptation tool

Authors: Nicholas R. Record (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Benjamin Tupper (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Stephen D. Archer (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Craig Burnell (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Isabella Grasso (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Kohl Kanwit (Maine Department of Marine Resources, Boothbay Harbor ME 04575 USA), Lisa A. Kerr (Gulf of Maine Research Institute, Portland ME 04101 USA), Philip J. Nyhus (Colby College, Waterville ME 04901), Daniel E. Pendleton (New England Aquarium, Boston MA 02110 USA), Andrew J. Pershing (Gulf of Maine Research Institute, Portland ME 04101 USA), Carlton Rauschenberg (Bigelow Laboratory for Ocean Sciences, East Boothbay ME 04544 USA), Camille Ross (Colby College, Waterville ME 04901), Zachary Whitener (Gulf of Maine Research Institute, Portland ME 04101 USA)

Presenter: Nicholas R. Record, nrecord@bigelow.org

In the coming decades, the Gulf of Maine will experience new and challenging conditions that will undermine our current approaches to resource use, management, and conservation. One approach that allows us to be proactive rather than reactive in how we cope with changing conditions is to develop and use ecosystem forecasts. The science of ecosystem forecasting is in its early stages, but there is a range of forecasting systems developed for the Gulf of Maine, including for whales, fish, jellyfish, and red tides, among others. The methodologies range from citizen science to artificial intelligence, and each approach highlights different monitoring needs, ecological dynamics, and forecasting potential. Dynamics tied strongly to temperature tend to have longer forecasting ranges, on scales from months to years, while dynamics tied strongly to biological interactions tend to have shorter forecasting ranges, on scales from days to weeks. Development and use of ecosystem forecasts can also reveal new ecosystem dynamics, such as the role of changing oceanographic currents in the distributions of organisms. The predictability, or lack thereof, of different ecosystem components is likely to have an increasing selective force on which of these components can be successfully managed in the Gulf of Maine. Just as weather forecasts have become essential to many aspects of modern society, ecosystem forecasts can play an important role in managing aquaculture, fisheries, and species of concern in a more variable future climate.

Day 4 Poster

Multi-faceted temperature effects on northern shrimp in the Gulf of Maine and hypotheses for a population collapse

Authors: Anne Richards (NOAA Northeast Fisheries Science Center, Woods Hole, MA 02543 USA), Charles Adams (NOAA Northeast Fisheries Science Center, Woods Hole, MA 02543 USA), Margaret Hunger (Maine Department of Marine Resources, Boothbay Harbor, ME USA)

Presenter: Anne Richards, Anne.Richards@noaa.gov

The northern shrimp Pandalus borealis supports important fisheries across the North Atlantic, including one in the Gulf of Maine (GOM) where the species reaches its southern limit. Productivity of the GOM stock is linked to temperature through recruitment processes and possibly also growth of individuals. Early life survival has declined steadily since 1998, and in 2012 the population experienced a sudden decline of all life history stages. The population is considered collapsed, and fisheries have been closed since 2014. We will review our current understanding of ecosystem processes linked to productivity of GOM northern shrimp and examine hypotheses for its sudden collapse in 2012, the warmest year on record in the GOM. Lethal temperature effects were not implicated in the collapse, there was no evidence of episodic disease, and no shifts were observed in distribution to habitats outside historical stock areas. Overfishing may have occurred in 2012 but cannot explain the disappearance of pre-recruit size shrimp. An index of predation pressure by fish on shrimp has approximately doubled during the past 3 decades, but a major change in the predation pressure index was not seen in 2012. However, an early thermal transition to summer conditions in spring of 2012 was associated with an unusual influx of longfin squid Doryteuthis pealeii, a relatively warm-water species that ordinarily has little spatial overlap with northern shrimp. We evaluate the possibility that temperature-mediated squid predation played an important role in the collapse of northern shrimp in 2012.

Day 2 Lightning talk

One Climate Future: Spearheading a two-city plan for climate resilience

Authors: Troy Moon (Sustainability Coordinator, City of Portland); Julie Rosenbach (Sustainability Director, City of South Portland); Jim Newman (Principal, Linnean Solutions)

Presenter: Julie Rosenbach, jrosenbach@southportland.org; and Troy Moon, thm@portlandmaine.gov

In January, the Cities of Portland and South Portland launched the One Climate Future process to develop a joint, two-city climate action and adaptation plan. This presentation will bring together sustainability department heads from both Portland and South Portland, Troy Moon and Julie Rosenbach, with Jim Newman from consulting firm Linnean Solutions, to discuss the processes and progress in joining forces with residents, businesses, and organizations to develop a shared vision for climate action across the cities, and how the process has charted the cities on a course towards specific action. While One Climate Future is new, local climate action is not: Research institutions, advocacy groups, industry sectors, nonprofit organizations, city departments, and concerned residents across Portland and South Portland have been monitoring environmental indicators, assessing flood vulnerability, promoting sustainable practices, and advocating for citywide and statewide climate- and energy-related policy change. As a two-city plan, One Climate Future aims to draw together and bolster the momentum of action across the two cities through the following premises: 1) The impacts of climate change do not follow municipal borders; 2) Consequently, solutions may not work best by following municipal borders either; coordinated action across cities can share resources, address systems that intersect both cities, and can create larger levers for change; and 3) Oftentimes the most critical and challenging aspect of climate planning comes in the form of consensus building: creating momentum, establishing priorities, and defining resource needs across a wide variety of community actors whose work also spans municipal borders. One Climate Future is working to create consensus ‘a vision’ for how Portland’s and South Portland’s communities can collectively take action by working with businesses, organizations, and residents leading climate action.

Day 4 Poster

Predicting regions of North Atlantic right whale, Eubaleana glacialis, habitat suitability in the Gulf of Maine in 2050

Authors: Camille H. Ross (Colby College, Waterville, ME 04901 USA), Nicholas R. Record (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544 USA), Daniel E. Pendleton (Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA 02110 USA), Ben Tupper (Bigelow Laboratory for Ocean Sciences, East Boothbay, ME 04544 USA)

Presenter: Camille H. Ross, chross20@colby.edu

North Atlantic right whales, Eubaleana glacialis, are critically endangered. Understanding the role environmental conditions play in E. glacialis habitat suitability is key in determining the regions in need of protection in order to conserve the species. As climate change continues to influence environmental conditions, understanding how E. glacialis respond to changes is sea surface temperature and prey abundance becomes increasingly imperative. This study uses different species distribution modeling (SDM) techniques to determine which environmental variables appear to have the greatest influence on E. glacialis habitat preference in the Gulf of Maine. Generalized additive models (GAMs), boosted regression trees (BRTs), and Maxent SDMs incorporating sea surface temperature, deep water temperature (depth = 50m), prey abundance, specifically the copepod Calanus fincmarchicus, and bathymetry are produced and the biological implications are analyzed. BRT models consistently performed better than the GAM and Maxent models. The model outputs suggest that over a given year deep water temperature and sea surface temperature are generally stronger predictors of E. glacialis habitat in comparison to prey abundance and bathymetry. Analysis indicates that the relative importance of each environmental variable changes seasonally, with an increase in the importance of prey abundance in the summer and an increase in the importance of temperature in the winter. These results indicate that E. glacialis are susceptible to the effects of climate change. Characterizing E. glacialis habitat preferences will allow us to predict likely locations and timings of suitable habitat in the Gulf of Maine in 2050.

Day 3 Poster

The Integrated Sentinel Monitoring Network (ISMN): Expansion of the Marine Biodiversity Observation Network (MBON) into the Gulf of Maine

Authors: Jeffrey A. Runge (School of Marine Sciences, University of Maine and Gulf of Maine Research Institute, Portland, ME 04101 USA)

Presenter: Jeffrey A. Runge, jeffrey.runge@maine.edu

The ISMN is a nascent regional infrastructure emerging from a plan developed by NERACOOS and the Northeast Regional Ocean Council (NROC) through a series of community workshops. The purpose of the ISMN is to facilitate coordination and analysis of data collected in numerous observing activities throughout the Northeast U.S. region. With funding from the National Oceanic and Atmospheric Administration and the Bureau of Ocean Management, and support of the National Oceanographic Partnership Program, the ISMN is overseeing the expansion of MBON into the Gulf of Maine. The expansion includes development of ISMN data management capabilities and time series observations at two fixed stations of plankton biodiversity, identified as a crucial gap for understanding phenological and long-term change in the Gulf of Maine pelagic marine ecosystem. Phytoplankton, micro- and mesozooplankton abundance and species diversity will be microscopically enumerated, and water samples will be processed for analysis with an Imaging FlowCytobot and water column eDNA. In a demonstration of the ISMN CAPE (Center for Analysis, Prediction and Evaluation), time series observations, temperature and chlorophyll seascapes, NOAA plankton data and NERACOOS-supported dynamic ocean circulation modeling will be integrated into predictions of change in the planktonic lipidscape. The lipidscape indicates the distribution of copepod lipids, the primary energy source for the endangered North Atlantic right whale, as well as planktivorous forage fish, including coastal herring and sandlance. A key sentinel biodiversity variable is the abundance of the subarctic copepod, Calanus finmarchicus, which constitutes >75% of the region's mesozooplankton biomass and is the primary lipidscape contributor. The lipidscape analysis may be useful to inform management decisions about right whale foraging distribution related to regulation of shipping lanes and entanglement in fishing gear.

Day 4 Poster

Predicting bycatch hotspots based on suitable habitat derived from fishery-independent data

Authors: Jocelyn Runnebaum (The Nature Conservancy Maine, Brunswick, ME, 04011/ University of Maine, Orono, ME, 04469), Kisei Tanaka (Princeton University, Princeton, NJ, 08544), Lisha Guan (Yellow Sea Fisheries Research Institute, China, Shandong, Qingdao), Jie Cao (North Carolina State University, Morehead City, NC 28557), Loretta O'Brien (East Falmouth, MA 02536), Yong Chen (University of Maine, Orono, ME, 04469)

Presenter: Jocelyn Runnebaum, jocelyn.runnebaum@TNC.org

Bycatch remains a global problem in managing sustainable fisheries. A critical aspect of bycatch management is understanding the timing and spatial extent of bycatch. This is becoming increasingly important because these interactions are also changing as climate conditions continue to change. Analysis of bycatch often relies on fisheries-dependent data, but these data are not always available due to a lack of bycatch reporting or observer coverage. Alternatively, analyzing the overlap in suitable habitat for the target and non-target species can provide a spatial management tool to understand where bycatch interactions are likely to occur. We developed a framework to predict possible bycatch hotspots based on suitable habitat. We applied this framework in the Gulf of Maine American lobster (Homarus americanus) fishery where cusk (Brosme brosme) are incidentally caught in the fishery. A delta-generalized linear mixed model (i.e. VAST) was used to combine data from multiple fisheries-independent surveys to generate density estimates which were then used in habitat suitability indices for each species independently. The overlap of suitable habitat was evaluated to predict spatially-explicit potential bycatch hotspot locations. Suitable habitat for American lobster has increased between 1980-2013 in both the spring and fall and habitat for cusk decreased throughout most the Gulf of Maine, except for Georges Basin and the Great South Channel. The proportion of overlap in suitable habitat varied interannually but decreased slightly in the spring and remained relatively stable in the fall over the time series. As Gulf of Maine temperatures continue to increase, the interactions between American lobster and cusk could decline as cusk habitat continues to constrict. Our proposed bycatch prediction framework can contribute to fisheries managers understanding in the interaction of habitat between targeted species and those needing conservation management measures.

Day 2 Poster

The Northeast Ocean Data Portal: Maps and Data for New England's Oceans

Authors: Emily Shumchenia and Nicholas Napoli (Northeast Regional Ocean Council); Kelly Knee, Jeremy Fontenault, Jenna Ducharme, and Stephen Sontag, (RPS); Daniel Martin (NOAA Office for Coastal Management); Peter Taylor (Waterview Consulting); James Craddock (Yellahoose); Marta Ribera (The Nature Conservancy)

Presenter: Emily Shumchenia, emily.shumchenia@gmail.com

The Northeast Ocean Data Portal (Portal) was established in 2009 as a centralized, peer-reviewed source of data and maps of the ocean ecosystem and ocean-related human activities in New England. The Portal serves as a common resource for practitioners working in various agencies or institutions on diverse topics and at various scales, including by bringing together data and information from multiple sectors to understand potential effects of climate change on both the ecosystem and human communities. Users can launch interactive thematic maps, view any combination of layers using the Data Explorer, access ready-made static and interactive maps in the map gallery, and download data. For nearly 10 years, the Portal has been used to support regulatory, management, and business decisions, stakeholder engagement, and educational and research activities on topics ranging from climate change to offshore aquaculture. Highlights include:

- Growing library of visualizations of commercial fishing vessel activity over the last several years including transit counts for vessels carrying Automatic Identification System (AIS) transponders, by fishery via Vessel Monitoring System, and by gear and port using Vessel Trip Report analyses.
- Updated marine life maps that include recent observations, new species, new species groups and a new tool for accessing individual species data within the Data Explorer.
- Vessel traffic (AIS) data for 2015, 2016, & 2017 including maps of vessel transit counts, new categories of various vessel types, and a time-slider allowing users to explore how activity varies by month throughout the year.
- The latest proposed project envelopes, potential cable routes, and lease areas for offshore wind development

For this 'interactive poster', Portal staff will provide a large display screen, computer, and all electronic components to display a fully interactive kiosk for attendees for the duration of the conference.

Day 2 Poster

What are your ocean observing needs, now and into the future?

Authors: Christina Macdonald (CIOOS-Atlantic), Julianna Mullen (NERACOOS), Shayla Fitzsimmons (CIOOS-Atlantic), Jackie Motyka (NERACOOS), and Alexi Baccardax Westcott (CIOOS-Atlantic)

Presenter: Tom Shyka, Jackie@neracoos.org

Both the U.S. and Canada are each supporting Integrated Ocean Observations in the Gulf of Maine through NERACOOS and CIOOS-Atlantic. As we consider the needs of the region into the future it's important that we gather stakeholder input to guide our collaborative development of the observing system. NERACOOS is one of eleven Regional Associations of the U.S. IOOS, and currently supports buoys, gliders, oceanographic modeling, coastal stations, high frequency radar, data integration and products; in order to fulfill its mission: to produce, integrate and communicate high quality information that helps ensure safety, economic and environmental resilience, and sustainable use of the coastal ocean. CIOOS is funded by Fisheries and Oceans Canada (DFO) and the Marine Environmental Observation Prediction and Response Network (MEOPAR), the Canadian Integrated Ocean Observing System (CIOOS) is expected to improve collaboration, ensure data is findable and accessible, improve interoperability through data and metadata standards, and enable the widespread reuse of data. CIOOS-Atlantic covers the Atlantic Seaboard from the coasts of Labrador down to the Gulf of Maine, its ambitious mandate is to improve coordination regionally while addressing the unique needs of the local oceanographic community, and contribute to improving coordination nationally in support of international coordination efforts. CIOOS is a newly-formed organization, and at current is partway through its initial phase. NERACOOS is re-evaluating their system in preparation for their upcoming five-year proposal. To ensure development of useful and beneficial tools and products, both NERACOOS and CIOOS-Atlantic are actively seeking feedback from stakeholders to better understand regional interests and needs: comments, criticisms and suggestions are strongly encouraged!

Day 3 Poster

High collocation between sand lance and top predators in the southwestern Gulf of Maine

Authors: Tammy L. Silva (NOAA Stellwagen Bank National Marine Sanctuary, Scituate, MA & Department of Fisheries Oceanography, School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA), David Wiley (NOAA Stellwagen Bank National Marine Sanctuary, Scituate, MA), Michael Thompson (NOAA Stellwagen Bank National Marine Sanctuary, Scituate, MA), Peter Hong (NOAA Stellwagen Bank National Marine Sanctuary, Scituate, MA), Les Kaufman (Department of Biology, Boston University, Boston, MA), Justin Suca (Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA), Joel Llopiz (Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA), Hannes Baumann (Department of Marine Sciences, University of Connecticut, Storrs, CT), Gavin Fay (Department of Fisheries Oceanography, School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA)

Presenter: Tammy L. Silva, tammy.silva@noaa.gov

Sand lance (Ammodytes spp.) are important forage fishes throughout the Gulf of Maine (GOM) and are expected to be impacted by warming temperatures and ocean acidification. Long-term changes in sand lance abundance and distribution may disrupt ecosystem structure through impacts on abundance and distribution of top predators. Sand lance are likely preferred prey for top predators in the southwestern GOM and shifts in their abundance have been correlated with general fluctuations and movements of key predator species. However, the degree of spatial overlap between sand lance and top predators within important habitats has not been quantified. We investigated spatial relationships between humpback whales (Megaptera novaengliae), great shearwaters (Ardenna gravis) and Northern sand lance (Ammodytes dubius) in Stellwagen Bank National Marine Sanctuary, an important foraging area for protected marine mammal and seabird species in the southwestern GOM. Counts of sand lance, humpback whales and great shearwaters were conducted at 44 sites in spring and fall from 2013-2018. We used spatial metrics and collocation indices to quantify overlap between sand lance, humpback whales, and great shearwaters at two spatial scales (site-level (local) ~ 1 km and sanctuary-level (global) ~300 km2). Based on collocation indices ranging from 0 (no co-occurrence) to 1 (local - species density proportional at sites; global - population centers coincide), we found weak to moderate collocation between sand lance and whales / birds at the site-level (local index range: 0 - 0.42 (humpbacks); 0 -0.6 (shearwaters)), but strong colocation at the sanctuary-level (global index range: 0.7 - 0.99 (humpbacks); 0.97 - 0.99 (birds)). Our results suggest humpback and great shearwater distributions can be tightly linked with sand lance abundance and that changes in sand lance abundance due to climate change could impact distributions of top predators, ecosystem structure and effectiveness of MPAs.

Day 4 Poster

Haul out behavior of Harbor seal and Gray seal in response to wind and haul-out abundance on Duck Island, Maine

Authors: Nannaphat Sirison (University of California - Berkeley), Andrea Bogolmoni (Woods Hole Oceanographic Institute), Lisa Sette (Center for Coastal Studies), Nadine Lysiak (Suffolk University)

Presenter: Nannaphat Sirison, david.buck@unh.edu

Haul out behavior is imperative to the conservation and management of pinniped species. Haul-out abundance is used as a proxy to estimate total population because it is used as a means for thermoregulation, mating, protection, resting, etc. It is expected that haul out behavior and choice of haul out site takes into consideration such physical needs. We examined haul out patterns of harbor and gray seals in response to environmental drivers (wind velocity and wind direction) and overall abundance. We took population counts using a photographic mark and recapture technique on Duck Island and its surrounding ledges, and wind speed and direction measurements were pulled from a nearby buoy (IOSN3). Wind velocity was not significantly related to the total number of seals for both species. Investigations of wind direction in relation to windward (exposed) vs. leeward (protected) haul-out habitats did not reveal a preference for either species; however, analysis displayed clustering behavior in both species, in which individuals tend to all haul out on either one side or the other. Following this observation, seal abundance was also investigated in relation to windward vs leeward haul out preference. Results demonstrated that at lower abundances, both harbor and gray seals exhibit no preference for clustering on either the windward or leeward side; at higher abundances, both species indicate a preference for clustering on the windward side, potentially due to increased thermoregulation and protection from abiotic factors with increasing density. Site specific understanding of haul out behavior in harbor and gray seals can inform conservation policies to protect specific habitats utilized by these species. Results can also help improve survey techniques to optimize more accurate population counts, and can reveal important information on how changing environmental drivers may impact behavior and haul out abundance of harbor and gray seals.

Day 3 Poster

Understanding Climate Change Impacts in the Gulf of Maine: Assessing Spatial and Temporal Trends of Water Quality in Blue Hill Bay from 2004 to 2019

Authors: Mary E. Stack, Michelle L. Berger, Heather L. Richard, Dr. Susan D. Shaw (Shaw Institute, Blue Hill, ME 04614 USA)

Presenter: Mary E. Stack, mestack@shawinstitute.org

The Gulf of Maine is one of the fastest-warming bodies of water on Earth. In Blue Hill Bay, the second largest bay in Maine, the Shaw Institute documented a 2°C increase in nearshore surface waters from 2004 to 2013. Accompanying this upward temperature trend was an increase in chlorophyll a, dissolved oxygen, and pH. Understanding changes in coastal watersheds is crucial to the success of coastal economies and communities amidst the increasing consequences of ocean warming and shifting climate conditions. During the 2019 field season, the Shaw Institute revisited its historic water quality sites to further investigate drivers of change in Blue Hill Bay watershed. From June through October, 37 sites were monitored using an EXO2 multi-parameter datasonde. Freshwater and marine sites accessed from land were monitored weekly and offshore sites measured via boat were monitored every two weeks. Water quality parameters included temperature, pH, dissolved oxygen, conductivity, salinity, chlorophyll a, and turbidity. Measurements from 2019 were added to the trend analysis of water quality data since 2004. When possible, the gap between 2014 and 2018 was supplemented with data from other monitoring projects that occurred at the historic sites. Data were also analyzed for significant changes in water quality parameters since 2013. Understanding the scope of climate change impacts in the Gulf of Maine is essential for developing local mitigation and response strategies as well as globally beneficial solutions to a rapidly changing ocean. Implications of anthropogenic influences on coastal water quality and the trajectory of future conditions will be discussed.

Day 3 Poster

An analysis of fishing community resilience in Maine

Authors: Joshua Stoll (School of Marine Sciences, University of Maine, Orono, Maine, 04469 USA; Maine Center for Coastal Fisheries, Stonington, Maine, 04681 USA), Heather Leslie (School of Marine Sciences, University of Maine, Orono, Maine, 04469 USA; Darling Marine Center, University of Maine, South Bristol, Maine, 04568); Marina Cucuzza (School of Marine Sciences, University of Maine, Orono, Maine, 04469 USA); Melissa Britsch (School of Marine Sciences, University of Maine, Orono, Maine, 04469 USA; Darling Marine Center, University of Maine, South Bristol, Maine, 04568);

Presenter: Joshua Stoll, joshua.stoll@maine.edu

The extent to which fishing communities adapt to socioeconomic and environmental drivers of change will, in part, be dictated by their past and present relationships to fisheries. Understanding adaptation strategies in the future, therefore, requires attentiveness to the specific histories of coastal communities and how these unique experiences enable and disable experimentation and, ultimately, the adoption of new paths forward. Here, we present on results of a multi-year analysis focused on community sustainability in coastal counties across Maine. The research provides new insights about the adaptive capacity of communities in Maine and underscore the utility of using a multi-species approach to studying resilience in fisheries-dependent places.

Day 3 Lightning talk

Collective wisdom: Using expert elicitation to inform climate change resilience in the Gulf of Maine

Authors: Peter H. Taylor (Waterview Consulting, Harpswell, ME 04079 USA), Curtis Bohlen (Casco Bay Estuary Partnership, Portland, ME 04102 USA)

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The impacts of climate change on the Gulf of Maine's coastal ecosystems are increasingly affecting nearly every aspect of life for people and other species who live there. Many of the drivers and impacts are understood in broad strokes, but it is exceedingly challenging to translate those broad strokes into specific, proactive actions to adapt. Because the impacts arise from complex, interacting stressors and processes, many types of expert knowledge must be brought to bear and synthesized to identify the most important risks and the most beneficial adaptation actions. To support strategic planning by the Casco Bay Estuary Partnership (CBEP), Waterview Consulting conducted a survey of subject-matter experts about the probabilities and consequences of risks arising from seven classes of climate change stressors on coastal and estuarine social-ecological systems. Survey participants were selected for their recognized expertise in relevant fields such as fisheries management, water quality protection, marine policy, oceanography, estuarine ecology, and natural resource economics. While the expert elicitation was tailored to the needs of CBEP and targeted Casco Bay, it generated valuable insights that are readily transferable to coastal communities throughout the Gulf of Maine. This presentation will highlight key findings for climate change resilience in the region and demonstrate how eliciting expert opinion can improve strategic planning.

Day 4 Poster

35 years of satellite-measured SST trends and 21st century climate model SST projections over the North American east coast

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Presenter: Andrew C. Thomas, thomas@maine.edu

Monthly OISST data over the 35-year period 1982 - 2016 for the North American eastern seaboard are used to view spatial differences in SST trends and contrast those in the Gulf of Maine with those to the north as far as Labrador and south as far as the South Atlantic Bight. Trends > 0.4ºC decade-1 over the Gulf of Maine and Scotian Shelf are the strongest in the study area, and deeper basins in the Gulf and mid Scotian Shelf have trends ~ 0.5ºC decade-1. Within these two regions, trends over shallow, well-mixed, areas such as Georges Bank are weaker. Seasonally separated trends show that those in summer months (June-September) are significantly stronger than those in winter - spring months (February - April), especially over the Gulf of Maine. The 26 models in the CMIP5 ensemble show that these global climate models project increasing SST over the entire study area over the 21st century, strongest over the Mid Atlantic Bight-Gulf of Maine and Scotian Shelf-Gulf of St Lawrence, with mean trends of 0.35 and 0.42ºC decade-1 respectively. By 2050, the CMIP5 ensemble mean projects SST averaged over the MAB - Gulf of Maine region to be 2ºC (summer) and 1.5ºC (winter) warmer than the 30-year baseline period 1982-2011. By 2099, this region is projected to be ~ 4.5 and 3.3ºC (summer, winter, respectively) warmer than the baseline period. In the period of OISST-CMIP5 temporal overlap (1982-2016), however, the CMIP5 ensemble mean over predicts SST trends south of Cape Hatteras, but under predicts trends by 0.1-0.2 ºC decade-1 at latitudes higher than this. The CMIP5 ensemble mean effectively captures the summer-winter seasonal differences in SST trends over the entire eastern seaboard.

Day 2 Poster

Why map the geologic substrates of the Gulf of Maine seabed?

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Presenter: Page C. Valentine, pvalentine@usgs.gov

The Gulf of Maine ecosystem is susceptible to ocean warming which could affect the life histories and geographic distributions of marine species in the region. Many of them play an important role in the gulf's ecosystem as forage or harvested species. In order to predict the effects of long-term environmental change on benthic species, particularly their geographic movement in response to ocean warming, it is necessary to identify the substrate types they inhabit at present and the locations of similar substrates in the gulf. A geologic substrate is a surface (or volume) of sediment or rock where physical, chemical, and biological processes occur, such as the movement and deposition of sediment, the formation of bedforms, and the attachment, burrowing, feeding, reproduction, and sheltering of organisms. In response to the need to know where species live and why, geologic substrate maps are being compiled in the Stellwagen Bank region. To date, an area of 630 km2 has been mapped at a scale of 1:25,000 that revealed 34 geologic substrates in water depths of 20 to 180 m. Substrate types in the mapped region are composed of various portions of mud, sand, gravel, and boulder ridges of glacial origin. Individual substrates are characterized and identified based on grain size composition, the grain diameter range of their sediment particles, sediment mobility, sediment layering, and seabed structures, all of which can be factors that attract species occupation. Related thematic maps show the distribution of mobile and immobile sediment and the sand and mud contents of the substrates. The need for information on the distribution of substrate types and on species-substrate relationships makes geologic substrate maps a requirement to guide present-day habitat research and fisheries management as well as to predict future species movements as ocean waters warm. For examples of geologic substrate maps, see Valentine and Gallea, 2015 https://pubs.er.usgs.gov/publication/sim3341.

Day 2 Oral presentation

Examining Climate Trends in the Gulf of Maine Region and their Impact on Riverine Flood Behavior

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Presenter: David R. Vallee, david.vallee@noaa.gov

The Gulf of Maine region has been experiencing an increasing trend in annual average temperature, annual average precipitation, and the frequency of heavy rainfall events over the past several decades. During this same time period, the region has experienced an increasing number of moderate to major flood episodes. These episodes have been associated with a variety of storm types and have affected the region at different times of the year. The common threads in each episode were a persistent storm track and the ability of each storm system to tap a tropical moisture source which resulted in very rainfall on already saturated ground. This presentation will put into perspective the impacts from these recent and in some cases record breaking events and will do so with respect to our changing climate and its impact on storm behavior, rainfall intensity and changes in flood frequency. The presentation will end with several examples of best practices employed by communities to improve their resiliency to increased heavy rains and flooding.

Day 2 Poster

Behavioral response of Fundulus heteroclitus to increased Cryptocotyl lingua parasite loading in a laboratory setting

Authors: Anna Van Dreser (Colby College), April Blakeslee (East Carolina University), Amy Fowler (George Mason University), Carolyn Keogh (Emory University)

Presenter: Anna Van Dreser, david.buck@unh.edu

To complete life-cycles, parasites may modify host behavior to enhance transmission success, and these parasite-induced behavioral manipulations could influence free-living species interactions. In northeastern North America, the trematode parasite, Cryptocotyle lingua, completes its life cycle using three hosts. Littorina spp. (periwinkle snails) are the first intermediate host; Fundulus heteroclitus (mummichog fish) are the second intermediate host; and Larus spp. gulls are the final, vertebrate host. The Isles of Shoals is a hotspot for C. lingua because all three host taxa are abundant on the islands, making it an ideal location to study potential behavioral impacts of the parasite on intermediate hosts. We examined how C. lingua might affect F. heteroclitus behavior, especially in response to a simulated predation threat by a gull final host. Fish were caught from a single pool on Appledore Island, Isles of Shoals, and four treatments were established: (1) wild-type (control) fish; (2) antihelminthic-treated fish; (3) fish exposed to C. lingua (from upstream L. littorea snail hosts) for 24-hours, and (4) fish exposed to C. lingua for seven days. Fish behaviors were recorded every five seconds for ten minutes, with a simulated gull attack at minute five. We expected to see stronger behavioral responses for fish with higher infection intensities because of visibility reductions due to cyst infestations on and around eyes. Among the four treatment groups, fish demonstrated trends towards behavioral differences related to time spent at the top of the tank, conspicuous behaviors, and panic response behaviors. In addition, cyst intensity was positively and significantly correlated with response to the simulated predation threat. Future work will investigate the influence of parasitism on natural tide pool jumping behaviors previously observed in F. heteroclitus on Appledore Island.

Day 2 Oral presentation

Comprehensive Dyke Vulnerability Assessment to Climate Change Impacts in the Bay of Fundy: Challenges and Opportunities

Authors: Danika van Proosdij (Department of Geography and Environmental Studies, Saint Mary's University, Halifax NS, Canada); Ray Jahncke (Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS, Canada); Chris Ross (Nova Scotia Department of Agriculture, Truro, NS, Canada); Reyhan Akyol (Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS, Canada); Kevin Bekkers (Nova Scotia Department of Agriculture, Truro, NS, Canada); Tony Bowron (CBWES Inc., NS, Canada)

Presenter: Danika van Proosdij, dvanproo@smu.ca

Over 350 km of dykes and associated infrastructure protect 32,350 Ha of low-lying land in NS and NB. This presentation combines findings from two interwoven projects funded by the National Disaster Mitigation and the AgriRisk initiatives programs. Their purpose was to assess the vulnerability of dykes to overtopping and erosion in dykeland areas within the Bay of Fundy, to help inform decision making for climate change adaptation. Analysis was performed using surveyed dyke elevations (as of 2018), Lidar elevations and, in NS, other attribute data within the Dykeland Decision Support Tool (DDST). Current and future vulnerability was identified as a function of water depth, dyke crest elevation, exposure, foreshore marsh width and rates of change. Using GIS, dyke tracks were coded into categories of low to high risk every 25 m and overlays performed identifying assets as risk from coastal flooding. Historical patterns of erosion and progradation were quantified for 1671 individual marsh units fronting 240 km of agricultural dykes in NS. This provided an empirical measurement of the '˜urgency to act', demonstrating the added value of accurate erosion rates for dykeland management decisions. Approximately 70% of dyke tracts analyzed within this project were classified as high or very high vulnerability to coastal erosion and overtopping by 2050. 82% would be overtopped by a 1:50 yr. storm in 2050, impacting 808 km of roads and highways. Our work is helping to inform decision making and prioritization which dykes to maintain in place and those where strategic managed re-alignment is or should be considered. These decisions need to and are being made on a case by case basis and include examination of geotechnical conditions, zoning implications, coastal processes and foreshore dynamics. This research is providing the evidence and tools needed to develop a strategic and proactive plan for addressing the vulnerability of dykelands in the Bay of Fundy.

Day 3 Poster

Revisiting the prevalence of the Nemertean parasite Pseudocarcinonemertes homari in American Lobster within the Gulf of Maine

Authors: Yulibeth Velasquez-Mendoza (University of Magdalena, Colombia), Sigmer Quiroga (University of Magdalena, Colombia), Jaime Gonzalez-Cueto (University of Magdalena, Colombia), David G Buck (Shoals Marine Laboratory)

Presenter: Yulibeth Velasquez-Mendoza, University of Magdalena

The nemertean worm Pseudocarcinonemertes homari is an ectoparasite of ovigerous female lobster Homarus americanus (Milne Edw. 1837). It is a predator that consumes lobster egg yolk. The parasite was first detected in lobsters in 1978 in the northern Gulf of Maine and its abundance and impact on fecundity were investigated between 1981 - 1986 in wild-caught lobsters from Grand Manan Bank, New Brunswick, Canada (Fleming and Gibson, 1981; Aiken et al., 1983, Brattey et al., 1985; Brattey and Campbell, 1986). It has not been investigated or documented in any other part of the Gulf of Maine for more than 30 years. Here, we present data on the prevalence, mean density, mean intensity, and host fecundity in 69 berried-lobsters caught and returned to the environment during June-July 2019 from areas around the Isle of Shoals. 13 percent of examined lobster had nemertean worms in their eggs. The intensity (mean number of worms/ infected lobster) was estimated to be 13 with a variance of 3/48 worms/infected lobster. The majority of lobsters had low mean densities of nemerteans (<2/1000 lobster eggs). There was a significant but low correlation between P. homari infection and the host fecundity. Prevalence and mean intensity are concentrated in embryos with embryonic development between 80-95%. However, results will help document to the potential risk of exposure to P. homari in American lobsters along the southern portion of the Gulf of Maine and serve as an important baseline for future studies of this parasite and its impact on egg loss.

Day 3 Poster

Ocean Acidification and Shell Habitation in a Marine Hermit Crab

Authors: Nicholas Funnell (Dartmouth College), Balthasar von Hoyningen Huene (Dartmouth College), Mark Laidre (Dartmouth College)

Presenter: Balt von Huene for Nicholas Funnell, david.buck@unh.edu

Increased atmospheric CO2 is projected to lower the pH of oceans worldwide, with some estimates predicting a 150% increase in acidity by 2100. While some behavioral and physiological effects of acidification on crustaceans have already been investigated, many indirect effects remain overlooked. For example, hermit crabs (superfamily Paguroidea) may be affected by structural changes to the vacant gastropod shells which they inhabit. In acidified ocean conditions, available shells may be thinner and weaker, possibly increasing predation risk and intensifying interspecific shell competition. To simulate possible structural impacts of acidification on gastropod shells, we treated a sample of shells (both Littorina littorea and Nucella lapillus) in a brief acid bath. To test whether Acadian hermit crabs (Pagurus acadianus) would accept these degraded shells, we paired each degraded shell with an intact shell in a dichotomous-choice test. Results differed by gastropod species: among Nucella shells, crabs preferred the degraded treatment, while displaying no preference among the Littorina shells. To test whether predation risk increased with shell degradation, we exposed crabs in each shell treatment to predatory crabs. Degradation increased predation risk among Nucella shells, but not among Littorina.

Day 2 Poster

Going Beyond Relative Sea-Level Rise: New Projections of Coastal Flood Risk and Companion Guidance for Coastal New Hampshire

Authors: Cameron Wake (University of New Hampshire, Durham, NH 03824); Jayne Knott (JFK Environmental Services LLC, Upton, MA 01568); Tom Lippmann (University of New Hampshire, Durham, NH 03824); Mary Stampone (University of New Hampshire, Durham, NH 03824); Nathalie Morison (NHDES Coastal Program, Portsmouth, NH 03801); Kirsten Howard (NHDES Coastal Program)

Presenter: Cameron Wake, Cameron.wake@unh.edu

One of the central recommendations of the 2016 New Hampshire Coastal Risk and Hazards Commission (and enacted into law by the State Legislature) was to update storm-surge, sea-level rise, precipitation, and other relevant projections for coastal NH at least every five years. The updated 2019 Coastal Flood Risk Science Summary report fulfills that obligation and provides detailed projections and key messages for sea level rise, storm surge, ground water rise, precipitation, and freshwater flooding for coastal NH. Key messages related to change in the future include: 1) sea levels will continue to rise for centuries and the rate of this continued rise will depend fundamentally on the rate of Antarctic ice sheet collapse; 2) inland and coastal impacts from storm surge in coastal New Hampshire will increase with rising seas; 3) mean groundwater levels are projected to rise as a percentage of relative sea-level rise with the magnitude of groundwater rise decreasing with distance from the coast; 4) the frequency of extreme precipitation events is projected to increase over the course of the next several decades, especially in the springtime; and 5) freshwater flooding is projected to increase in the future. The Coastal Flood Risk Science Summary will serve as the scientific foundation for the companion Coastal Flood Risk Guidance that will be used to inform coastal land use planning and decision-making in New Hampshire's coastal communities. This panel presentation will provide an overview of both the 2019 Coastal Flood Risk Science Summary and companion Guidance, highlighting New Hampshire's most recent effort to integrate science and decision-making for coastal resilience.

Day 2 Lightning talk, Poster

Undercurrents: Navigating the Human Dynamics of Climigration: An Applied Theatre Approach

Authors: Julia Peterson (NH Sea Grant Extension, Lee, NH 03861 USA), David Kaye (Department of Theatre and Dance, University of New Hampshire, Durham, NH 03824 USA), Cameron Wake (Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH 03824 USA)

Presenter: Cameron Wake, cameron.wake@unh.edu

Advances in climate and ocean modeling are enhancing the accuracy of current and future projected coastal vulnerability, improving visualizations of risks in coastal communities, and propelling policy discussions. However, when places we love are threatened, we feel it. This session introduces a humanities-meets-science approach designed to help scientists, planners, policy makers, and climate resilience professionals better understand the perspectives of stakeholders and improve communication with community leaders about places at high risk from rising seas and intense coastal storms. Undercurrents uses Applied Theatre (AT) to educate resilience professionals on a range of diverse, sometimes conflicting, perspectives on managed retreat. Applied theatre invites 'audience' members to observe social interactions on difficult topics, like retreat, as dramatized by professional actors, and then interact, in a facilitated session, with the characters to learn more about their thoughts and feelings. As observers to these inner workings and social interactions, audiences are exposed to a range of perspectives that might otherwise be inaccessible. The workshop is designed to improve the ability of climate resilience professionals to empathize more closely with and assist communities more sensitively and constructively to consider strategies, including retreat, in the face of increasing risk. This training helps make facing these deeply personal and emotionally charged discussions feel more insightful, less alienating, and ultimately more productive. This interdisciplinary workshop is executed by UNH PowerPlay. It was developed with input from resilience professionals and community members in coastal New England areas at risk. It's best delivered as a plenary session (60-90 minutes) where its innovative approach can be experienced by all participants. It debuted at the 2019 ME-NH Beaches Conference and the At What Point Managed Retreat? conference at Columbia University.

Day 3 Poster

The Debris Free Fundy project; strategies to keep marine debris out of the Bay of Fundy

Authors: Jackie Walker (Huntsman Marine Science Centre, St. Andrews, NB E5B 2L7 Canada)

Presenter: Jackie Walker, jackie.walker@huntsmanmarine.ca

Since 1969 it has been Huntsman Marine Science Centre's (HMSC) vision to design and deliver the highest quality marine research and education programs and to convey these to our communities in support of sustaining the marine environment and economy. Our mission at Huntsman is to inspire stewardship through:

- The engagement of the community in the discovery of the oceans;
- The advancement of marine sciences through collaborative research and the development of innovative technical solutions for our public and private sector partners;
- The design and delivery of inspirational educational experiences.

Since 2015 the Debris Free Fundy project has focused on strategies to keep marine debris out of the Bay of Fundy. The outreach and awareness components to the Debris Free Fundy project include development and participation in school programs, shoreline cleanups, media interviews, conferences and other community engagement. The Debris Free Fundy business acknowledgement program has engaged 25+ local businesses in the town of St. Andrews and encouraged them to make eco-friendly decisions in their daily operations, while pledging to limit their single-use plastic consumption. The Marine Debris Strategy Action Committee is a group of multiple stakeholders (15+) that are developing a marine debris strategy in the southwest New Brunswick region. HMSC is successfully coordinating that committee, and facilitated the development of an updated strategy through meetings and a workshop in fall 2018; implementation is ongoing. The rope recycling project has expanded since its inception and to date has kept over 7500lbs of old and unwanted fishing rope out of the marine environment with 10 rope recycling bins at 7 harbours, as well as providing signage and education to fishing communities in southwest New Brunswick.

Day 4 Poster

Changes in Calanus finmarchicus size on the Northeast US Shelf

Authors: Harvey Walsh (NOAA, Northeast Fisheries Science Center, Narragansett, RI), Quentin Nichols (Integrated Statistics and NOAA, Northeast Fisheries Science Center, Narragansett, RI), Katey Marancik (Integrated Statistics and NOAA, Northeast Fisheries Science Center, Narragansett, RI), David Richardson (NOAA, Northeast Fisheries Science Center, Narragansett, RI),

Presenter: Harvey Walsh, harvey.walsh@noaa.gov

Calanus copepods are one of the most abundant mesozooplankton of the Northwest Atlantic and are considered a top prey for many fish, seabirds, and marine mammals including North Atlantic Right Whales. Right whale population in U.S. and Canadian waters is experiencing shifting foraging areas. A Calanus working group led by DFO scientists that includes NEFSC collaborators have begun using a model to examine interannual variations in Calanus biomass, the main prey of right whales, on the northwest Atlantic shelves to explore changes right whale feeding ground locations. The model uses zooplankton abundance from several sampling programs including the NEFSC's Ecosystem Monitoring (EcoMon) program and DFO's Atlantic Zone Monitoring Program. The programs use different sampling and analysis methodology, which have not yet been subjected to a systematic comparison. Currently, Calanus biomass is estimated using Generalized Additive models that predict the biomass based on total abundance and average stage-specific Calanus prosome length. Calanus growth rates and molting are influenced by water temperature, warmer temperatures generally result in faster molting and smaller body size. Thus, both interannual variability in water temperatures and the overall increasing trend in water temperatures on the Northeast US Shelf may potentially impact biomass estimates and phenology of life stages. We have begun measuring prosome length and width of Calanus finmarchicus from the EcoMon sample archive to examine interannual variability in size for use in future modeling efforts. Initial results from analysis of spring sampling of the Georges Bank - Gulf of Maine regions indicate no Significant difference by region, but a recent decline in size for copepodite stage V and VI. More measurements will be needed spatially and temporally in order to detect trends and variability for the ecosystem.

Day 2 Poster

High-Resolution Surficial Geology Mapping of the New Hampshire Inner Continental Shelf and Coastline: An Important Step Towards Coastal Resiliency.

Authors: Larry G. Ward (Center for Coastal and Ocean Mapping/NOAA-UNH Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH, USA), Zachary S. McAvoy (Center for Coastal and Ocean Mapping/NOAA-UNH Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH, USA), Nathan W. Corcoran (Department of Earth Sciences, University of New Hampshire, Durham, NH, USA), Giuseppe Masetti (Center for Coastal and Ocean Mapping/NOAA-UNH Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH, USA), Paul Johnson (Center for Coastal and Ocean Mapping/NOAA-UNH Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH, USA), and Rachel C. Morrison (Center for Coastal and Ocean Mapping/NOAA-UNH Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH, USA)

Presenter: Larry G. Ward, larry.ward@unh.edu

The continental shelf off New Hampshire (NH) is extremely complex with extensive bedrock outcrops, remnant glacial deposits, sand and gravel ridges and shoals, and muddy offshore basins. The depositional features were significantly modified by marine processes as sea-level fluctuated following deglaciation. Many of the glacial features found on the inner shelf continue onshore. The NH coast is extremely heterogeneous as well, ranging from pocket beaches, attached barriers interrupted by rocky headlands (many previously covered with till) or glacial features (e.g., drumlins), and a barrier island. The composition of the beaches reflects the variability in sediment sources ranging from fine sand to cobbles with bimodal beaches being common. The combination of a reduction in sediment supply and an acceleration in sea-level rise has led to much of the NH coast being stressed by erosion and more frequent flooding. Furthermore, coastal erosion and flooding are expected to be exacerbated by climate change. To help build coastal resiliency, high-resolution surficial geology maps of the NH shelf were developed depicting seafloor features (geoforms) and surficial sediment using CMECS. In addition, potential sources of sand and fine gravel were evaluated for beach nourishment. Presently, similar work is being done on the NH beaches: mapping major coastal features, determining beach sediment grain size under accretional and erosional conditions, and assessing beach stability. A goal of this work is to link the surficial geology of the mainland (published by the NH Geological Survey), the coast, and the inner shelf to better define the physiography, the sediment distribution (and sources), and the controlling processes. Ultimately, mapping the surficial geology, along with existing and new high-resolution topography and bathymetry surveys, will help coastal managers, planners, and the public prepare for sea-level rise and climate change, and build coastal resiliency.

Day 2 Poster

Addressing Critical Environmental Issues in the Gulf of Maine: Results of Recent Studies of Information and Communication by the Gulf of Maine Council

Authors: Peter G. Wells (International Ocean Institute-Canada, Halifax, Nova Scotia and Marine Affairs Program, Dalhousie University, Halifax, Nova Scotia), Bertrum H. MacDonald (School of Information Management, Dalhousie University, Halifax, Nova Scotia), Suzuette S. Soomai (Fisheries and Oceans Canada, Halifax, Nova Scotia), Rachael Cadman (Marine Affairs Program, Dalhousie University, Halifax, Nova Scotia), Sarah D. Chamberlain (Fisheries and Oceans Canada, Halifax, Nova Scotia), Curtis Martin (Ocean Frontier Institute, Dalhousie University, Halifax, Nova Scotia), Hali Moreland (Marine Affairs Program, Dalhousie University, Nova Scotia), Simon Ryder-Burbidge (Ecology Action Centre, Halifax, Nova Scotia), Lee Wilson (Portage Network / Canadian Association of Research Libraries, Halifax, Nova Scotia)

Presenter: Peter G. Wells, oceans2@ns.sympatico.ca

The Gulf of Maine and Bay of Fundy face numerous environmental challenges, climate change being the most pressing. Scientific information (credible, relevant, and legitimate) and its communication, directed to the public and to key policy and decision makers, underpin numerous efforts to manage and adapt to such environmental change. The generation of new information and understanding has been central to the mission of the Gulf of Maine Council on the Marine Environment over many years. Our research program (www.eiui.ca) has worked with the Council, documenting its information output and conducting several studies to understand information flow at the science-policy interface(s) of its partners. This poster summarizes key findings, insights, and lessons based on studies of the State of the Gulf of Maine Report, the Gulfwatch monitoring program, community place-based values, networking amongst project partners, and others. Common enablers and barriers to effective information communication are evident in the studies. Importantly, this research emphasizes that society must effectively and urgently use the new understanding about impacts of climate change on the Gulf of Maine. It is crucial to communicate this new information in multiple ways and to recognize the pivotal role of non-government organizations in this task. In addition, collective effort is needed to shorten the lag-time between new scientific information, its communication, and effective action by coastal communities, practitioners, and decision-makers at all governmental levels.

Day 2 Poster

Bay of Fundy Ecosystem Partnership: Addressing Issues Influencing the Bay of Fundy, Gulf of Maine

Authors: P.G. Wells (Dalhousie University, Halifax, NS), J.A. Percy (SeaPen Communications, Granville Ferry, NS), K. McLean (Clean Annapolis River Project, Annapolis Royal, NS)

Presenter: Peter G. Wells, seapencom@gmail.com

The Bay of Fundy in the upper Gulf of Maine is a biologically productive and diverse coastal ecosystem, rich in renewable living resources and non-renewable mineral resources. For many years, individuals and groups have been concerned about effects of various pressures, alone and combined, on the bay's biota, habitats and ecosystems. BoFEP was formally established in November 1997. Its objective has been to promote diverse, dynamic and productive Bay of Fundy plant and animal communities, coastal habitats and watersheds that are appreciated, valued and wisely used by residents and visitors. BoFEP comprises individuals and partner organizations committed to acquiring and disseminating information about the bay and its watersheds, in support of environmental protection and conservation, sustainable resource use and integrated management. BoFEP sponsors a Biennial Bay of Fundy Science Workshop, open to all interested individuals, to review new studies, promote the group's activities, discuss initiatives on issues, and work together towards solutions. Over the years, BoFEP has also organized many working groups (WGs) to examine specific topics and research areas, and promote communication and cooperation among its partners. At present, there are two active WGs: 'ocean literacy' and 'environmental information - use and influence'. BoFEP publications include the Proceedings of its workshops (12 since 1996), many research reports on a wide variety of topics, 31 Fundy Issues Fact Sheets and a quarterly newsletter 'Fundy Tidings'. BoFEP's website, Facebook page and Twitter feed provide information about the organization, pertinent publications, news about the Bay, and links to Fundy related information sources and organizations. BoFEP invites participation by all interested citizens and groups who share a vision of a sustainable, healthy, productive and biologically diverse Bay of Fundy, especially during this period of climate change.

Day 4 Poster

Putting recent Gulf of Maine changes into context using a 300-year reconstruction of water properties from Arctica islandica shells

Authors: Nina M. Whitney (Iowa State University, Ames, IA 50010 USA), Alan D. Wanamaker (Iowa State University, Ames, IA 50010 USA), Beverly J. Johnson (Bates College, Lewiston, ME 04240 USA), Caroline C. Ummenhofer (Woods Hole Oceanographic Institution, Woods Hole, MA 02543), Shelly M. Griffin (Iowa State University, Ames, IA 50010 USA), Erin Lower-Spies (Iowa State University, Ames, IA 50010 USA), Karl J. Kreutz (University of Maine, Orono, ME 04469 USA), Philip D. Dostie (Bates College, Lewiston, ME 04240 USA), Katharine Luzier (Iowa State University, Ames, IA 50010 USA), Douglas S. Introne (University of Maine, Orono, ME 04469 USA)

Presenter: Nina M. Whitney, nwhitney@iastate.edu

Accurately predicting the state of the Gulf of Maine in the decades to come is critical for ecosystem management policies and mitigation efforts. However, with the sparse and short instrumental records available, assessing natural variability and its primary drivers in the Gulf of Maine, two components essential for predictions of future conditions, is difficult. Reconstructing past changes in Gulf of Maine hydrographic conditions is therefore critical to understanding changes in the Gulf of Maine today and predicting how it might evolve in future. Here we present a 300-year record of hydrographic variability in the Gulf of Maine using geochemical proxies obtained from Arctica islandica (ocean quahog) shells. Shells were collected from near Seguin Island in the western Gulf of Maine, dated using crossdating techniques, and measured for oxygen, nitrogen, and radiocarbon isotopes. Each of these geochemical systems varies in composition between Warm Slope Water (WSW) and Labrador Slope Water (LSW) and therefore can be used to assess changes in the proportion of these water masses in the Gulf of Maine through time. Geochemical proxy reconstructions reveal significant centennial-scale variability in water masses present in the Gulf of Maine over the last 300 years. Most recently, the reconstructions suggest that the proportion of WSW entering the region has been increasing since 1890, contributing, among other changes, to the significant warming in the Gulf of Maine seen recently. Increases in the proportion of WSW in the region began around the time that several western North Atlantic reconstructions suggest the Atlantic Meridional Overturning Circulation (AMOC) began to weaken. This finding supports several recent studies that have implicated the AMOC as a primary driver of the recent changes seen in the Gulf of Maine, which have been exacerbated by anthropogenic surface warming.

Day 2 Poster

Building Resilience by Rethinking Research and Engagement: Lessons from conflicts over science

Authors: Lindsey C. Williams (MIT Sea Grant, Cambridge, MA 02139 USA)

Presenter: Lindsey C. Williams, lcwillia@mit.edu

For science to be actionable it needs to be viewed as credible, legitimate, and salient (Cash et al. 2003; Lubchenco 2017). We often focus on what actions need to be taken within coastal communities to build resilience, but it is equally imperative to look within the scientific community as well to explore how our past research and engagement practices might be modified to better reflect the new social and ecological realities of the systems within which we work. More specifically, we can explore cases of distrust in science and the concomitant disputes over management, to better understand potential paths ahead. Drawing on two case studies along the New England coast (groundfish management and water quality regulation), we present initial findings that explore perceptions of science used in management and the role that cross-sectoral engagement opportunities (e.g. workshops, cooperative research, etc.) play in science intensive disputes. Based on participant observation and analysis of semi-structured interviews with researchers, managers, and the regulated community within each case, we explore the role of credibility, legitimacy, and salience in the use of science and discuss other patterns emerging from the data. Ultimately, this research seeks to contribute to a better understanding of how efforts to engage across groups may impact science-intensive disputes over coastal and ocean management and - where appropriate - provide recommendations to adjust approaches to seek to build resilience and create more durable solutions to move forward through disputes in these systems. We also explore lessons for how researchers and managers are trained, particularly in preparation for entry into work on controversial topics. Taken together, efforts to think differently about systems approaches, changes to research processes, new perspectives on stakeholder engagement, and multi-partner collaboratives might help make the jump towards real change in the Gulf of Maine.

Day 3 Poster

An assessment of vertical line use in Gulf of Maine fixed gear fisheries and resulting conservation benefits for the North Atlantic right whale

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Providing adequate protection for the critically endangered North Atlantic Right Whale (Eubalaena glacialis) while minimizing detriment to fishery-reliant communities that overlap their distributional range requires immediate development of models inclusive of human and environmental requirements. A large threat to this species is entanglement in fixed gear fishery vertical lines, but the current spatial distribution and variability in vertical lines across the Gulf of Maine is poorly defined. Spatial variation in the threat lobster gear poses to whales is expected, corresponding to overall vertical line strength, type, and depth. Management measures that limit the strength of vertical lines used in the American Lobster fishery are likely to negatively impact the economic resilience of New England fishing communities, but the line strength requirements of these communities are not well characterized. Analyzing the spatially explicit variables that affect vertical line strength requirements allows nimble management strategies that meet biological management goals while mitigating socio-economic disruption. We will model the breaking strength of lines used by commercial lobster fisheries spatially across the Gulf of Maine and create an index of risk to Right Whales inhabiting the area. We will measure the load put on lines used in typical American Lobster fishery operations to determine the minimum strength necessary to fish safely and effectively. We will highlight areas where rope strength reduction is beneficial for whales and provide guidelines for the minimum rope strength necessary for fishery operation to inform management decision goals that include a sustainable lobster fishery, and conservation of right whales.

Day 2 Oral presentation

Linear and Nonlinear Responses to Northeasters Coupled with Sea Level Rise: A Tale of Two Bays

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This study aimed at dissecting the influence of sea level rise (SLR) on storm responses in two bays in the Gulf of Maine through high-resolution, three-dimensional, hydrodynamic modeling. Saco Bay, an open bay characterized by gentle coastal slopes, provided a contrast to Casco Bay that has steep shorelines and is sheltered by barrier islands and peninsulas. The Finite-Volume Coastal Ocean Model (FVCOM) was implemented for Saco and Casco bays to simulate the February 1978 northeaster and an April freshwater discharge event in 2007 following the Patriot's Day Storm. Both events were repeatedly simulated under SLR scenarios ranging from 0 to 7 ft. Modeled storm responses were identified from the 1978 blizzard simulations and were tracked across SLR scenarios. By comparing changes in inundation, storm currents, and salinity distribution between the two bays, freshwater discharge and bathymetric structure were isolated as two determining factors in how storm responses change with the rising sea level. The step-like bottom relief at the shoreline of Casco Bay set up nonlinear responses to SLR. In contrast, storm responses in Saco Bay varied significantly with SLR due to alterations in river dynamics attributed to SLR-induced flooding.