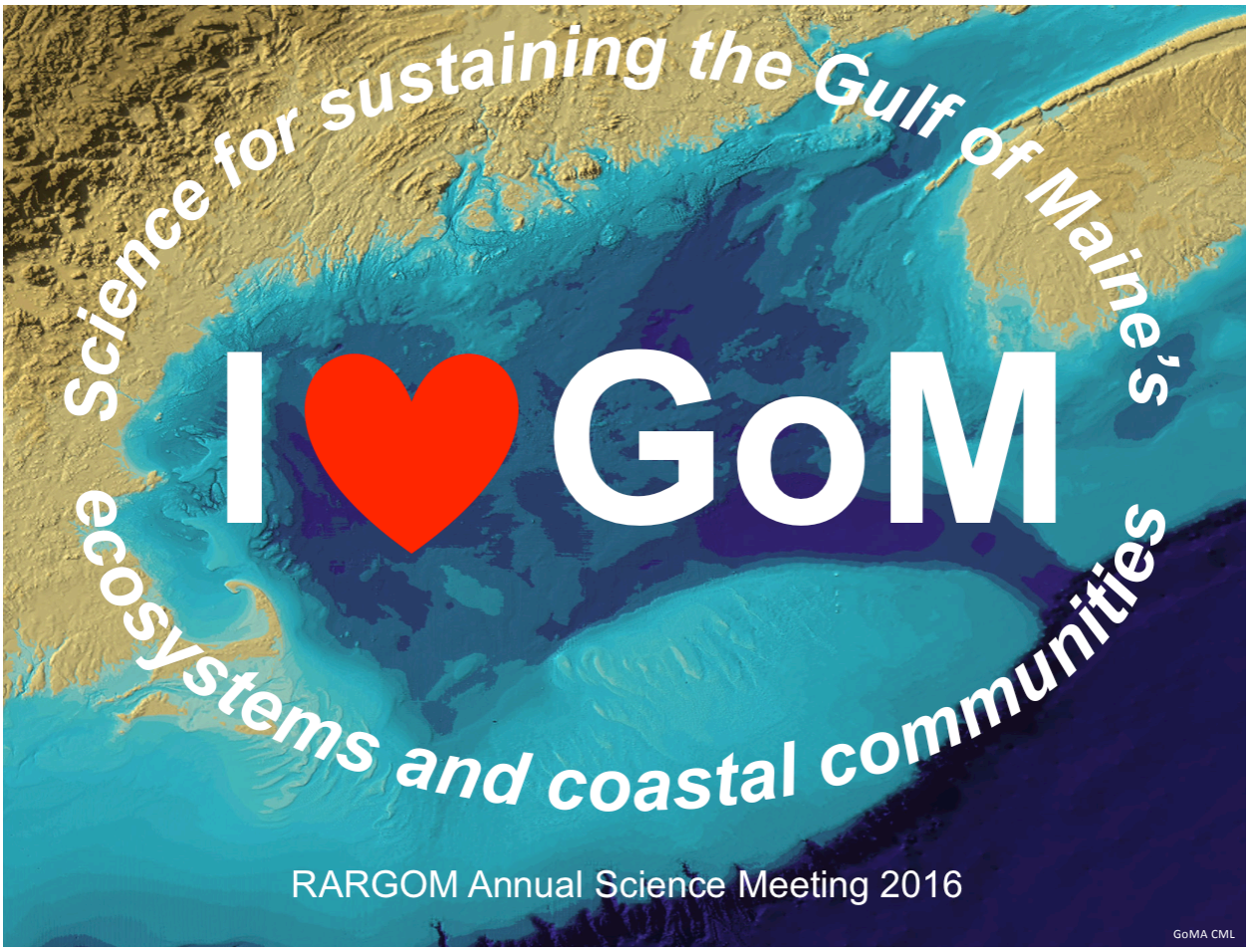
RARGOM Annual Science Meeting



PROGRAM

RARGOM Annual Science Meeting

Science for sustaining the Gulf of Maine's ecosystems and coastal communities

Date: October 13, 2016
Location: Red Hook Brewery, 1 Redhook Way, Portsmouth, New Hampshire

Featured keynote speaker:
Anthony Charles
Director, School of the Environment
Saint Mary's University, Halifax, Nova Scotia

Contents

Meeting Schedule and Oral Presentations

Start	Dur.	Presenter	Title
8:30 AM	0:30		**REGISTRATION and poster set up**
9:00 AM	0:05		**WELCOME**
9:05 AM	0:15	Staudinger, M.	It's about time: A synthesis of changing phenology in the Gulf of Maine Ecosystem
9:20 AM	0:15	Townsend, D.	Water mass fluxes to the Gulf of Maine: Importance to water temperatures and nutrient loads
9:35 AM	0:15	Valentine, P.C.	High-resolution maps of geologic substrates on Stellwagen Bank provide a framework for describing habitats in a complex, glaciated bank and basin terrain
9:50 AM	0:15	Kaufman, L.	The functional role of sand lances in the Southern Gulf of Maine Ecosystem: Silver threads weaving ecosystem-based management together
10:05 AM	0:15	Wiley, D.	The distribution and relative abundance of sand lance, seabirds and whales in Stellwagen Bank National Marine Sanctuary (2013–2016)
10:20 AM	0:25		**BREAK & POSTERS**
10:45 AM	0:25	Charles, A.	**Keynote**: Sustaining ecosystems, sustaining coastal communities
11:10 AM	0:15	Stoll, J.	How access to Maine's fisheries has changed over a quarter century: the cumulative effects of licensing on resilience
11:25 AM	0:15	Strong, A.	Understanding the Gulf of Maine's coastal ecosystem servicesheds and their implications for stakeholders in coastal environmental management
11:40 AM	0:15	Runnebaum, J.	Using modeling approach and fishermen's knowledge to define suitable habitat for cusk (*Brosme brosme*) and evaluate potential economic impacts of conservation
11:55 AM	0:15	Rodrigue, M.	Developing a sentinel longline/jig survey for groundfish species in the eastern Gulf of Maine
12:10 PM	1:35		**LUNCH & POSTERS**
1:45 PM	0:05		**John Annala Fishery Leadership Award announcement**
1:50 PM	0:15	Tanaka, K.R.	Impacts of climatic variations on the spatial distribution of *Homarus americanus* in the inshore Gulf of Maine
2:05 PM	0:15	McGuire, C.	Identifying the distribution of Atlantic cod spawning activity to inform fishery management in the western Gulf of Maine
2:20 PM	0:15	Winton, M.	Investigating the seasonal residency and habitat use of white sharks in the coastal waters off Cape Cod, Massachusetts, using passive acoustic telemetry
2:35 PM	0:15	Scopel, L.	How well do fishery-derived herring estimates predict seabird diets?
2:50 PM	0:15	Taylor, P. H.	Make way for marshes: A regional model for knowledge sharing among scientists and managers to support sustainability of ecosystems and coastal communities
3:05 PM	0:15	Belknap, S.	Lobster and ocean planning: A spatial characterization of the lobster fishery for the New England regional planning body
3:20 PM	0:15	Zaykoski, P.	Finding efficiency through integrated fisheries management & marine planning data collection
3:35 PM	0:25		**BREAK & POSTERS**
4:00 PM	0:15	Mills, K.	Evaluating climate vulnerability and adaptation strategies for Northeast US fishing communities
4:15 PM	0:15	Franklin, B.	Evaluating economic impacts of climate-driven species changes on Northeast US fishing communities
4:30 PM	0:15	Leslie, H.	Sustaining coupled social-ecological marine systems of the Gulf of Maine: the role of ecosystem service science and tools
4:45 PM	0:15	Stephenson, R.	Science for sustaining the Gulf of Maine's ecosystems and coastal communities
5:00 PM	0:15		Facilitated Discussion led by Leslie and Stephenson
5:15 PM			**END - On to Happy Hour!**

Poster Session: Titles and Presenters

Presenter	Title
Ackerman, S.	Accessing sea floor and coastal video and photographs from the USGS Coastal and Marine Geology Program
Arno, H.	Monitoring Changes in Somes Sound In the Past Two Decades
Balstad, B.	You're gonna get wet: Intertidal monitoring at Appledore Island
Belknap, S.	Stakeholder Driven Disease Modeling: The Case of Lobster Shell Disease
Bogomoli, A.	Population assessment of Harbor (*Phoca vitulina*) and Grey seals (*Halichoerus grypus*) at Duck Island ledges, ME
Brayden, C.	Assessing the impact of ecolabels on consumer preferences for seafood: the role of production method, certification and origin on wild harvest and aquaculture products
Caffrey, M.	The Citizen Intertidal Ecologist Project
Calandrino, M.	Variation in minimum Gray seal (*Halichoerus grypus)* and Harbor seal (*Phoca vitulina)* minimum abundance counts on Duck Island, ME due to meteorological variables
Carr, M.	Entanglement of Grey (*Halichoerus grypus*) and Harbor seals (*Phoca vitulina*) at Duck Island ledges, ME
Cole, K.	Understanding exchange at the bay-shelf interface
Conlon L.	High resolution modeling of nearshore flow patterns and blue mussel population connectivity in Downeast Maine
Coupland, K.	Understanding shellfish growth potential in the Damariscotta River using a coupled modeling approach
Feeney, R. G.	Catch Share Management in the Northeast Multispecies Fishery: Have the Theorized Benefits Been Realized in New Hampshire?
Gallo, B.	Factors affecting spiny dogfish (*Squalus acanthias*) at Jeffrey's Ledge in the Gulf of Maine
Gassett, P.	Ocean and coastal acidification governance in Maine: Conservation in networks
Goldstein, J.	A fishery in flux: Claw removal and its impacts on survivorship, behavior, and physiological stress in Jonah crab (*Cancer borealis*)
Mazur, M.	Evaluating fishing effort levels in the Maine lobster fishery: an individual-based model approach
Ozmon, I.	A Collaborative Approach to Characterizing Sand and Gravel Deposits Using Multibeam Sonar in the Gulf of Maine
Parlee, K.	ESIP's new ICUC smartphone app - linking citizen scientists to their own places of wonder
Powers, K.	Movements and Foraging Areas of Great Shearwaters *Puffinus gravis* in the Gulf of Maine
Randall, S.	Soft-Shell Clams in Crisis Mode: Field Research Tells Us Why and Gives Us Tools to Adapt
Ritchie, M.	Impacts of Data Quantity and Quality on Habitat Modeling
Schlipp, L.	Size-at-age trends in Northwest Atlantic ground fish and implications for stock assessment
Tsourounakis, G.	Fine-scale haul-out preferences of harbor seals (*Phoca vitulina*) and gray seals (*Halichoerus grypus*) at Duck Island, ME
Valentine, P.	High-resolution maps of geologic substrates on Stellwagen Bank
Wang, L.	Maximum entropy modeling of marine fish species' spatiotemporal distributions utilizing earth system data
Wells, P.	Diluted Bitumen Spills in the Bay of Fundy and Greater Gulf of Maine: an update on the scientific and technological challenges
Wells, P.	Sustaining the Gulf of Maine: The Importance of Understanding the Science, Information, and Policy Interface for Effective Coastal and Ocean Management
Wildermuth, R.	Structural uncertainty and data limited ecosystem-based management of the Georges Bank social-ecological system
Yakola, K.	Long-term changes in the Chick Diet, Growth and Fledgling Success of Three *Strena spp.* in Response to Changing Climatic Conditions in the Gulf of Maine

Abstracts: Oral presentations

Lobster and Ocean Planning: A Spatial Characterization of the Lobster Fishery for the New England Regional Planning Body

Belknap, S., Battista, N., Clark-Uchenna, R., Lapointe, G.

Presented by: Belknap, S. (samuel.belknap@maine.edu)

The lobster fishery is synonymous with New England's coast, providing food, economic and cultural value since the colonial era. Nowhere is this more evident than in Maine. For many coastal communities, the lobster fishery has provided stability and a sense of place that is more important today than in the past. Increased landings in the fishery, combined with reduced fishing opportunities in other fisheries, create a significant economic dependence on the lobster fishery. The area covered by the fishery has changed over the past 20-30 years with fishery landings shifting farther offshore and farther to the eastern portion of the range of U.S. lobster fishing. Information on the spatial characteristics of the lobster fishery are generally understood by the industry and managers, but are poorly quantified. Mapping of lobster fishing patterns has been an objective of regional ocean planning efforts. This effort has been hampered by lack of regional spatial characterization products with sufficient resolution or consistency to determine how other ocean uses, particularly place-based uses, would impact lobster fishing locally, sub-regionally, and regionally. We interviewed Maine lobstermen to better understand spatial use patterns in the lobster fishery, and how lobstermen view new and shifting uses of the ocean in the context of their lobster fishing businesses. Lobstermen were selected in all lobster management zones, with an emphasis on lobstermen who fish federal waters because the developing New England Regional Ocean Plan focuses on federal waters.

Sustaining ecosystems, sustaining coastal communities

Charles, A. (tony.charles@smu.ca)

There is no doubt that human wellbeing depends on living within a healthy and productive environment—this is the essence of 'sustainable development'. While certainly sustaining marine and coastal ecosystems is a prerequisite for sustainable communities along the coast, what is less often realized is that benefits also flow in the reverse direction. The evidence shows that strong and sustainable coastal communities are more likely to have within them the interest and capability to maintain their local ecosystems. Indeed, as shown by Elinor Ostrom and many others, abundant examples of community initiatives show how environmental conservation and livelihood security can be sustained together. It is a two-way street. This presentation explores the nature and dynamics of coastal communities, their drivers of environmental stewardship, and the manner by which local marine and coastal decision-making sustains ecosystems and sustains communities. This draws on work in the Community Conservation Research Network (CCRN), a global partnership of indigenous, community, academic, governmental and non-governmental organizations.

Evaluating Economic Impacts of Climate-Driven Species Changes on Northeast US Fishing Communities

Sun, J., Franklin, B., Kennedy, B., Mills, K., Allyn, A., Schuetz, J.

Presented by: Franklin, B. (bfranklin@gmri.org)

Understanding the economic consequences of warming oceans and changing ecosystems on the Northeast shelf is critical to implementing effective adaptation strategies. As the conversation surrounding climate and fisheries evolves to include the impacts on fisheries and fishery-dependent communities, economic models provide a means of quantifying the impacts of climate-related changes and bridging the gap between the science community and fishery stakeholders. In this paper, we link species distribution and vulnerability forecasts with an economic model that incorporates fleet characteristics and market conditions to capture the supply and demand of commercial landings and landings values by various communities. We will focus on both Maine's lobster fishery and the New England groundfish fishery and explain how the economic modelling will provide integrated estimates of changes in fishing effort, profits, and aggregate economic impact under different warming scenarios. Ultimately, our results will facilitate discussion and decision-making amongst communities, managers, and industry as they evaluate the costs and benefits of management, investment, and fishing strategies under climate variability and change.

The Functional Role of Sand Lances in the Southern Gulf of Maine Ecosystem: Silver threads weaving ecosystem-based management together

Kaufman, L., Altman, A., Boumans, R., Wiley, D., and Thompson, M.

Presented by: Kaufman, L. (lesk@bu.edu)

The Northeast Regional Ocean Plan calls for an ecosystem-based approach for maximizing use compatibilities and synergies, and to minimize negative tradeoffs. Second and third-order consumers (forage species) lie at the nexus of tradeoffs among the ecosystem services that provide biodiversity maintenance, food, livelihoods, recreation, and beach renourishment in rising seas. We report early results of a study focused on ammodytid fishes (sand lances) in the southern Gulf of Maine, including their distribution and abundance, functional differentiation (there are 2 local species), nutritional value, life history, and systemic relationships with predatory fishes, marine mammals, seabirds, people, and the regional economy. The results indicate a high nutritive value, strong predator-prey linkages, short realized life span, and a complex relationship with ecosystem service flows and tradeoffs. What we have learned of these small silver fishes, about which still astonishingly little is known, underscores a critical need for levels of preventative guidance, monitoring vigilance, and adaptive policies that are absent from the first Northeast Regional Ocean Plan, and must be included in the second.

Sustaining coupled social-ecological marine systems of the Gulf of Maine: the role of ecosystem service science and tools

Leslie, H. M. (heather.leslie@maine.edu)

Sustaining ecosystem services and the coupled social and ecological systems that support and generate them is a central goal of marine spatial planning and marine ecosystem-based management, both in the US and globally. However, operationalizing this goal in ways that are Specific, Measurable, Attainable, Relevant and Timely remains a challenge in many contexts. My presentation will address this challenge by focusing on the emerging opportunities to further develop and apply ecosystem services science and tools in the implementation of the Northeast Ocean Plan, and in the Gulf of Maine region more specifically. The Northeast Ocean Plan, the nation's most fully developed regional ocean plan, is close to being finalized, following four years of close collaboration among state, federal, and tribal partners. Scientists from the Bay of Fundy to Long Island Sound, together with researchers working in other marine settings, have played a significant role in supporting plan development; their participation in its implementation will be equally if not more important. I will draw on my nearly 20 years of experience in the science and practice of coastal conservation in the Northeastern US, as well as my substantial engagement in Mexico's Gulf of California region, where I lead an interdisciplinary research program focused on sustaining the coupled social and ecological systems associated with the region's small-scale fisheries. I will make the case that by leveraging approaches from both the natural and social sciences – particularly analyses framed by the concepts of ecosystem services and social-ecological systems – and committing to meaningful and long-term engagement with coastal community members and other key stakeholders, the Northeast Ocean Plan has the potential to make ecosystem-based management for the oceans real in ways that matter for the varied coastal communities of America's oceans.

Identifying the distribution of Atlantic cod spawning activity to inform fishery management in the western Gulf of Maine

McGuire, C., Zemeckis, D., Dean, M.J., Hoffman, W.S., Izzi, A., Van Parijs, S., Baumgartner, M., Hatch, L., and Cadrin, S.X.

Presented by: McGuire, C. (cmcguire@tnc.org)

Rebuilding the Gulf of Maine stock of Atlantic cod (*Gadus morhua*) has been much slower than anticipated. Many historical spawning components have been depleted, which has reduced stock productivity and stability. In response, fishery managers have implemented closures to protect cod spawning aggregations. The spatial and temporal extent of these closures has changed due to scientific uncertainty and to allow fishing for other species. The objective of this project was to identify the spatial and temporal distribution of cod spawning activity during the winter to inform future fishery management decisions for Massachusetts Bay in the western Gulf of Maine. Multiple acoustic technologies were used, including acoustic telemetry and passive acoustic monitoring equipment, with the latter involving the recording of grunts produced by males during courtship rituals. Both technologies were deployed during three consecutive winter spawning seasons (October 2013 through March 2016) at either fixed locations or on mobile Slocum gliders. Based upon preliminary acoustic telemetry results (n=317 cod), peak spawning occurred from November–January. Spawning site fidelity

was documented, and multiple 'hotspots' were identified where tagged cod were annually aggregating, including some evidence for inter-annual variability in timing. Preliminary passive acoustics results from fixed location recorders show a temporal trend of cod grunts (a proxy for spawning) occurring from mid-September through the beginning of January in all three years, with the most grunts occurring during Year 3. The majority of grunts recorded by gliders were within the Stellwagen Bank National Marine Sanctuary, often beyond the detection range of fixed location equipment. Therefore, combination of multiple complimentary technologies and deployment strategies increased our capacity to monitor cod spawning activity over multiple spatial and temporal scales. Continued analyses will integrate results from each method and provide a more holistic description of cod spawning activity to inform future fishery management decisions.

Evaluating climate vulnerability and adaptation strategies for Northeast US fishing communities

Mills, K., Allyn, A., Colburn, L., Hare, J., Schuetz, J., Alexander, M., Eayrs, S., Franklin, B., Hartley, T., Kennedy, B., Labaree, J., Pershing, A., Sun, J., Thunberg, E.

Presented by: Mills, K. (kmills@gmri.org)

Throughout the world, climate change is affecting marine ecosystems, fish populations, and fisheries. Marine waters of the Northeast Shelf have warmed rapidly over the past decade, and the impacts of climate variability and change are being felt acutely in this region. The conversation around climate and fisheries is moving from a discussion of climate impacts on fish populations to a discussion of impacts on fisheries and fishing communities. Anticipating climate-related changes in species availability and devising effective adaptation strategies to buffer negative impacts will be essential for sustaining fishing communities in the context of climate change. For fishing communities along the Northeast Shelf, we are implementing a coupled social-ecological vulnerability assessment that integrates information on vulnerability, resilience, and adaptive capacity. Preliminary results of a shelf-wide assessment have been derived by using species vulnerability ratings, species distribution projections, fishery landings data, fishing location records, and social resilience indicators to rate social-ecological vulnerability on a community basis. Results enable a high-level view of the vulnerability of fishing communities in the context of climate-driven ecosystem changes and support a shelf-wide evaluation of risk levels and types. Ongoing and future work will use economic models, stakeholder focus groups, and fishing industry surveys to (1) quantify economic effects of climate impacts in specific communities, (2) evaluate the buffering potential offered by different adaptation strategies, and (3) assess factors facilitating or hindering the implementation of adaptation measures.

Developing a Sentinel Longline/Jig Survey for Groundfish Species in the Eastern Gulf of Maine

Rodrigue, M., Chen, Y.

Presented by: Rodrigue, M. (mattie.rodrigue@gmail.com)

The eastern Gulf of Maine, while not closed to groundfishing, has been perceived to have a low groundfish population and is subject to little targeted groundfish activity. State and federal fisheries-independent survey programs have limited sampling coverage because of fixed gear conflicts. Currently, groundfish stock assessment and management encompass the entire Gulf of Maine, although the majority of fishing effort and catch occurs in the western Gulf of Maine. Sparse fishery-independent as well as fishery-dependent data in the eastern Gulf of Maine, and skewed distribution of the groundfish fisheries into the western Gulf of Maine may complicate the determination of the status of groundfish stocks in the Gulf of Maine. Working with local fishermen, we developed a stratified random sentinel longline/jig survey targeting key groundfish species that have low catchability in the bottom trawl survey. We estimate the abundance indices for Atlantic cod (Gadus morhua), cusk (Brosme brosme), Atlantic halibut (Hippoglossus hippoglossus), and white hake (Urophycis tenius) in the eastern Gulf of Maine. This study shows large spatial inconsistency of temporal variability in fish populations, raising importance of fine-scale groundfish populations in management.

Using modeling approach and fishermen's knowledge to define suitable habitat for cusk (Brosme brosme) and evaluate potential economic impacts of conservation

Runnebaum, J., Guan, L., Cao, J., O'Brien, L., Chen, Y., Tanaka, K.

Presented by: Runnebaum, J. (jocelyn.runnebaum@maine.edu)

Cusk (Brosme brosme) is a gadoid groundfish currently under status review for the Endangered Species Act (ESA) in the USA. Cusk are territorial and thought to have complex stock structure of local populations. Increased distance between localized populations and loss of habitat led to the ESA status review. This study addresses knowledge gaps in the understanding of distribution of suitable habitat for cusk in the Gulf of Maine using a habitat suitability index model. Habitat quality is quantified by density of cusk caught at different depths, sediment types, and seasons. The important qualities of the physical environment where cusk are most abundant are elucidated through distribution maps. These maps are produced from imperfect knowledge, but fishermen's local ecological knowledge can fill these data gaps. Fishermen's knowledge regarding important environmental variables for cusk is used to fine-tune habitat model development. Fishermen's knowledge for areas where cusk are likely to be caught can also validate habitat suitability maps produced in modeling. Combining habitat suitability modeling with fishermen's knowledge will provide a better understanding of cusk distribution in the Gulf of Maine as well as potential critical habitat areas for cusk. This research provides information critical for understanding areas where cusk may be bycaught in the Maine lobster fishery and potential economic costs of conservation measures for avoiding cusk bycatch. Based on the final habitat maps for cusk, the economic impact of potential area closures for cusk, if it were classified as endangered species, will be evaluated based on lobster seasonal fishing effort.

How well do fishery-derived herring estimates predict seabird diets?

Scopel, L., Diamond, A., Kress, S., Shannon, P.

Presented by: Scopel, L. (l.scopel@unb.ca)

Seabirds are considered good bioindicators owing to their dependence upon marine prey, especially juvenile fish. As oceanographic conditions change in the Gulf of Maine, a desire to move toward ecosystem-based fisheries management could see the incorporation of seabird data to better inform stock assessment. However, the relationship between seabird-derived and fishery-derived estimates of fish abundance is poorly understood, making the value of seabird data in fisheries management difficult to judge. We examined foraging data from three seabird colonies in the Gulf of Maine from 1995-2013, in order to examine their concordance with fishery-derived and fishery-independent estimates of Atlantic herring. We correlated the incidence of herring in the diet of three seabird species (Arctic Tern, Atlantic Puffin, and Razorbill) to estimates of spawning stock biomass from acoustic surveys, estimates of the number of juveniles from the Department of Fisheries and Oceans' virtual population analysis, and combined landings reported in the Gulf of Maine and Bay of Fundy. Lags of +2 to -2 years were also imposed on the seabird data to assess whether stock assessment data can predict seabird diets, and vice versa. Across species, acoustic estimates of spawning stock biomass from one or two years previous correlated most strongly with herring incidence in seabird diets (R^2 = 0.51-0.92); the strength of the correlation varied by colony. Correlations between other pairs of fishery and seabird data were less consistent. We will expand the investigation of seabirds as ecosystem bioindicators in future analyses.

It's about time: A synthesis of changing phenology in the Gulf of Maine Ecosystem

Staudinger, M., Mills, K., Rebuck, N., Hudak, C., Jordaan, A., Stamieszkin, K., Pendleton, D., Friedland, K., Ji, R., Allyn, A., Calandrino, G., Diamond, A., Feng, Z., Feurt, C., Golet, W., Henderson, M., Hernandez, C., Huntington, T., Johnson, C., Johnson, D., Li, Y., Liebman, M., Mlsna, I., Nichols, O., Record, N., Robben, T., Seavey, J., Sun, J., Thomas, A., Walsh, H., Yakola, K.

Presented by: Staudinger, M. (mstaudinger@usgs.gov)

The 2015 Annual RARGOM meeting convened an interdisciplinary group of regional scientists from governmental, academic and other organizations to address the theme, "How is the timing of all things changing in the Gulf of Maine?". Subsequently, an expert working group formed to synthesize the current understanding of changes in timing of recurring seasonal environmental and ecological events, as well as the implications of those shifts on regional management, conservation, and climate change adaptation strategies. This presentation will describe the process, goals, and challenges of ongoing working group activities. Results will highlight where we have sufficient evidence and observations to detect regional phenological shifts and where gaps remain. Two integrative case studies will explore the drivers, ecosystem responses, and human implications surrounding 1) a key zooplankton species, Calanus finmarchicus, and 2) highly migratory diadromous fishes. While climate change is a likely factor influencing observed or inferred shifts in phenology, we will also discuss other direct and indirect mechanisms that are potentially confounding our detection of regional signals. Although phenology has been well explored in terrestrial systems, particularly for flowering plants, insects and songbirds,

documentation of phenological changes in marine systems lags far behind. This is partially due to limitations in existing monitoring programs in the marine realm. We conclude with a set of recommendations that address bias and gaps in survey coverage and identify where effort is needed to improve spatial and temporal resolution for specific variables and species of high conservation and management concern. We anticipate this comprehensive examination of shifting phenology will be useful to inform climate change adaptation strategies seeking to reduce uncertainty and sustain important natural resources in the Gulf of Maine region.

Science for sustaining the Gulf of Maine's ecosystems and coastal communities

Stephenson, R. (Robert.Stephenson@dfo-mpo.gc.ca)

Evolving, more holistic, ecosystem-based and integrated management approaches demand consideration of ecological, economic, social and institutional outcomes. This poses a considerable challenge for science in the Gulf of Maine. There is increasing need for interdisciplinary, or trans-disciplinary, methods applied in collaborative processes in the perspective of a social-ecological system. This presentation will explore progress has been made since the needs identified in the 2009 GOM Symposium, including recent research in the Canadian Fisheries Research Network.

How access to Maine's fisheries has changed over a quarter century: the cumulative effects of licensing on resilience

Stoll, J., Beitl, C., Wilson, J.

Presented by: Stoll, J. (joshua.stoll@maine.edu)

We describe how the evolution of the licensing system for commercial fisheries in Maine has progressively limited the ability of both fishers and the State to respond to changing environmental circumstances. Over the twenty-five year period from 1990 to 2014 new licenses were created at the rate of about 0.6 per year. The changes that have occurred have not been the result of a strategic policy agenda that was set to decrease fishers' access, but rather the consequence of multiple decades of policy interventions that have sought to improve the socioeconomic and ecological productivity of individual fisheries. However, the cumulative effect has limited the flexibility of individual fishers and created strong economic interests that are incompatible with shifts towards ecosystem-based management. We use this finding to contribute to the literature on resilience, with a specific focus on the relationship between adaptive management and sustainability.

Understanding the Gulf of Maine's coastal ecosystem servicesheds and their implications for stakeholders in coastal environmental management

Strong, A. (aaron.strong@maine.edu)

There is increasing scientific and government interest in the incorporation of the non-market values provided by ecosystems to human communities within environmental management. In 2015, the White House issued a memo directing federal agencies to develop guidelines for the incorporation of ecosystem services, including those generated from both natural and working lands and from coastal and marine ecosystems, into all federal agency decision-making processes. The goal of this increased attention is ostensibly to ensure that all of the quantified and non-quantifiable values that functioning ecosystems provide to human communities are known and considered when assessing costs and benefits, trade-offs and management priorities. Ecosystem services are, by definition, generated from within spatially defined ecosystems that are geographically locatable and bounded. Yet the values provided by ecosystems are also multiple; a given ecosystem can simultaneously generate provisioning, regulating, sustaining, and cultural ecosystem services, and these services provide values to communities at scales ranging from a few meters (e.g. a coastal wetland's water pollution mitigation benefits) to the entire planet (e.g. carbon sequestration's climate change mitigation benefits). The Gulf of Maine's tidal salt marsh ecosystems present excellent cases for examining the scales and distributions of stakeholders in ecosystem services because of the wide range of ecosystem services they generate. In particular, for the complex coastal social-ecological systems of the Gulf of Maine in which these ecosystems are embedded, understanding who has a stake in which ecosystem services is a key question facing the future of environmental and ocean management in the region. Using a series of case studies of *Spartina*-dominated tidal salt marsh ecosystems along the coast of the Gulf of Maine, I argue that the effective management of coastal ecosystem services, as envisioned by federal agencies, requires governance approaches that can effectively engage with stakeholders across multiple geographic scales of servicesheds.

Impacts of climatic variations on the spatial distribution of *Homarus americanus* in the inshore Gulf of Maine

Tanaka, K.R., Chang, J-H., Chen, Y.

Presented by: Tanaka, K.R. (kisei.tanaka@maine.edu)

The American lobster (*Homarus americanus*) supports one of the most valuable fisheries in the United States. While both abundance and distribution of H. americanus are hypothesized to be influenced by some climate-driven environmental factors, studies that quantify the species response to altered climatological conditions associated with climate change are limited. In this study, we developed a seasonal and sex- and size-specific Tweedie-generalized additive model (GAM) to quantify the spatial and temporal distribution of H. americanus in the Gulf of Maine (GOM) over the last 32 years (1982-2013). The abundance and distribution of *H. americanus* are modeled as a function of key abiotic variables including bottom temperature, bottom salinity, depth, latitude, longitude, distance offshore, and bottom substrate. Impacts of climatic variations were evaluated by forecasting distributions under different temperature scenarios, which revealed higher relative lobster abundance under the warm temperature scenario. The model-based gravity centers of H. americanus distribution showed significant

northeastward shift during spring. This study provides a hind/now/forecasting coupled bio-physical modeling framework to evaluate spatial and temporal variability in abundance and distribution of H. americanus, which could be used to improve our understanding of GOM lobster spatial dynamics given the expected changes in climate-driven environment in the northeastern U.S. marine ecosystem.

Make Way for Marshes: A Regional Model for Knowledge Sharing Among Scientists and Managers to Support Sustainability of Ecosystems and Coastal Communities

Taylor, P. H. (peter@waterviewconsulting.com)

Sharing of knowledge among scientific and management communities is a critical component of any effort to support sustainability of the Gulf of Maine's ecosystems and coastal communities. An initiative sponsored by the Northeast Regional Ocean Council (NROC) in 2014-15 provides a model for knowledge sharing on a priority management issue when scientific understanding of the issue is newly emerging and rapidly evolving. NROC's members and partner organizations had identified tidal marsh migration in response to sea level rise as an important issue because of the marshes' ecological significance, the diverse ecosystem services they provide to people, and the marshes' vulnerability to climate change. Scientific research on the topic is advancing dramatically and managers are seeking to respond on scales ranging from individual marshes and towns to states and the entire Northeast region. However, practitioners saw an immediate need for a well-targeted, timely effort to link science and management to support effective management outcomes. In particular, government agencies and non-government organizations are harnessing computer-based models of marsh ecosystems to inform management and policy strategies to sustain tidal marshes. We worked in collaboration with NROC's Ocean and Coastal Ecosystem Health Committee and a project steering committee to facilitate knowledge sharing on this issue. We conducted interviews with 45 scientific and management experts at government, academic, and non-government entities; conducted a scientific and technical literature search; and participated in a regional workshop. The tangible result of this process is the publication Make Way for Marshes: Guidance on Using Models of Tidal Marsh Migration to Support Community Resilience to Sea Level Rise (northeastoceancouncil.org/marshmigration). This visually engaging and reader-friendly guide covers the entire modeling lifecycle from developing a modeling approach and working with data to communicating modeling results. The less tangible results are a strengthened community of practice and a replicable knowledge-sharing process.

Water Mass Fluxes to the Gulf of Maine: Importance to Water Temperatures and Nutrient Loads

Townsend, D.W., Pettigrew, N.R., Switzer, M., Thomas, M.A., Neary, M.G.

Presented by: Townsend, D. (davidt@maine.edu)

The offshore waters of Gulf of Maine exhibit variable water properties between and among years, and appear to be evolving over time in response to climate change and far-field processes associated with Arctic melt waters. Nutrients and salt are supplied to continental shelf waters of the Gulf of Maine -

Georges Bank region by inflows of deep offshore water masses; once in the Gulf they are transported with the residual circulation and mix with surface waters, both in the Gulf and on the Bank. Because water properties of those inflowing water masses vary, variability in the magnitude of influxes can be important to water temperatures (and salinities) of interior Gulf waters. Recent years, since 2001, have witnessed periods of warm, salty and high-nutrient water masses in the deep interior Gulf (of Warm Slope Water origin), alternating with cold, relatively fresh and low nutrient water masses (of Scotian Shelf Origin). These episodic periods last months to years, and, as we will show, are important in altered nutrient regimes as well as in recently observed warming (and cooling) trends in surface waters. Analyses are based on moored sensors maintained by the University of Maine Ocean Observing System (UMOOS), which is a component of NERACOOS (Northeast Regional Association of Coastal Ocean Observing Systems), which has recently been supplemented with in situ nitrate sensors, and eight recent oceanographic survey cruises to the Gulf of Maine and Georges Bank as part of NOAA's ECOHAB Program. Results show variability in both the magnitude and nature (relative proportions of silicate and nitrate) of nutrient fluxes to the interior Gulf of Maine from offshore, which in turn are the main nutrient sources to Georges Bank, brought onto the Bank by tidal pumping on the Northern Flank. The importance of these water mass fluxes to the well-known 2012 "ocean heat wave" are discussed. In addition, we show evidence of, and discuss the significance of, penetration of Gulf Stream waters into the interior Gulf of Maine.

High-resolution maps of geologic substrates on Stellwagen Bank provide a framework for describing habitats in a complex, glaciated bank and basin terrain

Valentine, P.C., Wiley, D.N.

Presented by: Valentine, P.C. (pvalentine@usgs.gov)

The Stellwagen Bank region is a bank and basin terrain covered by glacial sediments that have been modified by processes associated with post-glacial sea-level rise, tidal currents, and by waves and currents generated by episodic storms from the northeast. New high-resolution maps (1:25,000) compiled from multibeam sonar bathymetric and backscatter imagery, video imagery, and sediment grain-size analyses (943) show the distribution of 27 seabed substrates across the south-central part of the bank (~420 km2) in water depths ranging from 25 m on the bank crest to >100 m in basins to the east and west. Geologic substrates are characterized by sediment type (mud, sand, gravel), by surficial features (ripples, burrows), sediment layering (finer sediment partly covering coarser sediment), sediment movement (ripples), and water depth. In the mapped area, substrate types include rippled coarse-grained sand, muddy fine-grained sand, sands partially veneering gravel, boulder ridges, and mud. Additional maps summarize the substrates on the basis of their mobility or immobility, the dominance of fine- or coarse-grained sand, and their mud content. A habitat is a place defined first by its physical attributes (here the substrate) and then by the species associated with it. Species found on more than one substrate utilize more than one habitat. Researchers can use these maps to associate species with substrate types, to investigate how species use the physical environment, and to predict the occurrence of species in areas with similar characteristics. For example, in an ongoing study, we observed that sand lance (Ammodytes dubius), an important prey species, predictably seeks refuge by burying itself in a single substrate type when not feeding in the water column. In the mapped area, the

preferred substrate of sand lance is a rippled coarse-grained sand that extends from the bank crest to ~50 m on its eastern and western flanks, an area of ~151 km2.

The distribution and relative abundance of sand lance, seabirds and whales in Stellwagen Bank National Marine Sanctuary (2013–2016)

Wiley, D., Valentine, P., Cabe, B., Robbins, J., Kaufman, L.

Presented by: Wiley, D. (david.wiley@noaa.gov)

Forage fishes are essential to sustaining the Gulf of Maine's ecosystem and coastal communities. The northern sand lance (Ammodytes dubius) is an important forage species that has received relatively little attention from scientists and managers. Since 2013 we conducted spring and fall surveys to monitor sand lance at 44 sites in Stellwagen Bank NMS using the USGS SEABed Observation and Sampling System (SEABOSS) equipped with a 0.1 m2 grab sampler and video cameras. At each site on Stellwagen Bank, the number of sand lance contained in the grab sample and observed during a 5-minute video drift were counted to estimate their relative abundance and spatial distribution. These data were used with concurrent observations of foraging activities and surface counts of marine mammals and seabirds to investigate the relationship of these taxa to sand lance. Further, we used data from satellite-tracked great shearwaters (Ardenna gravis; n= 10/year; 2013 -2016) and compared the habitat use of great shearwaters with that of sand lance. Independent data on the number and distribution of humpback whales in the sanctuary (2013–2015) also closely followed similar patterns observed for sand lance. Observations to date indicate that the abundance and spatial distribution of whales and seabirds closely follow those of sand lance, with almost all activity occurring on the southern part of the bank. Commercial fisheries exist for many species of forage fish, and sand lance constitute one of the largest fisheries in the North Sea. While no current sand lance fishery exists in the Gulf of Maine, our observations suggest that they are important to the sustainability of both seabirds and marine mammals, and managers should be aware of potential effects on the ecosystem should a fishery be considered.

Investigating the seasonal residency and habitat use of white sharks in the coastal waters off Cape Cod, Massachusetts, using passive acoustic telemetry

Winton, M., Skomal G., Chisholm J., Fay G.

Presented by: Winton, M. (megan.winton@gmail.com)

Over the past decade, the coastal waters off of Cape Cod, Massachusetts, have emerged as the only known seasonal aggregation site for the white shark in the western North Atlantic. The species' now-predictable summer presence in the region has largely been attributed to the recovery of the local gray seal population, which has recolonized the protected beaches of Cape Cod. While many members of Cape Cod's coastal community have celebrated the white shark's return as the sign of a healthy ecosystem, the growing presence of a large apex predator in close proximity to popular swimming

beaches has raised concerns regarding public safety. To gain a better understanding of white shark movements and habitat use off the coast of Cape Cod, the Massachusetts Shark Research Program tagged sixty individual white sharks (ranging in length from 2.1 to 5.4 m) with passive acoustic transmitters from 2010 to 2015. Here we present an overview of detection data collected during 2015, the year with the greatest number of tagged sharks at liberty. Sharks were detected on all receivers in the array during the course of the season; the first detection was recorded in June and the last in December. Of the 36 individuals tagged in previous years, 11 were detected in 2015. Geostatistical mixed models were applied to investigate aggregate and individual trends in space use. Model results indicate that most sharks traverse the coast during the course of a given summer, but also suggest that some individuals display a relatively high degree of site fidelity. When considered in conjunction with potential environmental drivers, knowledge of the distribution of white sharks in the waters off the Cape may help inform beach management and public safety practices to reduce the chance of negative interactions between the Cape's seasonal shark and human residents.

Finding Efficiency through Integrated Fisheries Management & Marine Planning Data Collection

Zaykoski, P. (pzaykoski@seaplan.org)

Both resource management and ocean planning efforts are data driven and often require different types of data from the same stakeholder groups. Through a collaborative effort among the Northeast Regional Planning Body (NERPB), state and federal fisheries officials, the Atlantic Coastal Cooperative Statistics Program (ACCSP), SeaPlan, George Lapointe Consulting, Harbor Light Software, and party and charter fishing industry members (interchangeably referred to as the for-hire sector), project partners conducted a small-scale pilot study in 2015 and 2016 to explore the integration of data collection for fisheries management and ocean planning purposes. Using a tablet-based software application, SAFIS eTRIPS / Mobile, partners collected catch and effort data directly from participating for-hire sector captains in Rhode Island, Connecticut, and New York, satisfying their fisheries management reporting requirements, while spatial information was collected automatically by the application, engaging the native GPS capabilities of the tablets. We posit that such consolidated data collection activities result in more collaboration and efficiency between regulators and planners and minimizes the burden on the regulated community, allowing for an individual project to address both ecological and social goals.

Abstracts: Poster presentations

Accessing sea floor and coastal video and photographs from the USGS Coastal and Marine Geology Program

Ackerman, S., Golden, N., Dailey, E.

Presented by: Ackerman, S. (sackerman@usgs.gov)

The U.S. Geological Survey's Coastal and Marine Geology Program (USGS-CMGP) has a vast collection of unique and valuable video and photographs from sea floor and aerial surveys along coastal shorelines. Until 2013, only a small amount of these data sets were available publically. Since then, a new geospatial web-portal has been created in order to provide a single point of access for CMGP video and photograph data. The portal work flow streamlines the processing and publication of imagery datasets and enables the USGS-CMGP to share the data quickly and in a meaningful geospatial format. Video and photograph data originally collected for a single use is now being easily shared with our own science teams, our research partners, the greater scientific community and the general public. As of September 2016, the USGS-CMGP Video and Photo Portal contains over 160,000 still images, more than 1000 hours of video and covers approximately 48,000 kilometers of US coastline and sea floor. The Portal is updated with new video and photos as they are collected by USGS scientists and data is being added from our archives. Increasing functionality of the Portal is also a priority to continue to: 1) make the site user-friendly ; 2) provide easy access to this rich USGS dataset of fine-scale imagery in an interactive web-portal; and 3) meet the needs of USGS scientists, USGS research partners, ocean planning experts and the public .

Monitoring Changes in Somes Sound In the Past Two Decades

Arno, H., Dawson, W.

Presented by: Arno, H. (hallie00@gmail.com)

It is well known that the Gulf of Maine is warming incredibly fast, in fact faster than almost everywhere else on earth. Because of this, the Gulf of Maine is changing very rapidly. To adapt to these changes, we must first understand exactly what is happening on a local level. Acadia Institute of Oceanography has been collecting data during the summer in the Somes Sound since 1990, and that data can be used to show long–term trends in the Gulf of Maine. Variables such as air and water temperature, pH, dissolved oxygen, dissolved carbon dioxide, salinity, turbidity, and water color and others were recorded. This data was analyzed along with historic weather data to determine the specific changes that have happened in the Somes Sound in recent years, and will allow us to understand and therefore adapt to a rapidly changing ocean. This project will also explore citizen science as a way to collect valuable data for scientists, since much of this data was collected by students of Acadia Institute of Oceanography, including the authors.

You're gonna get wet: Intertidal monitoring at Appledore Island

Balstad, B., Brewster, S., Clarke, B., Miller, K., and Siddon, C.

Presented by: Balstad, B. (bethany.balstad@gmail.com)

Since 1976, students at Shoals Marine Lab have surveyed permanent vertical transects in the rocky intertidal of Appledore Island. Since 2011, we have focused on 5 sites representing the exposed and sheltered sides of the island and have included replicated permanent photoplots at 4 tidal levels at two sites. Our goal is to provide baseline information on the composition, abundance and vertical distribution of key intertidal organisms. From 1992 to 2016, the zonation patterns created by the dominant organisms are consistent, although there is strong inter-annual variability among many of the common species, especially Fucus, barnacles, and mussels due to episodic recruitment events. Barnacle cover declined markedly in 2013, but recovered in 2014 - 2016 to levels comparable to those of 2011/2012. Cover of Elachista and Vertebrata, epiphytes on the foundation species Ascophyllum nodosum, were different on sheltered compared to exposed shores. Cover of Mastocarpus and Chondrus, foundation species in a lower zone, were similar from 1996 to 2006, after which the cover of Chondrus declined dramatically, likely due to colder than usual winters (periods of 3 or more hours at -5C). To detect community-related responses to climate change in the face of large inter-annual variability, a long-term baseline is essential.

Soft-Shell Clams in Crisis Mode: Field Research Tells Us Why and Gives Us Tools to Adapt

Beal, B., Randall, S., Coffin, C., Goodenow, C.

Presented by: Randall, S. (sara.randall1@maine.edu)

Soft-shell ("steamer") clams, *Mya arenaria*, are an economically valuable fishery and culturally important Maine food source; however, predation, spurred by warming ocean waters, has taken a toll on this iconic species. Recently, clammers from the Maine Clammers Association sounded the alarm about the dramatic increase of invasive green crab, Carcinus maenas, populations in Casco Bay and the corresponding decrease in soft-shell clam populations. The Town of Freeport, ME took initial steps to begin efforts to address the problem in 2013. In 2014, the Downeast Institute for Applied Marine Research & Education (DEI) and the University of Maine at Machias launched its large-scale field research program in Freeport, ME to examine the effectiveness of different methods to protect shellfish from green crabs and other predators, and how to restore soft-shell clam populations. Since 2014, the project has deployed nineteen different field experiments to this end, including: green crab trapping; operation of upweller clam nurseries; predator exclusion fencing, netting, and boxes; recruitment boxes; bio-remediation; and examining the relative importance of predation vs. coastal acidification on juvenile clam recruitment. The 2016 set of field experiments are still underway, but overarching conclusions drawn from previously analyzed field data as well as 2016 observations show clearly that predation is the most important factor causing the decline of soft-shell clams, while the effects of ocean/coastal acidification relative to predation are minimal. In addition to green crabs, native milky ribbon worms, Cerebratulus lacteus, are another key predator negatively impacting clam populations. Our field trials

demonstrate that predator-deterrent netting and boxes are promising clam protection tools. Considering predictions of increased Gulf of Maine ocean water temperatures in the future, and that green crabs thrive in warmer waters, it is critical that Shellfish Managers quickly implement tools to adapt to the changing ecosystem to maintain and preserve the fishery.

Population assessment of Harbor (*Phoca vitulina*) and Grey seals (*Halichoerus grypus*) at Duck Island ledges, ME

Bogomoli, A., Calandrino, G., Carr, M., Lysiak, N., Tsourounakis, G.

Presented by: Bogomoli, A. (abogolmoni@whoi.edu)

Harbor (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) congregate in close proximity at a rocky haulout site within the Isles of Shoals known as Duck Island ledges. This area lies in the middle of both species' ranges and acts as a central resting point along their seasonal migration routes. An ongoing study that began in 2011 uses shipboard photographic mark-recapture surveys to assess this transient population of seals. Since 2011, the minimum abundance of each species has increased each year. In 2016, the average minimum abundance was 325 for P. vitulina and 181 for H. grypsus. Interesting findings in 2016 included over 11 cases of seal pox and more than 30 injuries of varying severity. One harbor seal was sighted with a green tag on its hind flipper. Entanglement in fishing gear and other materials affected 24 H. grypus and 18 P. vitulina, and more than twenty seals were resighted from previous years, including a grey seal "Granite" that had not been seen at this haulout since 2011. Duck Island serves as an important habitat for harbor and grey seals, and the continuation of this study is imperative in order to create long-term datasets for better monitoring of human interactions and population health.

Assessing the impact of ecolabels on consumer preferences for seafood: the role of production method, certification and origin on wild harvest and aquaculture products

Brayden, C., Noblet, C., Snell, M., Kashkooli, M.

Presented by: Brayden, C. (william.brayden@maine.edu)

The production of seaweed and bivalve shellfish represents a substantial and growing sector of the U.S. and global seafood industry (NOAA, 2016; Watson, 2016). While the increase in production of bivalve shellfish and seaweed has been matched by heightened seafood demand, consumers often experience confusion over the characteristics of products during the purchasing process. At the same time, producers and retailers struggle to determine optimal methods of production and marketing to maximize profits. Seafood labels play an important role in the communication of product characteristics from the producer to the consumer and vice versa. This paper explores the impact of ecolabels on consumer preferences for seafood products. We examine three key attributes that may impact consumer choice: (1) preferences for production method: wild harvest or aquaculture products; (2)

preferences for organic (aquaculture) or sustainably harvested (wild harvest) products; and (3) whether a product is labeled as imported, from the U.S., or from a consumer's home state. We use data from a 2016 online consumer experiment (n=2000) and perform a conjoint analysis to improve our understanding of the role these three attributes may play in decision making. This work fills a key knowledge gap by examining consumer preferences for coastal shellfish (oysters, mussels, scallops and clams) and seaweed products across the nation. Preliminary findings indicate that consumers prefer products from their home state regardless of production method or certification.

The Citizen Intertidal Ecologist Project

Caffrey, M., Jones, A., Wiley, M.

Presented by: Caffrey, M. (mmp97@wildcats.unh.edu)

Although the Gulf of Maine is one of the fastest warming parts of the ocean in the world, few long term and wide spread studies have been conducted to examine how this warming is affecting the Gulf of Maine intertidal zone. We are initiating a citizen scientist program to collect intertidal species abundance data as it will allow each participant or group to establish transects to collect data multiple times and multiple sites each year. With the potential to attract tens or hundreds of participants throughout the Gulf of Maine, the amount of data accessible through our database should paint a picture of the ecology of the intertidal in the entirety of the Gulf of Maine, and how species composition is changing due to warming. The protocol is simplified for citizen scientists and utilizes a list of species that fulfill several criteria. Sample data for the project were collected on Star Island of the Isles of Shoals to demonstrate species trends. The citizen science approach also serves to get the public involved in biology and informed on how human impacts effect their local environment.

Variation in minimum Gray seal (*Halichoerus grypus*) and Harbor seal (*Phoca vitulina*) minimum abundance counts on Duck Island, ME due to meteorological variables

Calandrino, M., Bogomolni, A., Lysiak, N.

Presented by: Calandrino, M. (gcalandrino@umass.edu)

Abundance data from a study conducted between 2011 to 2016 were used to examine meteorological predictor variables in relation to harbor seal and gray seal haul-out behavior on a small, mixed-species haul-out site in the Gulf of Maine. Julian day was highly positively correlated with water temperature one meter below the ocean surface and water temperature twenty meters below the surface. There was an observed significant relationship between number of gray seals seen per hour and Julian day, with a midsummer peak in number of gray seals observed. This peak in observed abundance was also correlated with water temperature one meter below the surface. Wind direction was the only variable significantly correlated with harbor seals seen per hour, with a peak in observed abundance occurring when winds originated in the northeast.

Entanglement of Grey (*Halichoerus grypus*) and Harbor seals (*Phoca vitulina*) at Duck Island ledges, ME

Carr, M., Lysiak, N., Bogomolni, A.

Presented by: Carr, M. (m.k.carr28@gmail.com)

Grey (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) congregate at Duck Island ledges, a haulout located in the Isles of Shoals, ME. This site was monitored using shipboard photographic mark-recapture surveys to assess population health during summers 2011-2016. Incidence of diseased, injured and entangled seals was noted. Entangled animals were assessed according to the severity of their wounds, type of entangling gear, and location of entanglement on the body. During summers 2011-2016, 63 grey seals and 86 harbor seals were observed entangled in marine debris at Duck Island and its surrounding ledges. Most entanglements (85%) were located on the neck, while 6% affected the face, flippers, or body and 9% affected multiple parts of the body. Of the identifiable entangling gear, monofilament line and gillnet were most common. Though the dominant local fishery is lobstering, no seals were observed entangled in lobster fishing gear, possibly due to the heavy lines associated with the gear. Severe or very severe wounds were noted in 95%* of P. vitulina entanglements and 89%* of H. grypus entanglements (*entanglements that could be scored). The relative entanglement rate for P. vitulina—– was higher than H. grypus. This site's high incidence of entanglement identifies a significant threat to both seal populations in the Gulf of Maine.

Understanding exchange at the bay-shelf interface

Cole, K., Pettigrew, N.

Presented by: Cole, K. (kelly.cole@maine.edu)

Understanding exchange between a bay and the surrounding shelf is important for many ocean applications including sediment, nutrient and pollutant transport. Previous studies find a transition region in outer Casco Bay where near-surface cross-shore currents shift from predominantly along-shore wind driven Ekman response to cross-shore wind forced within the east bay. However, the vertical structure and temporal and spatial scales of variability of this cross-shore current structure are not well understood and cannot be simply summarized by an exclusive coastal or estuarine process. In this research, the impact of physical environmental conditions in Casco Bay and the surrounding shelf on the salinity and current structure of the east bay is examined using idealized experiments with the Regional Ocean Modeling System (ROMS). This effort is focused on better understanding the role of bottom boundary layer dynamics at the bay-coastal interface. The bottom boundary could contribute significantly to cross-shore transport for three reasons: cross-shore exchange is linked to alongshore flow structure, which is tied to the upcoast Kennebec River plume at the entrance to Casco Bay. Poorly understood mid- to far-field plume dynamics occur in the region where the bay forms a break in the coastal wall. Under what forcing plume isohalines intersect the bottom is not well understood, but could result in significant buoyancy transport cross-shore. Second, boundary layers can span the entire

water column and affect or be affected by the strength and structure of interior flow. Wind driven circulation is important throughout much of the water column in this case, but the response to the timing and variability of this forcing in a region of fresh water influence, and its affect subsurface, possibly through sea surface setup, is not clear. Third, the spatial scales and bathymetric slope of the outer bay support the possibility of these dynamics.

High resolution modeling of nearshore flow patterns and blue mussel population connectivity in Downeast Maine

Conlon L., Xue H., Yund P.

Presented by: Conlon L. (leannconlon@gmail.com)

Knowledge of population connectivity is critical for understanding population dynamics and developing appropriate management strategies for benthic marine species. Circulation models are a useful tool in assessing connectivity because they incorporate numerous parameters such as temperature, salinity, and flow patterns and thus permit an evaluation of the physical dynamics that underlay connectivity. We used a high resolution FVCOM model (Finite Volume Coastal Ocean Model) to simulate the nearshore flow patterns along the eastern Maine coast to investigate population connectivity of blue mussels (*Mytilus edulis*). Our model is highly resolved in intertidal and nearshore regions to accurately simulate flow dynamics in these regions that are critical for larval dispersal. We are validating the model using in situ temperature, salinity, and current velocity data collected within the study region. To simulate dispersal, we represent larval mussels as Lagrangian particles with a temperature dependant growth and survival function, released from mussel bed locations. These simulations show particles lingering in the nearshore waters for several days, and then either moving among neighboring bays or entering the coastal current and moving along the coast from northeast to southwest. Whether or not particles enter the coastal current is dependent on a number of factors, such as tides, bathymetry, and season.

Understanding shellfish growth potential in the Damariscotta River using a coupled modeling approach

Coupland, K., Cole, K., Brady, D., Newell, C.

Presented by: Coupland, K. (Catherine.Coupland@maine.edu)

As climate change continues to alter marine ecosystems through temperature and salinity changes, acidification, and sea level rise, understanding how the estuaries and aquaculture may respond to these changes is critical to sustainable management. The Damariscotta River is the highest producer of oysters annually in Maine. Understanding this system is paramount to expand aquaculture throughout the state to meet the needs of a growing population and support coastal communities. We are developing a coupled hydrodynamic-biogeochemical model of the Damariscotta River that will focus on

understanding why the Damariscotta River is such a productive oyster aquaculture area. The model will incorporate parameters such as temperature and salinity, nutrient sources, fresh water flow, primary productivity rates, chlorophyll a standing stock, uptake rates by oysters, proportion of food coming from detritus vs phytoplankton, benthic pelagic coupling and remineralization rates, bottom type, and bathymetry. Several questions of interest to be answered with the model include: What is the carrying capacity of the Damariscotta River for oysters? How does the composition of detritus in the river impact oyster growth rates, and what are the possibly implications due to shift in detritus composition? Increased temperature will likely increase oyster growth rates, will the oyster food supply increase proportionately? Will shelf intrusion of acidic water be of concern for the growing areas in the upper portions of the river? Will decreased pH due to increased freshwater runoff have an impact on growth rates?

Catch Share Management in the Northeast Multispecies Fishery: Have the Theorized Benefits Been Realized in New Hampshire?

Feeney, R. G.

Presented by: Feeney, R. G. (rfeeney@nefmc.org)

A great deal of controversy has attended the introduction of catch shares in fisheries, particularly the Northeast groundfish sector program. Although social research often involves theory generation, in the case of sectors, and catch share programs more generally, a number of theories have already emerged that are ripe for testing. This dissertation research (while a student at the University of New Hampshire) examined these theories - their validity and limits relative to the sector program, particularly within New Hampshire, though broader outcomes were considered. Answers to commonly asked questions about catch shares were sought through a series of fishery participant interviews in 2012. It was hypothesized that fishing in a sector has resulted in: more efficiency and flexibility for fishermen to decide where, when, and how to fish; greater social capital among fishermen; reduced bycatch; and improved economic performance, safety, and well-being. The groundfish fishermen of New Hampshire revealed that the theorized benefits of catch share programs do not necessarily hold true; only the benefits related to fishing practices, bycatch and safety aligned with what had occurred in this local fishery. With declining fishery participation, and dim potential for positive economic performance, the sense of well-being and future outlook for self and fishery had diminished. These conclusions must be contextualized with outcomes for other sectors and the concurrent severe reductions in catch limits that have likely masked much of the positive potential for catch shares. Success under a catch share program is perhaps more likely attained in fisheries not constrained by stock rebuilding plans and by those participants able to adapt (e.g., with tools, skills, financial resources, business savvy).

Factors affecting spiny dogfish (*Squalus acanthias*) at Jeffrey's Ledge in the Gulf of Maine

Gallo, B., Chapman, E.

Presented by: Gallo, B. (bdw35@wildcats.unh.edu)

In the Western Atlantic Ocean, Spiny Dogfish (*Squalus acanthias*) is a highly migratory species (HMS) found from North Carolina to Canada. Historically considered bycatch by commercial fishermen, recent declines in some valuable groundfish stocks (e.g. Atlantic Cod (*Gadus morhua*) and a concurrent increase in abundance and annual residence time have created a fishery for Spiny Dogfish in the Gulf of Maine (GOM). These changes have impacted fishing operations and are likely to have important ecological effects due to the strong predation pressure associated with this species. Although increasing water temperatures in the GOM have been implicated as an important environmental driver behind changes in dogfish abundance, little is known about factors associated with this phenomenon. From 2014-2016, UNH and The Nature Conservancy have worked with local fishermen to better understand factors associated with the seasonal entrance and departure of dogfish from Jeffery's Ledge. Temperature loggers were placed on gillnet gear to collect benthic water temperature and fishermen's catch was also recorded during the study. The data allowed analysis of conditions during one seasonal appearance and two departures of Spiny Dogfish from Jeffery's Ledge. Results suggest that the spring appearance of dogfish in the area may be associated with warming temperatures (6.5-7.0^{o}C, 60-90m) while the late summer or early fall departure of dogfish occurs as water temperatures are continuing to warm (8.0-8.5^{o}C, 60-90m), perhaps indicating ecological factors triggering movement out of the area. Informal observations also suggest a possible demographic shift from larger pregnant females in early summer to smaller males in late summer and fall. Future research directions include adding more vessels to the research program to broaden regional coverage, continuing to build the time series, tracking age and sex distribution, and adding additional existing data-sets to the analysis.

Ocean and coastal acidification governance in Maine: Conservation in networks

Gassett, P., Strong, A.

Presented by: Gassett, P. (parker.gassett@maine.edu)

As the understanding of the drivers and impacts of ocean and coastal acidification (OCA) has improved, states have increasingly recognized that they have a role in regional-to-local OCA management, and Maine has been at the forefront of a movement for state actions to address OCA. In 2014, a state commission was formed to assess the threats of OCA to Maine's fisheries and the opportunities to take actions to address those threats. One recommendation of the commission was the creation of an on-going state-sponsored council to manage the state's OCA responses. In 2015, in the wake of failed legislative funding to support such a state sponsored OCA task force, leaders from among Maine's robust network of non-profit conservation organizations have partnered together to lead Maine's response. Unlike other states that have addressed this issue through top-down state action, Maine's approach is currently multi-faceted, volunteer, and "bottom-up". Such an approach involves an evolving community of water quality organizations, aquaculture fisheries, municipal engineers, conservation organizations and University researchers. Because OCA has multiple, complex drivers, and because

adaptability to OCA is linked to environmental, social, and economic conditions, all of which are locally highly variable, understanding how the current governance approach can improve resilience to changing ocean chemistry requires understanding how communities develop an identity as stakeholders in this issue. Here, I explore the challenges and potential for independent collaborations to implement regional OCA governance actions in response to environmental change. In particular, this work investigates the facilitators of stakeholder buy-in to OCA mitigation and adaptation strategies. Understanding community responses to environmental concern, in absence of formal government action, is a key element of global change research, and Maine's current situation provides a case study of the social structures, opportunities, and barriers of bottom up approaches to large scale strategy for environmental change.

A fishery in flux: Claw removal and its impacts on survivorship, behavior, and physiological stress in Jonah crab (*Cancer borealis*)

Goldstein, J., Carloni, J., Kibler, R.

Presented by: Goldstein, J. (jsgoldstein2@gmail.com)

Found in coastal and shelf waters along the Atlantic coast of North America, from Newfoundland to Florida, Jonah crab (*Cancer borealis*) have been captured as incidental bycatch in the New England lobster industry for over 80 years. In the last 20 years however, Jonah crabs have become an alternative fishery target and landings have more than quadrupled. This has necessitated evaluation of the current status and prospective long-term health of the fishery. The biological implications of harvesting Jonah crab through the live removal of claws remain mostly unknown. The goal of this ongoing research is to evaluate current harvest practices (claw removal) and the implications on the health and behavior of Jonah crabs. Preliminary results from laboratory trials (n = 232 total crabs) suggest that double-claw removal incurs markedly more mortality (~74 %) compared with single-claw removal (~56 %) and control animals (~19 %). Physiological stress, assessed through concurrent haemolymph analyses suggest elevated levels of glucose and lactate in de-clawed crabs. Continued studies on behavior (feeding) and growth are ongoing in an effort to better understand Jonah crabs and manage this rapidly developing fishery in New England waters.

Stakeholder Driven Disease Modeling: The Case of Lobster Shell Disease

Hupper, A., Belknap, S., Homola, J., Tanaka, K.

Presented by: Belknap, S. (samuel.belknap@maine.edu)

The spread of emerging and established marine diseases pose substantial threat to marine resources and the communities that rely upon them for their livelihoods and sense of identity. The threat posed by these marine diseases is well documented by the case of lobster shell disease in Long Island Sound (LIS). Lobster harvesters in Maine are well aware of the impact of this disease in LIS and its potential threat it

poses to the Gulf of Maine Lobster Fishery. In 2013, Maine lobster harvesters brought their concerns to the attention of our research team and requested more information regarding the future spread of the disease under climate change scenarios. This poster presents initial results of a stakeholder concern and needs assessment regarding the future spread of shell disease, as well as a description of modeling efforts directly motivated by these concerns and needs.

Evaluating fishing effort levels in the Maine lobster fishery: an individual-based model approach

Mazur, M., Chen, Y.

Presented by: Mazur, M. (mackenzie.mazur@maine.edu)

The Maine lobster fishery is the most valuable commercial fishery in the state, and as such, supports a large number of families across very diverse communities. Evaluating fishing effort levels and efficiency of the Maine lobster fishery is important platform from which to understand how regulation impacts the fishery dynamics and the economy. An efficient fishery maintains a specific yield while reducing effort and costs. Although current Gulf of Maine lobster landings are at a historical high, the large quantity of traps (and thus fishing effort) used in the fishery makes it less profitable. To research efficiency, an individual based model (IBM), previously developed for the Gulf of Maine lobster, will be modified and used to evaluate how yield may change at different levels and temporal distributions of fishing efforts i.e., traps hauls. The lobster IBM mimics the life history and fishery of individual lobsters and quantifies how they grow in size, become mature and die due to fishing and natural mortalities. Using this model, we simulate the Maine lobster fishery under different realistic management strategies. This research focuses on identifying ways to maximize economic value of the Maine lobster fishery through improved fishery efficiency.

A Collaborative Approach to Characterizing Sand and Gravel Deposits Using Multibeam Sonar in the Gulf of Maine

Ozmon, I., Enterline, C., Nixon, M., Dobbs, K.

Presented by: Ozmon, I.

A comprehensive understanding of the benthic environment is necessary to effectively manage coastal resources and increase resiliency. We characterize substrate, biological communities, habitat and infauna at submerged glacial paleodeltas in Maine (3-8 nm offshore) using a Kongsberg multibeam sonar and Ponar dredge paired with underwater video camera. Although historical sidescan and multibeam sonar and seismic profiles provide some bathymetry information and have been used to model surficial sediment composition there are still large gaps in high resolution bathymetry, and very little is known about benthic habitat in Maine waters. The Maine Coastal Mapping Initiative utilizes a small vessel survey platform in both offshore and nearshore areas to collect bathymetry information and compare backscatter intensity data with video footage and sediment grabs to ground-truth sediment type. We

characterize benthic infauna, which, when paired with an underwater video camera and water column profiles, are used to characterize biological communities to aid benthic habitat classification. These data will dramatically enhance the capacity for coastal resiliency, ocean planning, and resource management on Maine's inner and outer continental shelf. We will present data collected on the submerged Kennebec River paleodelta, within the Saco River, and marine waters of southern Maine.

ESIP's new ICUC smartphone app – linking citizen scientists to their own places of wonder

Parlee, K., Tilburg, C., Latimer, J.

Presented by: Parlee, K. (kathryn.parlee@canada.ca)

The Gulf of Maine Council's EcoSystem Indicator Partnership (ESIP) was formed in 2006 to look at changes in the health of the Gulf of Maine ecosystem through the use of environmental indicators. ESIP has always recognized the value of datasets generated by citizen scientists. To harness more of the energy and curiosity of citizen scientists in the region, ESIP has released a new smartphone app: ICUC ("I See You See"). ESIP's initial approach to indicator development focused on seven ecosystem themes, which were based on priority issues identified by scientists, decision-makers, and other stakeholders. To date, ESIP has made indicator data available online through its Indicator Reporting Tool and fact sheets published on seven of its indicator themes: aquaculture, aquatic habitats, climate change, coastal development, contaminants, eutrophication, and fisheries. ESIP's community of users, which include academics, governmental, and non-governmental individuals, has grown dramatically since its formation. Concurrently, the citizen science movement has connected citizens in the US and Canada using observational science. The new app provides users with information on monitoring activities in the Gulf of Maine and the opportunity to participate in knowledge collection in their local areas by uploading smartphone photos at specific locations to an on-line photo library. As the photo library grows, both in number of photos and number of locations, users will be able to observe environmental changes at each location over time via an associated web page on the ESIP website (http://www.gulfofmaine.org/2/esip-homepage/).

Movements and Foraging Areas of Great Shearwaters *Puffinus gravis* in the Gulf of Maine

Powers, K.D., Wiley, D.N., Allyn, A.J., Welch, L.J., Ronconi, R.A.

Presented by: Powers, K. (kdpowers24@gmail.com)

In the western North Atlantic, great shearwaters *Puffinus gravis* consume vast amounts of marine prey and are among the most abundant seabirds during summer months, yet little is known about their movement ecology and habitat requirements in this ecosystem. We used platform terminal transmitters (PTTs) and a Bayesian switching state-space model (SSSM) to describe shearwater movements, foraging areas, migration timing, and how such habitat use might be related to age in the Gulf of Maine. From July to November great shearwaters traveled an average 515 km per week (individual weekly average bird range 365-765 km) and spent the majority of their time foraging (Area Restricted Search behavior)

around the rim of the gulf primarily using shallower waters (<100 m) where bathymetry was more steeply sloped. Movements associated with their southern migration began in August and continued through much of September with birds leaving the study area via a pathway south of Nova Scotia, Canada. The age composition of the Gulf of Maine great shearwaters as determined by nape plumage was predominately young; 89% of birds examined were <3 years old. Core foraging areas were identified in three locations: lower Bay of Fundy, northeast Georges Bank and Stellwagen Bank/Cape Cod Slope. Foraging areas were not characterized by consistent environmental variables across sites indicating a flexible foraging strategy based on high mobility. Given the apparent adaptability assumed from their use of different habitat patches within the Gulf of Maine, great shearwaters may have the capacity to adapt to climate change and environmental variability during the non-breeding season.

Impacts of Data Quantity and Quality on Habitat Modeling

Ritchie, M., Tanaka, K., Chen, Y.

Presented by: Ritchie, M. (max.ritchie@maine.edu)

Understanding factors influencing habitat quality of study species plays a critical role in informing us of changes in the distribution and abundance of fish populations. Well-developed habitat models can help managers assess the changes in habitat for species likely to be impacted by climate change. This study evaluates and quantifies the impacts of data quantity and quality on habitat modeling. Two species of economic and ecological importance are used as case studies: the American Lobster (*Homarus americanus*), and the Northern Shrimp (*Pandalus borealis*) in the Gulf of Maine. Fisheries independent survey data are used to develop species-specific Habitat Suitability Index (HSI) models. Three separate model calibration processes are compared. First, a parsimonious model selection criterion is compared to a literature based variable selection. Second, three different covariate weighting techniques, equal weighting, machine learning and parametric generalized additive model weights, are compared. Third, model performances using the full and trimmed data set are compared to assess the impact of outliers. Model outcomes are compared for each case species to ascertain which model calibration technique provides the best model performance measured in cross validations. Spatiotemporal variability in suitable habitat will then be evaluated and quantified using the best model outcome for each species in the context of potential climate change scenarios in the Gulf of Maine.

Size-at-age trends in Northwest Atlantic ground fish and implications for stock assessment

Schilpp, L., Fay, G., Miller, T.J.

Presented by: Schlipp, L. (lschilpp@umassd.edu)

Our work focuses on implications of changing ecosystem dynamics on fisheries by exploring possible drivers on variation in size-at-age, and implications for stock assessment. We use generalized linear models to evaluate the effects of demographic, temporal and environmental factors on variability in

weight-at-age and condition factor for eight commercially important stocks. Although the most significant factors affecting size-at-age tend to be demographic (ie maturity, sex), location and temporal factors are important as well; generally fish on Georges Bank have higher weights-at-age than in the Gulf of Maine. We then explore the implications of this variation for modeling natural mortality within a state-space statistical catch at age stock assessment model. We compare the status quo model with various models which incorporate time, age, and size-at-age varying natural mortality. Although these more complex models may result in a better fit to the data, the AIC suggests that the simplest model is the most parsimonious. Our work explores the linkages between ecosystem components such as climate variation and susceptibility to predation and healthy fisheries by focusing on size-at-age as both a response to these changes as well as a possible component in fisheries model inaccuracies.

Fine-scale haul-out preferences of harbor seals (*Phoca vitulina*) and gray seals (*Halichoerus grypus*) at Duck Island, ME

Tsourounakis, G., Bogomolni, A., Lysiak, N

Presented by: Tsourounakis, G. (grt27@cornell.edu)

Harbor Seals (*Phoca vitullina*) and Gray Seals (*Halichoerus grypus*) haul-out at Duck Island and the surrounding ledges, but the reasons are unknown. Data for seal numbers were collected by a means of summing the count data for each ledge for each year. Ledge description was assayed by shipboard analysis, photographic analysis, and by use of a navigating app. An investigation of probability of presence reveals a preference for specific ledges: harbor seals for low relief areas and gray seals for intermediate relief areas. Algal cover, depth, slope, and size of ledges had little to no effect on harbor or gray seal presence. Fine scale analysis of such sites can provide insight on habitat preferences when it comes to recreating these sites with respect to rising sea levels and warming oceans.

Maximum entropy modeling of marine fish species' spatiotemporal distributions utilizing earth system data

Wang, L., Kerr, L.A., Bridger, E., Record, N.R., Tupper, B.

Presented by: Wang, L. (lwang@gmri.org)

Understanding how ocean conditions influence marine fish distributions is critical for elucidating the role of climate in ecosystem change and forecasting how fish may be distributed in the future. Species distribution models (SDMs) enable estimation of the likelihood of encountering species in space or time as a function of environmental conditions. Traditional SDMs are applied to scientific survey data that include both species presence and absence information. Maximum entropy (MaxEnt) models are promising tools as they can be applied to presence-only data, such as those collected from fisheries or citizen science programs. We used MaxEnt to relate the occurrence records of marine fish species (e.g. Atlantic herring, Atlantic mackerel, and butterfish) from the NOAA Northeast Fisheries Observer

Program to environmental conditions. Environmental variables included sea surface temperature (SST) and Chlorophyll-a based on NASA satellite observations, as well as bathymetry and climate indices (NAO and AMO). We developed habitat suitability maps for these fish species in Northeast Shelf area, and assessed the relative influence of environmental factors on their distributions. Overall, SST and Chlorophyll-a had the greatest influence on their monthly distributions, with bathymetry having moderate influence and climate indices having little influence. Across months, Atlantic herring distribution was most related to the 10th percentile values of monthly SST, and Atlantic mackerel and butterfish distributions were most related to the previous month's SST. Fish distributions were most affected by the previous month's Chlorophyll-a in summer months, which may be related to the accumulative impact of primary productivity. These MaxEnt habitat suitability models have the potential to provide hindcasts of where species might have been in the past in relation to historical environmental conditions, nowcasts in relation to current conditions, or forecasts of future species distributions, and provide useful information for sustaining marine ecosystems and coastal communities in the Gulf of Maine.

Sustaining the Gulf of Maine: The Importance of Understanding the Science, Information, and Policy Interface for Effective Coastal and Ocean Management

Wells, P. G., Soomai, S. S., De Santo, E. M., MacDonald, B. H., Ross, J. D.

Presented by: Wells, P. (oceans2@ns.sympatico.ca)

Few would disagree that in combatting serious anthropogenic ecological problems affecting the oceans, such as climate change, public policy development should be informed by the best available scientific information. However, with the vast volume of information now available through multiple communication methods and with public resources often constrained by current austerity measures, an urgent need exists to understand and strengthen the channels by which scientific information reaches policy- and decision-makers. In this poster, we present key conclusions drawn from the contributions to the new book, Science, Information, and Policy Interface for Effective Coastal and Ocean Management, published by CRC Press (Taylor & Francis), 2016. The poster outlines fundamental concepts and principles of the science-policy interface, including: 1) The complexity of the pathways by which scientific information flows within and among organizations that set the context for policy and management decisions; 2) The significance of the processes by which information is generated and assembled to inform policy; 3) The necessity to produce information in styles and formats that are helpful to intended users; and 4) The diversity of methods by which information can be used (or misused) in policy development. The poster will also note major challenges facing researchers and practitioners who wish to improve the processes of evidence-based decision-making relevant to oceans, including the need to: 1) Develop policy solutions to balance trade-offs between evidentiary, political, and economic imperatives; 2) Enhance knowledge sharing and information management processes to ensure that decision makers access the relevant information; 3) Improve the reliability of scientific information presented to policymakers; 4) Understand and effectively communicate the consequences of inaction on environmental issues; and 5) Encourage interdisciplinary approaches, that include information management, in the practice and study of integrated coastal and ocean management.

Diluted Bitumen Spills in the Bay of Fundy and Greater Gulf of Maine: an update on the scientific and technological challenges

Wells, P., Stewart, I.

Presented by: Wells, P. (oceans2@ns.sympatico.ca)

Safe transportation of diluted bitumen (dilbit) on land and sea already poses critical scientific and technical challenges for the further sustainable development of Canada's oil industry, and the proposed Energy East pipeline (from Alberta to Saint John, NB) would see substantial increases in tanker traffic of dibit in the Bay of Fundy and the greater Gulf of Maine. Scientific knowledge of the distinctive behaviour of dilbit (compared to other hydrocarbons) when released into marine environments is evolving, although interpretation of that information has varied, as have claims regarding our technological capacity for mitigating environmental impacts of dilbit spills. This paper will present an update on what scientific consensus has emerged in the recent literature, and indicate remaining areas of uncertainty and concern that are relevant in particular to the region's ecosystems and communities.

Structural uncertainty and data limited ecosystem-based management of the Georges Bank social-ecological system

Wildermuth, R., Fay, G., Gaichas, S.

Presented by: Wildermuth, R. (rwildermuth@umassd.edu)

Ecosystem-based management requires making informed decisions about systems that meet multiple social, economic, and environmental objectives. Limited sampling of marine social-ecological systems often restricts applications of quantitative models. However, qualitative models inform management decisions using expert knowledge. Additionally, uncertainty about the underlying system structure affects model estimates and resulting conclusions about potential management actions. We apply qualitative loop analysis to assess sensitivity to structural uncertainty within the Georges Bank social-ecological system. This work parallels models developed for the Gulf of Maine system as part of the ICES Working Group on the Northwest Atlantic Regional Sea. Loop analysis defines interactions as presence of positive or negative causal relationships between system components. These analyses provide inference about the cascading effects of increased pressures to certain system components. We compare sensitivity of two management scenarios in a base model to two alternate structures of the Georges Bank system: additional lower trophic interactions, and increased socioeconomic complexity. We evaluate each scenario-structure combination by summarizing system responses to perturbation and comparing responses to stated management objectives. Our approach demonstrates 1) the ability to investigate the dynamics of the Georges Bank social-ecological system using qualitative models, 2) expected tradeoffs among potentially conflicting ecosystem-based management objectives, and 3) effects of uncertainty in system structure on model outcomes and associated management implications.

Long-term changes in the Chick Diet, Growth and Fledgling Success of Three *Strena* spp. in Response to Changing Climatic Conditions in the Gulf of Maine

Yakola, K., Staudinger, M., Jordaan, A., Kress, S., & Shannon, P.

Presented by: Yakola, K. (kyakola@gmail.com)

Environmental and ecological changes such as variability in ocean temperatures and prey availability are negatively affecting many marine populations globally. Indeed, in the Gulf of Maine (GOM) where sea surface temperatures are rapidly rising, climate change presents a new set of conservation challenges. The National Audubon Seabird Restoration Program has collected over 25 years of data on nesting seabirds on seven islands in the GOM, including the Maine Coastal Islands National Wildlife Refuge. This time-series has not yet been fully explored and presents an exceptional opportunity to study how an increasingly variable ecosystem and climate are affecting three migratory seabird species of high conservation concern: the federally endangered Roseate Tern *Sterna dougalii*, Common Tern *S. hirundo*, and Arctic Tern *S. paradisaea*. We will use this long-term data set to quantify changes in population dynamics in response to physical changes in the environment and to evaluate how the composition of chick diets influences chick growth and survival. In addition, we will explore the potential for phenological mismatches between the timing of chick rearing and peaks in primary prey abundance. Results are anticipated to increase the understanding of how cross-trophic-level interactions and changing environmental conditions are impacting *Sterna* populations at the colony and regional levels in the GOM, and to increase the predictive capacity of population viability models supporting conservation decisions and actions.

Getting to the RARGOM Annual Science Meeting

Meeting Location:
Redhook Brewery
1 Redhook Way, Portsmouth, NH 03801
Phone: (603) 430-8600

DRIVING

From south:
Take I-95N
Use the left 2 lanes to take exit 4 for US-4/NH-16 toward White Mts 1.8 mi

From north:
Take I-95S
Take exit 5 for US-4/NH-16 toward Newington/Dover

Same from north and south:
Continue onto NH-16 N/US-4 W 0.5 mi
Take exit 1 for Gosling Rd toward Pease International Tradeport 0.3 mi
Turn left at end of ramp onto Gosling Rd./Newington St.
Use the left 2 lanes to turn left onto International Dr 0.2 mi
Turn left onto Corporate Dr 0.2 mi
Turn left onto Redhook Way

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