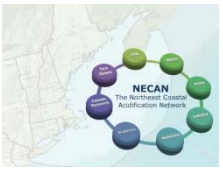
Northeast Coastal Acidification Network (NECAN) Ocean and Coastal Acidification Stakeholder Workshop: Canada



October 6, 2015

I. Overview and Context

A day-long workshop was organized by the Northeast Coastal Acidification Network (NECAN) to inform and learn from fishermen, clam harvesters, aquaculturists, and coastal water quality volunteer programs regarding ocean and coastal acidification (OCA). The workshop was held as a part of the Fishermen's Forum 2015: "Working Together to Monitor our Changing Coasts and Oceans" at the Keating Centre at St. Francis Xavier University in Antigonish, Nova Scotia. The 'Fishermen's Forum' is an annual conference organized by the Gulf Aquarium and Marine Station Cooperative (GAMS) in order to stimulate communication among fishermen and industry people, academic and scientist, government, and other stakeholders. The theme of the 2015 Forum centered on the changes in marine systems that are occurring due to the effects of climate change. The topic of ocean and coastal acidification therefore fit in seamlessly as a day-long focus for the Forum. This one-day workshop was the fifth of the NECAN stakeholder workshop series that started in December 2014 and took place in Walpole, Maine; Barnstable, Massachusetts; Narragansett, Rhode Island; and Gloucester, Massachusetts.

This summary is designed to capture key themes and topics from the day[1]. Presentation slides from the workshop can be found at the GAMS website (www.cmag-gams.org).

Gregor Reid from the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN) opened the workshop with a presentation on "The Atlantic and Pacific NSERC Workshops on Climate Change and Aquaculture: Outcomes and Implications for Water Quality." Reid explained that as climate change is becoming an increasing concern for aquaculturists around the world, NSERC took action by organizing two workshops on Climate Change and Aquaculture for both the Atlantic and Pacific coasts in Canada. Central themes at these workshops included climate change impacts such as storms and rising waters, warming waters and temperature extremes, fish and shellfish health, and ocean acidification. The outcomes of these workshops included the confirmation that the development of monitoring and early warning systems, nutrition, enabling governance, engineering solutions and biotechnology as feasible options for action.

Following this presentation, Cassie Stymiest, Program Manager for the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), the parent organization of NECAN, provided an overview of what NECAN is and some of the Network's accomplishments thus far. NECAN was formed in September 2013 in response to the observation of slower growth, lower survival rates, and deformed shells in shellfish hatcheries

[1] This summary was written by Hannah Blondin (NERACOOS), adapted from the workshop proceedings found at http://www.cmag-gams.org/images/pdf/ffreportnov10.pdf and notes from Cassie Stymiest (NERACOOS/NECAN). The workshop was organized by the Gulf Aquarium and Marine Station Cooperative (GAMS) in collaboration with NECAN members.

on the East Coast. Industry member and resource managers, academia and scientists, and state and federal government agencies are linked via NECAN and are working together on an array of ocean and coastal acidification topics in waters from Long Island Sound, George's Bank, the Gulf of Maine and Brown's Bank, and Sable Island Bank out to the shelf break.

NECAN's role is to: (1) review and asses the most recent scientific, technical and socio-economic information relevant to the economically important marine organism's potentially impacted by ocean and coastal acidification, (2) communicate critical knowledge gaps identified by stakeholders to relevant state and federal agencies, (3) help to coordinate and set regional priorities for monitoring and research designed to further our understanding of coastal acidification, and (4) respond to user and stakeholder needs. Since its formation, NECAN has held 16 science-based webinars led by experts on OCA, which are available on the NECAN Website. It also hosted a two-day State of the Science Workshop in April 2014. As a result, NECAN was able to develop a state of the science synthesis article titled, "Ocean and Coastal Acidification off New England and Nova Scotia." This article was published in the June 2015 issue of *Oceanography*. NECAN is currently holding a stakeholder engagement workshop series in serval Northeast Region communities in order to inform and learn from fishermen, aquaculturists, and coastal water quality groups regarding OCA. The result of all these efforts will be an Implementation Plan for the NECAN region, planned to be written in 2016.

In just two years, NECAN has learned that although ocean acidification is a global issue, coastal ocean acidification effects are localized and can lead to diverse impacts among different areas. NECAN recognizes common concerns about OCA that have been brought up in several stakeholder engagement workshops thus far, including:

- The lack of a coordinated monitoring effort that is standardized to get consistent data and analyses
- The need for improved understand on how OCA relates to climate change and other resulting environmental stressors
- A lack of research on the specific risks for each industry group
- The need to provide specific action items

II. What is Ocean and Coastal Acidification?

Joe Salisbury, a professor and researcher of Oceanography at the University of New Hampshire, provided background information to answer "What is Ocean and Coastal Acidification? What does the Science Say? What Don't We Know, and How will it Affect Atlantic Canada?"

Salisbury stated that present-day CO2 levels are the highest they've been in the past several million years. The rate of increase is 50-100 times larger than the natural rates of change. An increase in carbon dioxide in the atmosphere threatens calcifying organisms in two ways. First, a decreased pH makes the water more corrosive which can cause shells to dissolve. Second, a reduction in the concentration of carbonate ions mean there is not enough calcium carbonate for organisms such as corals and calcifying plankton to grow and make new shells. Fresher water can be more sensitive to acidification than saltier water, and colder water tends to be more acidic with a lower omega than warmer water. Coastal acidification threatens all commercially and ecologically important calcifying organisms. There are several topics we don't know enough about including: sediment-water interactions, land-ocean- coastal biological interactions, drivers of sub-surface conditions, the role of multiple stressors in the environment, the future trajectory of coastal OA, and organism response to OA. The estimates for global change in CO2 over the next 100 years range from 0.2- 0.4 decrease in pH units. This will impact marine life. The Northwestern Atlantic Ocean is sensitive to OA, and may be changing quickly. We must slow the rate of CO2 addition to the atmosphere.

III. Setting the Local Context

Presentation 1: "MEOPAR's Ocean Acidification Research":
Helmuth Thomas, from the Department of Oceanography at Dalhousie University, discussed some of the research the Marine Environmental Observation Prediction And Response Network (MEOPAR) is doing to better understand ocean acidification.

Thomas concluded that three objectives for next steps for research have emerged from consultations by the Canadian Ocean Acidification Research Partnership (COARP): (1) What is the natural variability of pH, and its controlling factors, and does this variability mask or amplify the long-term secular trend of rising acidity? (2) How representative and relevant are the observations and findings obtained to date by monitoring agencies ((i.e. Fisheries and Oceans Canada) for actual shellfish production and harvesting sites across Canada? (3) What are the biological and economic implications of current and future OA conditions?

Presentation 2: " I-Cap, an Integrated Coastal Acidification Program":
Tony Charles from St. Mary's University presented on the Integrated Coastal Acidification Program, known as I-CAP. The I-CAP project, directed under MEOPAR, integrates new observations with experiments, modelling efforts and socioeconomic and policy analysis. There are four general themes that assist in long-term planning for the impacts of ocean acidification:

- Theme #1, Field observations: what is the spatial and temporal variability of carbonate chemistry in near-coast areas where harvesters are operating?
- Theme #2, Biological Interactions and Impacts: How does this variability affect species important to harvesters and coastal communities?
- Theme #3: Biogeochemical Impacts: What are dominant controls on variability in near coastal regions in Canada?
- Theme #4 Socio-economic Impacts: What are the socio-economic risks to Canadian coastal communities possibly affected by coastal acidification?

I-CAP will assess risks to social/economic well-being of communities and First Nations, work on Canada's Atlantic and Pacific coats, develop an integrative model for social-economic risk, and more!

Presentation 3: "Ocean Acidification and Oyster Aquaculture":
Bill Mook of Mook Sea Farm in Maine gave a presentation about what is actually going on in oyster aquaculture in relation to ocean acidification. Mook stated that it is time to pay attention to bivalve hatcheries and patterns of natural bivalve recruitment. He noted that although it can be hard to look through all of the natural variability inherent in coastal waters, changing climate and ocean chemistry is already affecting aquaculture. Because there are more questions than answers about how and when – rather than if – we will be impacted, marine resource-based industries need to demand action from political leaders immediately.

Hatchery production effects include poor egg conversion and early survival/performance, cessation of larval feeding, poor growth, and protracted larval phase. Mook determined large storm events to be the common denominator. In his experience, he found that when he has controlled carbonate chemistry in his own larval tanks, growth and development were normal. Mook predicts that hatcheries in other areas will start seeing larval production problems, and the window of conditions sufficient for natural bivalve larvae will continue to close. As this happens, recruitment will become less and less predictable. Businesses can't avert crises that they don't know about. Industry needs to demand government investment in monitoring infrastructure, and push for research that helps people in the industry to predict species and ecosystem responses to a changing ocean.

IV. Participants Observations and Concerns about Ocean and Coastal Acidification (Breakout groups)

Meeting participants broke into the same groups as the previous day and discussed the following questions.

What are your unanswered questions about OCA?

Participants noted the following questions and puzzles related to OCA:

- Fisheries and industry:
    - Are any of the changes we are seeing caused by freshwater runoff? What impact do storms and rainfall have on OA?
    - How can we figure out if OA in the wild differs from more controlled/acute changes we have observed with climate change or we see in lab experiments (i.e., mussel farms)?
    - Does OCA have an impact on the natural settlement of spat and are there protocols to figure this out? Is there natural variability (tidal, seasonal, annual) and what are the animal responses to variability? What is the adaptive capacity? What biological responses are associate with the variation of acid inputs, are they the same or different? Is there high variability among different species adaptive capacities?
    - What biological effects and thresholds can be identified?
    - Could calcifying algae be an indicator species?
    - Is phytoremediation a possible solution/mitigation strategy?
    - What are the sediments/water interactions and impacts/effects to fauna/benthic organisms?
    - Can you genetically select for seed with high Ω values?
    - How can you tell what is an impact of OA in a coastal community?
    - Can shellfish growers correlate the larval growth process with storms?
- Messaging and action:
    - How much communication already exists among coastal communities with similar problems who are completing monitoring work? Can we increase conversations along the eastern seaboard and between the East and West Coast within the specific industries?
    - Can we look at different approaches to science since it seems that no one listens/addresses the problems fishermen are seeing? How do we address the limited funding to scientists?
- Research needs and research design:
    - We know what the issues are but we are not sure of the questions, we need more research. The abstract is too hard to comprehend. The lobster and crab industry does not deal with this use right now, but we can see it as being an issue in the future. The finfish industry will not be immune to the effects of OA, especially concerning finfish reproduction.
    - What is the best protocol and equipment to use for monitoring? Is there a standardization of data and information collection so analysis can be done?
    - Can we combine efforts between OTN and needed OA measurements and utilize technology advancements?
    - How will the spatial distribution of Ω change with warming temperatures? Can we model how that will change with water temperature changes? Can we make predictions in the region?

What are you seeing that could be related to OCA?

Participants discussed the following observations:

- Fisheries and industry
    - We are concerned about “dead muds,” there are no more lobsters and crabs where there were 10 years ago (Whitehead).
    - Starting to see problems with larval oyster sets, they used to be consistent and are extremely variable within the province (i.e., one area does really well, but approximately 40 km up/down the coast is doing very poorly). Seems to be linked to rainfall.

    - "Lazy larvae" syndrome – the larvae do well up to a couple weeks, then they stop feeding.
    - In 2012, early molts of lobster were observed with warmer weather.
    - Observed increased variability in mussel/bivalve species recruitment, linked to inter-annual variability in Northeast North America. Can biofouling increases be connected to temperature, CO2, or OCA? We may not have a long enough time scale to answer this question yet. Need long term datasets.
    - Maine is observing issues with clams.
    - Still gaps in research on finfish. Known that finfish will not be immune (i.e., reproduction) and increased calcification. Need to know how to change management.
    - In 2009, larvae troubles were associated with wet winter and spring when the salinities were low.
    - The aquaculture industry reports already documenting OA (ex. Maine). Currently driving over shells. Looking for options in Canada.
    - Observed changes in larvae production after heavy rain events.
    - Prince Edward Island is missing the age class of salmon.
    - Observing shell erosion when transplanting healthy clams to poor growth areas.
- Water Quality
    - Observed that eelgrass beds have a characteristic smell when the grass dies off. The smell is persistent until the eelgrass returns and the smell dissipates.
    - Question: has there been trouble in growing microalgae?
    - Phytoplankton blooms increased when water was locked up in snow and ice
    - Need to better understand the interaction between eutrophication and pH.
    - Need to better understand the interaction between agriculture and increased nitrogen.
    - Island of Cliffside in Germany which is acidic on one side and alkaline on the other – are there differences that connect to acidification?
    - In 2015, the winter was cold with little runoff causing phytoplankton bloom to increase.
    - Multiple stressor modelling and localized calibrator
    - Ocean canyon belts feedback
- Messaging and action
    - Observed that current approaches to science are not working because no one is addressing the problems fishermen are seeing.
    - The province and buyers will give funding, but there is limited access to scientists.
    - Money exists from oil and gas industry, however fishermen's voices (people on the ground) aren't loud enough
    - Need to acknowledge the limitations of DFO with the project (ex. Fisheries Collaborative). Need to connect with Ottawa and MP's because scientists are limited. Provincial biologists need to work closer with industry.
    - Funding is the biggest problem because it is small and competitive. Overlap between freshwater and ocean funding.

<u>What is of most concern to you?</u>

Participants described the following as their most substantial concerns:

- Of most concern to the lobster industry are:
    - Loss of the keystone species
    - Species specific questions – effects on mussel stocks, shrimp, lobster (especially deep-water effects of Gulf of St. Lawrence hotspots); winners and losers among habitat forming species
    - The lack of data about OA in relation to lobsters
- Of most concern to those focused on shellfish aquaculture are:

    - What is the susceptibility of individual species? What is the likelihood of increases in diseases and parasites both in abundance and dispersal?
    - Loss of keystone species and predation on shellfish aquaculture
    - There is a lack of information and standardization of information to assess recruitment. Where are the reductions? Sea star, sand dollars, etc.
- General concerns included:
    - Lack of long term funding to back up longer term commitment to studies
    - Need to make sure equipment is used properly and data is collected consistently
    - Don't yet understand how OCA could be impacting fisheries that are important to us, need more information. Need a more proactive and less reactive approach, and need for adaptation/mitigation strategies.
    - Incorporating politicians into the discussion – need to tie this issue to economic case for aquaculture and bring together stakeholder to have a united/stronger voice to politicians.
    - Need to distinguish between overharvesting impacts and climate change impacts on the fisheries.
    - Need to maintain credibility in terms of how scientific findings are perceived by the public – be careful with how we communicate so we don't create confusion.
    - Need more data on inshore vs. offshore, different model systems (i.e., calcified red algae), and generally how OA is impacting fisheries.
    - Need for coastal monitoring
    - Need to measure ocean pH more readily given our own technological advances in other areas, septic system regulation

V. Current Research Capacity

Presentation 4: "Jointly Mitigating Ocean Acidification, a US Perspective":
Dwight Gledhill from the National Oceanic and Atmospheric Administration (NOAA) gave insight on the US strategy on Ocean Acidification. The coastal system is extremely variable, and answers are still missing. The US started taking interest in ocean acidification in the early 2000s. In 2009, a law was passed called the Federal Ocean Acidification Research and Monitoring Act, which created the NOAA Ocean Acidification Program. Ocean acidification is very carefully defined as, "a decrease in the ocean's pH due primarily to the atmospheric uptake of carbon." Over the years, NOAA has started looking at coastal biogeochemistry dynamics. Agencies such as the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), the United States Geological Survey (USGS), the United States Fish and Wildlife Service (FWS), the Bureau of Ocean Energy Management (BOEM), the Department of Energy (DOE), and the US Navy have teamed with NOAA to create the "Strategic Plan for Federal Research and Monitoring of Ocean Acidification". The plan states that we need to know what the vulnerability of human society is to this change. In order to know this, we need to monitor, assess the sensitivity of the system, and determine the dependency of human society. The plan calls for seven thematic actions: education and outreach, socioeconomics and adaptation, modeling, data management, response research, technology, and monitoring. The agencies work together in their different areas of expertise.

Monitoring is much more than monitoring chemistry. NOAA is currently looking at the nexus of the changing chemical environment, the biological responses to it, and human dependency. NOAA's most significant monitoring effort is in the coral reef environment using fixed autonomous systems, as well as seasonal and tri-annual measurements. The monitoring is holistic, but only gets us so far; we need to know what the species responses are. Phytoplankton species such as *Chlorella autotrophica* and *Thalassiosira rotula* react positively to enhanced CO2 while species such as blue king crab and krill respond negatively. Some species remain

ambiguous, but NOAA is currently examining the effect on species like the mummichog and sea scallop. Fish behaviors are also altered by CO2. Gledhill concluded by stating that in communicating results, it is important to remember that people don't want data: they want insight.

Presentation 5: "Impact of Ocean Acidification on Lobster":
Daniel Small from St. Francis Xavier University offered information on what ocean acidification means for lobsters. The impacts of OA on lobster include smaller lobsters, lower reproductive output, and higher mortality at developmental bottlenecks. The mineral content is changing, as are the carbon-nitrogen ratios (protein content), which may even impact the overall marketability of lobsters. There are numerous transitional stages of lobster that are sensitive to OA: larval stage I exhibits increased mortality, and larval stage IV shows OW sensitivity to resource allocation (mineralization, organic content, growth). Early benthic juveniles are in an energetically limited stage with high energy demands and a limited scope for increasing energy intake, while molting individuals seem to have amplified OA sensitivities leading to higher mortality and decreased growth. Small identified we must continue researching key aspects of lobster biology, communicate our findings, and maintain sustainability, realizing that not every environment is the same.

VI. Participant Recommendations for Focusing Research and Monitoring Effects (Breakout Groups)

Are there other monitoring efforts we should be aware of?
Participants mentioned several monitoring efforts:

- Fishermen networks and Volunteer Networks
- Gulfwatch
- Canada
    - AZMP
    - Baseline monitoring at MPAs, potential MPAs DFO
    - Kamiko Azetsu-Scott at DFO at BIO: monitors several sites including the Gulf Fisheries Center
    - Aquatron at Dalhousie: likely monitoring pH from seawater in the Northwest Arm
    - DFO organized inshore/offshore and is trying to come up with a standard approach
    - DFO mooning buoy, industry, Environment Canada, Fishers & Aquaculture through lease, NGOs
- US
    - NOAA ship, buoy observations, hatchery monitoring, USGS stream monitoring, EPA NGOs
    - Dick Feeney: Expert on OA in the US, has developed a guiding to monitoring OA. He is applying this to the East Coast to tighten efforts, make sure the data is usable, and ensure that findings aren't wasted.
- Offshore monitoring is more prevalent and inshore monitoring is needed.
- The tracking rainfall and juvenile population in lobster (location?)
- Are individual aquaculture farms monitoring?
- pH is not currently measured because it is difficult to do so; calculated pH is easier and quicker. Even if not exact pH is unknown, at least the method is consistent and relative comparisons can be made. It is more reliable to measure alkalinity.
- Includes citizen science
    - NECAN has extensive list of volunteer groups
    - NECAN is developing a monitoring protocol
    - Community Aquatic Monitoring Program – beach seines, eel grass, sediment samples

Where should we focus our research?

Participants made the following suggestions:

- Fisheries and Industry
    - Genomic measurement of shellfish in real time.
    - How OA impacts food web dynamics. Will some species experience negative impacts, while others will experience positive impacts?
    - Temperature-dependent growth rate. What is the impact of OA on the larval state length and does this affect the connectivity of populations? Would there be more mortality with a different larval stage length, and would the stage length then affect dispersal?
    - Link between OA and inter-annual variability for bi-valves and mollusks, the role OA plays in mollusk and bivalve settlement variability
    - Lobster research and egg development: is the quality of the eggs influenced? Is the clutch size influenced by stress? More energy is expended in molt cycles, how does the ion regulation stress effect contribute?
    - Resiliency of population, are some more adaptive than others?
- Water Quality
    - Machine needed to measure CaCO3 saturation (expensive)
    - How biofouling and biocontrol efforts react to OA.
    - What are the interactions with OA and other chemicals? With O2? Examples include juxtaposing, hypoxia, and elevated CO2 interplay (i.e., Saint Lawrence Estuary upper layer depleted? Interactions with other chemicals)
- General
    - "We need a few good samples from characteristic estuaries instead of trying to measure 150+ estuaries, sample sites would be too large. Comes down to salinity/alkalinity relationship."
    - Represent fishermen from each area, must sample in each port and can't play favoritism. Need more funding or independent research in order to complete long term measuring in each area.
    - Temperature loggers are available in many areas, however, collecting data is more difficult for people who don't know how to interpret the data.
    - Nearshore and coastal OA; the intersection of OA and coastal biogeochemistry.
    - What is the effect of multiple variables at once? How do we measure all exacerbating influences?
    - Carbon budgets (regional) and the contribution of different benthic species in processing carbon.
    - Establish a pH baseline of the past.
    - Examine the indirect effects of OA and the possible loss of primary production.
    - Invasive species research (i.e., green crabs and Codium fragilis algae).

Where do we need to focus our efforts?

Participants offered the following suggestions:

- Funding
    - Funding and research is too spread out and only depends on who can get funding
    - We should determine if all grants and funding go to one place, would this make efforts more or less successful?
    - Navigate funding and make it more accessible; recognize the importance of researcher's findings so that they can more readily receive funding
    - Gain government and academic support towards companies
- Research

    - Define threshold of points, tipping point, and socio-economic perspective (vulnerability and adaptive management)
    - Focus on the lobster industry – shifting distributions, shell disease, etc.
    - Look at the connection between OA and economically important marine species
- Monitoring
    - Create a standardization of data in one location; create a standardized/best practices monitoring program
    - Leverage already existing monitoring
    - Focus on increased collaboration to create an infrastructure for monitoring efforts and coordinated research
- General
    - Streamline different research organization and know what committees/companies exist
    - Example scoping exercise, focus on commercialization
    - Pool US efforts with Canadian counterparts
    - Focus on communicating with people who are stakeholders, but may not be aware that they are stakeholders
    - Link GOMC data repository with focal articles on species to NECAN
    - Encourage volunteer organizations to put out settlement plates
    - Think about creating a tax credit for growers and industry
    - Focus on commercialization – example scoping exercise
    - Climate re-analyzer: PhD student worked on a website to compile data into graphical presentations

VII. Communication and Outreach

Group discussion on communications and outreach- led by Esperanza Stancioff

Presented with a list of four questions, participants had a discussion focused on what we should do in the future to better communicate our message. The general outcome of the discussion was that we need more collaboration between organizations and industry. These are the questions we used to focus the conversation along with comments from each.

1. How should we reach out and share what we have learned?
    - Climate Re-analyzer is a product that compiles large amounts of data into graphical representations. NECAN webinars are also available for review.
2. How will you share this information?
    - David G plans to share this information with his students as it will open students' minds up to what's going on in the real world both in communities and at the research level.
    - Peter Sykes has an aquaculture newsletter that goes out to growers and others, and will feed the NECAN updates into that.
    - Helmuth will utilize MEOPAR communication channels.
    - Climate Re-analyzer is a product that compiles large amounts of data into graphical representations. NECAN webinars are also available for review.
3. What is the best way to communicate with stakeholders? What is the best way for scientist and stakeholders to communicate with each other?
    - There was interest in engaging lobstermen in meetings like this. Gretchen will send out a survey to try and figure out the best way to do this. Next year, consider having one day for science and the other day for industry.

- Bill Mook wants to take the information to the fishermen with a program for association meetings (a "traveling show" of sorts). This would require the message to be concise, the data to be in limited or clear graphs, and in bullet point form.
- Hold lobster advisory meetings in each LFA. Send out the meeting to them and they will share it.
- Talk to lobstermen on the dock or at meetings of opportunity.
- FSRS in another group to engage.
- Would a press release get the information to the fishermen?

4. What do you need from NECAN to help you share this information?
    - Cassie offered to add participants to the NECAN listserv which sends out monthly updates. There was also interest in having funding announcements be included in these updates.
    - Gregor said the workshop itself was a success of NECAN's goal to share information as it brought together a variety of people to look at the issue, and should be done again in the future.
    - The last group talked about the overlap of the work NECAN and Gregor are both doing. The two should pool efforts with the literature review. NECAN's website will be a valuable resource for everyone and could be a central repository for other sources of information.
    - GOMC has a data repository and articles on specific species. Can we make this available on NECAN?
    - Need to continue communicating with stakeholders. The monitoring protocol that NECAN is putting together will be useful.

Appendix: Participant List

First Name	Last Name	Affiliation
Andrew	Bagnall	NS Fisheries & Aquaculture
Tammy	Blair	DFO
Saybeeha	Bobat	
Anne	Castonguay	Aquaculture Association of NS
Tony	Charles	Saint Mary's University
Jöel	Chassé	DFO
Kasey	Chinner	
Niko	Clair	
Levi	Cliché	Clean Annapolis River Project
Emily	Cowie	STFX (student)
Sarah	Delorey	GCIFA
Mattisen	Dirubio	
Michelle	Dixon	PEI Agriculture & Fisheries
Angela	Douglas	Southern Gulf of St. Lawrence Coalition on Sustainability
Cecilia	Engler	Dalhousie University
Andrea	Flynn	GAMS
Shana	Fredericks	
David	Garbary	STFX University
Melanie	Giffin	PEI Fishermen's Association
Dwight	Gledhill	NOAA
Lauren	Grant	GAMS
Patterson	Gray-Rochon	
Gretchen	Hull	GAMS
Jonathan	Hull	GAMS
Heather	Julian	
Niklas	Karbowski	
Donald	Killorn	Eastern Charlotte Waterways Inc.
Sandra	Kucharski	
Chelsey	Landry	
Marc	Lanteigne	DFO
Donelda	MacAskill	Donelda's Puffin Boat Tours
Gabrielle Tompkins	MacDonald	
Jordan	MacDougall	Area 19 Crab; Inverness South Fishermen's Association
Kimbra	MacLean	
Robert	Marshall	
Bill	Mook	Mook Sea Farm
Steve	Neil	

Geoff	Nishi	Mabou Oyster Farmer
Brooke	Nodding	Bluenose Coastal Action Foundation
Eugene	O'Leary	GCIFA
Ariana	Orasanin	STFX (student)
Lynn	Patterson	STFX University
Sheldon	Peddle	ACAP Humber Arm
Sarah	Penny	ACAP Cape Breton
Akexa	Reedman	MEOPAR
Gregor	Reid	UNB
Patricia	Rhynold	GCIFA
Lauren	Ruff	STFX (student)
Joe	Salisbury	University of New Hampshire
Daniel	Small	STFX University
Zaria	Sorel	STFX (student)
Ashley	Sprague	NS Fisheries & Aquaculture
Esperenza	Stancioff	NECAN
Chris	Stevenson	
Cassie	Stymiest	NERACOOS/NECAN
Peter	Sykes	Aquaculture Association of NS
Kimberley	Taylor	
Helmuth	Thomas	Dalhousie University
Jared	Tomie	ACAP Cape Breton
Brittany	White	NS Environment
Bill Mook	Whitman	NS Fisheries & Aquaculture
Tyler	Wilson	Dalhousie University
Julie	Zatzman	