Stewarding the North Atlantic

A White Paper of Policy Recommendations based on the Findings of the Future of Oceans Symposium, held at Memorial University, on the 16th of March, 2019.

Sponsored by:
The President's Office, Memorial University
The Royal Society of Canada, College of New Scholars, Scientists, and Artists
The Royal Society of Canada Atlantic
For a New Earth (FANE)

Co-Authored by the Committee on the Future of Oceans

July 30th, 2019

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To: The Honourable Dwight William Ball
Premier, President of the Executive Council, Minister for Intergovernmental and Indigenous Affairs, and Minister responsible for Labrador Affairs
The Honorable Siobhan Coady
Minister of Natural Resources, Government of NL
The Honorable Lisa Dempster
Minister of Municipal Affairs and Environment, Government of NL
The Honourable Gerry Byrne
Minister of Fisheries and Land Resources
The Honorable Christopher Mitchelmore
Minister of Tourism, Culture, Industry and Innovation
The Honorable Catherine McKenna,
Minister of Environment and Climate Change, Government of Canada
The Honourable Jonathan Wilkinson
Minister of Fisheries, Oceans and the Canadian Coast Guard

From: For a New Earth (FANE) and the Committee on the Future of Oceans (see Appendix A for members)

Acknowledgements

The *Future of Oceans* symposium was organised by For a New Earth (FANE) and funded by the College of the Royal Society of Canada, the Royal Society of Canada, Atlantic, Memorial University President's Office, and FANE. This Policy Paper was written by Dr. Sean McGrath, Professor of Philosophy, Memorial and Co-Director of FANE, Dr. Carina Ramm, Biology, Memorial, and Ocean Science Advisor for FANE, Terry Hewlin, M.Phil, Education Advisor for FANE, and Kyla Bruff, PhD Candidate, Memorial, and Co-Director of FANE. The Committee received input and comments from Dr. Brett Favaro, Marine Institute, Memorial, Dr. Scott Neilson, Archaeology, Memorial, Dr. Bill Montevecchi, Biology and Ocean Sciences, Memorial, Dr. Uta Passow, CRC, Ocean Sciences, Memorial, Dr. Maxime Geoffroy, Marine Institute, Memorial, and Brit Kolditz (PhD candidate), Memorial, and intern at FANE. The document draws on keynote presentations and discussions which were part of the *Future of Oceans* symposium, as well as on additional research by the four main authors.

The concomitant ocean-related fine art show which made the symposium more than just an academic event was organised by Esther Squires, Gerald Squires Art Gallery, and displayed art work by Anita Singh, Boyd Chubbs, George Horan, Gerald Squires, Gerald Vaandering, Will Gill and Peter Wilkins. Shawn Bath presented artefacts collected in his harbour clean-ups. Music was provided by Dr. Laura Loewen, Piano, University of Manitoba and Dr. Jane Leibel, Soprano, Memorial.

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Symposium Overview

On the 16th of March 2019, the *Future of Oceans* Symposium assembled forty-three delegates, representing academia, industry, media and concerned citizens, to discuss the future of the western North Atlantic Ocean. The event was organized by local NPO *For a New Earth* (FANE)[1] and sponsored by the Royal Society of Canada Atlantic, the Royal Society of Canada, College of New Scholars, the Ocean Frontier Institute, and Memorial University of Newfoundland and Labrador. The delegation met for eight hours at the Emera Innovation Exchange Convention Centre in St. John's. The proceedings, which were live-streamed and captured in high definition video, can be viewed here: https://youtu.be/rBw7uX3HVq4[2].

The purpose of the symposium was twofold: Identify environmental challenges facing the western North Atlantic and generate policy recommendations in areas such as climate change, ocean acidification and fisheries management. A bracing morning of keynote speeches from ocean researchers and policy makers described, with up-to-date science, the condition of the western North Atlantic with respect to marine ecology, ocean acidity, water oxygenation, oil spillage, water temperature, fisheries management and international governance. In the afternoon, an open discussion was moderated. The event concluded with an exhibit of Newfoundland and Labrador marine art, curated by the Gerald Squires Art Gallery, and a music performance by Dr. Laura Loewen (Piano, University of Manitoba) and Dr. Jane Leibel (Soprano, Memorial University).

As the event progressed, the catastrophe of anthropogenic climate change and its effects on the world's oceans (the western North Atlantic in particular) became the focus of discussion. The assembled group concluded that virtually no dimension of Newfoundland and Labrador culture and society, or the waters and land on which it is based, would remain unaffected by the transformation of the North Atlantic ecosystem.

In the following pages, the Future of Oceans Committee will summarize its findings and propose 12 recommendations intended to inform public policy in Newfoundland and Labrador. Appendix A includes a detailed program of the event, as well as information concerning our sponsors; Appendix B lists participants of the event and their positions in the community (and abroad where applicable).

Climate Change in the North Atlantic

Two weeks before the *Future of Oceans* symposium, the Government of Newfoundland and Labrador released its policy on climate change in The Way Forward: On Climate Change in Newfoundland and Labrador[3]. Although the "action plan" makes climate change a more integral part of public discussion in the province, the document is marred by a glaring inconsistency. The government is aiming—by 2030—to reduce provincial greenhouse gas emissions to 30% below its 2005 emissions level. This is in response to the recommendations of the 2018 COP24 meeting held in Katowice, Poland[4], which called for a global emissions reduction to zero by mid-century to keep temperatures at 1.5ºC above pre-industrial averages. However, the Government of Newfoundland and Labrador has not indicated—in this document or elsewhere—how a 30% reduction by 2030 is compatible with doubling offshore oil production, which the provincial and federal governments announced in the February 2018 Advance 2030: A Plan for Growth in the Newfoundland and Labrador Oil and Gas Industry[5].

Nick Mercer summarized the conundrum in The Independent on the 5th of March, 2019[6]:

> In 2016, the production of 77 million barrels of offshore crude oil was responsible for 1.6MT of GHG emissions. Assuming the province's stated goal of increasing offshore oil production to 237 million barrels annually, we can extrapolate our numbers to suggest emissions from the sector will account for a staggering 4.9MT annually by 2030. The province's new annual emissions target for 2030 is 6.9MT, meaning offshore oil production alone will account for 71 per cent of provincial emissions, assuming targets are met. We cannot have meaningful climate action in Newfoundland and Labrador without curtailing the production of oil and gas.

McGlade and Ekins[7] reported in 2015 that to stay below an increase in global warming by 2ºC, 85% of Canadian oil reserves must stay in the ground due to the highly polluting effects of producing Canadian oil. The dependence of Newfoundland and Labrador, and Canada in general, on fossil fuels is unsustainable in light of the inevitable end of the oil age before the middle of this century. It is also incompatible with the global agenda on climate change[8] required of all governments at this crisis moment, a time which many climatologists regard as the last chance to mitigate anthropogenic climate change.

At the *Future of Oceans* symposium, the link between ocean acidification (due to increased carbon in the atmosphere) and climate change was explained. CO_2 released into the atmosphere is absorbed by the sea, causing increased acidity. Ocean acidification is directly affecting whole marine ecosystems, including those that support fisheries and tourist

activities. Additionally, these alterations will affect the ocean's capacity to sequester and store CO_2, thus changing the global carbon cycle.

Climate change also leads to a reduction in the amount of oxygen[9] the ocean can hold (deoxygenation). During his keynote talk, Dr. Brett Favaro (Memorial University) described how deoxygenation affects marine ecosystems, particularly invertebrates such as crabs and plankton, which make up the basis of marine food webs. In general, climate change causes the "maximum sustainable yield" of fisheries—or the amount of fish that can be caught before it harms the integrity of the stock—to decrease. A 2019 study published in Science[10] examined the impact of warming on 235 fish populations from 1930 to 2010. Temperature-dependent models reveal that the MSY has decreased by 4% on average, with some fisheries losing as much as 35%. Participants at the *Future of Oceans* symposium also learned that large parts of Canada are warming twice as fast as the rest of the planet, and weather patterns in Canada are changing dramatically.

According to the Paris Accord (signed by 175 governments, including Canada, in 2015), members must cut emissions significantly to ensure that the planet does not warm more than 2ºC above pre-industrial averages. However, scientists predict that we will not meet this target at the present rate of CO_2 emission reductions. To limit the increase in average global temperature to 2ºC, the amount of CO_2 in the atmosphere must remain below 450ppm[11] but the current level[12] is already at 414ppm and there is no sign that the rise in atmospheric CO_2[13] concentration is decelerating. If emissions cuts had started in 2000, reductions of 3% per year would have been sufficient to keep the increase in global average temperature below 2ºC. Now cuts in CO2 emissions of more than 10% per year are necessary to achieve the same goal (Figure 1).

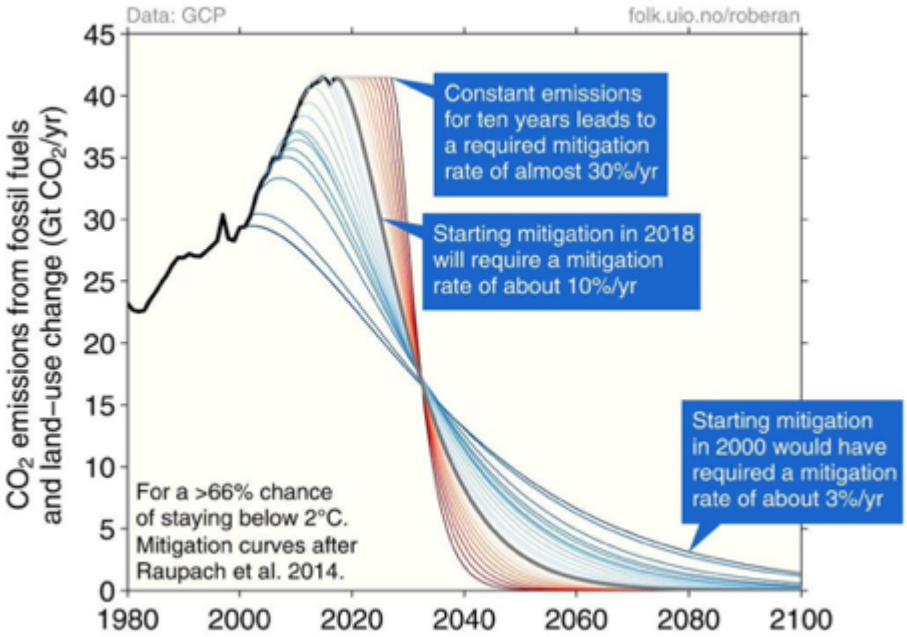

Figure 1: Yearly emission reductions necessary to meet Paris Agreement (Sanderson et al. 2016[14])

Without emission reductions, the global average temperature will rise by 4ºC[15] within this century, a scenario that is likely incompatible with our current standards of living. Water expansion and the melting of arctic glaciers are causing the sea level to rise.[16] The socio-

political effects of climate change are being felt already. Rapidly increasing temperatures, if left unmitigated, will displace billions of humans with unbearable summer heat in the south and disturbances[17] in the production of agriculture and water supply world-wide. Frequent intense storms and flooding, desertified agricultural[18] belts, acidified and deoxygenated oceans[19], billions of climate change refugees[20]—all of this combined with unforeseeable feedback loops will likely have profound impacts on the international political order.

Given the amount of greenhouse gasses from unfettered human growth already in the atmosphere, some of these changes are now inevitable, leading many climatologists to recommend that—in addition to *mitigation*—we must think in terms of *adaptation*. Global warming is not uniform; 2ºC is an average. The *UN Environment Program* reported in a press release on the 13th of March 2019 that, "Even if the world were to cut emissions in line with the existing Paris Agreement commitments," which we are not on track to do, "winter temperatures over the Arctic Ocean[21] would rise 3-5ºC by 2050." By the end of the century temperatures will increase by at least 7ºC in the North[22] (with some estimates ranging as high as 10ºC[23]). This means that Canada, with its vast northern territories, will experience massive environmental alterations due to global warming. Indeed, it already has. The tundra is melting[24] and thawing permafrost[25] will trigger the release of even more greenhouse gases causing additional warming. Species like seals, polar bears and walrus, which rely on ice cover, are being forced to adapt to unprecedented conditions[26] and face decimated numbers in some areas.

All levels of marine life in the North Atlantic, from phytoplankton[27] to the northern cod[28], are currently being impacted by habitat loss and shifts in population distribution (Figure 2).

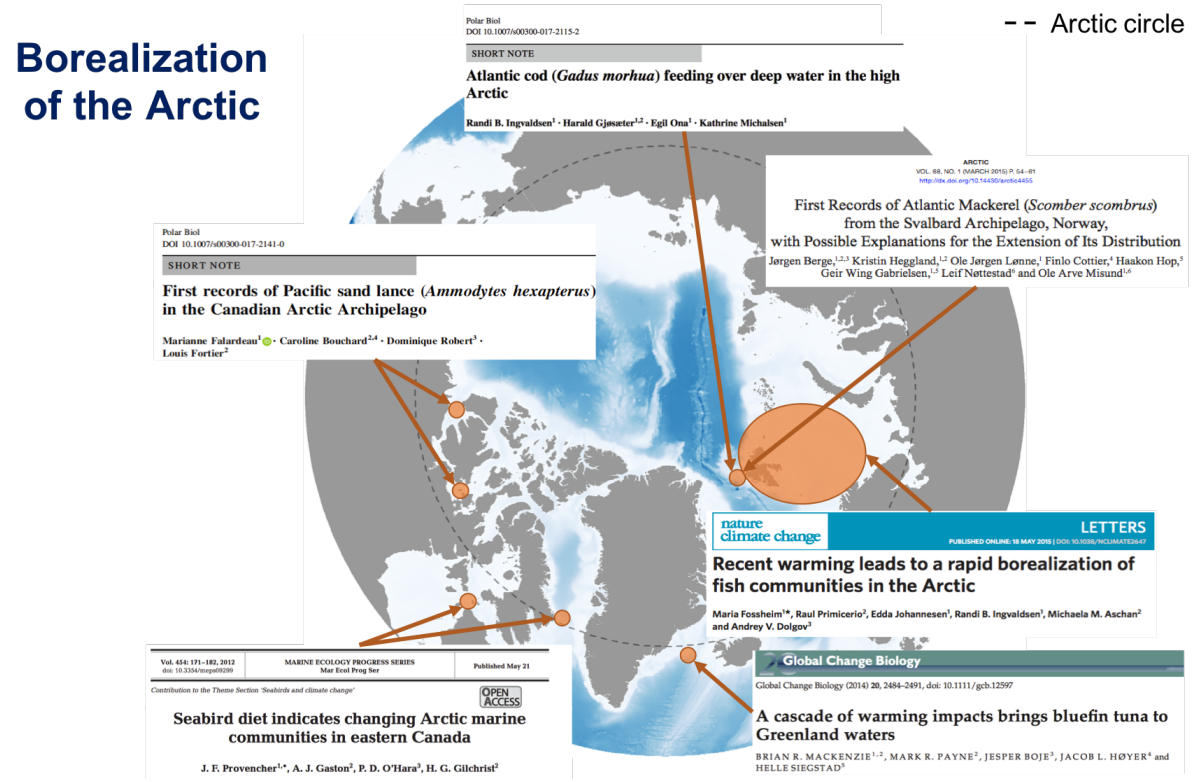

Figure 2: Distributional shifts of temperate species towards arctic waters

This, in turn, impacts Northern communities relying on marine ecosystems. The Northern peoples of Canada, including the Innu and the Inuit[29] of Eastern-Québec and Labrador, are

seeing dramatic changes in their ways of life; more than any demographic group, they are dependent on predictable environmental characteristics and weather patterns. In recent years Arctic peoples are facing unstable land and sea-ice conditions as well as increased economic and food insecurity[30]. "By 2050, four million people, and around 70% of today's Arctic infrastructure, will be threatened by thawing permafrost[31]." Some Northern communities have already declared a "climate change state of emergency[32]."

Yet, as we mobilize mitigation and adaptation actions in resistance to our modern climate crisis, it is important to keep in mind that we are not the first in the history of this land to do so. There is a 9000-year history of human occupation within the present boundaries of Newfoundland and Labrador, and this history is marked by periods of adaptation, transformation and migration, correlating with environmental and climatic changes in the past. The Innu, Inuit and Mi'kmaq are our connections to this past, and if we are to be successful, they must be involved in all discussions and decisions related to mitigation and adaptation in the present and future.

This committee recommends that the effects of climate change, which are empirically demonstrable—not future possibilities but present realities—be brought to the forefront of public debates on oil-production, as well as social and economic development. All parties in this province need to outline their plans for both climate change mitigation and adaptation. There should be more discussion and transparency, accompanied by a detailed roadmap to guide us out of a fossil fuel-based economy. Events such as Decarbonize NL[33], which took place at the Emera Innovation Exchange Convention Centre on July 11 and 12 this year, can help focus our attention on socially and environmentally sustainable alternatives.

In view of these effects of climate change, and discussions that took place at the *Future of Oceans* Symposium, this Committee proposes twelve recommendations to inform public policy in Newfoundland and Labrador.

Policy Recommendations

i) Support ecosystem-based research & fisheries management.

Ecosystem approaches to marine research have been implemented on Canada's West Coast and in many other parts of the world for decades. However, in this province marine studies are generally limited to commercially important species, leading to a very incomplete understanding of the ecology of our waters. A notable exception is Nunatsiavut's Imappivut[34] marine plan. The *Future of Oceans* Committee recommends conducting more research on how climate change affects phyto- and zooplankton and the implications for crustaceans, fish and marine mammals in local waters. Phytoplankton organisms form the base of marine food webs, and as such, play an instrumental role[35] in the health of whole ecosystems, which can be compromised by distributional shifts in response to warming, acidification and deoxygenation. Phytoplankton also annually remove between 30 and 50 billion metric tons of CO_2[36] from the atmosphere. As Dr. Zoe Finkel explained at the *Future of Oceans,* a decrease in phytoplankton productivity due to changing environmental conditions means reduced productivity of our oceans as a whole. She emphasized the need for more research on this phenomenon, particularly in the western North Atlantic, where productivity has been decreasing at all trophic levels over the past few years (Figure 3).

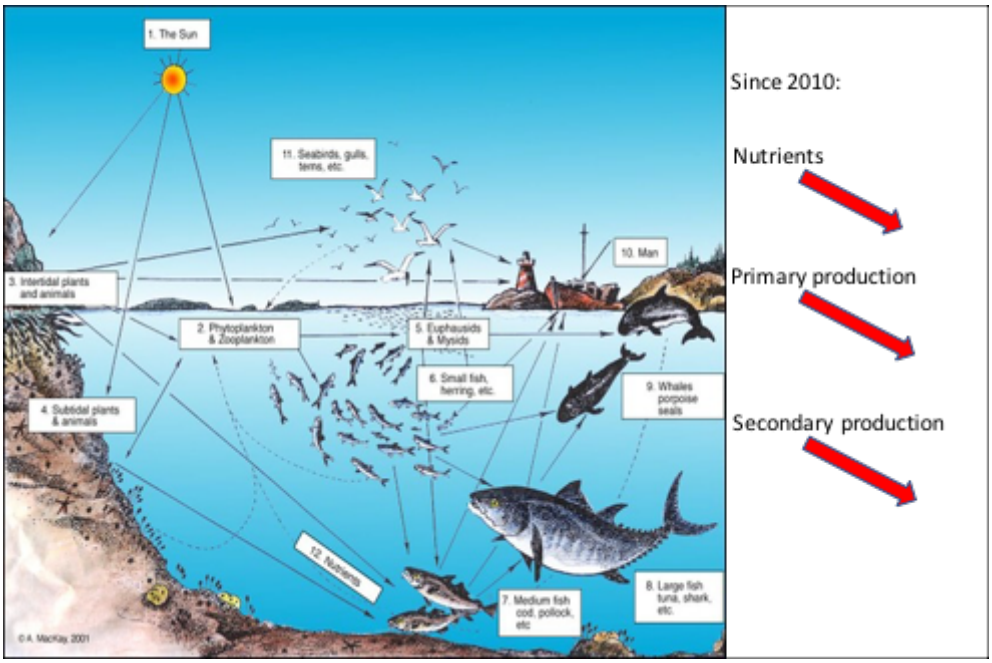

Figure 3: Decrease in productivity of the western North Atlantic since 2010 (Adapted from Art MacKay, 2001)

Strong governance should support the Department of Fisheries and Oceans (DFO) in their effort to include ecosystem-based management in fisheries. This approach accounts for rapid environmental change with cascading effects on all levels of the ecosystem. Changes in water temperature are already driving fish stocks further north, altering the ecosystem in ways we don't understand. These changes should be taken into account when establishing quotas. It should be noted that no amount of fisheries management will offset the effects of climate change in long-term warming scenarios; however, knowledge of the whole ecosystem can prevent sudden surprises and facilitate adaptation. Therefore, Newfoundland and Labrador must take current changes seriously and anticipate the impacts of climate change not only directly on commercially important species but also indirectly through alterations of prey, predator and competitor populations. The Minister of the Environment should be intimately familiar with the content of this year's DFO report[37] on Atlantic ecosystems, released on the 10th of April, 2019.

ii) Replace gillnets with sustainable fishing gear & support bycatch reduction research.

Although banned in many other parts of the world, gillnets are still the most common fishing gear in Newfoundland and Labrador, particularly in the harvesting of salmon and cod. These nets lead to highly unselective catches with large amounts of bycatch species including sharks, seabirds, turtles and marine mammals. The Committee therefore recommends an implementation of bycatch reducing net alterations such as the attachment of warning flags (to deter diving bird species). Ultimately, gillnets should be phased out completely, but an immediate ban should be implemented around seabird ecological reserves. Other fishing techniques are available: hand-line fishing and cod pots that catch fewer, but higher quality products are available. More research addressing the reduction of bycatch should be conducted, including bycatch related to the longline fishery.

iii) Make offshore oil production less hazardous to seabirds.

At the *Future of Oceans* symposium Prof. Bill Montevecchi explained that 3,300,000 Leach's storm petrels vanished from the western North Atlantic ecosystem over the past three decades, corresponding to 40-50% of the population. Since these birds migrate across regions where offshore oil platforms are located, and are attracted to light, the most plausible explanation is that the petrels died in oil production related flaring (Figure 4).

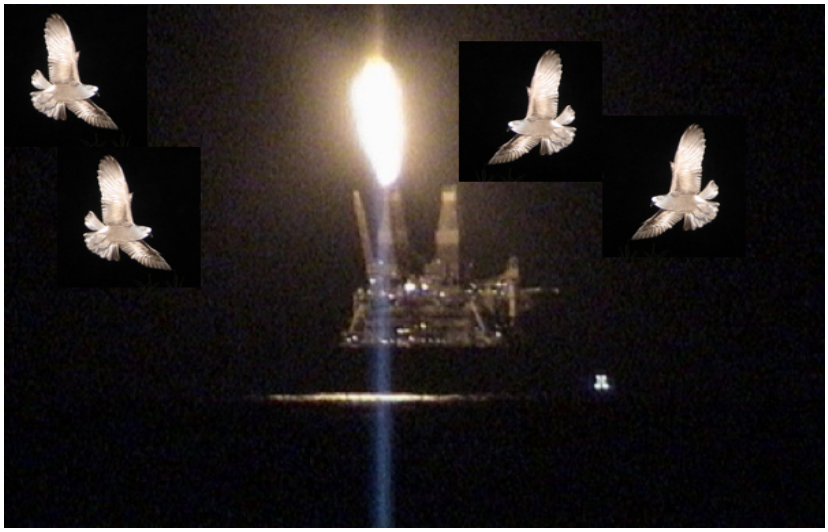

Figure 4: Leach's storm petrel is the most vulnerable bird to flaring and lighting

The Committee therefore suggests placement of independent observers on offshore oil platforms to facilitate seabird monitoring[38] and collection of robust scientific data to improve seabird conservation. Since various seabird species are known to be attracted by light[39], flare shut-downs required for refits and maintenance should be synchronized with the fall migration of seabirds in September/October when their density around offshore platforms is particularly high. Finally, window shades on oil platforms should be closed at night to avoid the attraction of seabirds by reducing light emission close to the water level.

iv) Explore post-oil economic alternatives for the province.

Due to detrimental effects related to climate change and its incompatibility[40] with the *Paris Agreement*, the scientific verdict is clear: most Canadian oil reserves must stay in the ground to keep the increase in global average temperature below 2ºC. The reality of this climate emergency needs to be recognized, taken seriously, and acted upon. By doubling offshore oil production, Newfoundland and Labrador is exempting itself from the changes and limitations that all economies must impose on themselves to meet the greatest challenge of our age. By capitalizing on the good will of other oil producing countries that are curbing production, Newfoundland and Labrador is failing to meet Canada's obligation to the *Paris Agreement*. At the same time, the province is missing an opportunity to diversify its economy and transition to a sustainable post-oil era.

In a press conference in St. John's on May 23, 2019, the Honourable Catherine McKenna, Federal Environment Minister, objected to the use of the terms "ethical oil" and "clean oil[41]," which have been used by some of the province's politicians[42] to refer to locally produced oil and gas. The terms are counterproductive for tackling environmental, political and human rights[43] issues and are misleading in that they elicit the wrong impression that Newfoundland and Labrador oil is free of negative environmental and ethical consequences. Therefore, the committee is in agreement with the objection to these terms.

v) Extend carbon tax to industry & invest in reduction & removal of atmospheric CO_2.
Instead of being exempt from the carbon tax, industry—and particularly high-emission sectors—must pay for the pollution they cause. There is empirical evidence that the carbon tax, even in its initial form, has the potential to be effective in reducing emissions[44] and stimulating alternatives to fossil fuel production without hampering[45] the economy. This concept needs consistent application among polluting parties to become an effective climate change mitigator. The carbon tax in Canada is creating awareness of the reality of climate change and has the potential to stimulate the economy of Newfoundland and Labrador in various ways. By increasing costs of imports, it could precipitate a renewal of the province's agricultural sector and lead to increased food security, even when agriculture is included in the carbon tax.[46] To achieve this, the province needs to focus on climate-resilient and reduced-carbon farming practices and the development of business risk management programs as outlined by Canada's Standing Committee on Agriculture and Agri-food.[47] The carbon tax could also encourage much needed diversification of the provincial economy and stimulate rural development.

Further initiatives that attribute an economic value to CO_2 can lead to its reduction and removal[48] from the atmosphere. These include practices such as agroforestry, carbon-farming, afforestation and the protection of old forests and salt marshes, the latter being very effective carbon sinks. Research and investment should be directed to both sustainable ways of energy production and reductions in energy consumption. Environmental and economic long-term solutions are needed to ensure the welfare of the province beyond the next few years, while taking responsibility for Canada's role in the global climate from the individual to the industrial level.

vi) Establish independent, comprehensive monitoring of the western North Atlantic.
Information collected from an independent provincial monitoring system would support the protection of marine life, particularly as it is affected by ocean warming, acidification, oil spills and acoustic exploration. This information should be intelligible and publicly accessible through a social media and communications department. At the *Future of Oceans* symposium, Dr. Uta Passow's keynote outlined how oil spills and leakage, as well as costly, invasive and incomplete environmental clean-ups affect marine life. These effects of spills[49] on marine ecosystems must be closely watched by independent observers and the resulting information should complement the monitoring systems of Fisheries and Oceans Canada. Reports by the latter are released every four years.[50]

Disaster prevention and reaction plans need to be developed to avoid the consequences of oil spills seen in other parts of the world being repeated in the fragile western North Atlantic cold-water ecosystem. The comprehensive oil spill response plan currently funded by the Canadian Government, which involves collaboration with various scientists at Memorial University, is a step in the right direction and will hopefully prioritize ecosystem health over corporate interests. However, spill prevention and the minimization of constant leakage are at least as important. We cannot afford the consequences of unwise decisions such as the restart of oil production by Husky Energy in November 2018[51] during the world's most intense storm, leading to the largest spill in the province's history. This example shows that stronger and more independent regulations around offshore oil production are needed.

vii) Promote eco-literacy in schools, communities & post-secondary institutions.
It is important that all age groups are aware of the complex connections between our behaviour, history, fishery, oil production and climate change. Statistics show that millennials

are highly engaged[52] with the issue of climate change and are more aware of environmental challenges than previous generations. Consequently, they require a school curriculum that addresses these concerns and better informs them on the politics and science of climate change. This should be accompanied by educational programs that promote outdoor activities in addition to classroom education. A recent article[53] on CBC.ca cites research[54] linking time spent in nature with positive benefits for physical and mental health. Developing eco-literacy in schools and communities involves having educational opportunities to explore natural surroundings in ways that are personal, experiential, intergenerational, interdisciplinary and immersive, combining aspects of science, art, culture and history. Specifically, young learners need the linguistic and technical skills to tackle the complex issue of climate change. This should be central to the school science curriculum, especially considering the rapid changes in the North, and accompanied by a provincially-funded, public awareness campaign about the facts of climate change, its relation to fossil fuel production, and its effects on ecosystems.

In the provincial school system, curriculum guides[55] provide an opportunity to extend the standard subject-oriented approach through Essential Graduated Learnings, which emphasize transdisciplinary areas like citizenship, communication, moral development, problem solving and technological competence. Fostering eco-literacy in schools is an excellent way to develop proficiency in these overarching areas. Additionally, "Education for Sustainable Development" in the English Language Arts curriculum[56] guide (as conceived by UNESCO) stresses the interrelationship of economy, society and environment and the importance of balancing development with ecological and social interests. Enhanced teacher training in areas such as ecology and climate change will allow educators to develop and implement elements of eco-literacy across the curricula. Spearheading these initiative, FANE partnered with St. Bonaventure's College in St. John's in the academic year 2016/2017 to provide a full day of eco-literacy programing and workshops and follow up activities during the year, culminating in an Earth Day celebration.[57]

Currently, there are a number of excellent provincial programs and initiatives that focus on ecology, sustainability and eco-literacy in Newfoundland and Labrador. Memorial's new farm initiative[58] in Goose Bay and the Labrador Institute's Lands and Water Science Camp[59] for Innu and Inuit youth are focused on sustainability, resource management and culture. On the Avalon Peninsula, environmental education programs at the Fluvarium[60] and the Brother Brennan Centre[61] have been in existence for years. Newer programs like the Coastal Explorers Field School[62] (through the Ocean Learning Partnership[63]) and the Canada C3[64] have provided immersive learning in marine settings and focus on linking scientific understanding with traditional knowledge of ecology. In Norris Point, the Bonne Bay Marine Station[65] offers an excellent range of programs for local schools and internships for students in Oceans Sciences. St. Bonaventure's College,[66] with its school garden and greenhouse, has collaborated with the Gathering Place,[67] Lester's Farm,[68] and Food First NL[69] to start the province's first Farm to Cafeteria program, bringing fresh produce into the school lunchroom. Finally, Memorial University's Energy Systems Engineering master's program provides innovative research on increased energy sustainability in the province. The program includes a strong focus on the transition from oil to those carbon-free renewables which are environmentally most suitable for this region. More programs of this type are needed and should be implemented at the BA level as well.

viii) Mobilize communities & support local projects.

Challenges to localized community action must be addressed in ways that are suitable to those particular places and circumstances; meaningful conferences with community members

should be based on an exchange of ideas between communities and authorities. Results should be made public and solutions organized into the categories of short-term, medium term, and long-term, beyond funding and government cycles. Common Front NL has outlined a detailed report[70] describing how this can be realized. For communities to regain trust in government we need to shift focus from the interests of large corporations to an environmentally and socially sustainable, job-rich economy that supports locally owned businesses and initiatives. This committee suggests marketing strategies that galvanize political will and empower communities to protect and value marine ecosystems. Local, tangible actions need to be prioritized and meaningful initiatives such as harbour and beach clean-ups[71] should receive funding to secure their continuation and province-wide expansion.

Communities need concrete, comprehensive action plans to guide policy and individuals toward changes in consumer habits that will make a difference to the environment. An action plan would speak to people about the importance of protecting oceans and the significance of the sea to their well-being. Memorial University should partner with businesses and communities to inform both of those aspects of their local ecosystems that are in danger. This could be achieved through the employment of a team of people trained in both science and community outreach. The public education program,[72] conducted by MUN's Ocean Science Centre and the Marine Institute's Science Communication for Fisheries[73] course (instructed by Brett Favaro), provides a model for development in this field and needs to be developed further.

ix) Strengthen & renew rural communities.

Newfoundland and Labrador's once vibrant rural communities have been systematically neglected[74] in recent years but they could play a crucial role in the province's creative and proactive response to climate change, especially since these areas are disproportionately affected[75] by it. The threatened fishery remains an important industry sector for many rural communities but continued overinvestment in the offshore industry has arguably benefitted St. John's to the detriment of rural communities, many of which are affected by out-migration and poor job prospects for young people. A more aggressive policy of investing in rural towns and communities would diversify their economic opportunities.

The *Future of Oceans* Committee recommends that "climate conscious" rural groups are identified and supported. At the symposium, Dr. Gordon Slade presented a viable model in the form of the New Ocean Ethic[76], which empowers residents of Fogo Island through initiatives such as oil spill response training and citizen science, as well as lucrative, sustainable hand-line fishing and cod potting (Figure 5). Many of these projects are in collaboration with Memorial University. The Government of Newfoundland and Labrador should be familiar with the New Ocean Ethic and support similar initiatives in other communities. The committee also recommends that community consultations be organized in rural areas to educate about the effects of climate change and the corresponding changes in industry.

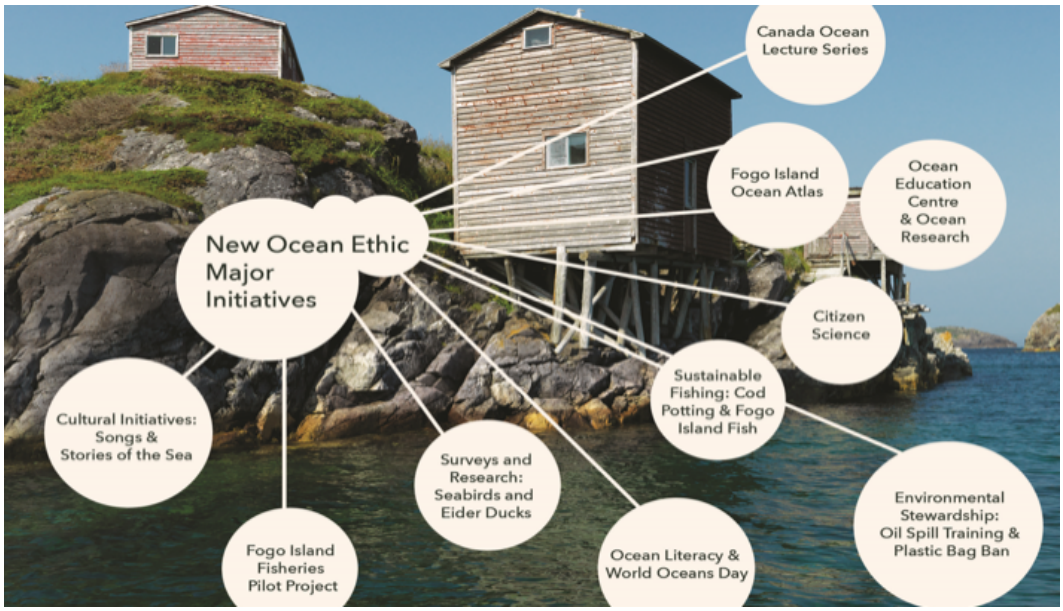

Figure 5: Shorefast's New Ocean Ethic Initiatives

Local knowledge is crucial to dealing with climate-related changes in rural communities. Programs such as Fishing for Success[77] should be implemented and encouraged with particular attention given to the local knowledge and experience of Innu, Inuit and Mi'kmaq communities. Communities like Bauline Line[78] are leading the way in combating the effects of climate change through local ingenuity and initiatives like the Harris Centre Future of Rural NL[79] Public Forum Series help by creating both solutions and awareness.

x) Support sustainable local food sources.

The province imports most of its food[80] and would become food-insecure in a matter of days if there were a disruption in the transportation system. This situation is in contrast to pre-confederate Newfoundland and Labrador, which abounded in locally grown crops and farmed animals, and was in many ways a model of self-sufficiency. Relying on out-of-province food is costly and will become increasingly so due to carbon tax. Resources such as cod need to be processed in the province, thereby creating jobs and reducing the carbon footprint. A renewed local agri- and marine culture will satisfy the increased consumer demand for wild and organic foods free of artificial preservatives and pharmaceuticals.

Food First NL[81] is a non-profit organization that collaborates with a network of 300 other organizations and individuals to improve food security in the province. For example, "Roughly half the population of Pool's Cove have embraced food sustainability[82] and are growing their own vegetables" with the help of Food First NL. Local endeavours of this type will help renew rural communities and support traditional ways of life. Public workshops on how to cook and prepare local foods are encouraged.

Attention and resources need to be specifically directed towards self-reproducing commodities such as fish, berries and seaweed. For example, The Newfoundland Distillery Company uses locally harvested, organic seaweed in its award-winning Seaweed Gin.[83] Other underused, sustainable food sources should be identified and promoted. Local consumption of seafood needs to be diversified to include shellfish and flatfish, which represent the majority of landings of Newfoundland and Labrador fisheries but are mainly exported outside the province. The recently rebuilt fish plant in Ramea diversified its harvest and will soon supply

sea urchins, a highly desirable food in Japan, along with sea cucumber, lobster and whelk.[84] Diversification in response to consumer demand creates new jobs. Government should actively promote and support such enterprises.

xi) Reduce the environmental impact of coastal aquaculture.

Wild salmon[85] of Newfoundland and Labrador are in serious decline. Research has shown that the high numbers of Atlantic salmon that escape from coastal farms each year can have devastating impacts on wild populations through competition, interbreeding and pathogen transmission. Disease outbreaks within and around BC salmon[86] farms, leading to the death of thousands of wild fish, further exemplify the adverse effects of coastal farming, and severe pollution by chemicals used to fight sea lice[87] is threatening Scottish ecosystems. Separating farmed from wild salmon by using streams that are not inhabited by wild populations can reduce these effects. Additionally, alternative technologies such as closed containment or offshore farming should be considered and supported. The ecological impact of the proposed expansion of ocean-based salmon aquaculture should be reviewed through independent environmental assessments to avoid damage to critical habitats and sensitive species. More research is needed to assess the impact of coastal aquaculture on the health of wild streams and to prevent disease and escape. Marking farmed fish to make escaped individuals recognizable would be helpful in this regard.

Avoiding the spread of pathogens is also important to local employment stability. Disease outbreaks[88] have caused mass layoffs[89] among already low-paid salmon farm workers in Newfoundland in the past, often followed by years of unemployment. Following the lead of Norway, the province should adopt a policy that moves all operators towards zero escapes. Obstacles to achieving clear scientific data and communicating that data to the public should be removed, and both government and industry must become more transparent. Wild salmon are not only important components of their ecosystems, but also part of the province's culture. Rural communities have a strong interest in restoring wild populations.[90] Public education and outreach initiatives on the threats to wild fish populations should be conducted throughout Newfoundland and Labrador.

Diversification of farmed seafood species reduces the likelihood of disease outbreaks compared to monocultures. For example, a Newfoundland fisherman who lives on the East Coast of the US has developed highly efficient vertical underwater farming,[91] a technique that facilitates the production of large amounts of seafood in a small area, including seaweeds and shellfish for food, fuel, fertilizer and feed. This approach has the potential to revolutionize aquaculture in a sustainable way. More research is needed in this area.

xii) Reduce wind-blown litter from landfills & plastic pollution by fishing gear & sewage.

Every year, 640,000 tons[92] of abandoned, lost or discarded fishing gear enters Canada's oceans. One million birds and more than 100,000 sea mammals worldwide are injured or die when mistaking plastic for food or becoming entangled. Ghost fishing tackle[93] and microplastics[94] are a major problem, particularly in the western North Atlantic. Plastics originating in Newfoundland and Labrador have appeared in the nests of seabirds on the remote islands of the Skelligs[95]. Plastics are found in the stomachs of invertebrates, fish, turtles, seabirds and mammals[96] where they clog digestive tracts and lead to malnutrition and starvation. They also cause injury and drowning by entanglement and are sucked into the gills of various marine organisms. Larger plastics break down into micro-particles that remain in the sea for centuries. They have been detected in the cells of most marine species across biota

and trophic levels where they cause energy depletion, toxicity and behavioural changes.[97] This includes commercially important species which are later used for human consumption. Hence microplastics end up in human bodies too.

Since the 1960s, the human production of plastics,[98] including packaging and cheap, non-recyclable consumer products, is heavily impacting our oceanic ecosystems and marine organisms in adverse ways. Education programs, such as the one launched by Memorial's Civic Laboratory for Environmental Action Research (CLEAR)[99] need to become province-wide, government sponsored initiatives. Government supported ocean clean-up programs such as Ocean Wise and World Wildlife Fund's Ocean's Great Canadian Shoreline Cleanup program[100], by which more than 1.3 million kilograms of trash have been removed are important, but more initiatives that reduce ocean trash at its source are needed. The plastic bag ban[101] initiated by Municipalities Newfoundland and Labrador is a crucial step towards reducing plastic waste, creating ecological awareness, and guiding the public through simple steps towards increased ecosystem health. The ban is already in place in several communities (including Nain, Goose Bay and Twillingate) and should be implemented[102] in the rest of the province, with plastic bags replaced by recyclable and reusable ones. The elimination of plastic bags needs to be accompanied by initiatives to reduce windblown litter from landfills, such as the installation of appropriate fences that keep waste away from the ocean. The committee further recommends programs that address marine plastic waste from fishing gear and sewage, the two main causes of plastic pollution in the waters of the province.

With these twelve recommendations, the Future of Oceans Committee, summarizing the work of the forty-three academics, scientists, community leaders, artists, and scientists, who gathered at the Signal Hill Campus on the 16th of March (and the countless others whose research and activism this group relied upon), concludes its report to government, industry, and the general public. We finished our meeting on the 16th of March agreeing upon one thing: Newfoundland and Labrador ought to be a leader in stewarding the North Atlantic in the 21st century. This ocean has been vital to our history as a people and an economy; we hope it will be vital for our future as well.

Appendix A: Future of Oceans Committee members

The Future of Oceans Committee was an ad hoc committee comprised of the following volunteers, who, in addition to participating in the meeting on the 16th of March 2019, lent their expertise as co-authors of this white paper.

Sean J McGrath, Professor of Philosophy, Memorial University, Co-Director of For a New Earth
Barry Stephenson, Associate Professor of Religious Studies, Memorial University, Co-Director of For a New Earth
Kyla Bruff, PhD Candidate, Philosophy, Memorial University, Co-Director, For a New Earth
Carina Ramm, PhD (Marine Biology), Ocean Science advisor, For a New Earth
Brit Kolditz, Id-PhD Candidate, intern, For a New Earth
Ian Goudie, Environmental Research Scientist, Ecology Advisor, For a New Earth
Scott Neilsen, Assistant Professor, Department of Archaeology, Labrador Institute, Memorial University
Terry Hewlin, Teacher, NL Eastern School District, Educational Advisor, FANE
Brett Favaro, Research Scientist, Marine Institute, Memorial University
Maxime Geoffroy, Research Scientist, Marine Institute, Memorial University
Uta Passow, Canada Research Chair, Ocean Sciences, Memorial University
Bill Montevecchi, John Lewis Paton, Distinguished Professor of Biology, Psychology and Ocean Sciences, Memorial University
Gabriela Sabau, Professor, Ecological Economics, Memorial University
Jay Foster, Instructor in Philosophy and Interdisciplinary Humanities, Memorial University

Appendix B: The Schedule, Future of Oceans Symposium

Saturday, March 16 at the Signal Hill Campus, Memorial University. Sponsored by the Royal Society of Canada (Atlantic), Memorial University, the Ocean Frontier Institute, and For a New Earth.

9am-12pm
Sean McGrath (Memorial University) - Introductory Remarks
John Michael Lannon (HSSE) - Land acknowledgment

President Gary Kachanoski (Memorial University) - Welcome to Signal Hill Campus

Six Keynotes (20 mins each)
1: Maxime Geoffroy (MI, Memorial University): *The North Atlantic Ecosystem*
2: Uta Passov (CRC, Memorial University): *Marine Waste*
3: Bernie Boudreau (Dal): *Ocean Acidification*
4: Gordon Slade (Shorefast): *Ocean Ethics: The Fogo Process*
5: Áslaug Ásgeirsdóttir (Bates College): *Ocean Governance*
6: Brett Favaro (MI, Memorial University): *Sustainable Fisheries*

12-1pm Lunch and Learn (lunch provided)
12:20-12:40 Zoe Finkel (OFI, DAL);
12:40-1:00 Mary Denniston (Nunatsiavut): Imappivut

1-4:15pm
Concurrent panel discussions and round table workshops with moderators:
Table A: *Restoring and Protecting Ecosystems* led by Bill Montevecchi (Memorial University)
Table B: *Renewing Rural Communities* led by Jane Adey (CBC, the Broadcast)
Table C: *Mobilizing the Community* led by Scott Neilsen (LI, Memorial University)
Table D: *Climate Change & Marine Ecosystems* led by Arnault Le Bris (MI, Memorial University)
Table E: *Sustainable Ocean Economies* led by Jay Foster (MPhil, Memorial University)
Table F: *Aquaculture and Food Security* led by Stephen Sutton (ASF)

Closing discussion moderated by Kyla Bruff followed by Art Exhibit and Performance by Laura Loewen (University of Manitoba) and Jane Leibel (Memorial University)

Appendix C: The Participants

Name	Affiliation/ Title	Details
Marine Science		
Geoffroy, Maxime	Marine Institute: Centre for Fisheries Ecosystems Research (CFER), Memorial University	Research focus: Understanding the ecology of North Atlantic and Arctic pelagic fish in relation to hydrography and climate change Postdoc: Department of Arctic and Marine Biology, Arctic University (UIT), Norway PhD (oceanography) and MSc (biology): Laval University, Québec;
Passow, Uta	Ocean Sciences, Memorial University, Canada Research Chair (Biological Oceanographic Processes)	Research focus: Impact of climate change and pollution on the oceanic biological carbon cycle Postdoc: Marine Science Institute, University of California Santa Barbara, CA PhD and Master: Biological Oceanography, University of Kiel, Germany
Favaro, Brett	Marine Institute, Memorial University, Academic Dir. of Fisheries Science graduate programs	Research focus: Sustainable fishing technology, science-policy interface, arctic ecosystems Postdoc: University of Victoria, BC PhD: Simon Fraser University, Burnaby, BC and Vancouver Island University
Boudreau, Bernie	Dalhousie, Dept. of Oceanography Professor Emeritus	Research focus: Chemical oceanography (Ocean acidification in rel. to climate change, marine geology) PhD: Geology and Geophysics, Yale University M Phil and Masters: Geology & Geophysics, Yale University Masters II: Oceanography, Texas A&M University
Montevecchi, Bill	Dept. of Psychology, Memorial University, Biology: Seabirds; John Lewis Paton Distinguished Professor	Research focus: Interdisciplinary ecosystems in relation to the behavioural ecology of birds, food webs Collaboration with NL fishers to minimize bycatch in fishing gear PhD: Rutgers University, NJ; Masters: Tulane University, New Orleans, LA
Le Bris, Arnault	Marine Institute: CFER, Memorial University	Research focus: Processes that drive the dynamics of marine fish and shellfish populations; effects of climate change on productivity of living marine resources; sustainable fisheries management Postdoc: Gulf of Maine Research Institute, Portland, ME PhD: Fisheries Ecology (Cod), Memorial University
Koen-Alonso, Mariano	DFO: Northwest Atlantic Fisheries Centre, Adjunct Professor at Memorial University	Research focus: Structure, dynamics and drivers of marine ecosystems, from predator-prey interactions to fishing impacts, ecosystem-based fisheries management, bycatch management Postdoc: University of Guelph, ON PhD: Biological Sciences, University of Buenos Aires, Argentina Licentiate in Biological Sciences, University of Patagonia, Puerto Madryn, Argentina
Finkel, Zoe	Dept. of Oceanography, Dalhousie	Research focus: Plankton biogeography and effects of climate change on phytoplankton communities

	Canada Res. Chair in Marine Microbial Macroecology	PhD: Rutgers University, NJ Master: Dalhousie University, NS
Cyr Couturier	Chair of aquaculture programs, Memorial University	Research Scientist, Marine Institute Centre for Aquaculture and Seafood Development Master of Marine Biology, Dalhousie University (1986)
Environmental Engineering and Geology		
Woodworth-Lynas, Chris	PETRA International Ltd. Cupids, CEO	Industry specialist in the process of seafloor ice scour, ice stratigraphy and geomorphological mapping Research focus: Marine geological history Former senior researcher at the Centre for Cold Ocean Resources Engineering (C-CORE)
Ethics/Humanities/Conservation		
Slade, Gordon	Shorefast Foundation (Director)	Independent consultant in heritage, cultural tourism and community development (since 1996) Member of the Order of Canada in recognition for his work in preserving and promoting NL's heritage Honorary Doctor of Laws degree, Memorial University (2014) Former Deputy Minister of Fisheries for NL CEO of One Ocean, Chair & Managing Director of Battle Harbour Historic Trust
Sabau, Gabriela	Grenfell College, Memorial University, Professor for Environmental Studies and Economics	Visiting Professor at University Center of the Westfjords in Iceland (since 2008) Research focus: Fisheries management and economics, sustainable development fueled by scientific knowledge and value judgements, global revival of small-scale fisheries Former Assistant Professor of Economics at the Academy of Economic Studies in Bucharest and a member of a National Research Network for Sustainable Reconstruction of Romania Bachelor + PhD: Academy of Economic Studies, Bucharest, Romania
Connors, Teresa	Memorial University of Newfoundland and Labrador	PhD, The University of Waikato, New Zealand Postdoctoral Research Fellow, International Institute for Critical Studies in Improvisation. MUN
Foster, Jay	Department of Philosophy, Memorial University, Director M Phil (Humanities)	Focus: Philosophy of science, ontology PhD: Science and Technology, University of Toronto
Rendell, Trevor	Parks Canada	Parks Canada Superintendent, Gros Morne National Park
Noseworthy, Ashley	Edgewise Environmental	CEO and founder of Edgewise Environmental, Canada's FIRST environmental consultancy focused on marine mammal observation, seabird observation and acoustic monitoring training

Huntington, Julie	Whale Release and Strandings Group	Co-manager of the non-profit organization *Whale Release and Strandings Group* which frees entangled whales and sea turtles Rescued >150 whales around Newfoundland with husband Wayne Ledwell in past 30 years *Tuck Walters Award*, awarded by Nature Newfoundland and Labrador (2018)
Politics		
Ásgeirsdóttir, Aslaug	University Centre of the Westfjords, Iceland; Professor, Bates College, Maine Dean of Faculty's Office	Focus: Settlement of maritime boundaries after 1960, international cooperation, ocean governance Previous focus: Cooperation around N-Atlantic shared fish stocks Author of: 'Who Gets What? - Domestic Influences on International Negotiations Allocating Shared Resources', SUNY Press (2008) PhD: Political Science, Washington University, St. Louis, MO; Bachelor: Journalism, University of Missouri, Columbia, MO
Denniston, Mary	AvatiKutiujop Paigijaunnisanganik Kaujisatti, Nain	Environmental Protection Analyst, Nunatsiavut Government Inuk from Nain, Nunatsiavut Focus: management of the development of Imappivut, Nunatsiavut's Marine Plan BA: Environmental Studies, Memorial University (2018)
Puddister, Jessica	Environmental Science Industry	Municipal Climate Change Advisor with the Conservation Corps of NL, carries out vulnerability assessments with partner towns and cities to help them build resilience Has worked as an environmental and geotechnical consultant and educator, and in the environmental not-for-profit sector Advocate of minimalist, back-to-basics, self-sustainable lifestyle, esp. of tiny houses in an effort to reduce carbon footprints B.Sc.: Earth Science, Dalhousie University
Communities		
Bath, Shawn	Diver, Founder of *Clean Harbours Initiative*	Commercial diver with 21 years of experience in the waters of Newfoundland. Seeing the deplorable state of local marine habitats, Mr. Bath was impelled to start *Clean Harbours Initiative* to remove waste from municipal waters.
Aylward, Chris	Faculty of Communication and Design, Ryerson University Assistant Professor	Experience as a filmmaker as writer, producer, director, editor, cameraman in drama and documentary PhD: Memorial University; M.F.A.: Film and Video Production, York Univ; M.A.: English Literature, Univ. of Toronto
Neilsen, Scott	Department of Archaeology, Labrador Institute, Memorial University, Assistant Professor	Research focus: Long-term history of indigenous people in eastern Quebec and Labrador, and their relations with one-another, settlers, visitors, government and the environment; impact of climate, environment and policy on culture, history and development of small-scale societies world-wide PhD + Master: Archaeology, Memorial University

Sutton, Stephen	Atlantic Salmon Federation	Coordinator of Community Outreach and Engagement Develops programs which encourage people to become more involved in salmon conservation Associate Prof. in Environmental Studies and Fisheries, James Cook University, Australia, for 12 years PhD: Wildlife and Fisheries, Texas A&M University; Master: Biology, Memorial University; background in social science Local salmon fishing enthusiast from Mount Pearl
Clarke, Lori	Artist, performer, counselor, psychotherapist	Focus: Embodied responses to loss in relation to ecological change; ways to increase individual and community resilience; somatic approaches to post-traumatic stress Professional Member of the Canadian Counselling and Psychotherapy Association Interdisciplinary PhD, Memorial University; MA: Somatic Psychology, California Institute of Integral Studies
Tee, Mary	Congregation of the Sisters of Mercy of Newfoundland	Founder and Director of Mercy Centre for Ecology and Justice Member of the Executive Committee for the Canadian Catholic Organization for Development & Peace Member of the Sub-Committee on Cosmology and Eco justice of the Sisters of Mercy International
Nichols, Mark	St. Mark's Anglican Church, St. John's, NL	Father Mark Nichols was ordained in the Anglican Church of Canada in June 2005 and has served as a parish priest in southeast Labrador and Conception Bay South. He currently serves as associate priest in the Parish of St. Mark the Evangelist in St. John's. Driven by a firm conviction that creation care is essential to the Christian faith, he has been very active in trying to mobilize the Anglican community to care for the environment in tangible ways.
Doney, Ethan	Food First NL	Everybody Eats Project Manager Master of Geography, Memorial University
Education		
Button, Clarence	Teacher (Science/ Robotics) O'Donel High, Mount Pearl	Science teacher and Robotics specialist at O'Donel High School in Mount Pearl. Regional Coordinator and Team Mentor at Marine Technical Society, Marine Advanced Technology Education (MATE) Centre.
Vaandering, Gerald	Artist, Pouch Cove, NL	Focus: Dependency of the nature of culture on the economy that supports it Works with images and ideas that explore what seems to be at the heart and soul of what drives culture Honours B.A.: Visual Arts, University of Western Ontario
Journalists		
Brown, Drew	Editor, The Independent	Editor, Freelance Writer PhD: Political Theory, University of Alberta (ABD) MA: Political Science, Memorial University
Adey, Jane	Journalist,	With CBC since 2001 working in every nook and cranny in Newfoundland and Labrador

	Host, The Broadcast since 2005	Reporter of news for radio and television, contributions to CBC's documentary program: 'Land & Sea' Studied Journalism at Ryerson University, Toronto
FANE		
Bruff, Kyla	Philosophy, politics Co-Director, FANE	PhD Candidate in Philosophy, Memorial University, focusing on politics in classical German philosophy MA through Erasmus Mundus Program: University of Toulouse II, University of Wuppertal, University of Bonn Managing Editor, Kabiri
Hewlin, Terry	Teacher, NL English School District	Teaching focus: English Language Arts and Social Studies Clean St. John's member (Co-founder of the SUPER Speak-off). *For a New Earth* member and co-organizer of *The Future of Nature: Gros Morne* (2015) Former Youth Worker (Waypoints) and frequent participant in community clean-ups. B.A., B. Ed, M. Phil. (Humanities), Memorial University
McGrath, Sean	Professor, Philosophy Faculty of Humanities and Social Sciences, Memorial University	Research areas: Religion and ecology Most recent book is *Thinking Nature* (2019) Founder and co-director of *For a New Earth* M.A. (Theology), M.A. (Philosophy), PhD (Philosophy), PhD (Theology) Univ. of Toronto
Stephenson, Barry	Associate Professor, Religious Studies, Faculty of Humanities and Social Sciences, Memorial University	Research focus: Study of ritual, religion and the arts, and religion in modernity. Published numerous articles and books including *Ritual: A Very Short Introduction.* Co-Director of *For a New Earth* Ph.D. in Religious Studies, University of Calgary
Lannon, J.M.	HSSE Consultancy	Precedents in public, private policies, procedures and legislation at Prov., National and United Nations
Ramm, Carina	Biology, Humanities	Marine biologist, humanities grad student PhD: Marine Biology, University of Kiel, Germany & Memorial University Master: Biology, University of Kiel, Germany
Kolditz, Brit	Philosophy, Aesthetics	Interdisciplinary-PhD Candidate, combining ecology and philosophy; Memorial University Master: Humanities, University of Leipzig, Germany
Students		
Michael Chislett	O'Donel High, Mount Pearl	
Erin Parsons	O'Donel High, Mount Pearl	
Iratxe Bieita Fernandez	O'Donel High, Mount Pearl	

Chunhao Han	Holy Heart High School, St. John's	
Ranjeevan Ilango	Holy Heart High School, St. John's	

Appendix D: References

#	Reference	Link
1	For a New Earth website.	http://foranewearth.org/
2	Future of Oceans (2019): A Symposium on Stewarding the North Atlantic. Memorial University of Newfoundland, 16 March 2019, St. John's, NL.	https://youtu.be/rBw7uX3HVq4
3	Letto, G. (2019): The Way Forward: On Climate Change in Newfoundland and Labrador. Municipal Affairs and Environment, Climate Change Branch, Climate Change Action Plan, 1 March 2019, St. John's, Provincial Government NL.	https://www.exec.gov.nl.ca/exec/occ/publications/The_Way_Forward_Climate_Change.pdf
4	Carbon Brief (2018): COP24 - Key outcomes agreed at the UN climate talks in Katowice. 16 December 2018.	https://www.carbonbrief.org/cop24-key-outcomes-agreed-at-the-un-climate-talks-in-katowice
5	Ball, D.; Coady, S. (2018): Advance 2030 - A Plan for Growth in the Newfoundland and Labrador Oil and Gas Industry. Executive Council Natural Resources, February 2018, Provincial Government NL.	https://www.nr.gov.nl.ca/nr/advance30/pdf/Oil_Gas_Sector_FINAL_online.pdf
6	Mercer, N. (2019): Newfoundland and Labrador's "Climate Action Plan" is All Bark and No Bite. The Independent, 5 March 2019.	http://theindependent.ca/2019/03/05/newfoundland-and-labradors-climate-action-plan-is-all-bark-and-no-bite/
7	McGlade, C.; Ekins, P. (2015): The Geographical Distribution of Fossil Fuels unused when limiting Global Warming to 2ºC. Nature, 517: 187-190.	http://www.martinbreum.dk/wp-content/uploads/2015/01/McGlade-Ekins-2014-The-geographical-distribution-of-fossil-fuels-unused-when-limiting-global-warming-to-2-°C.pdf
8	Rockström, J.; Gaffney, O.; Rogelj, J.; Meinshausen, M.; Nakicenovic, N.; Schellnhuber, H.J. (2017): A Roadmap for Rapid Decarbonization. Science, 355: 1269-1271.	http://www.rescuethatfrog.com/wp-content/uploads/2017/03/Rockstrom-et-al-2017.pdf
9	Keeling, R.F.; Körtzinger A.; Gruber, N. (2010): Ocean Deoxygenation in a Warming world. Annual Review of Marine Science, 2(1): 199-229.	https://www.researchgate.net/publication/49667843_Ocean_Deoxygenation_in_a_Warming_World
10	Free1, C.M.; Thorson, J.T.; Pinsky, M.L.; Oken, K.L.; Wiedenmann, J.; Jensen, O.P. (2019): Impacts of Historical Warming on Marine Fisheries Production. Science, 363: 979-983.	https://science.sciencemag.org/content/363/6430/979
11	IPCC (2014): Climate Change Synthesis Report. Summary for Policymakers. Intergovernmental Panel on Climate Change. Fifth Assessment Report, AR5.	https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

12	McGrath, M. (2019): Climate change: Global impacts 'accelerating' - WMO. BBC News, 28 March 2019.	https://www.bbc.com/news/science-environment-47723577
13	Kemp, J. (2019): Column: Climate change targets are slipping out of reach. Reuters, 17 April 2019.	https://uk.reuters.com/article/uk-energy-climatechange-kemp/column-climate-change-targets-are-slipping-out-of-reach-idUKKCN1RT0P0
14	Sanderson, B.M.; O'Neill, B.C.; Tebaldi, C. (2016): What would it take to achieve the Paris temperature targets? Geophysical Research Letters, 43(13): 7133-7142.	https://www.osti.gov/servlets/purl/1438457
15	Immink, R. (2019): A dark perspective on climate change. Irish Tech News, 14 April 2019.	https://irishtechnews.ie/a-dark-perspective-on-climate-change/
16	Strong, W. (2019): Future Arctic won't look like the Arctic we know now, says report. CBC News, 8 April 2019.	https://www.cbc.ca/news/canada/north/arctic-changing-face-report-1.5088244
17	Kang, S; Eltahir, E.A.B. (2018): North China Plain threatened by deadly heatwaves due to climate change and irrigation. Nature Communications, 9: 2894.	https://www.nature.com/articles/s41467-018-05252-y
18	Zeng, N.; Yoon, Y. (2009): Expansion of the world's deserts due to global warming and vegetation-albedo feedback. Geophysical Research Letters, 36: L17401.	https://pdfs.semanticscholar.org/cd0b/bdde0083f357685ae4cc5cf0e77976d6886e.pdf
19	Hönisch, B.; *et al.* (2012): The geological record of ocean acidification. Science, 335: 1058-1063.	https://www.academia.edu/2754843/The_geological_record_of_ocean_acidification
20	Geisler, C.; Currens, B. (2017): Impediments to inland resettlement under conditions of accelerated sea level rise. Land Use Policy, 66: 322-330.	http://isiarticles.com/bundles/Article/pre/pdf/95420.pdf
21	UNEP (2019): Temperature rise is 'locked-in' for the coming decades in the Arctic. United Nations Environment Programme, Press Release, 13 March 2019.	https://www.unenvironment.org/news-and-stories/press-release/temperature-rise-locked-coming-decades-arctic
22	IPCC (2018): Global warming of 1.5ºC. Intergovernmental Panel on Climate Change, Special Report, Summary for policymakers, Switzerland.	https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf
23	Epstein, K. (2019): The Doomsday Vault's home is already altered by climate change: A report says it could get worse. The Washington Post, 27 March 2019.	https://www.washingtonpost.com/climate-environment/2019/03/27/doomsday-vaults-home-is-already-altered-by-climate-change-report-says-it-could-get-worse
24	Byers, A. (2019): How permafrost scientists discovered Yukon summers are hottest in nearly 14,000 years. CBC News, 15 April 2019.	https://www.cbc.ca/news/canada/north/yukon-climate-change-warming-permafrost-1.5097458
25	Banks, K. (2018): The big thaw. Canadian Geographic, 21 February 2018.	https://www.canadiangeographic.ca/article/big-thaw
26	Becker, R.A. (2015): 4 Ways polar bears are dealing with climate change. National Geographic, 4 September 2015.	https://news.nationalgeographic.com/2015/09/150904-polar-bears-dolphins-seals-climate-change/
27	Barton, A.D.; Irwin, A.J.; Finkel, Z.V.; Stock, C.A. (2016): Anthropogenic climate change drives shift and shuffle in North Atlantic phytoplankton communities.	https://www.pnas.org/content/pnas/113/11/2964.full.pdf

	PNAS, 113(11): 2964-2969.	
28	Dahlke, F.T.; Butzin, M.; Nahrgang, J.; Puvanendran, V.; Mortensen, A.; Pörtner, H.-O.; Storch, D. (2018): Northern cod species face spawning habitat losses if global warming exceeds 1.5°C. Science Advances, 4: eaas8821.	https://advances.sciencemag.org/content/advances/4/11/eaas8821.full.pdf
29	Mercer, G. (2018): 'Sea, ice, snow ... it's all changing': Inuit struggle with warming world. The Guardian, 30 May 2018.	https://www.theguardian.com/world/2018/may/30/canada-inuits-climate-change-impact-global-warming-melting-ice
30	Hassol, S.J. (2004): Impacts of a warming Arctic. Arctic Climate Impact Assessment, Cambridge University Press, Cambridge, UK.	https://www.amap.no/documents/download/1058/inline
31	UNEP (2019): Temperature rise is 'locked-in' for the coming decades in the Arctic. United Nations Environment Programme, Press Release, 13 March 2019.	https://www.unenvironment.org/news-and-stories/press-release/temperature-rise-locked-coming-decades-arctic
32	Avery, H. (2019): Old Crow to declare climate change state of emergency. CBC News, 11 April 2019.	https://www.cbc.ca/news/canada/north/old-crow-climate-emergency-1.5093166
33	Favaro, B. (2019): Decarbonize NL: Envisioning a carbon-free economy in Newfoundland and Labrador. Memorial University, Conference, 11-12 July 2019, St. John's, NL.	http://decarbonizenl.ca/
34	Nunatsiavut's Imappivut Marine Plan website	https://imappivut.com/about/
35	Richardson, A.J.; Schoeman, D.S. (2004): Climate impact on plankton ecosystems in the Northeast Atlantic. Science, 305: 1609-1612.	https://www.researchgate.net/profile/Anthony_Richardson/publication/259259936_Climate_impact_on_plankton_ecosystems_in_the_Northeast_Atlantic_Science/links/53f7a34c0cf24ddba7d9f072/Climate-impact-on-plankton-ecosystems-in-the-Northeast-Atlantic-Science.pdf
36	Falkowski, P.G. (1994): The role of phytoplankton photosynthesis in global biogeochemical cycles. Photosynthesis Research, 39: 235-258.	https://www.academia.edu/12496615/The_role_of_phytoplankton_photosynthesis_in_global_biogeochemical_cycles
37	Bernier, R.Y.; Jamieson, R.E.; Moore, A.M. (2018): Canada's oceans now: Atlantic ecosystems, 2018. Fisheries and Oceans Canada, Tech. Rep. Fish. Aquat. Sci.: 3167.	http://dfo-mpo.gc.ca/oceans/publications/soto-rceo/2018/atlantic-ecosystems-ecosystemes-atlantiques/index-eng.html
38	Montevecchi, W.A.; Wiese, F.K.; Davoren, G.; Diamond, A.W.; Huettmann, F.; Linke, J. (1999): Seabird attraction to offshore platforms and seabird monitoring from offshore support vessels and other ships literature review and monitoring designs. Environmental Studies Research Funds Report, 138, Calgary, AB.	http://publications.gc.ca/collections/collection_2016/one-neb/NE22-4-138-eng.pdf
39	Ronconi, R.A.; Allard, K.A.; Taylor, P.D. (2015): Bird interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques. Journal of Environmental Management, 147: 34e45.	https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=2ahUKEwjSxbqdr-biAhXPtVkKHZFCBFAQFjAEegQIBhAC&url=https%3A%2F%2Fwww.researchgate.net%2Fprofile%2FArvind_Singh56%2Fpost%2FDoes_anyone_know_studies_on_birds_associated_to_Oil_and_Gas_rigs_in_the_West_Pacific_region_or_South_China_Sea_in_particular%2Fattachment%2F5ace35afb53d2f63c3c53987%2FAS%253A614265010520073%25401523463599131%2Fdownload%2FBird_interactions_with_offshore_oil_and_gas_platfo.pdf&usg

		=AOvVaw2oJsBNdFVfU8T-a6THY2UR
40	Rockström, J.; Gaffney, O.; Rogelj, J.; Meinshausen, M.; Nakicenovic, N.; Schellnhuber, H.J. (2017): A roadmap for rapid decarbonization. Science, 355: 1269-1271.	http://www.rescuethatfrog.com/wp-content/uploads/2017/03/Rockstrom-et-al-2017.pdf
41	Maher, D. (2019): Canada must act now on climate change, Environment Minister Catherine McKenna says. The Western Star, 24 May 2019.	https://www.thewesternstar.com/news/local/canada-must-act-now-on-climate-change-environment-minister-catherine-mckenna-says-315637/
42	Roberts, T. (2019): Ches Crosbie threatens legal action to protect NL's 'ethical' oil industry. CBC News, 23 April 2019.	https://www.cbc.ca/news/canada/newfoundland-labrador/crosbie-oil-ethical-1.5107256
43	Hall Findlay, M. (2012): Please stop calling it 'ethical oil'. The Globe and Mail, 20 April 2012.	https://www.theglobeandmail.com/news/politics/please-stop-calling-it-ethical-oil/article4101409/
44	McCarthy, S. (2018): 'Carbon pricing works,' Canadian economists say as national debate heats up. The Globe and Mail, 4 April 2018.	https://www.theglobeandmail.com/business/article-carbon-pricing-works-canadian-economists-say-as-national-debate/
45	Nuccitelli, D. (2018): Comprehensive study: carbon taxes won't hamper the economy. The Guardian, 16 July 2018.	https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/jul/16/comprehensive-study-carbon-taxes-wont-hamper-the-economy
46	Rivers, N.; Schaufele, B. (2014): The effect of carbon taxes on agricultural trade. Canadian Journal of Agricultural Economics, 00: 1-23.	https://www.ivey.uwo.ca/cmsmedia/1361386/effect-of-carbon-taxes-on-agricultural-trade.pdf
47	Finnigan, P. (2018): Toward a resilient Canadian agriculture and agri-food system: Adapting to climate change. Proceedings of the House of Commons, 11th Report of the Standing Committee on Agriculture and Agri-Food.	https://www.ourcommons.ca/Content/Committee/421/AGRI/Reports/RP9814809/agrirp11/agrirp11-e.pdf
48	Johnson, S. (2019): Canadian company to build plant that will remove CO2 from atmosphere - convert it to fuel. Big Think, 22 March 2019.	https://bigthink.com/surprising-science/negative-emissions
49	Love, M. (2019): Interview: Dr. Bill Montevecchi on Oil and Dispersant Effects on Birds Wintering in the Gulf of Mexico. Ocean Conservancy.	https://oceanconservancy.org/blog/2014/01/09/interview-dr-bill-montevecchi-on-oil-and-dispersant-effects-on-birds-wintering-in-the-gulf-of-mexico/
50	DFO (2019): State of the Atlantic Ocean report shows the effects of climate change on marine ecosystems. Fisheries and Oceans Canada, Press Release, 10 April 2019, Ottawa, ON.	https://www.canada.ca/en/fisheries-oceans/news/2019/04/state-of-the-atlantic-ocean-report-shows-the-effects-of-climate-change-on-marine-ecosystems.html
51	McKenzie-Sutter, H. (2018): Largest oil spill in N.L. history impossible to clean up: regulatory board. The Candian Press, 20 November 2018.	https://www.ctvnews.ca/canada/largest-oil-spill-in-n-l-history-impossible-to-clean-up-regulatory-board-1.4185086
52	Anonymous (2019): Millennial socialism. The Economist, 14 February 2019.	https://www.economist.com/leaders/2019/02/14/millennial-socialism
53	Cuttler, M. (2019): Nature offers serious benefits to our physical and mental health, research suggests. CBC News,	https://www.cbc.ca/news/health/nature-health-1.5128482

	10 May 2019.	
54	Kuo, M.; Barnes, M.; Jordan, C. (2019): Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. Frontiers in Psychology, 10: 305.	https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00305/full
55	Government of NL Curriculum Guides; Education and Early Childhood Development, P.O. Box 8700, St. John's, NL A1B 4J6	https://www.gov.nl.ca/eecd/k12/curriculum/guides/
56	Government of NL, English Language Arts Curriculum Guide	https://www.gov.nl.ca/eecd/files/k12_curriculum_guides_english_eng_grade9_ela9_curr_guide2017.pdf
57	St. Bonaventure's College (2016): Eco-Literacy at St. Bon's. St. Bonaventure's College News Archives.	https://www.stbons.ca/2016/12/21/eco-literacy-at-st-bons/
58	Sorensen, D. (2019): Farming the North: Memorial to establish centre for northern food research. Gazette, Memorial University, 27 June 2019.	https://gazette.mun.ca/campus-and-community/farming-the-north/
59	Memorial University website: Labrador Institute: Labrador Lands and Waters Science Camp	https://www.mun.ca/labradorinstitute/about/locations/nwr/engagement_outreach/LLAWSC/
60	The Fluvarium. 5 Nagle's Place, St. John's, NL A1B 2Z2.	http://fluvarium.ca
61	Environmental Education Commission: Brother Brennan Centre. Tower Rd. Division 1, NL A0B 1G0; PO Box 2265, St. John's, NL A1C 6E6	http://www.brotherbrennancentre.ca
62	Coastal Explorers Field School. Oceans Learning Partnership Inc.	http://coastalexplorers.ca/our-story/
63	Government NL (2018): Connecting coastal classrooms to ocean science technology. Press release, 12 January 2018.	https://www.releases.gov.nl.ca/releases/2018/aesl/0112n01.aspx
64	Canada C3 (2016): A concept for the science program. Coast to Coast to Coast.	http://www.bamfieldmsc.com/wp-content/uploads/2017/01/C3ScienceProgramConceptDec19th-1.pdf
65	Bonne Bay Marine Station, Memorial University of Newfoundland and Labrador, Norris Point	http://www.bonnebay.ca/Pages/default.aspx
66	St. Bonaventure's College. 2A Bonaventure Ave, St. John's, NL A1C 6B3	https://www.stbons.ca
67	The Gathering Place, 172 Military Road PO Box 1761, St. John's, NL A1C 5P5	https://kindnesswanted.ca
68	Lester's Farm Market. 173 Brookfield Rd., St. John's, NL.	http://www.lestersfarmmarket.com/index.php
69	Food First NL: 44 Torbay Rd., Suite 302, St. John's, NL, A1A 2G4	http://www.foodfirstnl.ca
70	Common Front NL (2016): A better future: Building a jobs-rich, fair, and sustainable economy for Newfoundland and Labrador. Final Report.	https://www.wearenl.ca/wp-content/uploads/2016/12/A-Better-Future-full-report-final-Dec-6-v3-2016.pdf

71	Adey, J. (2018): Harbour hero: Twillingate scuba diver determined to rid ocean of garbage. CBC News, 10 October 2018.	https://www.cbc.ca/news/canada/newfoundland-labrador/twillingate-ocean-garbage-1.4855237
72	OSC Public Education Program. Ocean Science, Memorial University.	https://www.mun.ca/osc/oscedu/
73	Favaro, B. (2018): FISH 6000: Science Communication for Fisheries. Memorial University, Course syllabus.	https://mifisheriesscience.github.io/assets/images/FISH_6000_Syllabus.pdf
74	Fitzgerald, R. (2005): Challenges facing rural communities: A Newfoundland and Labrador perspective. Canadian Parliamentary Review, Autumn: 9-12.	http://www.revparl.ca/28/3/28n3_05e_Fitzgerald.pdf
75	Badjeck, M.-C.; Allison, E.H.; Halls, A.S.; Dulvy, N.K. (2010): Impacts of climate variability and change on fishery-based livelihoods. Marine Policy, 34(3): 375-383.	https://www.academia.edu/14097231/Impacts_of_climate_variability_and_change_on_fishery-based_livelihoods
76	Shorefast (2016): New Ocean Ethic. Shorefast & WWF.	https://shorefast.org/perch/resources/shorefast-2018-new-ocean-ethic-booklet-1.pdf
77	Island Rooms of Petty Harbour (2013): Fishing for Success.	https://www.islandrooms.org/
78	Anonymous (2004): Officer charged in weapons offence. CBC News, 15 July 2004.	https://www.cbc.ca/news/canada/newfoundland-labrador/bauline-green-energy-1.514069
79	Future of Rural NL (2019): Public Forum Series, The Harris Centre, Memorial University of Newfoundland.	https://www.mun.ca/harriscentre/whatwedo/publicpolicy/ruralnl.php
80	Kelland, A. (2019): With closest grocery store 55 km away, this community is embracing food sustainability. CBC News, 21 May 2019.	https://www.cbc.ca/news/canada/newfoundland-labrador/pools-cove-food-sustainability-1.5127439
81	Food First NL: 44 Torbay Rd., Suite 302, St. John's, NL, A1A 2G4	http://www.foodfirstnl.ca
82	Cooke, R. (2019): What's stopping the people who want to help food security? CBC News, 13 February 2019.	https://www.cbc.ca/news/canada/newfoundland-labrador/farm-food-security-nl-sarah-pritchett-amanda-cull-1.5016669
83	Seaweed Gin. The Newfoundland Distillery, 97 Conception Bay Highway, Clarke's Beach, NL.	https://thenewfoundlanddistillery.com/pages/our-spirits
84	Roy, R. (2018): Labrador Gem Seafoods moves to add four new species to Ramea seafood processing plant. The Telegram, 3 December 2018.	https://www.thetelegram.com/news/regional/labrador-gem-seafoods-moves-to-add-four-new-species-to-ramea-seafood-processing-plant-264805/
85	Government of Canada: *Salmo salar*, species profile. Atlantic salmon South Newfoundland population.	https://wildlife-species.canada.ca/species-risk-registry/species/speciesDetails_e.cfm?sid=1127
86	Morton, A.; Roscovich, T. (2013): Salmon Confidential. BC Salmon Farm Documentary.	https://www.youtube.com/watch?v=fTCQ2IA_Zss
87	Vidal, J. (2017): Salmon farming in crisis: 'We are seeing a chemical arms race in the seas'. The Guardian, 1 April 2017.	https://www.theguardian.com/environment/2017/apr/01/is-farming-salmon-bad-for-the-environment

88	Anonymous (2013): N.L. salmon farm quarantined. CBC News, 3 June 2013.	https://www.cbc.ca/news/canada/newfoundland-labrador/n-l-salmon-farm-quarantined-1.1307283
89	Anonymous (2018): Massive Placentia Bay aquaculture project released from environmental assessment - again. CBC News, 6 September 2018.	https://www.cbc.ca/news/canada/newfoundland-labrador/placentia-bay-project-released-again-1.4812791
90	Gardner Pinfold Consultants Inc. (2016): An international regulatory review to support consistent and improved management of the impacts of sea cage salmon aquaculture. Report submitted to Atlantic Salmon Federation.	https://www.asf.ca/assets/files/02-13ReportASFAquaReview.pdf
91	Smith, B. (2016): Ocean farmers are using technology to start an economic revolution and save humanity. Quartz, 7 April 2016.	https://qz.com/656096/ocean-farmers-are-using-technology-to-start-an-economic-revolution-and-save-humanity/
92	Trudeau, J.P.J. (2019): Canada to ban harmful single-use plastics and hold companies responsible for plastic waste. Prime Minister Press Release, 10 June 2019.	https://pm.gc.ca/eng/news/2019/06/10/canada-ban-harmful-single-use-plastics-and-hold-companies-responsible-plastic-waste
93	Ghost Fishing Foundation. Dutch North Sea, The Netherlands.	https://www.ghostfishing.org/
94	NOAA: What are microplastics? National Oceanic and Atmospheric Administration, National Ocean Service, US.	https://oceanservice.noaa.gov/facts/microplastics.html
95	Hilliard, M. (2018): 'Little Skellig looks like a rubbish tip due to plastic pollution'. The Irish Times, 8 June 2018.	https://www.irishtimes.com/news/environment/little-skellig-looks-like-a-rubbish-tip-due-to-plastic-pollution-1.3523185
96	Derraik, J.G.B. (2002): The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin, 44: 842-852.	https://www.academia.edu/9857868/The_pollution_of_the_marine_environment_by_plastic_debris_a_review
97	Galloway, T.S.; Cole, M.; Lewis, C. (2017): Interactions of microplastics throughout the marine ecosystem. Nature Ecology and Evolution, 1(5): 116.	https://ore.exeter.ac.uk/repository/bitstream/handle/10871/34727/Interactions%20of%20microplastic%20debris%20throughout%20the%20marine%20ecosystem%20final%20tracked.pdf?sequence=5&isAllowed=y
98	Ocean Conservancy (2019): Fighting for trash free seas. 1300 19th Street, NW, Washington, DC 20036, US.	https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/
99	CLEAR: Civic Laboratory for Environmental Action Research.	https://civiclaboratory.nl/
100	The Great Canadian Shoreline Cleanup website	https://www.shorelinecleanup.ca
101	Municipalities of Newfoundland and Labrador (2019): Plastic bag ban.	https://municipalnl.ca/engagement/plastic-bag-ban/
102	Anonymous (2019): Sure, N.L. is going to ban plastic bags, but how, and when? CBC News, 11 April 2019.	https://www.cbc.ca/news/canada/newfoundland-labrador/plastic-ban-next-steps-1.5090281