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**“OUR ANCESTORS ARE IN OUR LAND,
WATER, AND AIR”: A TWO-EYED SEEING
APPROACH TO RESEARCHING
ENVIRONMENTAL HEALTH CONCERNS WITH
PICTOU LANDING FIRST NATION**

**FINAL REPORT
2010–2016**



**PICTOU LANDING NATIVE WOMEN'S GROUP
AND
H. CASTLEDEN, D. LEWIS, R. JAMIESON, M. GIBSON,
D. RAINHAM, R. RUSSELL, D. MARTIN, AND C. HART**

“Our Ancestors Are in Our Land, Water, and Air”: A Two-Eyed Seeing Approach to Researching Environmental Health Concerns with Pictou Landing First Nation

Final Report

2010–2016

Prepared for:
Pictou Landing First Nation

How to cite this report: Pictou Landing Native Women’s Group (c/o Sheila Francis, Past President), Castleden, H., Lewis, D., Jamieson, R., Gibson, M., Rainham, D., Russell, R., Martin, D., & Hart, C. (2016). “Our Ancestors Are in Our Land, Water, and Air”: A Two-Eyed Seeing Approach to Researching Environmental Health Concerns with Pictou Landing First Nation – Final Report.

Every care has been exercised in carrying out the research and every precaution taken to ensure that the content in this report is accurate and current, but we acknowledge that errors can occur.

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Executive Summary

A'se'k, “the other room,” is the tidal estuary commonly known today as Boat Harbour, adjacent to Pictou Landing First Nation on the Northumberland Strait of Nova Scotia, Canada. Historically, A'se'k was a gathering place that exemplified the Mi'kmaw ethic of sharing: food, knowledge, and skills were exchanged there between generations and amongst family groups. These uses of the land and its recreational, physical, mental, spiritual, cultural, and emotional purposes have been compromised since a pulp and paper mill was built in 1965 and began operating in 1967.

Almost 50 years later, the effects of the pollution on the surrounding land, air, soils, and water are not fully known and understood. Out of concern for their children, families, and community, the women of the Pictou Landing Native Women's Group (PLNWX) mobilized around the issue of Boat Harbour in 2010, inviting academic members to join them in exploring their question, “Is Boat Harbour making us sick?” It is due to their initial collective and continual organizing that the research this report describes was carried out.

This multi-year community-based participatory project, co-led by Past PLNWX President Sheila Francis and Dr. Heather Castleden (formerly with Dalhousie University, now at Queen's University), employed a Two-Eyed Seeing approach. Dr. Debbie Martin, with her expertise in this approach of bringing Indigenous and Western knowledge systems (ways of seeing the world and ways of doing research) together, was consulted in the development of our research design and continually throughout the project.

Four Research Retreats and five Community Dinners provided opportunities to share and discuss community-relevant concerns of environment and health in a multi-generational and female-centred forum. This, in turn, helped establish, revisit, reconfirm, and revise goals and priorities throughout the research partnership between and within the academic members of the team and the PLNWX. Monthly one-page updates were sent to Pictou Landing First Nation, c/o Chief Andrea Paul.

The Two-Eyed Seeing approach resulted in the use of diverse methods, including documenting oral histories; conducting a comprehensive literature review; establishing a web-based community map; carrying out a Youth Camp; creating digital stories; conducting a community-wide Environmental Health Survey, deploying an array of environmental monitoring techniques including water, air, soil, and sediment sampling and analysis as well as mammal analysis and dendrochronology; and sharing our new knowledge across multiple platforms. The varied methods allowed for a broad assessment of health concerns; they intersect and overlap to inform a wholistic understanding of individual and collective health in Pictou Landing First Nation.

Oral histories, collected in large part by Ms. Ella Bennett, illustrated intergenerational impacts as Elders expressed their concerns over the decline of their community's engagement with the land and waterways that they have witnessed since the start of the pulp and paper mill's operations and use of the Boat Harbour Effluent Treatment Facility. Our literature review, conducted in large part by Ms. Ziyun Wang, found that, unsurprisingly, the limited research to date has focused on physical health impacts and concerns. The review also identified three gaps in the literature: (1) legislation in Nova Scotia has never (and does not) require human health risk assessments; (2) regulations left a gap of more than 20 years when the mill operated without effluent control; and (3) little research has been conducted on the topic of tidal flush.

The Environmental Health Survey, led by Ms. Diana Lewis, assessed community-wide environmental and human health concerns, perceptions, and experiences. The face-to-face survey, conducted by members of the PLNWG, reflected questions that the PLNWG wanted information on and received an exceptional 60% response rate. Findings are highlighted here; a detailed Community Report of the survey results is forthcoming. While it is clear that Pictou Landing First Nation members have been experiencing poorer health outcomes compared to other First Nations people living on reserve both provincially and nationally, they have not been the beneficiaries of the socioeconomic benefits that typically come with, and are often touted as the impetus for, regional industrial development.

Dr. Mark Gibson led air quality sampling in summer 2013 and spring and summer 2014 using passive and real-time samplers across 13 sites. Ammonia, nitrogen dioxide, sulfur dioxide, volatile organic compounds, particulate matter, and dioxins and furans were monitored and all of the air quality data were found to be below the Canadian Council of Ministers of the Environment's (CCME) limits. That said, Dr. Gibson noted that there were certainly challenges to monitoring air quality, including equipment malfunction and the unknown impact on the data of the mill's closure during summer 2014 after the effluent spill.

Dr. Rob Jamieson led water sampling, testing for total suspended solids, conductivity, *E. coli*, nitrogen, phosphorus, a range of metals, biological oxygen demand, dissolved oxygen, pH levels, and dioxins and furans across eight sites. In general, samples from within Boat Harbour were above the limits specified by the Canadian Water Quality Guidelines for the Protection of Aquatic Life. Samples from surrounding sites mostly met guidelines, with the exception of some heavy metals: silver, zinc, iron, and lead.

Dr. Jamieson also led the soil quality analysis. Soil was first sampled at 14 sites and was analyzed for various metals as well as dioxins and furans. Follow-up sampling occurred to confirm the first round's findings and drew from six sites. The soil results indicated

that contaminant concentrations in these samples generally met Canadian guidelines for protection of human and environmental health, and that the samples between Pictou Landing First Nation and the town of Pictou were of similar quality.

Dr. Ron Russell led the ecotoxicology and sediment analysis to determine aquatic toxicity and what chemicals were present in the samples. The sediment analysis revealed the presence of dioxins and furans well above the CCME limits for environmental quality (human health guidelines don't exist). The chemicals, however, are mainly present in the sediment, and contact with Boat Harbour sediments should be avoided. Dr. Russell's determination of aquatic toxicity found that Boat Harbour is unable to support aquatic life due to hyper-eutrophication (causing low oxygen), high water temperature, decreased sunlight penetration, and toxic chemical inputs.

Dr. Russell's mammal analysis found that detectable but low concentrations of dioxins and dioxin-like compounds were found in beaver and muskrat tissues. Liver exhibited consistently higher concentrations than muscle since metabolic detoxification pathways are predominantly found in the liver. Toxicity of dioxins in mammal tissue was approximately the same as plankton and significantly lower than that calculated for sediment. Beaver and muskrat are not part of the commercial food industry; however, the low concentrations of dioxins detected in both muscle and liver of these mammals still exceeded European Union guidelines for commercial meat, indicating local wild meats should not be consumed.

Dr. Russell also conducted an analysis of the June 2014 effluent spill near Boat Harbour. He found that most metals in samples from the effluent exceeded guidelines for the protection of aquatic life, with copper and lead as the worst cases (exceeding the guidelines by greater than 10 times).

Mr. Geoff Kershaw undertook basic dendrochronology, the analysis of tree rings, to determine whether there were impacts to tree growth in the area. Twenty trees were sampled from an old-age white spruce stand near Boat Harbour and, for comparison, 18 trees were sampled from a control site. While the analysis showed statistical differences suggesting unique growth-influencing factors at each site, it is unclear whether these differences are associated with pulp mill activity.

Three key legacies of the project are detailed in this report. First, Dr. Daniel Rainham carried out an interactive community mapping activity for the project, bringing together sites of data collection and stories associated with the data. In doing so, he has created a legacy map that can be explored online to visualize land use in terms of traditional and recreational use over time as well as places relevant to the project (e.g., air sampling sites, soil sampling sites, tree sampling sites, places where community members used to go for traditional medicines and traditional foods).

Second, a capacity-building legacy of the project has been the training and certification of water monitors in Pictou Landing. Ms. Kim Strickland, Ms. Colleen Denny, and Ms. Lucie Francis are trained to use the equipment associated with Wet-Pro, a community-based water monitoring kit received from CURA H₂O.

Third, and also related to capacity-building, a Youth Camp took place over two weeks in 2015. Ms. Cecilia Jennings and Ms. Kim Strickland brought five Mi'kmaq youth from Pictou Landing together to learn about the PLNWG's research project and to share their perspectives concerning Boat Harbour in the form of digital stories.

This report is one knowledge-sharing product of many from our work together; more are described herein. The Research Team is proud of this community-owned research.

Foreword by Sheila Francis, Past President Pictou Landing Native Women's Group

Here it is: Our final report after 6+ years of research, meetings, presentations and laughs!

I must say, this has been a long and emotional journey, not just for me but especially for the women of the community. At the same time, it has been one of empowerment and voice. Many women in our community have shown themselves to be leaders through this project. They have given themselves that opportunity to express their concerns, their fears, and their hopes.

I would like to thank the University members of our Research Team who helped us with the scientific part of this project. Your expertise enabled us to understand the technical aspects and you put it in a language we could understand. But most of all, you brought your humanness. You cried with us. You gave us a safe and compassionate space. You heard us.

I would like to thank Heather Castleden, our Lead Academic Researcher. Right from the start, you were our partner. You did not come in and assert your credentials or your experience. You did not minimize our lack of expertise as scientists. What you brought was what we had never received before – compassion, safety, someone who listened to our concerns and who really cared. I think that was the most important thing we needed to move this project forward so successfully. From the bottom of my heart Heather, I thank you.

To the ladies who played a role in this project:

Whatever conclusions you have taken from this research study, I hope one of them is the fact that you were a part of this study. You led this study. You controlled this study. You are the authors of this study. I hope you will continue to demand and express your concern for your and your family's health, and the health of our community. I hope you will continue to use your voice. I want to thank you for allowing me to represent you. I had to step out of my own comfort zone many times to tell your story, our story, but I would do it again for you. I really love that we worked together, we spent time together, we began to create an understanding for and about each other. I hope we will continue to work as a team. I really appreciate you giving me the chance to move this forward.

All my best!

Sheila Francis

Acknowledgements

Our team wishes to offer its sincerest thanks to everyone from Pictou Landing First Nation for supporting this community-based research project that was led by the Pictou Landing Native Women's Group with Sheila Francis (Past President) serving as the Community Research Lead and Heather Castleden serving as the University Research Lead, joined by Diana Lewis (Dalhousie University), Daniel Rainham (Dalhousie University), Debbie Martin (Dalhousie University), Mark Gibson (Dalhousie University), Rob Jamieson (Dalhousie University), and Ron Russell (Saint Mary's University).

Our deepest and warmest heartfelt thanks to the Elders of the Pictou Landing Native Women's Group for their guidance throughout the project, and to the Community Research Associates from Pictou Landing without whom this work would not have been possible: Kim Strickland and Colleen Denny, and the surveyors who conducted the Environmental Health Survey: Colleen Denny, Kim Strickland, Pam Denny, Haley Bernard, Jordan Francis, Sheila Francis, Fran Nicholas, April Nicholas, Darlene Bachiri, Holly Francis, Heather Mills, Sylvia Francis, and Loretta Sylliboy. Special thanks to Haley Bernard and Lucie Francis for their internship work on the project, Durney Nicholas for trapping mammals for analysis, and Dakota Francis for his work with the Boat Harbour Youth Camp.

Thank you to each student whose graduate work has fulfilled pieces of this project: Diana "Dee" Lewis (PhD, Environmental Health Survey), Ella Bennett (MES, Oral Histories), Ziyun Wang (MREM, Health Canada Literature Review), and Jane McCurdy (MREM, Community Map). Thanks also to the many university-based Research Assistants involved in this project, including Chris Garda, Cecilia Jennings, Codey Bennett, Geoff Kershaw, James Kuchta, Jenny Hayward, Justine Lywood, and Rick Scott, for their integral roles in data collection and beyond. We are also grateful for Emily Skinner and Catherine Hart, who served as consecutive Project Coordinators. Thanks also to the CURA H2O team, namely, Oliver Wood and Sarah Weston, for supporting the WetPro component of this project. And finally, enormous thanks to Martha Stiegman, Catherine Martin, and Frank Clifford for documenting moments of this project on film throughout its duration.

Funding for this research was provided by a Canadian Institutes of Health Research Operating Grant (# 119395), a Nova Scotia Health Research Foundation Development Initiative Grant and the in-kind contributions of the Health, Environments, and Communities Research Lab (Castleden), the Centre for Water Resources Studies (Jamieson), the Atmospheric Forensics Research Group, (Gibson), the Spatial Intelligence for Health Knowledge Lab (Rainham) and the Biology Laboratory (Russell). In-kind contributions were also provided by the Pictou Landing Native Women's Group.

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Durney Nicholas, Trapper, Ecotoxicology Analysis

Picture Unavailable

Holly Francis, Research Assistant, Environmental Health Survey

Contents

List of Tables	xvii
List of Figures	xviii
1. Introduction	1
<i>A Brief History of the Pulp and Paper Mill at Abercrombie Point</i>	3
<i>Pulp and Paper Mill and Government Interactions with Pictou Landing</i>	
<i>First Nation</i>	4
<i>Developing a Community-Academic Research Partnership</i>	5
2. Research Retreats	9
<i>First Research Retreat (2011)</i>	9
<i>Second Research Retreat (2012)</i>	11
<i>Third Research Retreat (2014)</i>	13
<i>Fourth Research Retreat (2015)</i>	15
3. Oral Histories	18
4. Literature Review	21
5. Environmental Health Survey	23
<i>Summary</i>	35
6. Air Quality	36
<i>Passive Sampling</i>	37
<i>Real-time Sampling</i>	37
<i>Results</i>	38
7. Water Quality	47
<i>Results</i>	50
8. Soil Quality	51
<i>Results</i>	51
9. Ecotoxicology and Sediment Analysis	54
<i>Guidelines</i>	55
<i>Results</i>	56
<i>Recommendations</i>	65
10. Tree Core Sampling	66
<i>Results</i>	67

11. Analysis of the June 2014 Spill	69
12. Community Mapping	72
13. Wet-Pro Water Monitoring	75
14. Boat Harbour Youth Camp, July 2015	77
<i>Camp Structure</i>	78
<i>Sharing the Stories</i>	79
15. Knowledge-sharing Activities and Capacity-building	81
<i>Event Participation and Conference Presentations</i>	81
<i>Peer-reviewed Academic Articles</i>	83
<i>Community Dinners</i>	83
<i>Awards</i>	85
<i>Media Communications</i>	85
<i>Training</i>	86
<i>Theses, Reports, and Booklets</i>	87
16. Concluding Comments	90
17. References	91

List of Tables

- Table 1. Pulp and Paper Mill and Government Interactions with Pictou Landing First Nation (Adapted from Hoffman et al., 2015)
- Table 2. Environmental Health Survey – Demographics
- Table 3. Environmental Health Survey – Employment and Income
- Table 4. Ammonia (NH₃) Concentration Results
- Table 5. Sulfur Dioxide (SO₂) Concentration Results
- Table 6. Nitrogen Dioxide (NO₂) Concentration Results
- Table 7. Particulate Matter (PM) Concentration Results
- Table 8. Summary of AERMOD PM_{2.5} Surface Concentrations Attributable to Emissions from the Northern Pulp Mill
- Table 9. Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg wet weight) in Boat Harbour Plankton
- Table 10. Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg wet weight) in Beaver and Muskrat Muscle and Liver
- Table 11. Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg lipid weight) in Beaver and Muskrat Muscle and Liver

List of Figures

- Figure 1. Timeline of our early research partnership.
- Figure 2. Two-Eyed Seeing illustration.
- Figure 3. Environmental Health Survey – Self-reported health status.
- Figure 4. Environmental Health Survey – Asthma.
- Figure 5. Environmental Health Survey – Mould or mildew in the home.
- Figure 6. Environmental Health Survey – Safety of drinking water.
- Figure 7. Environmental Health Survey – Mental health.
- Figure 8. Environmental Health Survey – Traditional practices.
- Figure 9. Environmental Health Survey – Racism.
- Figure 10. Environmental Health Survey – How do you feel about the air around you?
- Figure 11. Environmental Health Survey – How do you feel about the land around you?
- Figure 12. Environmental Health Survey – How do you feel about your drinking water?
- Figure 13. Environmental Health Survey – How do you feel about the odours and smells around you?
- Figure 14. Environmental Health Survey – How do you feel about the mist that settles over the community?
- Figure 15. Environmental Health Survey – How do you feel about the game/fish/shellfish in and around the community?
- Figure 16. Environmental Health Survey – How do you feel about the impacts of industrial pollution on Pictou Landing First Nation?
- Figure 17. Environmental Health Survey – I feel Boat Harbour is making us sick.
- Figure 18. Environmental Health Survey – I am always worried about the effects of Boat Harbour.
- Figure 19. Environmental Health Survey – I miss what Boat Harbour used to be.
- Figure 20. Environmental Health Survey – Impacts of perceived risk make me feel depressed.
- Figure 21. Environmental Health Survey – I worry about the risks of Boat Harbour and pollution on the health of my community.
- Figure 22. Map of passive and active air monitoring sites used during the air quality monitoring.
- Figure 23. Deployment of passive samplers: Ogawa and thermal desorption tube.
- Figure 24. Spatial map of the average ammonia concentrations observed June 27, 2013 to July 31, 2014.
- Figure 25. Spatial map of the average surface sulfur dioxide concentrations observed June 27, 2013 to July 31, 2014.
- Figure 26. Spatial map of the average surface nitrogen dioxide concentration observed from June 27, 2013 to July 31, 2014.
- Figure 27. Comparison of volatile organic compounds (VOCs) measured at Pictou Landing First Nation with samples collected in Halifax.
- Figure 28. Water sampling sites.

Figure 29. Plan view map of the 2014 and 2015 soil sampling locations in Pictou Landing First Nation and the town of Pictou.

Figure 30. Acute toxicity of Boat Harbour water to adult and young-of-year mummichogs.

Figure 31. Acute toxicity of Boat Harbour water to wood frog tadpoles.

Figure 32. Acute toxicity of Boat Harbour water to stage 25 and stage 30 green frog tadpoles.

Figure 33. Acute toxicity of Boat Harbour water to bullfrog tadpoles.

Figure 34. Tree sampling sites (Boat Harbour and Caribou Control).

Figure 35. Collection site for two of the effluent samples.

Figure 36. Assortment of basemaps to display as a background for the data.

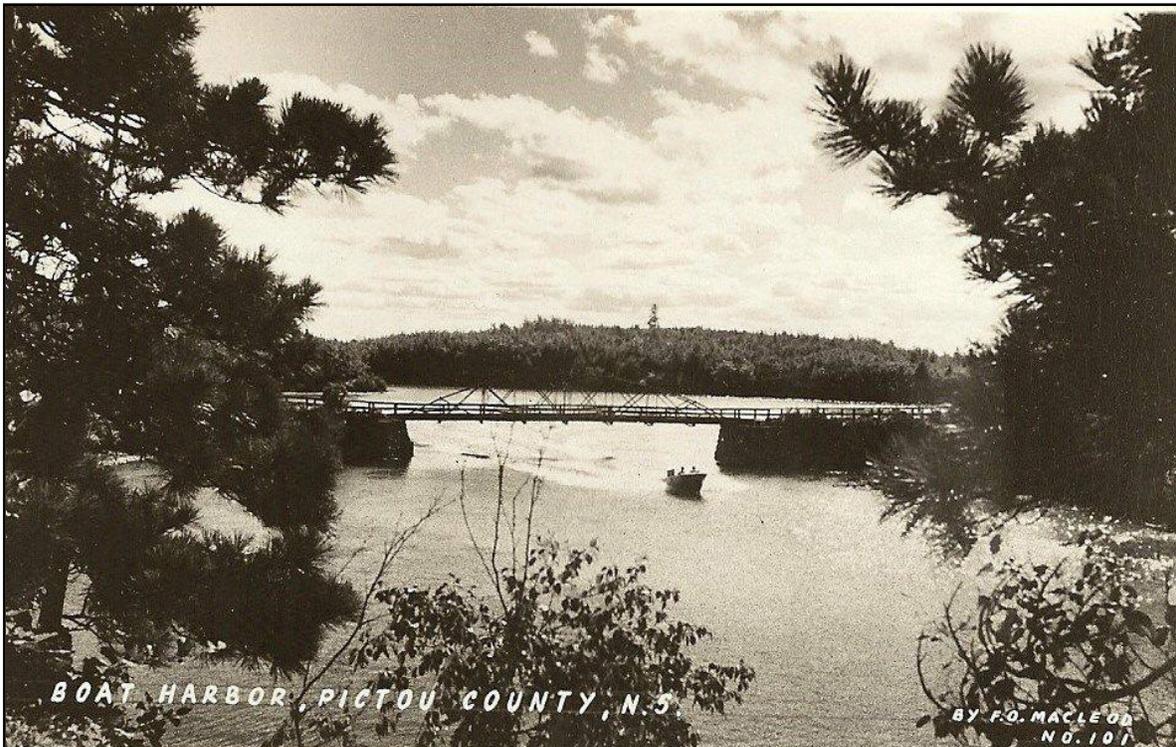
Figure 37. Two figures from the Web Mapping Application's User Guide.

Figure 38. Map layer and informational pop-up.

1. Introduction

Mi'kmaw peoples have lived in Mi'kma'ki (now frequently referred to as the Canadian Maritimes) for hundreds of generations. It is where our Mi'kmaw origin stories begin and where we, the Mi'kmaw people, continue to raise our families and live on the land. For those of us from Pictou Landing, A'se'k is "the other room." This tidal estuary is commonly known today as Boat Harbour, Nova Scotia. But historically, A'se'k was our gathering place that exemplified our Mi'kmaw ethic of sharing: food, knowledge, and skills were exchanged there between generations and amongst family groups (see www.plfn.ca).

A'se'k and its recreational, physical, mental, spiritual, and emotional purposes have been compromised since a pulp and paper mill was built nearby and began dumping its effluent into this cherished body of water. For nearly 50 years, we – our Elders, our leaders, all of us – have been trying to redress this environmental and social injustice.



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In 2010, the women of the Pictou Landing Native Women's Group (PLNWG) mobilized as a result of our health and environmental concerns related to Boat Harbour, and it is

A Brief History of the Pulp and Paper Mill at Abercrombie Point

In 1957, Scott Paper Company Ltd. acquired lands at Abercrombie Point and established a kraft pulp and paper mill there. In 1967, the mill began operating and dumping its effluent (wastewater) into Boat Harbour; it continues to do so today at a rate of approximately 85 million litres per day (Jacques Whitford Environment & Beak Consultants, 1992). The effluent from the mill was dumped directly into Boat Harbour without being treated until a treatment plant was built on Simpsons Road adjacent to Pictou Landing First Nation in the early 1970s (Nova Scotia Government, 2015). Even so, Scott Paper admitted in a brochure mailed to all Pictou County households in the fall of 1989 that the mill equipment was largely of 1967 technology and, in terms of air emissions, was not designed to meet modern mill standards (Reid, 1989).

Industrial operations like those at the mill at Abercrombie Point involve two stages – kraft pulping and bleaching. Kraft pulping and bleaching typically consume huge amounts of fresh water and considerable quantities of chemicals, meaning the wastewater from the kraft bleaching processes contains various toxic chemicals such as dioxins and furans, polycyclic aromatic hydrocarbons (PAHs), hydrogen sulfite, and mercury (Pokhrel & Viraraghavan, 2004). The Nova Scotia Government acknowledges that there are dioxins and furans in Boat Harbour (2015).

Wastewater treatment at Boat Harbour happens in two stages (previously three; see Stantec, 2004). Once effluent is delivered to the treatment facility by pipeline, primary treatment takes place in the settling basin followed by secondary treatment in the aerated stabilization basin before the water is released into Northumberland



Strait (Stantec, 2011). In 2015, an industrial approval included three main conditions for Northern Pulp (the company that eventually bought Scott Paper): (1) lower annual emission limits for particulate matter and sulfur dioxide beginning January 2016; (2) stack testing of recovery and power boilers doubling to four times a

Photo Credits: University of King's College Journalism (2009)

year; and (3) a restriction of water use, which would lead to a 35% reduction of effluent being dumped into Boat Harbour on a daily basis, and a subsequent 25% reduction by 2020 (Hoffman et al., 2015). After appeals by Northern Pulp about these conditions, a final decision was released in February 2016, which included revisions to the third condition (see Miller, 2016).

Pulp and Paper Mill and Government Interactions with Pictou Landing First Nation

Concerns about how the mill's operations impact the land, air, soil, and water have been expressed since its establishment. Yet Nova Scotia has repeatedly granted approval to the mill to continue its operations. A timeline of interactions between the mill, the province, and Pictou Landing First Nation is presented in Table 1.

Table 1

Pulp and Paper Mill and Government Interactions with Pictou Landing First Nation
(Adapted from Hoffman et al., 2015 and New Glasgow News, 2010)

1964	Scott Maritimes decides to build a pulp and paper mill at Abercrombie Point.
1965	Pictou Landing First Nation Chief and Council state concerns about odour. The province and Scott Maritimes take them to a similar mill site in Saint John, New Brunswick, to show another mill with no odour (it was not operating at the time). An agreement-in-principal is signed.
1965	Soon after, a resolution is signed for a lump sum payment of \$60,000 to Pictou Landing First Nation for permanent loss of fishing and hunting revenue and other benefits derived from land/estuary use, with a final settlement subject to further negotiations between the province and Indian Affairs.
1967	Mill begins operating.
1986	Pictou Landing First Nation begins action against federal government for breach of fiduciary duty in Boat Harbour.
1991	Federal government negotiates settlement with Pictou Landing First Nation. Province promises to abate adverse effects of effluent when agreement expires in 1995.
1993	The federal government and Pictou Landing First Nation agree to settle out of court for \$35 million.
1995	No alternative effluent treatment site identified before agreement expired. Province promises closure of Boat Harbour by December 2005.
2004	Mill ownership transferred to Neenah Paper.
2005	Province and mill request extension to December 2008.
2008-2009	Band Council Chief meets with negotiator and advises province that they will not agree to further licence extensions. Meetings halt following provincial election. When talks resume, transportation minister requests more time to study issues.

Table 1, cont.

2008	Province asks Pictou Landing First Nation not to protest extension of licence to December 2008 and promises not to extend it without consultation, but province extends licence after December 2008 on a month-to-month basis.
2010	Pictou Landing First Nation asks province to terminate licence, effective June 30. After no change, a lawsuit is filed against province and mill.
2014	Effluent leak sparks protest by residents seeking a commitment from province for firm deadlines to find an alternative location for mill's effluent and remediation of Boat Harbour. Pictou Landing First Nation Chief and Nova Scotia's Minister of Environment sign an agreement. Government commits to legally implementing a timeline to stop flow of effluent into Boat Harbour and site's remediation by June 30, 2015. Clean the Air concert raises awareness about mill's emissions. Public consultation on behalf of mill for public to voice opinions related to mill's industrial approval renewal application. Smoke stack precipitator shutdown triggers ministerial order requiring the mill to install new air pollution equipment by May 2015.
2015	New industrial approvals issued by Nova Scotia Environment for improvements in air emissions, water use, and effluent. Mill immediately appeals new industrial approvals claiming that they are tougher than rest of the pulp and paper industry emission standards. US company hired to supply and install new air pollution equipment pulls out of \$22 million project before completion. <i>Boat Harbour Act</i> is passed, stating that the Boat Harbour Effluent Treatment Facility will close by 2020.
2016	Northern Pulp appeals the industrial approval issued by the province. Nova Scotia subsequently amends its conditions, and Northern Pulp drops the appeal. Nova Scotia court issues a fine to Northern Pulp in the amount of \$225,000 for the company's effluent spill in 2014. Of this amount, \$75,000 will go to the Mi'kmaw Conservation Group, \$75,000 to the Pictou County Rivers Association, and \$75,000 to eligible recipients in the area, including residents of Pictou Landing First Nation.

Developing a Community-Academic Research Partnership

After discussions with the Nova Scotia Native Women's Association president, **Cheryl Maloney**, the PLNWG invited **Diana "Dee" Lewis**, a Mi'kmaw woman from Sipekne'katik First Nation with graduate-level training in environmental studies, to

discuss the women's concerns and what could be done about them. Early on, there was discussion about traditional knowledge and the traditional uses of Boat Harbour, and the potential of oral histories and community mapping as ways of exploring this further. With the PLNWG's permission, Lewis then invited **Dr. Heather Castleden**, a community-based participatory Settler (non-Indigenous) researcher from (then) Dalhousie University with 15+ years experience working with Indigenous peoples, and **Ella Bennett**, her Settler graduate student, to meet with the PLNWG in the community in November 2010 to discuss the future of PLNWG's interests in research and action about Boat Harbour. Discussion continued about how some of the questions the PLNWG had about Boat Harbour could be answered through Dee's doctoral research and Ella's Master's research (see Figure 1).

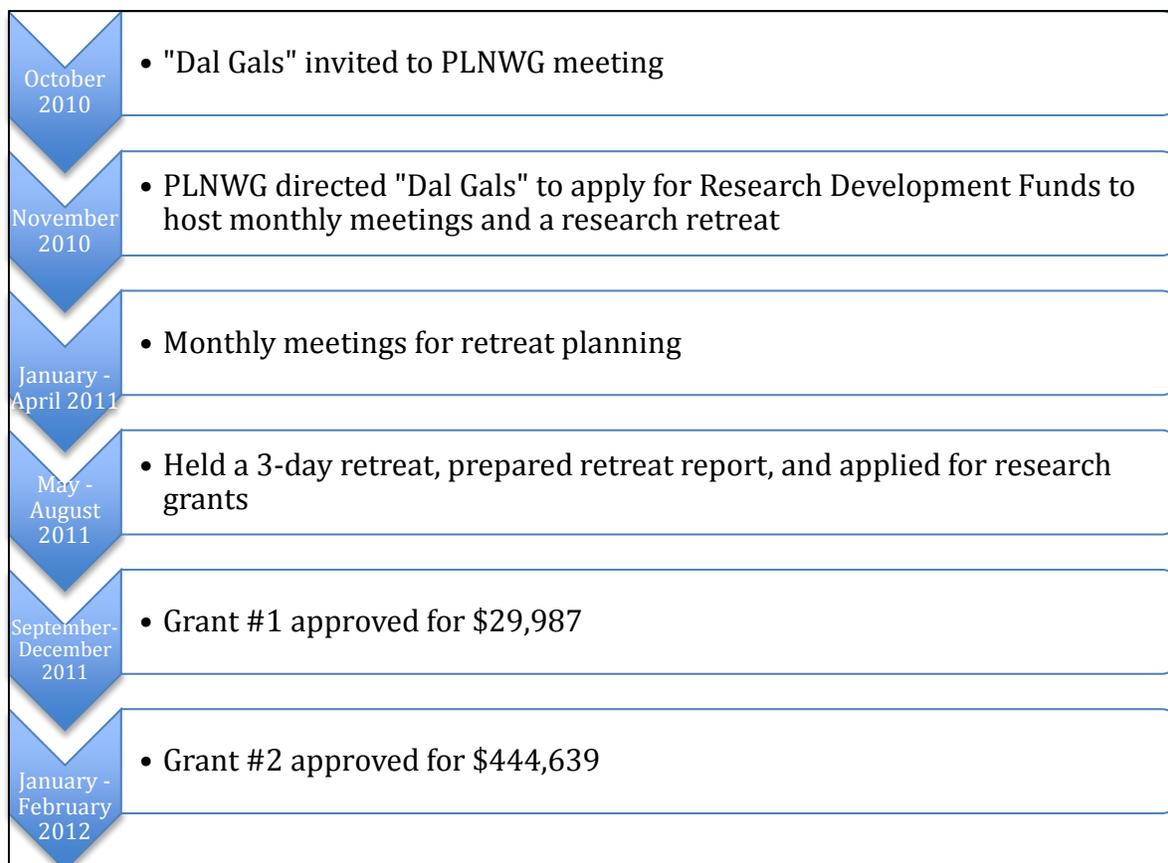


Figure 1. Timeline of our early research partnership.

At this November meeting, three key components of a research relationship between the PLNWG and the trio of researchers, who became known as “the Dal Gals,” emerged:

1. The community's health must be the number one priority of the research;

2. The research partnership should result in transparent and impartial research with direction coming from the women, but with the consideration of all community members' input; and
3. The research must have a focus on capacity-building, including training community researchers and involving students from the community.

The research relationship began with meetings that had an atmosphere where the women could share their concerns and goals for community health and wellbeing, as well as discuss ways to move forward on positive environment and health reform; in other words, we “spent the first year drinking tea!” (Castleden, Sloan Morgan, & Lamb, 2012, p. 16).

From the beginning, the research partnership sought to embody what are known as the “4 Rs” of research (Kirkness & Barnhardt, 1991): to be relevant, respectful, responsible, and carry out reciprocal research, with shared decision-making about and ownership of the research plan, the information we collect, how we analyze and make sense of what we collect, and how/when results are shared with others.

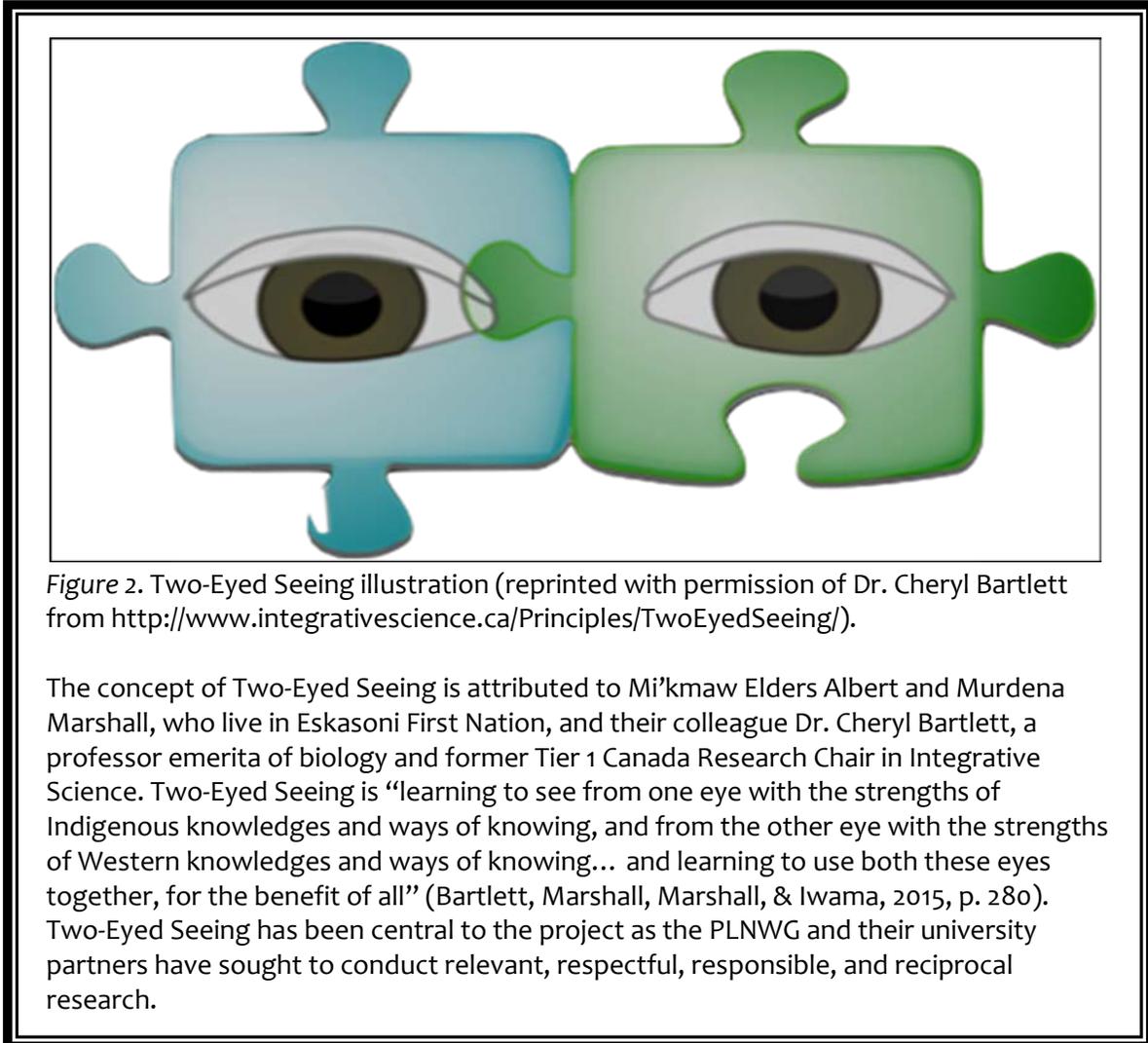


Following direction from the PLNWG, Heather applied for and received funding to hold a research retreat (Grant #1). Then, after the first research retreat, and with guidance and support from the PLNWG, Heather led a second grant submission to the Canadian Institutes of Health Research (Grant #2). Included on the team were other researchers: **Dr. Rob Jamieson** (Dalhousie University), **Dr. Mark**

Gibson (Dalhousie University), **Dr. Daniel Rainham** (Dalhousie University), **Dr. Debbie Martin** (Dalhousie University), and **Dr. Ron Russell** (Saint Mary's University). The PLNWG and university researchers were then awarded Grant #2 to explore the question: “Is Boat Harbour making us sick?” using Indigenous and Western approaches to the research design.



The approach to health within this community-based project was wholistic; it did not solely focus on physical health like previous research, but equally looked at mental, spiritual, and emotional wellbeing. Central to the project and research partnership was the guiding principle of Two-Eyed Seeing (Figure 2, below).



2. Research Retreats

Research retreats were held, approximately annually, over the course of the community-university partnership as a means to strengthen and maintain good relationships between all team members and as spaces where important decision-making about the project occurred. Each retreat served different purposes, balancing relationship-building with research design, knowledge sharing, and reporting of findings. They were held in multiple places in Nova Scotia (Halifax, Tatamagouche, Truro) across the life course of the project. Each retreat is briefly described below. Retreat Reports for the first, third, and fourth retreats can be downloaded from www.heclab.com.

First Research Retreat (2011)

“We have the voice, we need the steps to move forward... that's called empowerment.”

The first PLNWG Research Retreat was funded through a grant awarded by the Nova Scotia Health Research Foundation. The retreat was titled *Epitik Mawi-ta'jik* and took place from April 29 to May 1, 2011, in Kijipjutuk (Halifax), and it was an important outcome of the evolving research partnership. Six academics and professionals from Atlantic Canada were invited to share their knowledge and expertise with the PLNWG. The retreat gave women from the community the opportunity to gain knowledge, share their concerns, and discuss relevant and accessible research priorities for the future.



Specifically, the goals as stated in the Retreat Report (Castleden & Bennett, 2011) of the *Epitik Mawi-ta'jik* were to:

1. Provide an opportunity to share and discuss community-relevant concerns of environment and health in an inclusive, multi-generational, and female-centred forum;

2. Increase the environmental and health literacy of retreat participants, especially as pertaining to Boat Harbour;
3. Allow participants to acquire and discuss information provided by invited panelists, who have particular backgrounds in environment and health fields; and
4. Establish goals and priorities for a continuing community-based participatory research partnership.

“We can’t just respond to research, we need to be the drivers of it!”



“Our women are strong and tough and we’re able to do it!”

After a night of social relationship-building, the women gathered for two days of learning and sharing, each day opening and closing with a prayer. The following panelists were invited to give presentations based on their relevant expertise:

1. **Deborah Carver** (*Executive Director of the East Coast Environmental Law Association*) discussed the legal issues surrounding Boat Harbour.
2. **Barbara Clow** (*Executive Director of the Atlantic Centre of Excellence for Women’s Health and Associate Professor in the Faculty of Health Professions at Dalhousie University*) discussed the relationship between gender and health in the context of Boat Harbour.
3. **Debbie Martin** (*member of NunatuKavut and Assistant Professor in the School of Health and Human Performance at Dalhousie University*) presented on Indigenous rights and the importance of moving forward acknowledging that health should be examined from all four directions: physical, mental, emotional, and spiritual.

4. **Inka Milewski** (*expert marine biologist*) discussed health and environmental (in)justice.
5. **Daniel Rainham** (*Assistant Professor in the Environmental Science Program at Dalhousie University*) described how his approach could capture meaning and story in a map.
6. **Ron Russell** (*Associate Professor in the Biology Department at St. Mary's University*) presented the language needed to articulate possible impacts of the mill's effluent from a physical science perspective.

In addition to panelist presentations, there was a morning spent developing health and environmental literacy with retreat participants. With a comprehensive list of over 50 concepts, tools, and terms related to health and environment, this session allowed the women to acquire a strong foundation on which to build throughout the retreat and for their collaborative work in the future. Booklets of the terms were also provided for everyone to take home. The women who attended the retreat described it as being extremely important, and the momentum it generated carried forward next steps of the research relationship as established by the PLNWG (for example, the Environmental Health Survey and the submission of Grant #2 to the Canadian Institutes of Health Research).

Second Research Retreat (2012)

“I suffered a lot of injustice, but now in this room, I feel empowered.”

The second PLNWG Research Retreat was held at the Tatamagouche Centre (April 28-29, 2012) to establish a good mind and heart across the team. It included prayers, ceremony, and sharing circles; shared food and meals; a traditional medicine walk and an archaeological walk; a screening of the CBC documentary about Boat Harbour; shared laughter and tears, bowling and bonfires; a review of OCAP,¹ TCPS2,² and the 4 Rs of research; and the development and confirmation of a Research Agreement. The research team members were taught by invited Elders **Albert** and **Murdena Marshall** from Eskasoni First Nation and **Dr. Cheryl Bartlett** (Professor Emeritus at Cape Breton University) about the Guiding Principle of Two-Eyed Seeing (see end of Introduction for a definition of Two-Eyed Seeing).

¹ Standing for ownership, control, access, and possession, OCAP asserts that First Nations control research in their communities and that they own the information and determine how it will be used. OCAP® is a registered trademark of the First Nations Information Governance Centre (www.FNIGC.ca).

² The TCPS2 is the second edition of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*. A joint policy of Canada's three main federal granting agencies in health, social sciences, and natural sciences, it is informed by international ethics practices and provides guidance to researchers working with people.

Indigenous scholar David Newhouse (2008) speaks of the Haudenosaunee concept of Ganigonhi:oh (“a good mind”) in regard to the balance between passion and reason; researchers need to balance these as they navigate institutional, professional, personal, and community interests. Participants in the second retreat discussed



approaching research with “a good mind” in terms of researchers’ roles in water and air sampling, the progress that had been made, and the challenges they encountered. Ron Russell and **Rob Jamieson** also delivered updates on ecotoxicology and water respectively, and Daniel spoke about the status of the community map.

“We don’t know how healthy our medicines are – we’re afraid to go and collect them.”

“This is all I ever wanted: the chance for people to speak up... to be able to sit together and get out feelings out... it’s so powerful.”



Third Research Retreat (2014)

The third PLNWG Research Retreat was titled *Sharing What We Were Learning: Where We've Come From, Where We Are Going* and took place March 1 and 2, 2014, in Kijipjutuk (Halifax) with 28 women in attendance. The first morning began with a welcome, introductions, and an overview of the research partnership provided by **Sheila Francis** (President, PLNWG) and **Heather Castleden**. **Dee Lewis** gave an update on the Environmental Health Survey, which had concluded on December 31, 2013. There was discussion about the potential for a documentary film about the overall project.

Three things emerged from the discussion about what stories the film could tell: (1) the history of Pictou Landing First Nation and the important role A'se'k played for the community; (2) the unjust placement of the Treatment Facility in the 1960s and broken government promises since then; and (3) the impact of the pollution and loss of use of the land, especially the reverberating impacts on younger generations.³



Jordan Francis, a student from Pictou Landing First Nation, and her supervisor, **Irena Knezevic**, presented on a project Jordan had been working on since the previous summer. Jordan's project, part of a larger one conducted through the Food Action and Research Centre (FoodARC) at Mount Saint Vincent University, involved Storysharing and Photovoice sessions with 18 participants. The results of the project showed that the community of Pictou Landing as a whole struggles to obtain affordable, nutritious food and that Boat Harbour has contributed to this struggle because people have felt they don't have access to food from the land since the estuary began receiving wastewater. Jordan also reported that people are hesitant to grow their own food because they don't trust the soil. This research led to the addition of soil sampling to the overall Boat Harbour project.

³ In 2014-2015, the PLNWG decided to carry out soil analysis in backyards out of interest in having individual and community gardens. The funds allocated to the film were redistributed to do the (expensive) soil analysis. In 2016, Heather and the PLNWG applied for additional funds to complete the film but the application was not successful in the funding competition.



Kim Strickland and **Colleen Denny** delivered a presentation titled *A Day in the Life of a Community Researcher*, in which they talked about their critical involvement in the project to keep things running smoothly. They described their roles in water sampling and air quality monitoring as well as the challenges they had experienced. They also explained how their families motivated them to do this work.

At the end of the first day a photobooth activity was organized where everyone was invited to complete the sentences “A’s’e’k is...” and “The Boat Harbour project is important to me because...” on a chalkboard and have their photo taken. After a full day, everyone headed downtown to enjoy dinner and a performance at the Grafton Street Dinner Theatre.

On the second day, Rob Jamieson presented on water quality testing he had completed and Ron Russell presented on the aquatic toxicity tests he’d conducted. Ron’s results indicate that the water is acutely toxic to creatures, meaning the effects happen in the short term. Because Daniel Rainham and **Mark Gibson** regrettably could

not attend, **Emily Skinner** shared updates about the community mapping and air quality monitoring components of the project. The day concluded with a sharing circle to reflect on the retreat. **Trina Roache** from APTN (Aboriginal Peoples Television Network) also came by the retreat and conducted interviews with some of the women in attendance as part of a three-part television series about Boat Harbour.⁴

Fourth Research Retreat (2015)

The fourth PLNWG Research Retreat took place December 12 and 13 in Wékopekwitk (Truro), Nova Scotia. The PLNWG arrived in the morning on December 12, and the day began with the opportunity to review a draft of this Final Project report as well as a draft Environmental Health Survey Community Report. The meeting opened with a prayer led by **Jackie Alex** as well as a song and drumming by Mi'kmaw filmmaker **Catherine Martin**. With two full days ahead of the group, it was important for the meeting to start, as all other meetings and retreats had, with allowing those present to enter discussions with open hearts and open minds. **Mary Irene Nicholas** also welcomed the group and noted that while this retreat would be the last one held specifically for this project, it signified a new beginning, not an ending.

Heather and Dee began the presentations with an oral history update – Dee had conducted three more in the fall of 2015. They also screened a short film that Ella had made, which was a collage of oral histories about Boat Harbour. The PLNWG decided to make the film available online through the HEC Lab website as well as Pictou Landing First Nation's website. Dee then presented findings from the Environmental Health Survey. The PLNWG offered comments and discussed the benefits and compromises of using microdata from provincial and regional databases, comments which Dee indicated she would continue to consider as she finalized the Community Report. The afternoon consisted of a Science Panel, comprising Daniel, Rob, Mark, and Ron. Daniel began the panel by illustrating what the community map is capable of showing by turning layers “on” and “off,” and in doing so communicating different information around land use and the project. The decision to make the map a legacy of the project was reconfirmed, meaning it will only be editable by way of request to Daniel. The second panellist, Rob Jamieson, reiterated findings from the water quality analysis and reported, for the first time, findings from the soil quality analysis. Mark Gibson delivered an update on the air quality analysis, which included more recent data sets from spring and summer 2014 and the modelling of pollutants. Ron concluded the panel by presenting the ecotoxicology aspect of the project, reiterating his aquatic toxicity report and reporting on the chemical analysis he also conducted. At the time of the retreat, the mammal analysis had not been completed. Throughout discussions

⁴ The APTN series can be viewed here: <http://aptn.ca/news/2014/03/26/pictou-landing-researches-health-effects-polluted-harbor/>.

during the Science Panel, the PLNWG emphasized their concern about the potential danger that the removal of sediment posed as well as perceived negative health impacts of the smell in the area: considerations in the context of future remediation and restoration processes.

At the end of Day 1, we held a sharing circle where participants reflected on the transformational path of this research and emphasized gratefulness for the time, resources, and spirit that each person contributed to this critical work. Retreat attendees then enjoyed dinner at Frank & Gino's who hosted us in their private room, making for a festive night of friendship and food.

On Day 2, Heather provided a budget overview of spending to date and what the remaining funds were committed to. The PLNWG reconfirmed the decision to pursue a documentary film; filmmaker Catherine Martin led the discussion to get a sense of possibilities for the film – as before, the women expressed it was a critical tool to document the story of the PLNWG mobilization and communicate Elders' stories about A'se'k. After the retreat, a grant application was submitted to the Canadian Institutes of Health Research. Unfortunately in July 2016 Heather received notice that the funding application had been rejected; however, there is the possibility of continued efforts to secure film funding.

Other opportunities for future collaborations were discussed, such as a way to connect Elders and youth in the community and the potential formation of a community-based Boat Harbour group, which would include men and youth as well as women. Heather and the PLNWG also took the time to discuss the Canadian Alliance for Healthy Hearts and Minds cohort project that Pictou Landing First Nation was invited to be a part of. It was decided that this would be an initiative taken on by Chief and Council, instead of the PLNWG.

Cecilia Jennings, Kim, and **Lexy Strickland** also presented on the Youth Camp's activities from summer 2015. They screened the youth's powerful and moving digital stories made by **Madison Nicholas**, **Hunter Francis**, and **Alexandria Francis**, as well as one by Cecilia. **Carter Hatfield** and **Laela Denny** also attended the camp. The stories will be made available on the HEC Lab website after the project's final Community Dinner.



In an emotional final roundtable discussion, there was an appreciation for the trust and sharing that this partnership enabled as well as pride in the work that had taken place with an eye forward on what would be next to come.



3. Oral Histories

Oral histories addressed topics of family heritage and future, health and wellbeing, childhood/youth of the storyteller, community, Boat Harbour, reasons for leaving or staying in Pictou Landing First Nation, and memories. The oral history interview guide was adapted from the Community-University Research Montreal Life Stories Project (2007-2012) at the Centre for Oral History and Digital Storytelling, Concordia University. In November 2011, **Ella Bennett** began to document oral histories to reconstruct what Boat Harbour was like before the mill opened. **Hayley Bernard**, while majoring in Mi'kmaq Studies at Cape Breton University, was awarded an undergraduate summer internship by the Atlantic Aboriginal Health Research Program and also collected several oral histories. **Dee Lewis** continued to record oral histories in the fall of 2015 and completed three as of this report's publication (September 2016).

Ella's graduate work, and Haley and Dee's continuing work, documenting oral histories offers Mi'kmaw perspectives on Boat Harbour from Elders who have lived through the loss of A'se'k and surrounding land. Many of the Elders discussed sharing practices in great length. Residents of Pictou Landing First Nation also spoke about the relationship between the pollution at A'se'k and the dramatic decrease of individual and community engagement with their lands and waterways. While sharing practices continue to function in Pictou Landing today and some people continue to engage in traditional harvesting activities (although usually away from Pictou Landing), it was clear from the



Elders Ella spoke with that trust in food and medicines from the land has been significantly compromised (Castleden et al., in press). The Elders also suggested that the lack of engagement with the land is especially true for youth. Many youth do not hunt or fish or know what foods and medicines are available on the land where they're from and where they live because they have lost a place to engage in these activities. In this sense, the pulp mill and treatment facility have compromised the community's physical, sociocultural, emotional, and spiritual health and wellbeing.

Ella's thesis, as well as the transcribed oral histories, are available to the community by contacting Sheila Francis.⁵

A'se'k: All Seasons, All Purpose

"That was safe haven for all of us. Everything that we needed was there." ~Sadie Francis

A'se'k: After the Mill Went In

"Well, I guess they didn't want to put it anywhere else in town. Let's put it near the Indians – Native people close by, we'll dump it on them! ... Let them deal with it. But it's always us that got dumped on. That's how they treated us I guess..." ~Mary Ellen Denny

A'se'k: No More

"Everything we used to do, we can't do. What we were brought up on, it's all been taken away." ~Don Francis

A'se'k: The Future

"I had a dream once. I dreamt it was clean, and our community became rich from it. And everybody worked together, in my dream..." ~Louise Sapier



⁵ Ella defended her thesis, titled "We Had Something Good and Sacred Here": Restorying A'Se'k with Pictou Landing First Nation, in June 2013 in Pictou Landing. It was the first time a Dalhousie University student defended a thesis in a Mi'kmaw community, and residents of Pictou Landing attended. At the defence, she also screened the short film she made that was a compilation of the oral histories she had documented; the film can be viewed online at the HEC Lab website as well as Pictou Landing First Nation's website.



4. Literature Review

Pulling the Plug on Boat Harbour: A Synthesis Review and Gap Analysis of Existing Environmental and Human Health Assessment Including Pictou Landing First Nation (1968-2007) by Ziyun Wang, Master of Resource and Environmental Management

Ziyun Wang, an international graduate student working with **Heather Castleden**, conducted a literature review in 2012 to determine what information about Boat Harbour existed and what was missing. Ziyun systematically reviewed and synthesized 70 government-funded and industry-produced environmental health studies published between 1968 and 2007. Her synthesis focused on 29 reports about health impact assessment and risk assessment in the Boat Harbour ecosystem as they most closely related to the Pictou Landing Native Women's Group's concerns, and resulted in three areas of findings: (1) water quality, (2) air quality, and (3) remediation options.

1. The water quality synthesis includes findings from Health Canada as well as the Canada and Pictou Landing First Nation Joint Environmental and Health Monitoring Committee (JEHMC). JEHMC has been directly sampling from the community drinking water system with three production wells to fulfill Canada's mandatory Environmental Health Program for all Aboriginal communities. Community drinking water has been sampled twice a year and then compared to the Guidelines for Canadian Drinking Water Quality (Health Canada, 2014). The JEHMC also sampled weekly for bacteria between 1998 and 2004. The most recent report (2005) from the JEHMC (provided by the PLNWG) reported there were no negative impacts to the community drinking water quality. Earlier negative observations included a drop in groundwater level, which has led to elevated levels of lead and barium. In addition, there were four instances of bacterial contamination in community drinking water, most likely resulting from activities near the water supply wells or the distribution pipes.

2. In terms of air quality, very few site-specific air quality monitoring events had been conducted at the time of this review. There is therefore very little information available on air pollutants in and around Boat Harbour. Starting in 1991, Nova Scotia Environment began monitoring total reduced sulfur in Pictou County, and the mill implemented additional emission controls in that same year. In February and July of 1995, Environment Canada assessed the levels of dioxins and furans in the ambient air in Pictou Landing First Nation to address community concerns about smog. Environment Canada's (1996) study findings did not find elevated levels of dioxins and furans, so no changes in operations by the mill were required.

3. Remediation options have included the installation of a rock berm in 1991 to control fish kills in the estuary. The rock berm was partially removed in 1993. Two other options were suggested in the 1990s: (1) Diffusing the effluent from the Aerated Stabilization

Basin to the Mackenzie Head and a plan for shoreline remediation, and (2) Opening Boat Harbour to tidal flush (opening it up to the Northumberland Strait again). To date, none of the proposed remediation promises have been enacted.

Three key gaps were found through this review:

1. Legislation in Nova Scotia does not (and has never) required human health risk assessments. There was one conducted in 2004 regarding the decommissioning of the Boat Harbour Effluent Treatment Facility, but as with other assessment processes the focus was only on physical health.
2. Federal pulp and paper effluent regulations left a gap of more than 20 years for the mill to operate without wastewater quality control.
3. There has been little research on the effects of tidal flush on deep water ecosystems. The impact of sediment from Boat Harbour travelling out to the ocean is unknown, and it is likely to be a major one. It is thought that this would speed up the eutrophication process because diluted effluent would increase light availability, meaning algae would be able to grow. Eutrophication is the result of increased algae (and other plant growth) in a water body, which reduces the amount of dissolved oxygen that other life forms (e.g., fish) in the water need to live. To address the concern of sediment release, dredging could be performed; however, our review found literature stating it is likely that only 50% of contaminated sediment could be removed, and that if the wastewater continued to flow into Boat Harbour, then it would not be possible to complete the dredging.

5. Environmental Health Survey

Alaptmeg aqq mawte'meg mst gogwe'l klamon ula utan jajigkaktow/Looking and Gathering Everything so This Community Will Be Healthy – Identifying, Documenting, Mapping, and Mobilizing Environment and Health Knowledge in Pictou Landing: An Environmental Health Survey by Diana Lewis, PhD Candidate

The Environmental Health Survey (EHS) began development in 2010 soon after the Pictou Landing Native Women's Group (PLNWG) had been meeting regularly to fundraise for and support community and cultural activities and to discuss community priorities. They asked to meet with representatives of Dalhousie University to explore the possibility of working together on a health research project to determine whether the community was getting sick from Boat Harbour. The PLNWG envisioned developing a survey instrument that would move beyond anecdotal health stories to reliable data about the community's health.

The overarching goal of the door-to-door EHS was to assess community-wide concerns and perceptions of environmental impacts, health problems, and access to healthcare, as well as the impacts on traditional, cultural, and spiritual activities affecting residents of the community. Prior to the survey, no independent scholarly study had specifically examined the relationship between the environmental contamination at Boat Harbour and its influence on the health of the people who live in Pictou Landing First Nation (PLFN). The EHS serves as the focus of **Diana (Dee) Lewis's** PhD research, and she led the survey development.

The gap in knowledge about Mi'kmaw health is, in part, due to the fact that while Statistics Canada regularly undertakes major national surveys on the health of Canadians, Aboriginal people living on reserve have often been excluded (Mi'kmaq Health Research Group, 2007). In 1997, the Assembly of First Nations began collecting data, developing the First Nations Regional Health Survey (RHS) for longitudinal study of First Nations and Inuit health, and it continues to do so today. The 13 Mi'kmaw communities in Nova Scotia participate in the survey, but the sample size for Pictou Landing is too small to disaggregate the data from the regional data set, and would not show statistical significance even if this were possible. Most importantly, the focus of the previous RHS survey was not on environmental health.

The definition of health used in the survey reflects the National Aboriginal Health Organization's definition that health is a balance between the "physical, mental, emotional and spiritual realms as well as the environment, culture, family, and community" (First Nations Centre, 2007, p. 1). The EHS was revised and adapted from the RHS and "Our Environment, Our Health: A Community-based Participatory

Environmental Health Survey in Richmond, California” (Cohen, Lopez, Malloy, & Morello-Frosch, 2012).

The PLNWG agreed to retain 140 questions from the two surveys which covered a wide range of health questions, including physical, mental, emotional, and spiritual health; as well, 157 new questions were added that were central to the cultural, intergenerational, and spiritual concerns of the community. Dee worked with the women over several months to ensure all of the questions they wanted included in the survey were there, and the questions, in relation to the needs of the community, would be answered. She also consulted with the “Science Guys,” **Daniel Rainham, Mark Gibson, Rob Jamieson, and Ron Russell**, to include questions that would be helpful to them with their work. The final EHS was a 297-question, 70-page survey instrument that took 90-120 minutes to complete.



The survey collected demographic information (age, education, employment, income – Tables 2 and 3); residence (air quality in home, water quality); health (perceptions of health, chronic conditions, access to health care, skin conditions, allergies, cancers, family history); traditional, cultural, spiritual information (ability to practice, access); residential school attendance; experiences of racism; and measures of quality of life, perceptions, and beliefs. These questions, unlike the RHS, allowed us to get to household-level data, which was the goal of the PLNWG.

Dee trained PLNWG members to administer the household-level Environmental Health Survey, and data collection began in November 2012. The first round of community research assistants to conduct the survey with Pictou Landing residents were **Haley Bernard, Colleen Denny, Pam Denny, Jordan Francis, Sheila Francis, and Kim Strickland**. Seven additional surveyors were also trained in the fall of 2013: **Darlene Bachiri, Holly Francis, Sylvia Francis, Heather Mills, April Nicholas, Fran Nicholas, and**

Loretta Sylliboy. The survey concluded on December 31, 2013, with a total of 279 out of a potential 470 survey respondents – an exceptional 60% response rate.

Dee has been able to compare EHS responses with data reported in 2013 in *The Health of the Nova Scotia Mi'kmaq Population* (NS RHS), using Nova Scotia First Nations Regional Health Survey data from 2008/10. She is also using publicly available data from the 2012 *National Report on Adults, Youth and Children Living in First Nation Communities* (N RHS), using national First Nations Regional Health Survey data from 2008/10 (FNIGC, 2012). Dee requested and was granted access to Statistics Canada data at the Atlantic Regional Data Centre at Dalhousie University, including the Canadian Cancer Registry, the Canadian Community Health Survey, the Survey on Living with Chronic Disease in Canada, and the Maternity Experiences Survey. As she continues with her analysis of the data in her PhD thesis, she will compare these data to the EHS and identify trends.

Dee's full analysis will be reported in a complete *Community Report – Environmental Health Survey*. Here, we provide a brief overview of key findings.

Table 2
Environmental Health Survey – Demographics

Variable	Category	Frequency (Total)	%
Gender	Female	150	56
	Male	117	44
		(267)	(100)
Marital status (Adults only 18 years +)	Single, never married	89	51
	Married, common law	62	36
	Separated, divorced, widowed	22	13
		(173)	(100)
Ages	0-11	46	18.1
	12-19 years	47	18.5
	20-29 years	45	17.7
	30-39 years	42	16.6
	40-49 years	28	11.0
	50-59 years	26	10.2
	60 years and older	20	7.9
	(254)	(100)	
Highest level of education completed (Adults only 18 years +)	Less than high school	66	39
	High school graduate	54	32
	College/trade school	40	24
	Bachelor	7	4
	Graduate	2	1
	(169)	(100)	

Table 3
Environmental Health Survey – Employment and Income

Variable	Category	Frequency (Total)	%
Employment status (Adults only 18 years +)	Employed F/T	37	22
	Employed P/T or seasonal	41	24
	Unemployed	73	43
	Retired	6	4
	Never worked	12	7
		(169)	(100)
Income (\$) (if working)	Less than 10,000	16	20
	10,000 to 19,999	23	28
	20,000 to 29,999	19	24
	30,000 to 39,999	13	16
	40,000 to 49,999	2	2
	Over 50,000	8	10
		(81)	(100)
Job category	Management/professional	13	13
	Administrative/sales	16	16
	Trade, transport, equipment operator	9	9
	Fishing, hunting, forestry, mining	24	24
	Care worker	5	5
	Student/Other (research, gardening, security, etc.)	32	32
		(99)	(100)
Source of income (if not working*)	Unemployment insurance	27	21
	Social assistance	59	47
	Pension/disability	8	6
	Child Tax Benefit/CTB and other	18	14
	Social assistance and other	7	6
	Education allowance/other	7	6
		(126)	(100)
If not working, why? (Adults only 18 years +)	Illness/disability	13	12
	Caring for family	19	17
	Seasonal layoff	13	12
	Retired	6	5
	No work available	26	24
	Student/other	33	30
		(110)	(100)

In surveys, self-reported health (Figure 3) is deemed a meaningful and reliable measure of current health that has been tested against mortality rates and results of clinical examinations. Beyond that, perceived self-rated health is accepted as a robust broad indicator of health status and wellbeing, incorporating the physical, emotional, and

personal aspects of health, and over the years it has maintained its reliability as a measure of current health. Moreover, self-rated health has been shown to be valid for use in different cultural groups including Indigenous populations, who have different perceptions of health based on a relational worldview (Chandola & Jenkinson, 2000; Sibthorpe, Anderson, & Cunningham, 2001; Strawbridge & Wallhagen, 1999; Wilson, Rosenberg, & Abonyi, 2011).

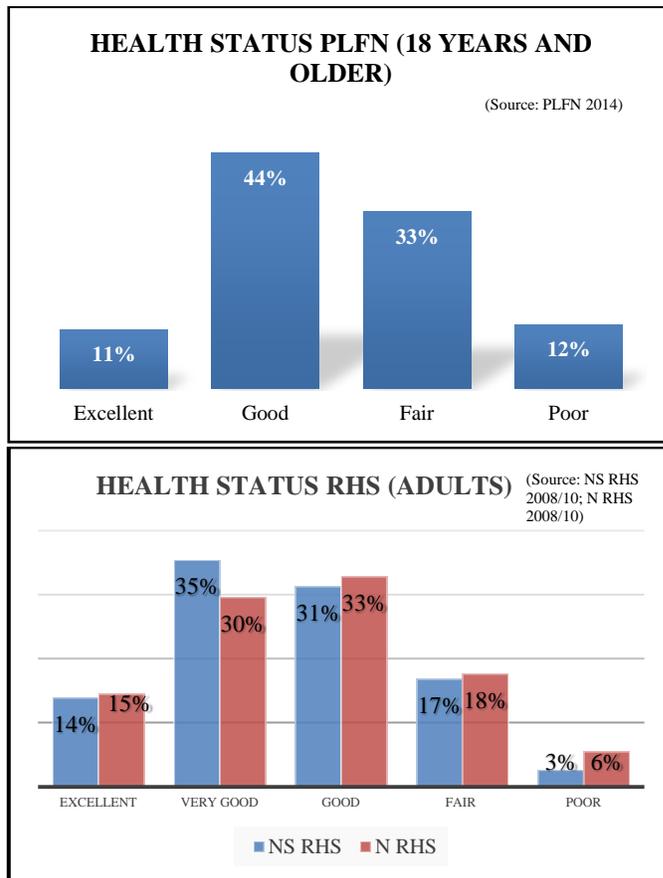


Figure 3. Environmental Health Survey – Self-reported health status (PLFN – Pictou Landing First Nation; NS RHS – Nova Scotia Regional Health Survey; N RHS – National Regional Health Survey).

For all adults aged 18 years and older in PLFN, 55% report their health as good to excellent compared to 81% of Nova Scotia First Nation adults on reserve and 77% of all First Nation adults on reserve nationally. Conversely, 45% of PLFN adult respondents report that their health is fair to poor, while 19% Nova Scotia First Nation adults on reserve and 23% First Nation adults on reserve nationally do.

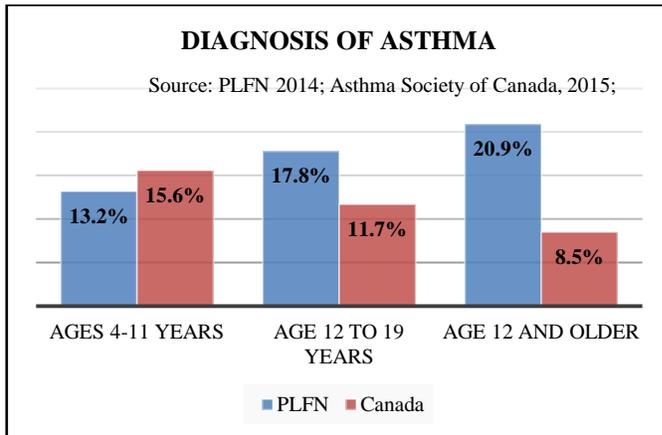


Figure 4. Environmental Health Survey – Asthma (PLFN – Pictou Landing First Nation).

According to the Asthma Society of Canada (2015), asthma is a disease of the lungs in which the airways become blocked or narrowed causing breathing difficulty. It is divided into two types: allergic (extrinsic) asthma and non-allergic (intrinsic) asthma. There are a number of potential causes, including heredity, the environment, and an impaired immune system. Risk factors (triggers) include a family history of asthma/allergies (including eczema and allergic rhinitis), exposure to tobacco smoke, mould, or pollen, and exposure to chemicals, odours, or pollution.

Figure 4 shows that younger Pictou Landing residents reflect similar percentages as other Canadians, but of PLFN youth aged 12 to 19 years, 17.8% have been diagnosed with asthma, compared to 11.7% of Canadian youth ages 12 to 19 years. Almost 2.5 times more PLFN community members age 12 and over have been diagnosed than in the general population. No one under the age of 4 has been diagnosed with asthma.

One trigger for asthma, as noted above, is mould or mildew in the home. Figure 5 shows that PLFN homes have more problems with mould and mildew than other First Nations communities.

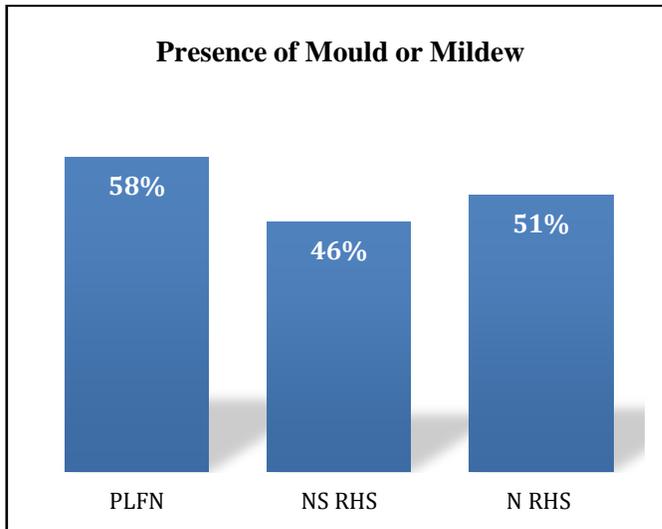


Figure 5. Environmental Health Survey – Mould or mildew in the home (PLFN – Pictou Landing First Nation; NS RHS – Nova Scotia Regional Health Survey; N RHS – National Regional Health Survey).



More than twice as many people from Pictou Landing do not think their water is safe to drink as compared to a national survey of Canadians (Figure 6, top chart). Consequently, more than 80% of PLFN respondents worry that the community water supply will impact their health (Figure 6, middle chart). As a result, 76% of respondents in PLFN drink bottled water compared to 71% of respondents on reserve nationally, and compared to 29% of Canadians in general (Figure 6, bottom chart).

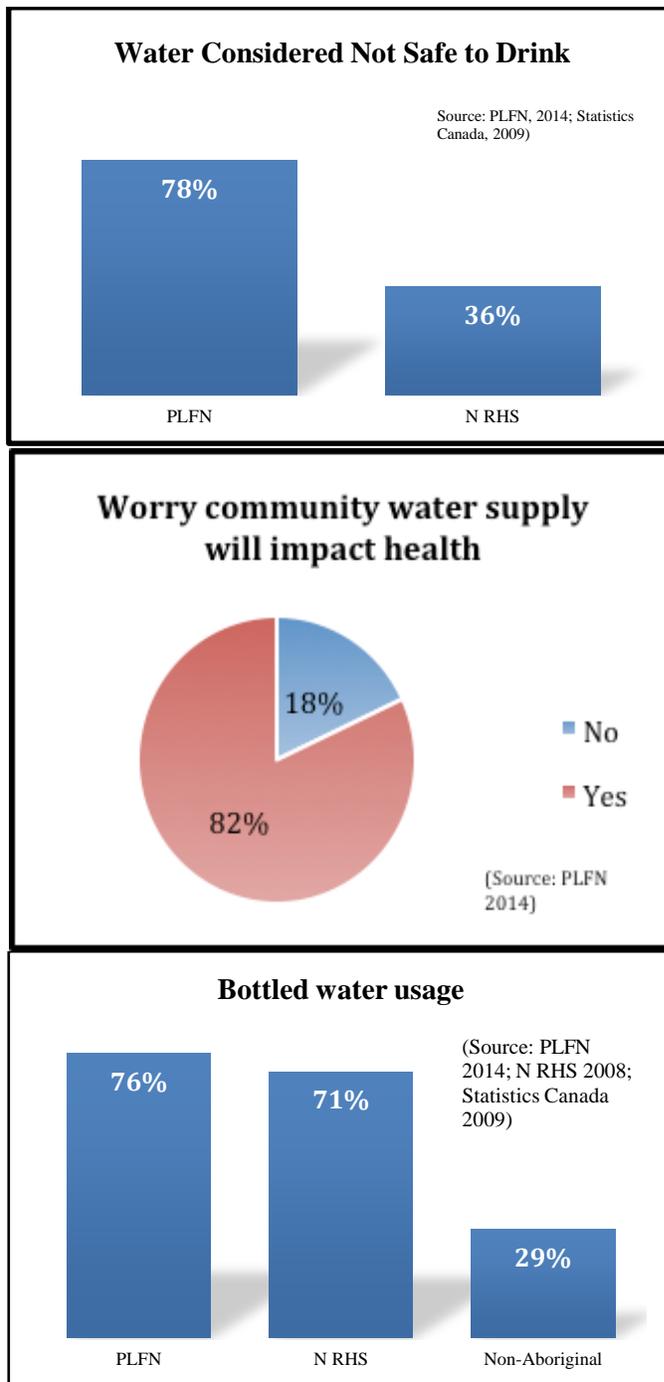


Figure 6. Environmental Health Survey – Safety of drinking water (PLFN – Pictou Landing First Nation; N RHS – National Regional Health Survey).

The Canadian Community Health Survey does not ask about mental health in the same way we asked about it in the EHS survey of PLFN members. However, when asking Canadians 12 years of age or older about their perceived mental health in 2013, 8%

report their mental health as fair to poor (Statistics Canada, 2013).⁶ In comparison, 68% of PLFN residents of the same age report that they sometimes or often feel down or depressed.

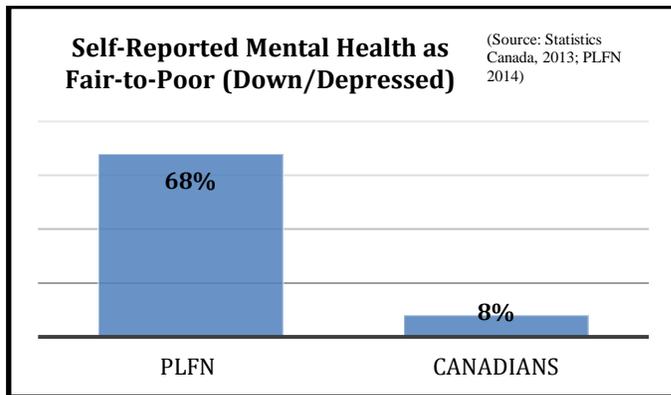


Figure 7. Environmental Health Survey – Mental health (PLFN – Pictou Landing First Nation).

Respondents were asked about whether they practise traditional activities now and whether they had practised these activities in the past (Figure 8) . All activities – use of traditional medicines, eating game, gathering shellfish and berries – showed a significant drop.

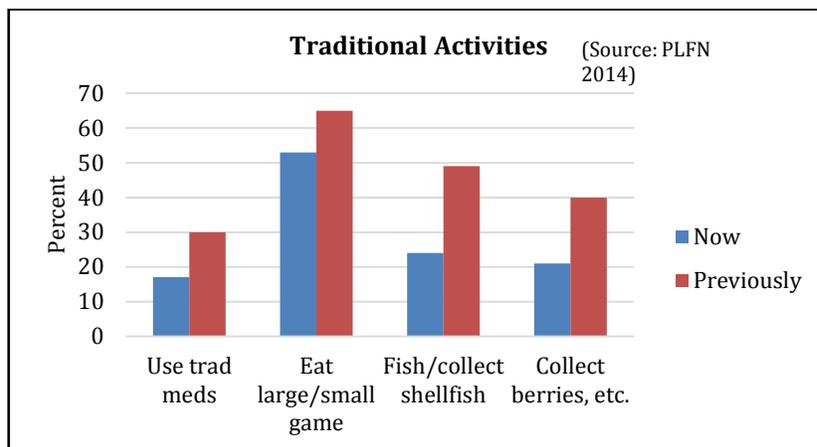


Figure 8. Environmental Health Survey – Traditional practices.

Figure 9 shows that 40% of PLFN members experienced racism in the past year. Racism, and the inevitable stress of being socially excluded, is damaging to health and wellbeing (Reading & Wien, 2009; Ziersch, Gallaher, Baum, & Bentley, 2011). Krieger

⁶ Source: Statistics Canada, Canadian Community Health Survey. CANSIM table no(s): [105-0501](#) (rates), [105-0503](#) (age-standardized rates).

(2001) defines racial discrimination as the process by which members of a socially defined racial group are treated unfairly because of membership of that group. Racism can occur at three levels – institutional, interpersonal, and internalized. It is important to understand how racism is constructed and practised, and rather than focusing on the disadvantaged position of the individual, it is also important to consider the impact of “whiteness and its associated privileges” and the inequity that produces (Durey, 2015, p. 197). Being subjected to discrimination and racism, it is now recognized (Castleden, Martin, & Lewis, 2016), has significant impacts on health.

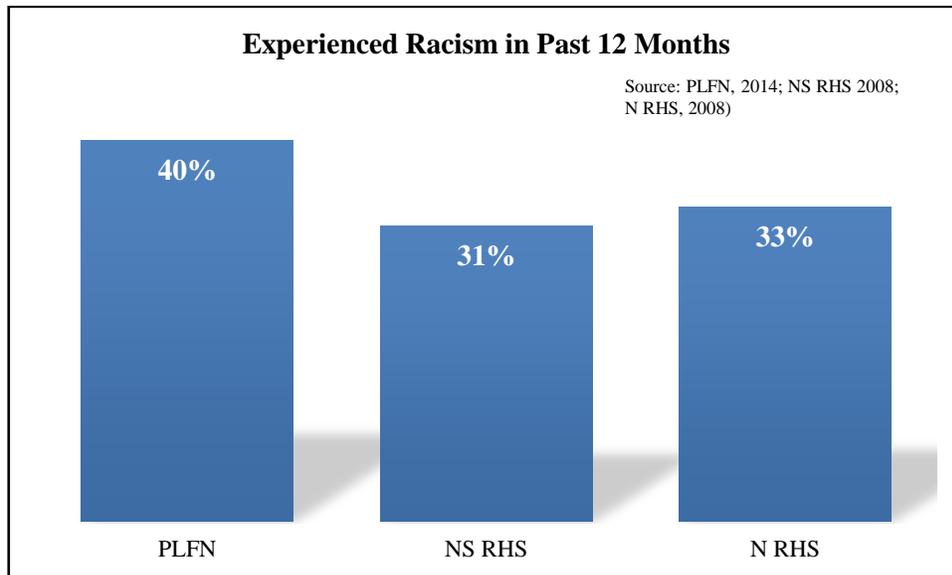
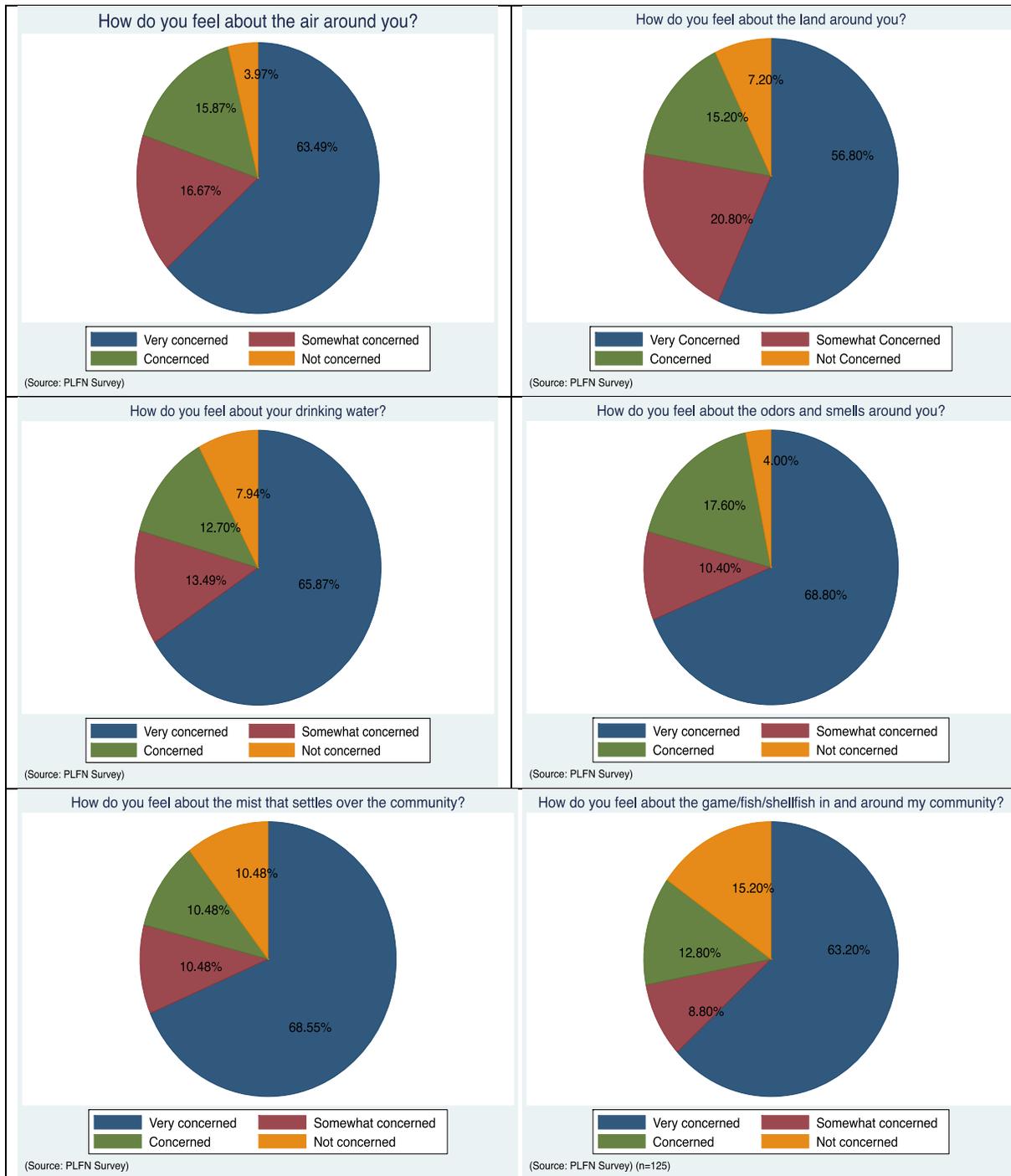
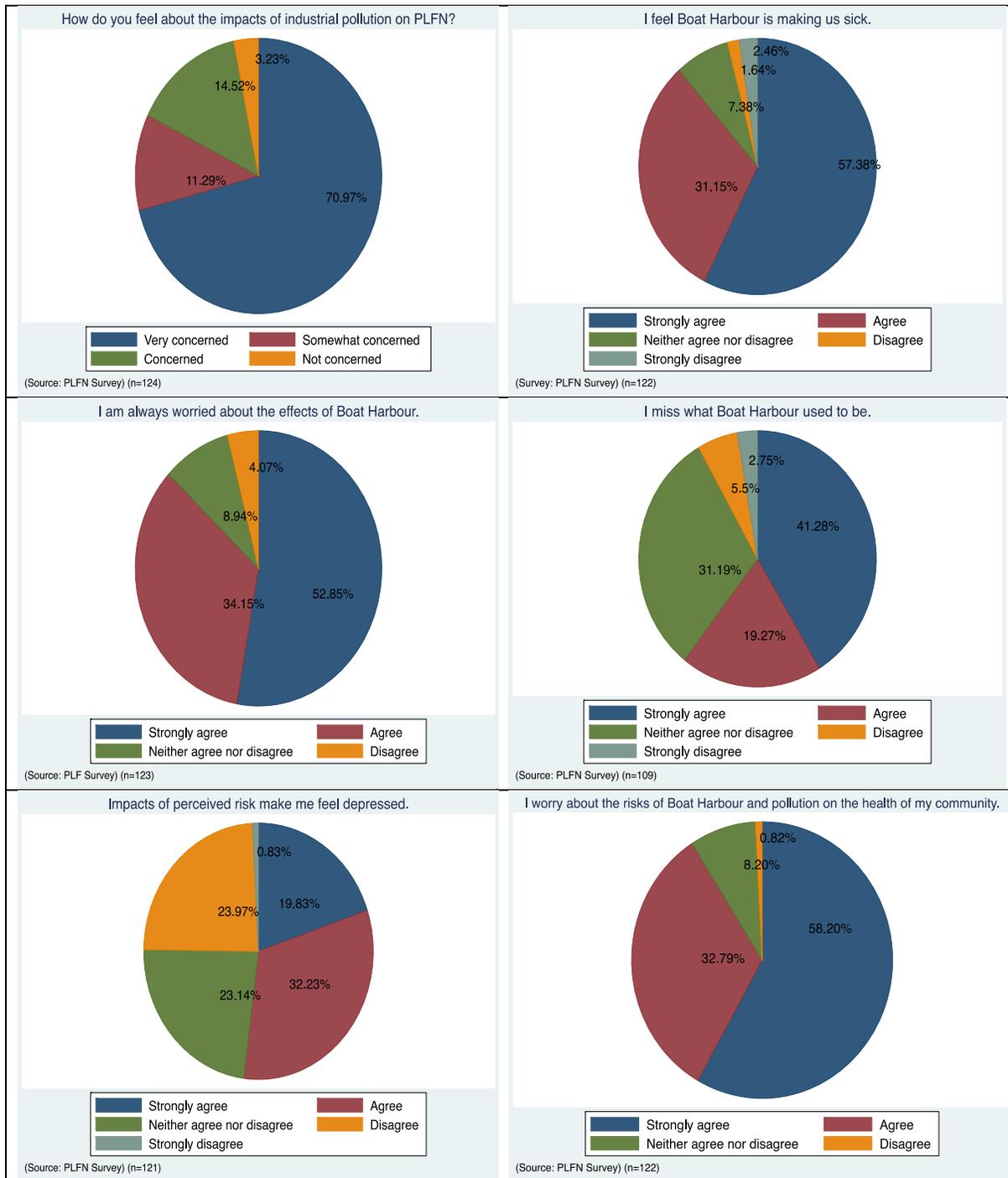


Figure 9. Environmental Health Survey – Racism (PLFN – Pictou Landing First Nation; NS RHS – Nova Scotia Regional Health Survey; N RHS – National Regional Health Survey).

During the collaborative development of the EHS survey questions, the PLNWG expressed concern about the air and water that surrounds their community, the odours that the members are exposed to, and the mist that settles on their land. We therefore developed the survey to determine whether the community as a whole was feeling the same types and levels of concern. As evidenced in the charts (Figures 10-21), it is clear that self-reported perspectives on their local environment convey a high level of concern and worry about the impacts that Boat Harbour is having on the health of the community through many different vectors, with most residents reporting that they agree or strongly agree that Boat Harbour is making them sick.



Figures 10-15. How do you feel about ...?



Figures 16-21. How do you feel about ...?

Summary

When we compare PLFN adult respondents' self-reports about poor health outcomes with those of other First Nations, both provincially and nationally, PLFN adults are reporting higher rates of poor health. Particularly worth noting is that more than half (approximately 60%) of adults in PLFN miss what Boat Harbour used to be when it was known as A'se'k, even though they may have not experienced A'se'k within their lifetime, having only heard stories that have been passed down to them over the years from their Elders.

Not only are PLFN residents experiencing poorer health outcomes compared to other First Nations, both provincially and nationally, they are at a disadvantage socioeconomically. The majority of households are headed by single parents, with a level of education at high school or less. Half the adult respondents 18 years or older are either unemployed or have never worked, and even if working, almost half exist on incomes below \$20,000 a year. Almost half of the households in PLFN exist on social assistance alone. If, indeed, the pulp mill was brought to Nova Scotia to benefit the residents of the region, these benefits have clearly not materialized in the community that may be paying the highest price.

6. Air Quality

The Atmospheric Forensics Research Group's part of the project was led by **Mark Gibson** (Associate Professor, Department of Civil and Resource Engineering, Dalhousie University). PLNWG members **Kim Strickland** and **Colleen Denny** were hired as Community Research Associates to work with Research Assistants **Geoff Kershaw**, **James Kuchta**, and **Codey Bennett** to manage the monitoring equipment and to sample. Air quality data were collected during the summer of 2013, spring of 2014, and summer of 2014. Harsh winters and a loss of power to the equipment that needed electricity to run real-time measurements meant the winters of 2013 and 2014 were excluded, reducing data completeness. Once the air quality monitoring was completed, the results were compared to existing data and regulatory air standards.

A total of 13 samplers (11 passive samplers and 2 real-time samplers) were set up throughout the community to sample indoor and outdoor air quality (see Figure 22).



Figure 22. Map of passive and active air monitoring sites used during the air quality monitoring.

Passive Sampling

Eleven passive samplers were set up around Pictou Landing, Boat Harbour, and downwind between the mill and the community. Wind patterns, the terrain, and distance were all taken into account with site selection. Passive sampling requires the sample to be transported to a lab to be analyzed. Two passive air samplers were used: Ogawas and thermal desorption tubes (TDTs; Figure 23). Ogawas and TDTs were paired at all 11 passive sampling sites, where the Ogawas measured **ammonia, sulfur dioxide, and nitrogen dioxide**, and the TDTs measured **volatile organic compounds (VOCs)**.



Figure 23. Deployment of passive samplers: Ogawa (left) and thermal desorption tube (right).

Real-time Sampling

The real-time monitors were set up at two sites (Mary Ellen's and Geoff Hatin' Us) and included monitors called VRae, Dylos, and DustTrak, monitoring the air at the two sites for one week. Real-time sampling allows the sample to be analyzed at the sample location.

- VRae measured **ammonium, nitrogen dioxide, sulfur dioxide, and hydrogen sulfide** (rotten egg smell). A VRae real-time monitor was set up to measure carbon monoxide, hydrogen sulfide, oxygen, and ammonia but was unsuccessful due to a terminal malfunction of the instrument.
- The Dylos measured the **number of particles** smaller than 2.5 μm (called $\text{PM}_{2.5}$) and 10 μm (PM_{10}).

· The DustTrak measured the **concentration** of the tiny dust particles of $2.5\ \mu\text{m}$, which you breathe in but are too small to see (e.g., nitrogen dioxide, sulfur dioxide, and ammonia). The particles come from a mixture of natural and human-made sources (e.g., sea salt spray, wind-blown dust, wood smoke, smokestacks, vehicle exhaust, aerosolized droplets from the Boat Harbour lagoon).

One 48-hour real-time sample of **dioxins and furans** was taken at two sites. No dioxins or furans were determined in the air at Pictou Landing First Nation. According to the National Pollution Release Inventory (publicly available and self-reported data), Northern Pulp releases $0.008\ \text{g-TEQ}$ (toxic equivalency) of dioxins and furans per year, which can be considered a very small amount similar to other industries that also emit dioxins and furans (Environment Canada, 2013). An attempt was made to model the emission of dioxins and furans from the Northern Pulp mill using the publicly available emissions rates. However, because the emission rate is extremely small ($2.535 \times 10^{-10}\ \text{g/sec}$) the model could not run because the surface concentrations were so low and completely uniform across the model, including Pictou Landing First Nation. This further highlights the low air emissions of dioxins and furans that are reported as being released from Northern Pulp.

Results

Ammonia

The highest ammonia concentration was found at the Settling Pond Outfall, with the second highest ammonia concentration found at Ground Zero (see Figure 24). The lowest ammonia concentrations were upwind of Boat Harbour. This is reasonable evidence to suggest that the elevated ammonia found at the Settling Pond Outfall and at Ground Zero are due to emissions from the mill (Ground Zero) and Boat



Harbour treatment lagoon. However, the ammonia concentrations observed in Pictou Landing First Nation are well below any ambient and occupational exposure limits and do not pose any health concern (Alberta Environment, 2005) – see Table 4. Ambient standards were not found; therefore occupational standards were used here.

Table 4
Ammonia (NH₃) Concentration Results

Seasonal mean (average)	Total mean	Maximum NH ₃ observed	Human health occupational exposure limit (8 hours)
Summer 2013	4.90 ppb		
Spring 2014	1.09 ppb	15.25 ppb	25 ppb
Summer 2014	3.18 ppb		

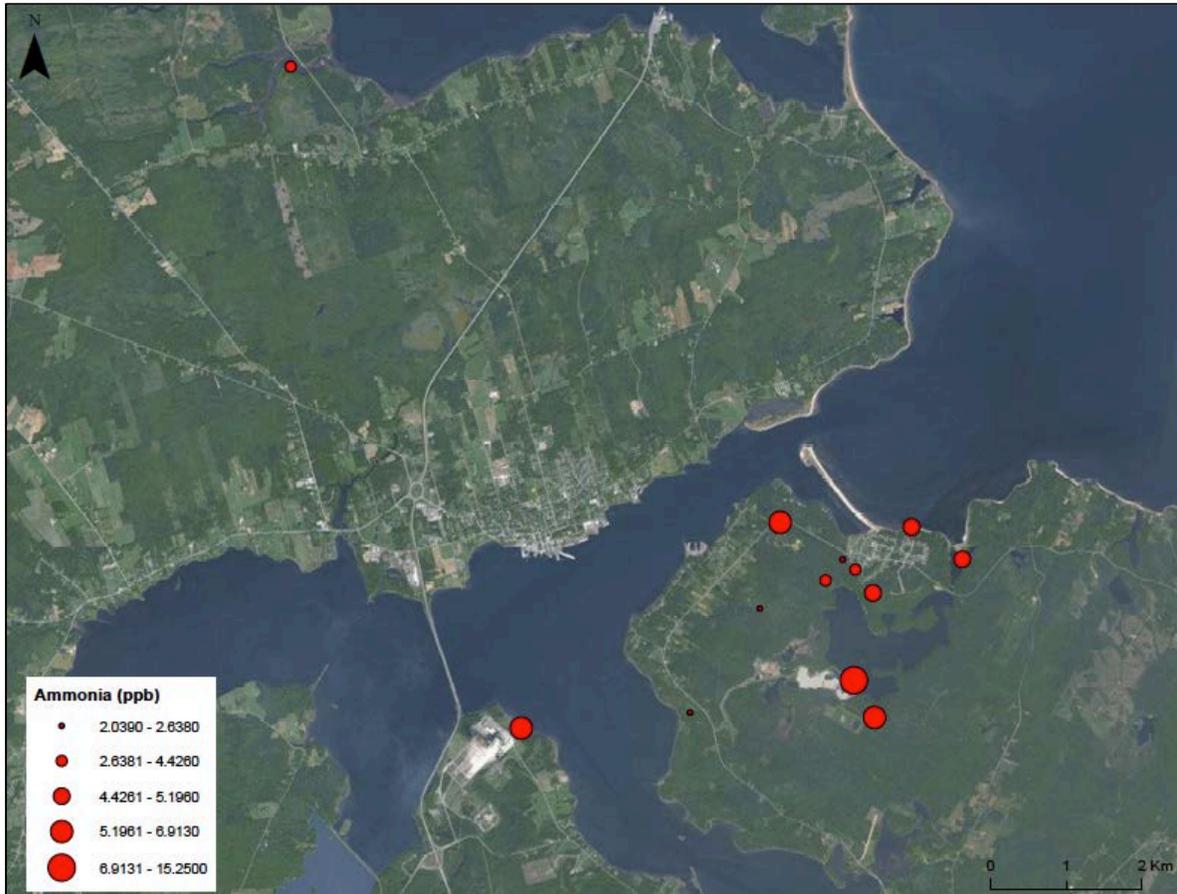


Figure 24. Spatial map of the average ammonia concentrations observed June 27, 2013 to July 31, 2014.

Sulfur Dioxide

The annual average **sulfur dioxide** concentration from Pictou Landing First Nation was 0.62 ppb, roughly double that found in Sydney and Cape Breton Highlands National Park, but still well below Canada's annual maximum air quality standard (22.9 ppb) – see Table 5.

Table 5
Sulfur Dioxide (SO₂) Concentration Results

Seasonal mean (average)		Total mean	Maximum SO₂ observed	Canada's annual maximum air quality standard
Summer 2013	0.70 ppb			
Spring 2014	0.41 ppb	0.62 ppb	5.56 ppb	22.9 ppb
Summer 2014	3.18 ppb			

The sulfur dioxide in Pictou Landing is likely not related to the Boat Harbour lagoon, but can be considered more of a background air pollutant carried from upwind sources that likely include some emissions from the mill and other local sources such as Michelin Tires and residential heating oil combustion.

A possible, but not definitive, reason for the increase in sulfur dioxide observed downwind of the mill is that stack plumes are impacting the ground as one moves away from the mill. This hypothesis is further supported because the prevailing wind is from the direction of the mill.

The sulfur dioxide concentrations are higher at the Boat Harbour Outfall (see Figure 25). This is an unexpected result as there are no strong sources of sulfur dioxide found at this site. However, it could be due to sea breezes carrying sulfur dioxide back onshore. Still, the sulfur dioxide concentrations observed across all sampling sites and sampling seasons are well below the US Environmental Protection Agency's National Air Quality Standards, even the 1-hour maximum level (75 ppb), and the Canadian Council of Ministers of the Environment Canada Wide Standard maximum annual acceptable amount (22.9 ppb).

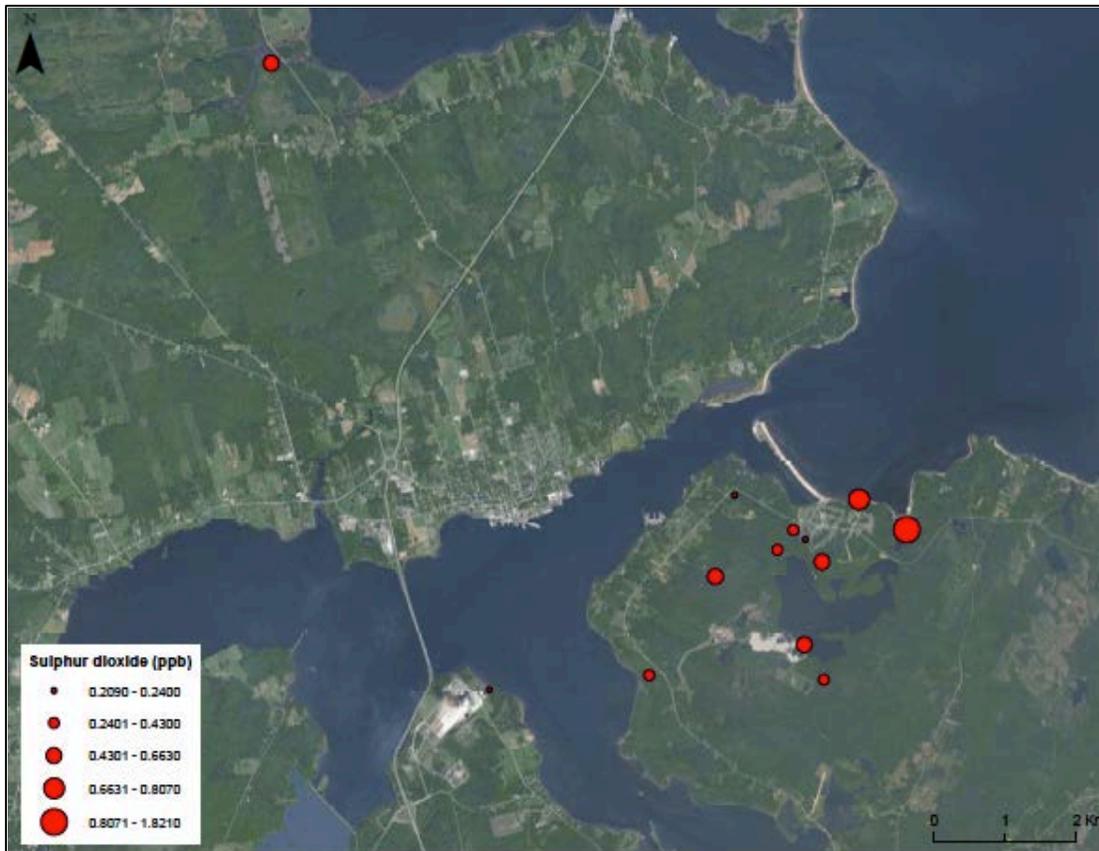


Figure 25. Spatial map of the average surface sulfur dioxide concentrations observed June 27, 2013 to July 31, 2014.

Nitrogen Dioxide

The nitrogen dioxide observed in Pictou Landing First Nation (see Table 6) can be considered to be similar to a city the size of Sydney, but still very low compared to larger cities in Canada that can experience nitrogen dioxide of approximately 10 ppb (metropolitan city roadways range between 22 ppb and 32 ppb; Brook, Dann, Galarneau, Herod, & Charland, 2014). As nitrogen dioxide is strongly linked to high-energy chemical reactions, for example, combustion of fuel for power, space heating, and transport, the nitrogen dioxide observed would be a mixture of background long-range transport into Pictou Landing First Nation likely combined with the mill, Michelin, New Glasgow, Trenton Power Station, residential heating and cooking, and local vehicle traffic. The highest average nitrogen dioxide (2.5-3.5 ppb) is found at the Boat Harbour aeration lagoon outflow (Settling Pond Outfall site; see Figure 26).

Table 6
 Nitrogen Dioxide (NO₂) Concentration Results

Seasonal mean (average)	Total mean	Maximum NO ₂ observed	Canada’s maximum desirable annual average
Summer 2013	1.38 ppb		
Spring 2014	0.75 ppb	6.02 ppb	32 ppb
Summer 2014	3.18 ppb		

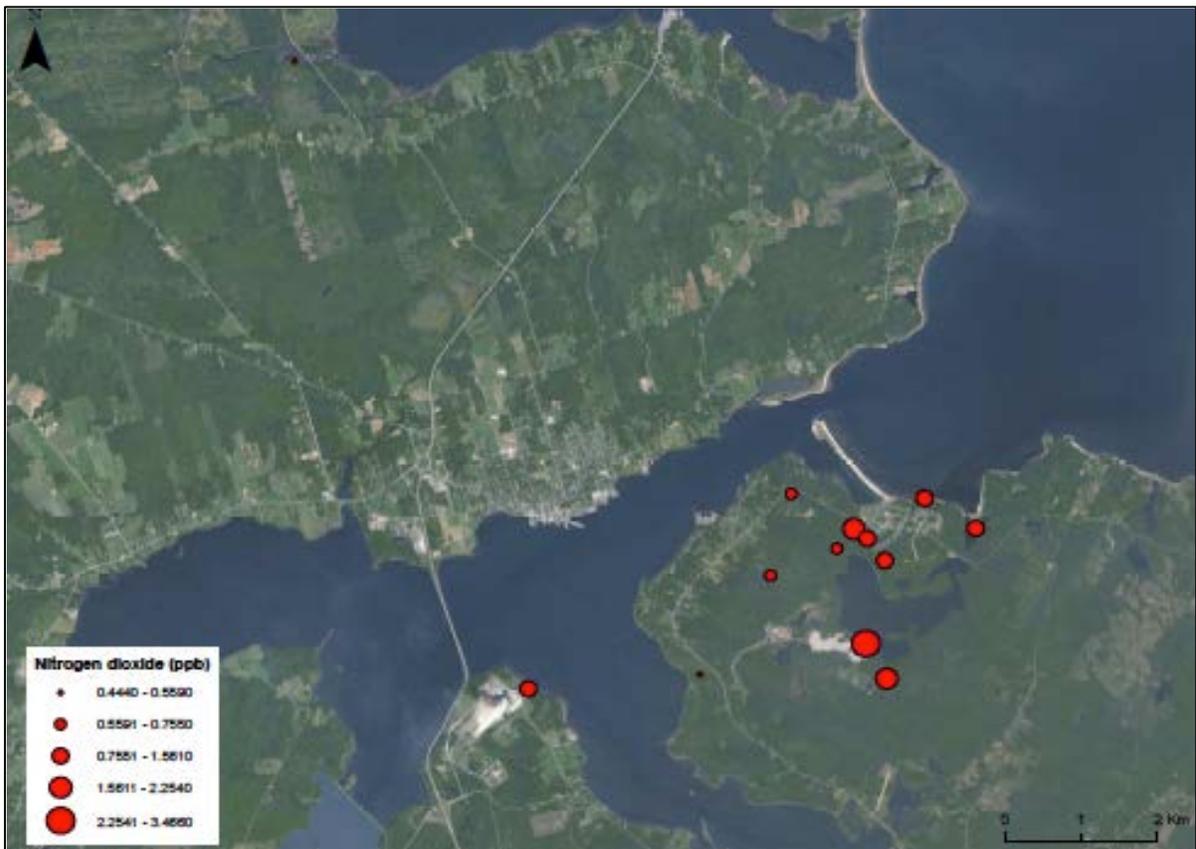


Figure 26. Spatial map of the average surface nitrogen dioxide concentration observed from June 27, 2013 to July 31, 2014.

As nitrogen dioxide is related to combustion, it is highly likely this is either diesel power equipment related to the aeration lagoon or lagoon service vehicles. The mean nitrogen dioxide concentrations are well below Canada’s maximum desirable annual average regulations (32 ppb).

Volatile Organic Compounds

To help place the VOCs measured at Pictou Landing into context, two samples of VOCs were collected in Halifax August 17-24, 2013, and August 24-31, 2013, and compared with VOC samples collected between June 28 and July 4, 2013, at Boat Harbour Outfall and Caribou Control. The comparison is shown in Figure 27.

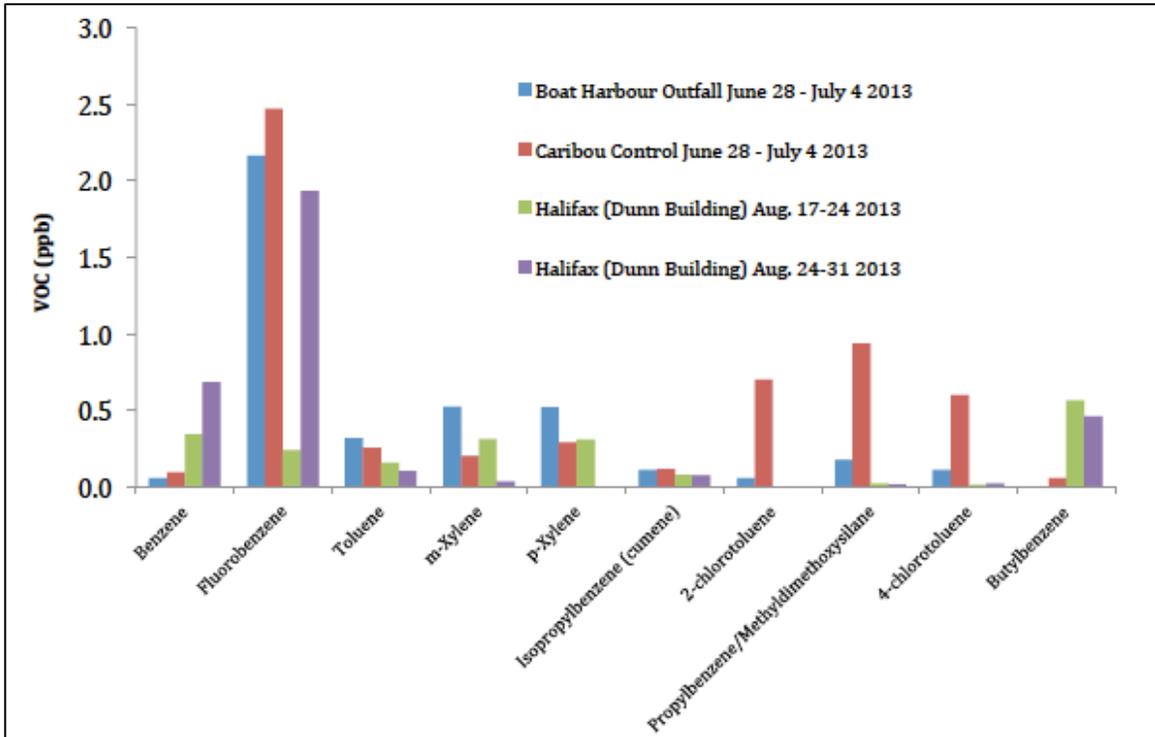


Figure 27. Comparison of volatile organic compounds (VOCs) measured at Pictou Landing First Nation with samples collected in Halifax.

In this regional comparison, five VOCs (fluorobenzene, 2-chlorotoluene, propylbenzene, methylmethoxysilane, and 4-chlorotoluene) were observed in greater amounts at Caribou Control and Boat Harbour Outfall compared with Halifax. The use of chlorine and fluorine in the kraft pulp and paper process and the large amounts of aromatic substances from the tree pulp and other chemicals are well known. The higher concentrations of these VOCs found at Caribou Control and Boat Harbour are likely related to emissions from the mill and being carried by the prevailing wind to Caribou Control and entering Boat Harbour by the mill’s effluent stream. The fact that these chemicals tend to be lower in the Halifax also adds weight to this argument.

The vehicle-related VOCs (benzene, toluene, and xylenes) were strongly associated with proximity to roads within Pictou Landing First Nation. The majority of VOCs that had higher concentrations within Pictou Landing appeared not to be associated with

Boat Harbour. Their source is likely related to vehicle emissions and wood and fossil fuel combustion for space heating and cooking. It is difficult to determine if any of these VOCs are related to the mill at this time. All of the VOCs measured were below ambient/indoor/occupational air quality guidelines.

Particulate Matter

PM_{2.5}, which is associated with gas-to-particle conversion or from combustion, accounts for 64% of the PM₁₀ mass concentration. Approximately 70% of the PM_{2.5} mass observed in Nova Scotia is from long-range transport from the northeastern United States and southern Ontario, carried to the region by the prevailing wind (Gibson et al., 2015).

Table 7 illustrates through fine particle number counts (associated with combustion and gas-to-particle conversions) and coarse particle number counts (related to wind-blown crystal material and ocean spray) that there are more fine particles per cubic centimetre that can be inhaled into our lungs than coarse particles. However, based upon these data, the concentration of PM_{2.5} and fine number counts are very low when compared to Beijing, where PM_{2.5} regularly reaches 500 µg/m³. It can be observed in Table 7 that the maximum observed PM_{2.5} concentration (35.45 µg/m³) is greater than the Canada Wide Standard (28 µg/m³). However, the maximum observed in Table 7 is for a five-minute average measurement and therefore not directly comparable with the Canada Wide Standard, which is an average of the 12 worst days measured over three years. It is common to see short-term “spikes” in monitoring over short periods of time such as five minutes. Once these are averaged over a day (e.g., 4.35 µg/m³ in Table 7), they become much reduced and more comparable to the Canada Wide Standards. To conclude, airborne particulate matter mass and number observed in Pictou Landing First Nation are well below air quality standards where they exist.

Table 7
Particulate Matter (PM) Concentration Results

Particle size	Average observed PM concentration	Minimum observed PM concentration	Maximum observed PM concentration	Air quality guideline
PM _{2.5}	4.35 µg/m ³	0.91 µg/m ³	35.45 µg/m ³	28 µg/m ³ *
PM ₁₀	6.77 µg/m ³	2.73 µg/m ³	39.55 µg/m ³	40 µg/m ³ **

* Guideline is taken from the Canadian ambient air quality guidelines (*Canadian Environmental Protection Act, 1999*)

** Guideline is European Commission Standard for annual average (Directive 2008/50/EC of the European Parliament); there is no PM₁₀ standard in Canada

An analysis of wind direction for PM mass and number concentrations was also performed. The main wind directional dependence for all three PM size fractions is from the NW and SW. The SW wind direction is in line with Boat Harbour but also the town of New Glasgow and the major highway. It is therefore difficult to determine if Boat Harbour is the source of $PM_{10/2.5/1}$ or other upwind local and long-range sources, which warrants further investigation. The $PM_{10/2.5/1}$ associated with NW airflow are in line with Pictou Landing First Nation and the roads therein, so are likely associated with gas combustion.

Since air pollution cannot be monitored everywhere at the same time, American Meteorological Society and United States Environmental Protection Agency Regulatory Model (AERMOD) air dispersion modelling offers a solution by estimating the impact of emissions from point sources on surface air quality within any given modelling area (Gibson et al., 2009, 2013a, 2013b). AERMOD was used to model the air dispersion of $PM_{2.5}$ from the Northern Pulp Mill stacks. The run time of the stacks was assumed to be 24 hours a day for a whole year. The AERMOD results illustrate how Pictou Landing First Nation is impacted by the mill's stack emissions (see Table 8 below).

Table 8
Summary of AERMOD $PM_{2.5}$ Surface Concentrations Attributable to Emissions from the Northern Pulp Mill

AERMOD modelling period	$PM_{2.5}$ concentration range ($\mu\text{g}/\text{m}^3$)
1-hr, Annual maximum	2.1 – 96.7
Annual average	0.013 – 0.451
1-hr, Winter maximum	1.0 – 96.7
Winter average	0.009 – 0.440
1-hr, Spring maximum	0.8 – 84.0
Spring average	0.014 – 0.646
1-hr, Summer maximum	0.5 – 54.3
Summer average	0.008 – 0.837
1-hr, Fall maximum	0.9 – 98.2
Fall average	0.014 – 0.440

The AERMOD surface concentrations maps showed that the highest concentrations of $PM_{2.5}$ are seen closer to the stacks; however, some locations farther downwind also show increased $PM_{2.5}$. These locations farther downwind are located on hills that likely intercept the mill stack plume centerline that has the highest $PM_{2.5}$ concentration. The maximum surface $PM_{2.5}$ concentration estimated to be attributed to the mill is $0.837 \mu\text{g}/\text{m}^3$, and was found during the summer. The maximum annual average was

found to be $0.451 \mu\text{g}/\text{m}^3$. These concentrations are well below the $\text{PM}_{2.5}$ Canada Wide Standard for a 24-hour period of $28 \mu\text{g}/\text{m}^3$. Therefore, the estimated $\text{PM}_{2.5}$ mass concentrations emissions from the mill, based upon reported emissions rates and stack characteristics, are of little impact to Pictou Landing First Nation. However, $\text{PM}_{2.5}$ health effects are not just related to the mass concentration but also the chemical, biological, and physical composition of the $\text{PM}_{2.5}$. Therefore, detailed information on the composition of the $\text{PM}_{2.5}$ modelled from the mill would also be needed to determine the potential health effects of the mill's $\text{PM}_{2.5}$ emissions on Pictou Landing residents. The AERMOD air dispersion modelling of $\text{PM}_{2.5}$ from the mill showed that there was some ground impact in Pictou Landing First Nation but at very low concentrations.

Despite not being able to obtain air quality data for the winters and falls of 2013 and 2014, a substantial data set was collected. All of the air quality data collected were below US National Ambient Air Quality Standards, the Canada Wide Standard, international standards, and/or occupational exposure standards where they existed. Some of the challenges encountered were inconsistent sampling times which made comparisons based on time problematic. There were also occasional Ogawa and TDT samples that were removed from the sites, and power losses at the active sites were not discovered until much later, leading to missed periods of time for data collection. Indoor air quality could also be a significant source of personal exposure, but the time and resource constraints within this project meant that these data were not collected.



7. Water Quality

Rob Jamieson (Associate Professor and Canada Research Chair, Department of Civil and Resource Engineering, Dalhousie University) led the water quality analysis component of the project. Staff from the Centre for Water Resources Studies, **Rick Scott** and **Justine Lywood**, also supported water sampling that was conducted with **Colleen Denny** and **Kim Strickland**. The findings reflect the water quality data that were collected in various locations around the community and from within Boat Harbour in the summer of 2013 (see Figure 28).

Water quality was sampled at eight locations. For each sample a range of tests were performed back in the lab. Water was tested for total **suspended solids**, **conductivity**, **E. coli**, **nitrogen**, **phosphorus**, and a range of **metals**. The water was also tested for its **biological oxygen demand**, **dissolved oxygen**, and **pH**. **Dioxins and furans** were tested in two Boat Harbour water samples that were taken on July 24, 2013. Of the six sites, two are located in Boat Harbour (BH1 and BH2), one is located at the mouth of Boat Harbour (BHB), one is located in a brackish zone downstream of the mouth (BHOF), and two are reference sites: one on a spring that discharges into Boat Harbour (FF), and one on a surface water system adjacent to Boat Harbour (FP).





Figure 28. Water sampling sites. Note: The pink sites were chosen as reference sites, not affected by Boat Harbour effluent.

What's being sampled?

Suspended solids are all particles in the water column that will not pass through a filter. As levels of total suspended solids increase, a water body begins to lose its ability to support a diversity of aquatic life.

Conductivity was also tested; it is an indirect way to measure the total dissolved solids of the water. A high conductivity indicates that the water is most likely impacted by industrial discharge.

E. coli is a type of fecal coliform bacteria found in the intestines of humans and animals. If present, it points to recent sewage or animal waste contamination that is not necessarily harmful, but which indicates the possibility of other harmful pathogens in the water.

Nitrogen and **phosphorus** are often found to be the limiting factors of plant growth in aquatic systems. The more of these nutrients that are present, the more plant growth can arise which means less oxygen in the water and a more stressful environment for aquatic life.

Metals that were tested for in the water samples included aluminum, silver, arsenic, cadmium, copper, iron, nickel, lead, selenium, uranium, and zinc, with different levels of toxicity. Some, like arsenic, are naturally occurring in Nova Scotia.

Biological oxygen demand is the amount of oxygen consumed by microorganisms in decomposing organic matter in a period of five days. If more oxygen is consumed than is produced, the amount of **dissolved oxygen** declines, which can negatively affect aquatic life.

The **pH** shows if the water is basic or acidic. Changes in pH can affect how chemicals dissolve in the water and whether organisms will be affected by them at all.

Dioxins (polychlorinated dibenzodioxins) and **furans** (polychlorinated dibenzofurans) are highly persistent compounds with a strong affinity for sediments and a high potential for accumulating in biological tissues. Dioxins and furans enter the environment mainly through waste incineration and **pulp and paper processing**, and have been found in very small amounts in all parts of the environment including air, water, soil, sediments, animals, and foods. All animals and humans in Canada are exposed to some level of these substances. Large exposures can lead to a variety of serious health problems (Health Canada, 2006).

Results

In general, the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007b) **were exceeded by water samples within Boat Harbour (BH1, BH2, and BHB – marked green in Figure 28) and directly leaving Boat Harbour (BHOE)**. For the surrounding sample sites, FF and FP, water quality guidelines were met, except in the case of some heavy metals (silver – both sites; zinc – FF only; iron and lead – FP only).

- The amount of total **suspended solids** in Boat Harbour and directly leaving Boat Harbour were above available guidelines for aquatic health, but still within typical guidelines for wastewater effluent.
- **Conductivity** levels in samples from within Boat Harbour and the BHOE sites indicate waters are most likely impacted by industrial discharge.
- **E. coli** levels at all sites were within guidelines considered acceptable for recreational use. On two occasions, *E. coli* levels were beyond what is considered safe for irrigation onto food crops (BHB on July 12, FP on July 26).
- The amount of **nitrogen** in water samples was below the water quality guideline for the protection of aquatic life.
- **Phosphorus** national guidelines for the protection of aquatic life do not exist, but there are trigger ranges delineated by the CCME that characterize ecosystems with different phosphorus concentrations. Within Boat Harbour, the concentrations exceed the hyper-eutrophic trigger range. Hyper-eutrophic aquatic systems are characterized by excessive plant and algae growth, poor water clarity, and low dissolved oxygen levels, making it difficult for aquatic life to survive.
- Of the metals tested, **aluminum, iron, lead, silver, and zinc** were all above CCME recommended levels for protection of aquatic life.
- **Biological oxygen demand** from within Boat Harbour and BHOE (Boat Harbour Outfall) were generally 5-12 mg/L, which is a typical concentration for effluent leaving a sewage treatment plant, but indicates that Boat Harbour is influenced by organic wastewater discharges.
- **pH** levels were within the accepted range for aquatic life.
- Both water samples tested for **dioxins and furans** were below available guidelines for drinking water quality (10 TEQ). There are no guidelines for the protection of aquatic life.

In summary, the water quality analysis demonstrated that the discharge of pulp and paper mill effluent to Boat Harbour has degraded the quality of water within Boat Harbour, with concentrations of several water quality parameters exceeding available guidelines for the protection of aquatic life. The water quality measured in the reference sites was much better, but a small number of samples still had concentrations of metals that exceeded water quality guidelines for the protection of aquatic life. A number of different industrial sources in the region could be contributing to these background levels of metals found within the reference sites.

8. Soil Quality

In addition to water quality, **Rob Jamieson** led the soil sampling component of the project. Representatives from the Centre for Water Resources Studies, Dalhousie University, collected soil samples from current or potential future sites of vegetable gardens at 13 residential properties around Pictou Landing First Nation (Samples #1-12 and #14) and one reference location near the shore of Boat Harbour (Sample #13) on October 3, 2014. The soil was analyzed for various **metals** as well as **dioxins and furans**, and the results were compared to national guidelines for acceptable concentrations of dioxins, furans, and metals in soil. Metals that were tested for included aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, rubidium, selenium, silver, strontium, thallium, tin, uranium, vanadium, and zinc.

On June 25, 2015, additional soil sampling was completed to confirm the 2014 sampling results. Soil samples were collected from two residential properties (Samples #15 and #16), one recreational property in Pictou Landing First Nation (Sample #17), and three reference locations in the town of Pictou (Samples #18-20). The soil samples were again tested for dioxins, furans, and metals.

Three soil subsamples were taken at each property and were then combined to obtain a composite sample. The sampling included the upper layer of the soil (to a depth of 0.2 m) so the results represent only these depths. The sample locations are shown in Figure 29.

Results

The federal guidelines from the Canadian Council of Ministers of the Environment (CCME, 2014) were used to compare the soil sample concentration results to the recommended Canadian guidelines for the protection of human and environmental health.

Metals

For three samples, metal concentrations in the soil exceeded the federal guidelines. Two instances of **arsenic** concentrations above the guideline of 12 mg/kg were found, in Sample #1 (41 mg/kg) and Sample #16 (13 mg/kg). Arsenic is common in the natural geology of many regions in Nova Scotia and therefore the observed concentration may be of natural origin. However, as the levels do exceed the CCME guideline, it would still be advised to avoid using the soil on these two properties for the establishment of vegetable gardens, and to minimize disturbance and contact with the soil.

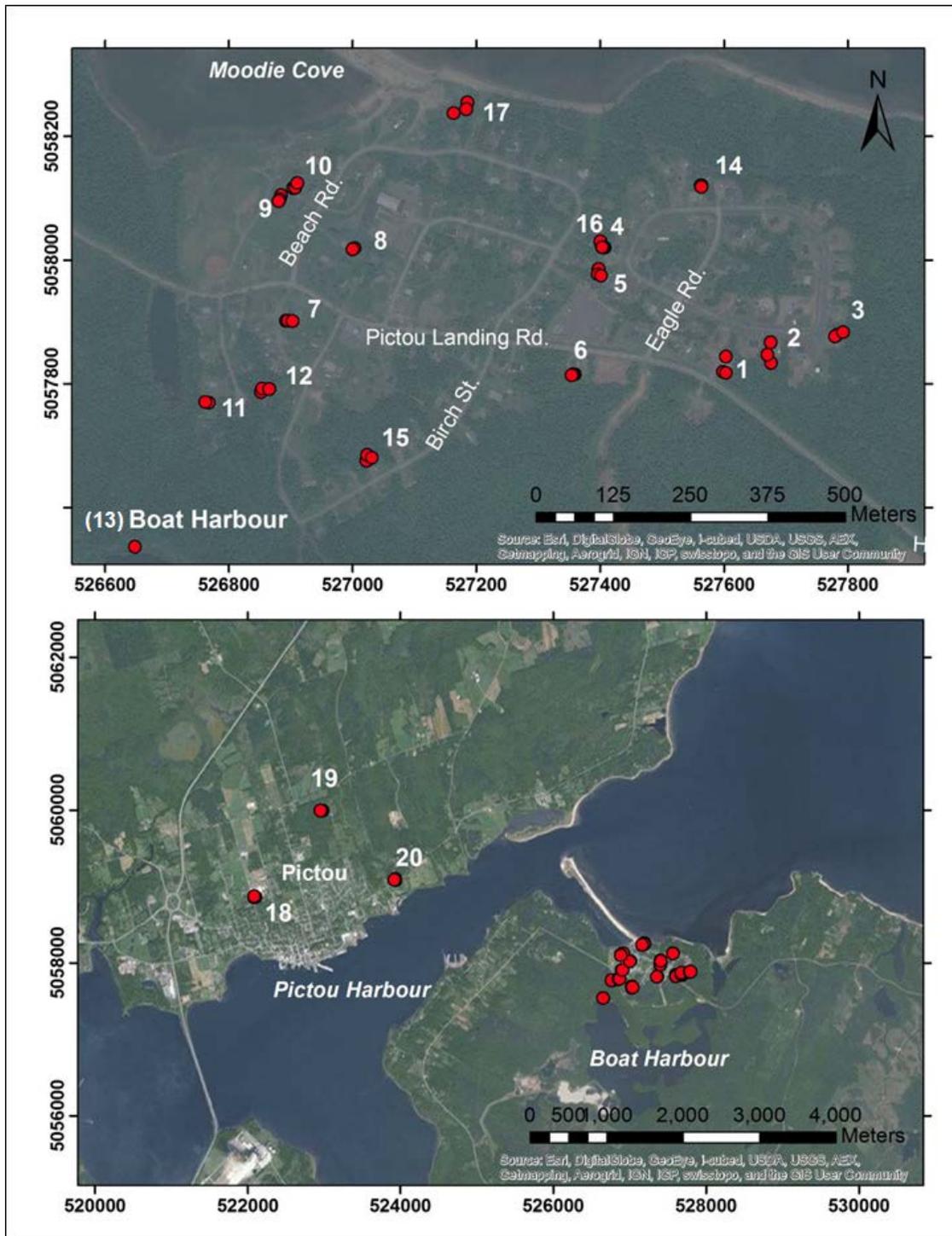


Figure 29. Plan view map of the 2014 and 2015 soil sampling locations in (upper map) Pictou Landing First Nation and (lower map) the town of Pictou.

In addition, **copper** exceeded the guideline level at one site, Sample #4. The copper concentration at that site was 330 mg/kg, well above the CCME environmental quality guideline of 63 mg/kg, but not above the CCME level for human health effects (1100 mg/kg). The source of the copper in Sample #4 is unknown; however, that sample was taken directly from an existing vegetable garden. If fertilizer was added to this garden, there might have been introduced copper from copper sulfate, which is present in some common soil amendments. Site #4 was resampled during the second round of sampling, and the copper concentration was then below the CCME guidelines.

Dioxins and Furans

The results for **dioxins and furans** were compared to the Canadian Soil Quality Guidelines (CCME, 2002). The guideline value is based on background concentrations observed in the environment and not on observed or predicted adverse human health effects. Therefore, any concentrations observed above the dioxin and furan guideline level may not necessarily cause negative human health effects.

In the first round of sampling, two soil samples had slight exceedances of the CCME guideline value for dioxins and furans. The exceedances were observed in Samples #4 and #6, where concentrations were 8.77 and 5.28 TEQ (ng kg⁻¹), respectively. The CCME guideline is 4 ng kg⁻¹. The source of dioxins and furans are unknown in these two samples. The property where Sample #6 was collected had imported fill in the backyard at the sample collection points. It is possible that the slightly elevated concentrations of dioxins and furans may be due to a previous use of the imported fill. Sample #4 (which also had elevated levels of copper in the first sampling round) showed elevated dioxins and furans as well. According to Rob, while the dioxin and furan concentration was above the CCME guidelines, it is typical of the range of soil concentrations found throughout Canada. In personal communication Rob stated: "There are small amounts of these chemicals in soils everywhere due to atmospheric deposition." Site #4 was resampled during the second round of sampling and concentrations of all contaminants, including dioxins and furans, were below the CCME guidelines.

In summary, the soil results indicate **the soil is generally safe** for vegetable harvest intended for human consumption and direct contact in terms of metals and dioxin and furan concentrations. Contaminant concentrations in samples obtained from Pictou Landing First Nation and the background samples from the town of Pictou were similar.

9. Ecotoxicology and Sediment Analysis

Ron Russell (Associate Professor, Department of Biology, Saint Mary's University) led the ecotoxicology analysis, which sought to investigate how living things are affected by Boat Harbour. His objective was to collect and analyze Boat Harbour sediments, plankton, and mammals for a variety of potentially toxic chemicals commonly observed in environmental samples. He also attempted to estimate the toxicity of Boat Harbour water to a variety of common vertebrates and describe the structure of the aquatic ecosystem.

In the summer of 2013, Ron, Community Research Associates **Kim Strickland** and **Colleen Denny**, and Research Assistant **Geoff Kershaw** collected sediment and plankton samples from three locations: (1) near the aeration pond outfall, (2) near the dam, and (3) midway between the previous two locations. They collected three sediment samples at each location; thus, in total they



collected nine soil/sediment samples, which underwent chemical analysis to test for **polychlorinated biphenyls (PCBs)**, **historic use pesticides**, **chlorophenols**, **brominated diphenyl ethers**, and **polychlorinated dibenzodioxins and furans**. Samples were prepared and analyzed by Research Productivity Consultants (RPC) of Fredericton, New Brunswick. Plankton sampling was intended to provide qualitative data only, and four samples were taken from within Boat Harbour.

Ron also collected about 200 L of water to use in toxicity tests. Ron exposed wood frog tadpoles, green frog tadpoles, recent metamorphs, and adult and young-of-year mummichogs (small killifish) to Boat Harbour water of varying dilutions for 7 days (acute toxicity tests) in Ron's lab. Adult frogs were exposed to 100% and 75% (diluted) Boat Harbour water for over 96 hours.



Additionally, a resident of Pictou Landing, **Durney Nicholas**, trapped a total of 12 muskrats and four beavers around Boat Harbour for tissue sample analysis between November 2014 and January 2015. Tissue samples were taken from these animals and compared to sediments from the bottom of Boat Harbour. Samples were once again prepared and analyzed by RPC.

Guidelines

Federal guidelines from the CCME and Environment Canada were used to compare the pollutant concentrations in sediments with the recommended Canadian guidelines for the protection of aquatic life. Canadian soil guidelines for the protection of human and environmental health and tissue guidelines for the protection of consumers of aquatic wildlife were also used where appropriate (CCME, 2014). Results for total PCBs were compared to sediment guidelines for the protection of aquatic life and soil guidelines for the protection of environmental and human health. Sediment guidelines for chlorophenols are not available. CCME sediment quality guidelines for dioxins and furans for the protection of aquatic life were compared against sediment sample results. There are no consumption guidelines for dioxins in human food in Canada. The European Union has established maximum levels of dioxin and related compounds in the European human food chain. The European Union does not state maximums for wild-caught terrestrial food, but has developed guidelines for a number of domesticated livestock species (EU, 2011). This report distinguishes between muscle and liver dioxin concentrations and considers the toxic contribution of dioxin-like PCBs to the overall toxicity (TEQ) of the meat.

Results

Plankton Community Structure

Boat Harbour exhibits a distinct truncated community profile for plankton where the rotifers are the largest planktonic organisms present in all samples. Common groups such as copepods, cladocerans, ostracods, and insects were absent from all samples. Equally alarming was the low biodiversity observed in these samples. High densities and biomasses of known pollution-tolerant species were observed in the Boat Harbour samples.

Toxicity Tests

Mummichogs are known to be highly tolerant of fluctuating salinities, temperatures, hypoxia, and pollution (Eisler, 1986). For these reasons, they are considered to be the ideal candidate for acute and chronic toxicity experiments. Both adult and young-of-year mummichogs exhibited 100% mortality in the full concentration Boat Harbour water by 168 hr (Figure 30). The young fish reached 100% mortality at 120 hr while the adults endured somewhat longer to 168 hr with the undiluted Boat Harbour water. The adult mummichogs reached about 60% mortality in the 75% dilution water, and about 35% mortality in the 50% dilution water, after 168 hr. Adult mummichog mortality in the 25% dilution water did not differ from the control which contained no Boat Harbour water.

Young mummichogs showed greater mortality earlier in the experiment than adults (Figure 30). Young mummichogs reached 100% mortality in the 75% Boat Harbour water dilution and about 30% mortality in the 25% dilution after 168 hr. It is clear that young fish are less able to persist in Boat Harbour water than adults.



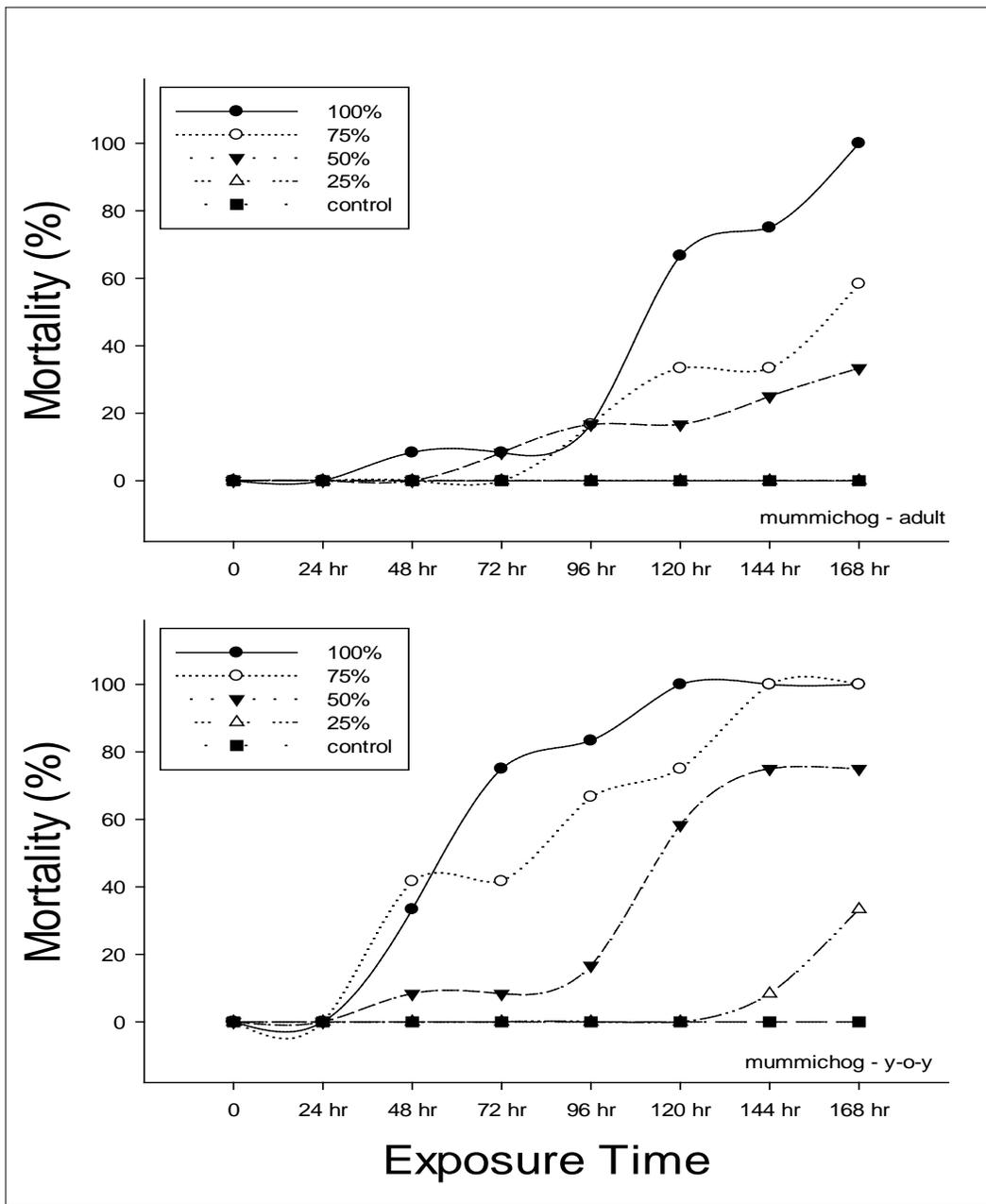


Figure 30. Acute toxicity of Boat Harbour water (undiluted and diluted to 75%, 50%, and 25%) to adult and young-of-year mummichogs.

Wood frogs have a near cosmopolitan distribution in Canada. They are a forest-dwelling species and reproduce in fishless ponds, so they are expected to be common around Boat Harbour; however, none were observed during the course of this study. Wood frog tadpoles reached 100% mortality in all dilutions of Boat Harbour water and reached 100% mortality in the full-concentration Boat Harbour water in less than 48 hr (Figure 31).

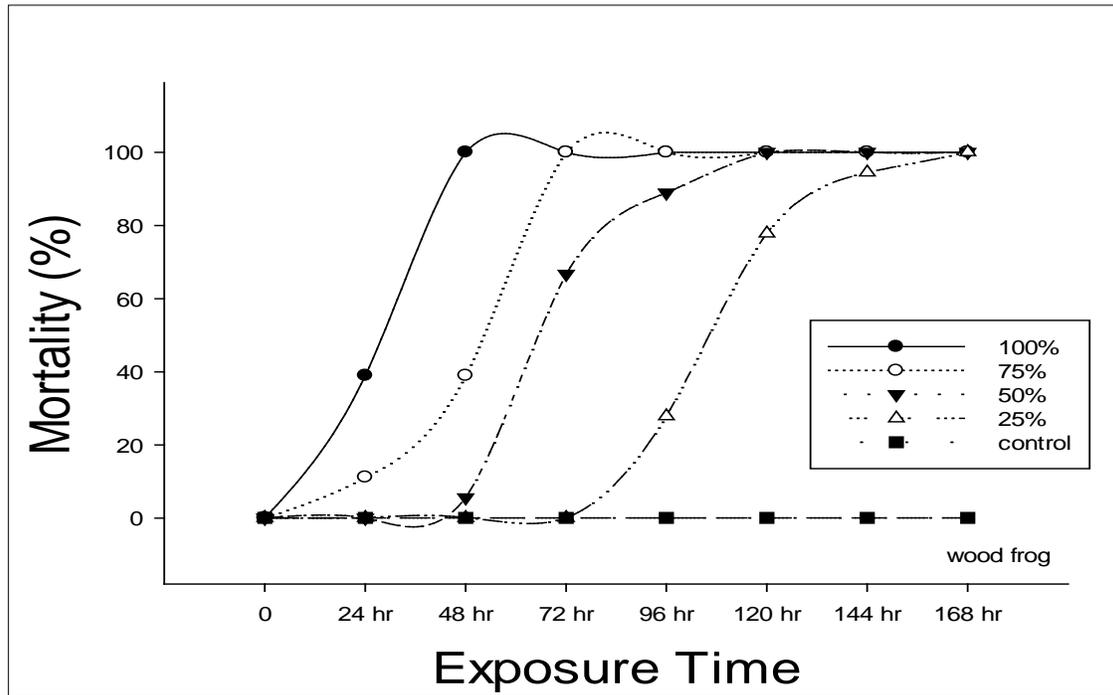


Figure 31. Acute toxicity of Boat Harbour water (undiluted and diluted to 75%, 50%, and 25%) to wood frog tadpoles.

Green frogs are a common and widely distributed species in Nova Scotia. They are tolerant of pollution and a pioneer species so are expected to be present in and around Boat Harbour. Adult green frogs were observed around the lower periphery of Boat Harbour. Stage 25 green frog tadpoles are the first feeding stage in these organisms. Tadpoles at this stage reached 100% mortality in the 100%, 75%, and 50% dilutions in less than 168 hr (Figure 32). The 25% dilution caused about 50% mortality in the same time frame. Stage 30 tadpoles are significantly larger and more fully developed than stage 25 green frog tadpoles. The stage 30 green frog tadpoles were clearly better able to survive, with 100% mortality observed in only the full concentration of Boat Harbour water (Figure 32).

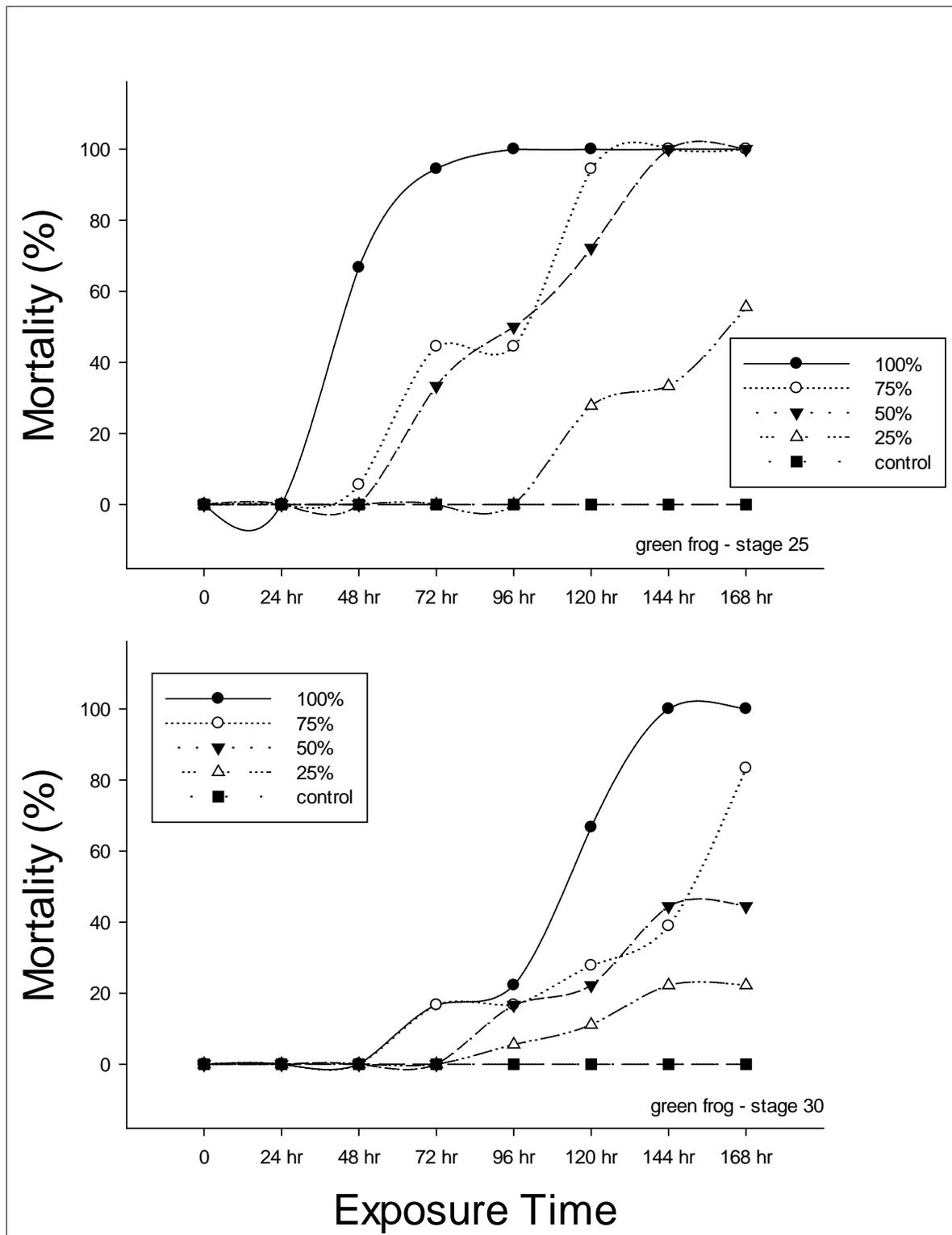


Figure 32. Acute toxicity of Boat Harbour water (undiluted and diluted to 75%, 50%, and 25%) to stage 25 and stage 30 green frog tadpoles.

Bullfrogs are the largest and potentially most tolerant of the amphibians to pollution (Weis, 1975). They are commonly found in rivers and large lakes are thus expected to be present in Boat Harbour. Bullfrogs were never observed in Boat Harbour over the course of this study. Bullfrog tadpoles showed a similar pattern of mortality as green frog tadpoles (Figure 33), with 100% mortality occurring in both the full concentration and 75% concentration treatments.

These data indicate that the three amphibian species probably cannot reproduce in Boat Harbour due to acute toxicity to early life stages.

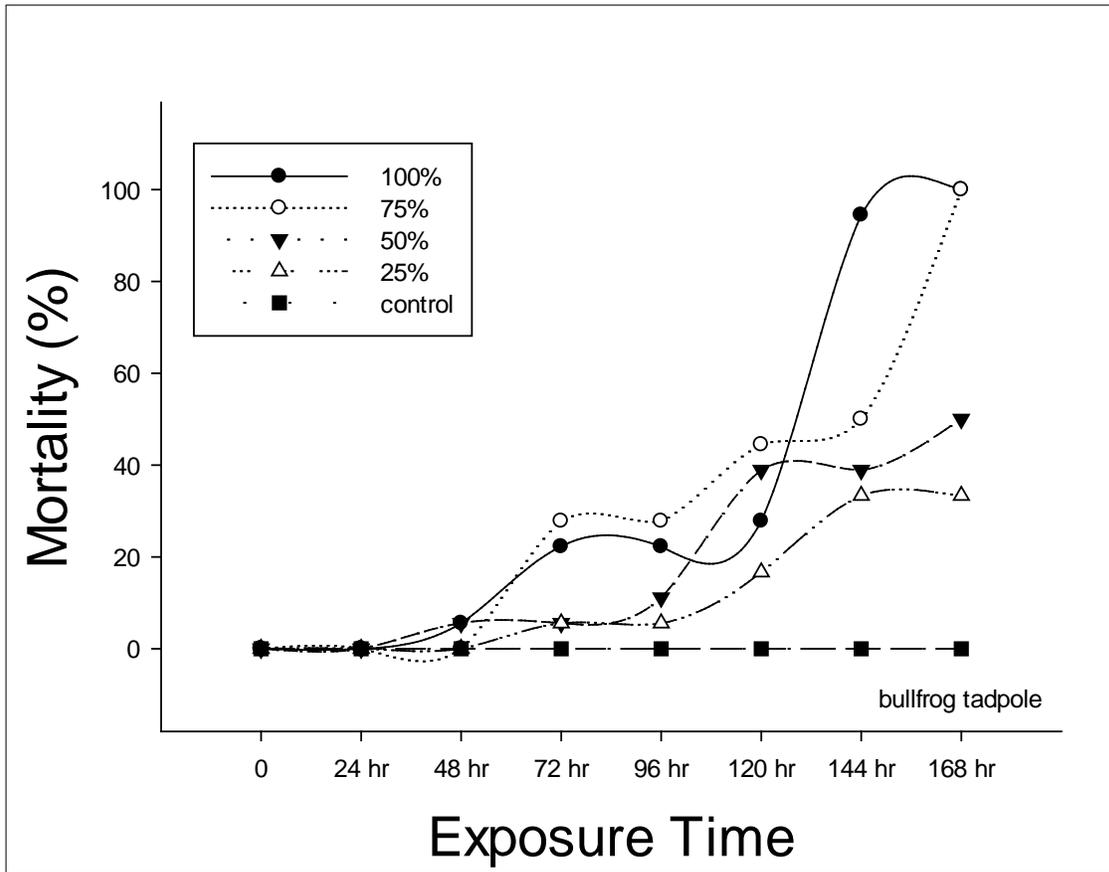


Figure 33. Acute toxicity of Boat Harbour water (undiluted and diluted to 75%, 50%, and 25%) to bullfrog tadpoles.

PCBs in Sediments and Plankton

All PCB concentrations measured in plankton and sediments were below CCME guidelines and are thus of little concern. PCB concentrations in Boat Harbour sediments are best described as background and do not indicate a point source in the area. Dioxin-like PCBs were routinely detected in both sediment and plankton; however, their

contribution to the TEQ was very low, typically less than 1 ng TEQ/kg. This indicates that observed toxic effects were most likely not due to PCB accumulation.

Pesticides in Sediments

All pesticide concentrations in Boat Harbour sediment were below CCME guidelines and below the detection limit of the analytical method of 0.05 mg/kg. This most likely indicates low historic use of pesticides in the Boat Harbour area. Toxicity arising from the past application of pesticides is of low concern.

Chlorophenols in Sediments

Chlorophenol concentrations were low. There are no sediment guidelines for phenols; however, all concentrations measured for phenols in sediments were well below the soil quality guideline of 3.8 mg/kg for phenol and 7.6 mg/kg for pentachlorophenol. Phenols are highly toxic, bleached kraft mill waste products, but there is little accumulation of these compounds in Boat Harbour sediments.

Polybrominated Diphenyl Ethers (PBDEs)

PBDEs were observed in all plankton and sediments samples. All concentrations were below federal sediment quality guidelines (Environment Canada, 2013). Relatively low concentrations of PBDEs were observed in sediments with no apparent pattern among sediment sampling locations. PBDE concentrations were lower yet in plankton and lower again in Boat Harbour mammals. There is no indication of magnification of PBDEs in the Boat Harbour ecosystem.

Polychlorinated Dibenzodioxins and Furans (PCDDs and PCDFs)

The distribution of dioxins and furans in sediments show that concentrations were greatest at the midway location and least near the aeration pond outfall. There is no simple explanation for this distribution. It could be due to historic changes in PCDD and PCDF concentrations in effluent, spatially variable sediment deposition, or the bottom profile of the sampled locations.

The most toxic sediments were found at the midway location, and the least toxic sediments were at the aeration pond outfall. The only conclusion possible is that PCDDs and PCDFs are found in Boat Harbour sediments, but they are not evenly distributed. PCDD and PCDF TEQs exceed both CCME interim sediment quality guidelines and probable effect level guidelines (CCME, 2001). Toxic effects on aquatic life are expected based on the calculated TEQs, and it is clear that the aquatic community is severely degraded.

Mean plankton TEQ for dioxins, dibenzofurans, and dioxin-like PCBs was 0.20 pg TEQ/g wet weight (SD = 0.03 ng TEQ/kg; Table 9), which is less than the CCME guideline. Clearly, PCDDs and PCDFs are accumulating in the Boat Harbour planktonic food web;

however, the severely degraded aquatic community with truncated structure may present few opportunities for these highly bioaccumulative compounds to be magnified with passage through the food web.

Table 9
Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg wet weight) in Boat Harbour Plankton

Sample	Dioxins		Dioxins + Dioxin-like PCBs	
	Mean	Std. Dev.	Mean	Std. Dev.
Plankton #1	0.18	0.03	0.02	0.03
Plankton #2	0.24	0.03	0.01	0.03
Plankton #3	0.18	0.03	0.02	0.03
Mean	0.20	0.03	0.02	0.03
Std. Dev.	0.03	0.03	0.01	0.03

Table 10 outlines wet weight TEQs for dioxins (including furans) and dioxin-like PCBs for Boat Harbour beaver and muskrat muscle and liver tissues. Dioxin TEQs in beaver muscle were slightly less than dioxin TEQs in plankton. Dioxin TEQs for beaver liver and muskrat muscle and liver were greater than TEQs in plankton; however, standard deviations were large in beaver liver and muskrat tissues, obscuring any real differences between these tissues and plankton. There is no clear evidence for magnification of dioxins and furans in beavers and muskrats.

Table 10
Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg wet weight) in Beaver and Muskrat Muscle and Liver

Sample	Dioxins		Dioxin-like PCBs		Dioxins + Dioxin-like PCBs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Beaver muscle	0.11	0.05	0.02	0.01	0.13	0.05
Beaver liver	0.60	0.22	0.07	0.05	0.68	0.27
Muskrat muscle	0.47	0.27	0.01	0.01	0.48	0.27
Muskrat liver	0.63	0.27	0.02	0.01	0.66	0.28

The European Union has specified maximum levels of dioxin and dioxin-like chemicals allowable in human food, but currently no similar guideline exists in Canada. TEQs for dioxins and dioxin-like PCBs are expressed on a per unit lipid basis since these are highly lipid-soluble compounds and are expected to be found predominantly in fatty tissues. Lipid-based TEQs for beaver and muskrat tissues exceed European Union guidelines for all meat except the guideline for beef and mutton (Table 11). Considering variability in the data set, all beaver and muskrat tissue TEQs are within one standard

deviation of the EU guideline. One must use this guideline with caution, since wild-caught foods such as beaver and muskrat do not appear on any guideline, presumably since they are traditionally not found in commercial food preparation and retail marketing.

Table 11

Dioxins (Including Furans) and Dioxin-like PCB TEQs (ng WHO-TEQ/kg lipid weight) in Beaver and Muskrat Muscle and Liver

Sample	Dioxins		Dioxin-like PCBs		Dioxins + Dioxin-like PCBs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Beaver muscle	2.43	0.83	0.47	0.13	2.90	0.94
Beaver liver	13.92	4.31	1.58	0.60	15.50	4.66
Muskrat muscle	8.21	0.79	0.31	0.19	8.53	0.78
Muskrat liver	15.41	6.83	0.59	0.10	16.00	6.92

It is clear that the Boat Harbour aquatic ecosystem is severely degraded, most likely due to a combination of hyper-eutrophication (resulting in low oxygen), high water temperature, decreased sunlight penetration due to heavy coloration, and toxic chemical input. This is not a new observation. Peer (1972) documented significant changes in the marine benthic community downstream of Boat Harbour a mere two years following the opening of the kraft pulp mill at Abercrombie Point. Proposed causes included changes in tidal flow caused by damming the previously tidal estuary and the Middle and West Rivers (Peer, 1972) and promotion of toxicity of pulp mill effluents due to flocculation of material upon entry to the marine environment.

Boat Harbour water is toxic to both fish and amphibians in the lab. None of the experimental groups survived 168 hr (7 days) in undiluted Boat Harbour water; however, adult mummichogs, stage 30 green frog tadpoles, and bullfrog tadpoles all survived over 7 days exposure in dilute Boat Harbour water. While Boat Harbour water may not exhibit acute toxicity over the traditional 96 hr exposure period to adults and more highly developed stages of organisms, it is acutely toxic at early developmental stages as demonstrated by calculated median lethal concentrations. This would prohibit any of the organisms tested from establishing viable populations in Boat Harbour under current environmental conditions. It must be considered that these toxicity tests conducted under laboratory conditions minimized the negative effects of high water temperature and hypoxia that were present in Boat Harbour. The toxicity tests therefore slightly *underestimate* the real conditions in Boat Harbour at the water collection period.

PCBs, persistent pesticides, and chlorophenols were detected at low concentrations or below detection limits in sediment and plankton. All of these compounds are capable of eliciting a wide range of toxic responses in aquatic organisms and humans and thus could contribute to the overall toxicity observed in Boat Harbour. The small concentrations in sediments indicate that these compounds do not pose a significant problem in Boat Harbour, presently or in the future. Sediments can act as a repository for many persistent organic compounds, releasing them into the aquatic environment for many generations (Russell, Hecnar, & Haffner, 1995). Since PCBs and most of the pesticides present in the analysis have been banned in Canada for many years, it is highly unlikely that they will increase in concentration in sediments in the future. Chlorophenols are mostly water-soluble chemicals and do not accumulate to a great degree in sediments.

Polybrominated diphenyl ethers (PBDEs) are structurally similar to PCBs, and like PCBs, they exhibit nervous system toxicity, reproductive and developmental disruption, endocrine disruption, and cancer at high doses (Birnbaum & Staskal, 2004). They are highly persistent in the environment, subject to long-range transport in the atmosphere, and highly bioaccumulative. These compounds were detected in all sediments, plankton, and mammal tissues. Sediment concentrations were below published guidelines and PBDE concentrations in plankton and mammal tissues were low. There was no indication of magnification through food web processes, possibly since the Boat Harbour food web is degraded and there are few opportunities for biomagnification. PBDEs in the environment is a global issue, but these compounds probably do not make a significant contribution to the toxicology concerns at Boat Harbour due to their low concentrations. Due to the persistent nature of highly brominated PBDEs, they will be retained in the sediments for many generations.

Dioxins and dioxin-like compounds were detected in all samples. The TEQ for dioxins was above the interim sediment quality guideline and probable effects level for all sampling locations. Dioxins and dioxin-like compounds are persistent chemicals and are expected to accumulate in sediments and in lipids (fat) of biota. The concentrations of PCDDs and PCDFs measured in Boat Harbour sediments raise concerns.

Dioxin concentrations in plankton were considerably less than concentrations measured in sediments. Boat Harbour plankton are most likely contaminated by the freely dissolved portion of dioxins in the water column and by contaminated suspended particles. Food web effects are not apparent since the Boat Harbour food web is very short. Tertiary (third-level) consumers and successive levels of primary and secondary consumers and producers are absent. There are few opportunities for biological magnification of dioxins by passage through the food web structure, unlike less disturbed ecosystems (Braune & Simon, 2003; Ross et al., 2004), where tertiary predators can accumulate high concentrations of dioxins.

Concentrations of dioxins and dioxin-like compounds in beaver and muskrat tissues were low, but detectable. Liver exhibited consistently higher concentrations than muscle, since metabolic detoxification pathways are predominantly found in the liver. Dioxin TEQs in mammal tissues were approximately the same as plankton and significantly lower than TEQs calculated for sediment.

There are no guidelines for consumption of dioxins and furans in Canadian foods. The CCME soil quality guideline for soil ingestion is 4 ng TEQ/kg (4 pg TEQ/g; CCME, 2002, 2007a) for the protection of environmental and human health. It is recognized that dioxins and dioxin-like compounds are accumulated primarily through the diet (Fries, 1995). Greater than 90% of human exposure to dioxins is through diet, mainly meat, dairy products, fish, and shellfish (WHO, 2014). Health Canada recommends a “tolerable” level of dioxin consumption from all sources of 2.3 pg/kg of body weight/day and 70 pg/kg of body weight/month (Health Canada, 2005). Beaver and muskrat are not part of the commercial food industry; however, dioxins in both muscle and liver of these mammals exceed European Union guidelines for most commercial meats.

Recommendations

There are multiple serious problems with the ecotoxicology of Boat Harbour. Remediation of any single issue could exacerbate other problems, so a remediation plan should consider all problems. The primary organic pollutants of concern in sediments are dioxins and furans. Contact with Boat Harbour sediments should be avoided. The movement of these pollutants off site should be evaluated, particularly potential contamination of downstream marine habitats. Additionally, biological vectors of dioxins and furans moving these pollutants from the aquatic environment to the terrestrial environment should be assessed. Although concentrations of dioxins and furans in tested mammals were low, consumption of beaver and muskrat tissues, particularly liver, could still result in exceeding recommended consumption limits.



10. Tree Core Sampling

In the summer of 2013, **Geoff Kershaw, Colleen Denny, and Kim Strickland** cored tree rings for testing and analysis at the Mount Allison Dendrochronology Laboratory (MAD Lab, now the Mistik Askiwin Dendrochronology Laboratory at the University of Saskatchewan).



Dendrochronology is the analysis of tree rings formed in wood as a means of measuring changes in environmental factors that influence a tree's growth (Speer, 2010). Tree core sampling was done because tree rings have been used successfully to document the onset and intensity of chlorinated hydrocarbon pollution elsewhere (Yanosky, Hansen, & Schening, 2001). As well, sulfur compounds are released to the atmosphere in the kraft bleaching process (Ali & Sreekrishnan, 2001), which may cause acid rain and

soil acidification issues that negatively affect forest wellbeing (Fox, Kincaid, Nash, Young, & Fritts, 1986; Savva & Berninger, 2010).

Twenty trees were sampled from an old-age (ca. 95 years) white spruce stand by Boat Harbour, with two cores taken at breast height from each tree (total of 40 cores). For comparison, 36 cores from 18 trees were sampled from a comparably aged (ca. 97 years) white spruce stand at the Caribou Control site (see Figure 34). Caribou Control was selected because it had characteristics considered



similar to what Boat Harbour would have been like before the dam and aeration ponds were installed. It was hypothesized that the sites would have similar but distinct histories, as proven with different statistical tests on the changes of yearly growth, and it was also hypothesized that stronger growth suppression would be obvious at the Boat Harbour site.



Figure 34. Tree sampling sites (Boat Harbour and Caribou Control).

Results

While the analysis showed statistical differences suggesting unique growth-influencing factor(s) at each site, it is unclear if these differences are associated with pulp mill activity. For example, causes could include insect outbreaks (Hogg, Brandt, & Kochtubajda, 2005), flooding (Speer, 2010),



coastal ice storms (Lafon & Speer, 2002), or other factors. Also, a growth suppression trend in Boat Harbour tree growth was not observed; instead, the Boat Harbour trees have a tendency to exhibit growth enhancement trends for both raw and standardized chronologies, while Caribou Control does not.

This is contrary to the hypothesis that pollution impacts will result in negative growth effects. As such, there is not sufficient evidence in this analysis to support the hypothesis that pulp mill activity has impacted growth of trees surrounding Boat Harbour. A more thorough assessment would require long-term emissions data from the mill and chemical analysis of tree tissues.

It could be that Caribou Control was not an effective reference and that 10 km was not a large enough buffer between sites (this meshes with **Mark Gibson's** interpretation of the air quality data once his analysis was completed as well). The best potential for establishing greater certainty in tree-ring associations with Northern Pulp pollution would be to expand the number of sites involved in the analysis. Data tracking pulp mill emissions via the main mill stacks and Boat Harbour settling ponds would also enhance our ability to identify pollution's association with tree growth. Dendrochemistry is another potential route for future research because trees internalize pollutants and retain them within their cells as they grow. Using additional sites with a focus on trying to determine any effects of wind direction from the mill site is also recommended.



11. Analysis of the June 2014 Spill

On June 10, 2014, a member of Pictou Landing First Nation discovered a leak at a pipe that was carrying effluent from the Northern Pulp mill to Boat Harbour. The following day, **Ron Russell**, a lab assistant of Ron's, and **Emily Skinner** travelled to Pictou Landing to collect water and plankton samples from the effluent spill site and Boat Harbour dam/bridge. They collected effluent water from the environment and not directly from the pipe. **Kim Strickland** and Emily also collected samples of the effluent from the spill to send to the Centre of Water Resources Studies for testing of biological oxygen demand (BOD), chemical oxygen demand (COD), ammonia-nitrogen, and bacteria (*E. coli*).

The water quality analysis did not detect *E. coli*. Values for BOD, COD, and ammonia-nitrogen were typical for pulp mill effluent. It is suspected that the effluent had probably become diluted before the samples were collected, which took place 24 hours after the discovery of the spill.

The metal concentrations in the effluent were compared to available CCME guidelines for the protection of aquatic life (freshwater). Most metals (aluminum, cadmium, copper, nickel, lead, selenium, silver, zinc) with associated guidelines exceeded said guidelines, with **copper and lead** as the worst cases – exceeding the guidelines by greater than 10 times. The water samples that Ron collected from the pipeline burst had octochloride dioxide (OCDD) in it, but this was likely from atmospheric fallout and was also present in the soil sample. OCDD concentrations detected were high (1350 pg/L). OCDD is the most persistent but least toxic of the influential dioxins. Furthermore, elevated concentrations, as in this sample, indicate an “old” source or environmental sink. The elevated OCDD could also be attributed to atmospheric deposition from a combustion source over time. As noted in the water quality section, there are no CCME water quality guidelines for dioxins at this time.

Samples were collected on June 17, 2014, for **Mark Gibson's** lab, at least one week after the effluent leak occurred. At the time of sampling, the leak site had been excavated and the effluent had been removed and pumped to a natural pond adjacent to Boat Harbour. It is unknown how much time had passed between the effluent being removed and the sampling. Water was collected at three different locations that were exposed to the effluent. The first was from the small pool at the bottom of the excavated hole where the leak had originated (see Figure 35). The second was collected from the exposed effluent-carrying pipe (see right on Figure 35), and the third was collected from the pond where the effluent had been transferred. The water samples were tested for volatile organic compounds (VOCs). Twenty-four VOCs were detected between the three samples. When the results were compared to the Canadian Council of Ministers of the Environment regulations for freshwater (CCME,

2014), none of the VOCs detected exceeded the regulatory limits, though not all VOCs have associated guidelines.



Figure 35. Collection site for two of the effluent samples.

The VOC results were also compared to reference studies conducted in Halifax. The VOCs that are related to vehicles and combustion were present in both Pictou Landing and Halifax. However, 4-chlorotoluene and 2-chlorotoluene were present only in Pictou Landing from the ruptured effluent pipe. Chlorine and aromatics are present during the kraft and pulp and paper process and these are the likely source of the chlorinated aromatics. Further research could possibly confirm this.

Since the effluent spill, in March 2015, the *Boat Harbour Act* was passed, which legislated the closure of the Boat Harbour treatment facility by January 30, 2020. And on May 11, 2016, Judge Del W. Atwood released his Sentencing Decision for *R. v. Northern Pulp*



Nova Scotia Corporation, 2016 NSPC 29. On January 20, Northern Pulp had pleaded guilty to breaching subsection 36(3) and subsection 40(2) of the *Fisheries Act* for the

illegal spill of pulp and paper effluent in water frequented by fish and/or in any other place where the effluent would then enter into water frequented by fish. The judge's opening of his Sentencing Decision is worth noting:

The first element of truth and reconciliation is truth. The undeniable truth is that the experience of the Pictou Landing First Nation has been one of subjugation and suppression under the Canadian federation. It shares this history with other First Nations of Canada, as described succinctly in the Report of the Truth and Reconciliation Commission of Canada. An instance of that injustice was the manner in which a pulp mill came to [sic] located at Abercrombie Point in Pictou County fifty years ago; along with the mill was built an effluent-treatment plant in Boat Harbour.

The spill in June 2014 released an estimated 47,000,000 litres of effluent into the East River/Pictou Harbour from the deteriorating pipe. Afterwards, Northern Pulp responded to and implemented remedial measures put forth by Environment Canada. Additionally, the prosecution's obligation to consult with Pictou Landing First Nation about the spill's impact led to a presentation by Chief Andrea Paul about the impact to the community. Chief Paul discussed the environmental impacts in the context of the area's historical environmental degradation as a result of the pulp and paper mill. She noted that the spill re-victimized Pictou Landing residents and relayed their feelings that they had disappointed the environment; that the burial grounds at Indian Cross Point would be destroyed; and that the commercial, food, and ceremonial fishery would be negatively impacted as well.

The judge's decision included a reflection on her presentation, as he noted:

In my view, while the historical account in Chief Paul's statement might extend beyond what counsel assert is admissible, the truth of the damaging impact that the pulp mill at Abercrombie Point and its toxic effluent-treatment site at Boat Harbour has had on the well-being of the Pictou Landing First Nation – and continues to have – is so conspicuous and notorious as to be beyond dispute. (R. v. Northern Pulp Nova Scotia Corporation, 2016)

Importantly, Judge Atwood noted his decision was a part of transitional justice and that reconciliation would move forward in a small way in light of it. The sentence of the court was that Northern Pulp be fined in the amount of \$225,000. It recommended that the fine be distributed by awarding \$75,000 to the Mi'kmaw Conservation Group, \$75,000 to the Pictou County Rivers Association, and \$75,000 to Pictou Landing First Nation to be used to conserve, protect, and restore fish and fish habitat in Pictou County and in other waters fished by Pictou Landing First Nation.

12. Community Mapping



Daniel Rainham (Associate Professor and Elizabeth May Chair in Sustainability and Environmental Health, Environmental Science Program, Dalhousie University) supervised the community mapping activities of his trainee, **Jane McCurdy**, a summer intern through Dalhousie University's Master of Resource and Environmental Management program. They created a "web map" configured with text, photos, video clips, and website links to display traditional, cultural, and spiritual practices and recreational activities connected to community-identified places over time – past, present, and future. The community map shows changes in the way residents of Pictou Landing have interacted with their land over time.

Jane worked with **Heather Castleden** and **Dee Lewis** to read the oral histories documented by **Ella Bennett** to discern places of importance for fishing; hunting; gathering berries, seaweed, and medicines; and other recreational, cultural, and spiritual practices. **Kim Strickland** reviewed the additional oral histories that Dee documented for other places of importance. Dee also reviewed responses to the Environmental Health Survey for important places. The Pictou Landing Native Women's Group (PLNWG) were then able to use printed maps to pinpoint the place names

referenced in the stories to include in the web map. The map has also been geocoded with air, water, sediment, tree, and soil sampling sites as well as trapping sites.

The community map is now embedded in Daniel's website (SILK-Lab: www.silk-lab.org/pictou-landing-first-nation-community-ma) and is to be linked into the Pictou Landing First Nation website as well as Heather Castleden's Research Lab website (www.heclab.com) as a legacy map. As well, Jane prepared a user-friendly guide for navigating the map: "Web Mapping Application: A User Guide for the Pictou Landing First Nation's Community Web Mapping," as well as an amendment called "Steps for Accessing a Web Mapping Application via ArcGIS Online." The User Guide explains that a Web Mapping Application is a "living map," meaning changes can be made to it. The map has background layers, which are called the basemaps and show the geographic area of Pictou Landing First Nation. Other layers can sit on top of the basemaps to display the map's many features. To access the map, you can visit the websites noted above and then explore basemaps and layers of information. Directions for navigating the map have been pulled from Jane McCurdy's User Guide and briefly noted below.

Figure 36 displays the basemap options that are available within the map – click the dropdown arrow next to the *Basemap* icon to view thumbnails of each basemap.

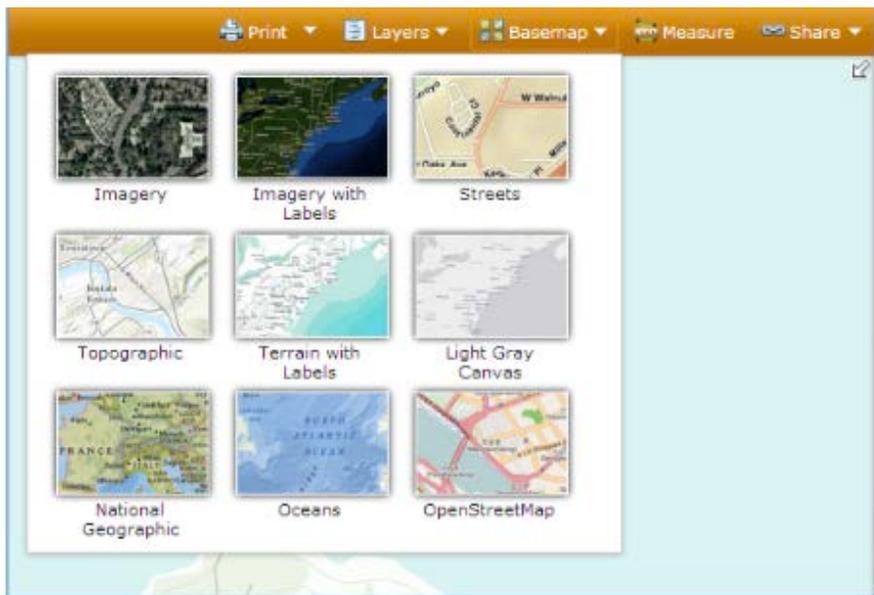


Figure 36. Assortment of basemaps to display as a background for the data.

Figure 37 shows two figures from the User Guide: Figure 2 from the User Guide illustrates that clicking the arrow in the top right-hand corner allows you to either show or hide the *Map Overview*. Figure 3 from the User Guide illustrates how to turn layers on and off – how to select what types of information you want to see displayed at any one

time by the map. In order to select which layers to display, click the dropdown arrow next to the *Layers* icon to check/uncheck the layers you would like to have visible on the map.

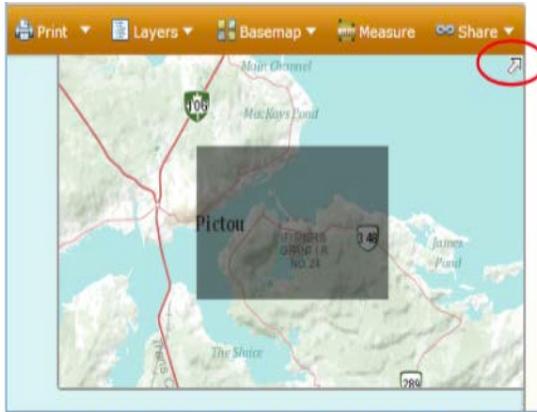


Figure 2: Clicking the arrow in the corner shows and hides Map Overview.

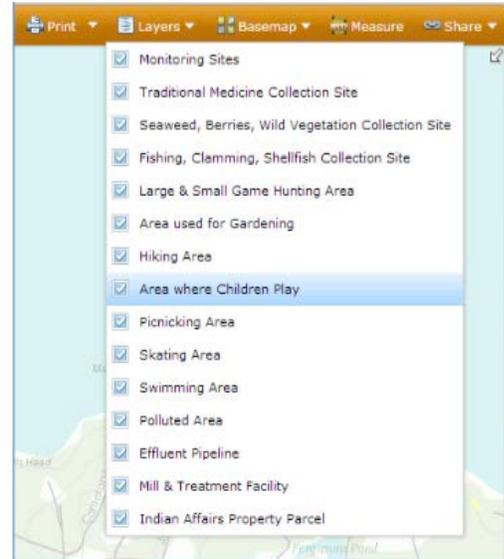


Figure 3: Display of layer list.

Figure 37. Two figures from the Web Mapping Application's User Guide.

Figure 38 shows what a layer of the map looks like and the informational pop-up that is visible when you click on a point of data on the map.

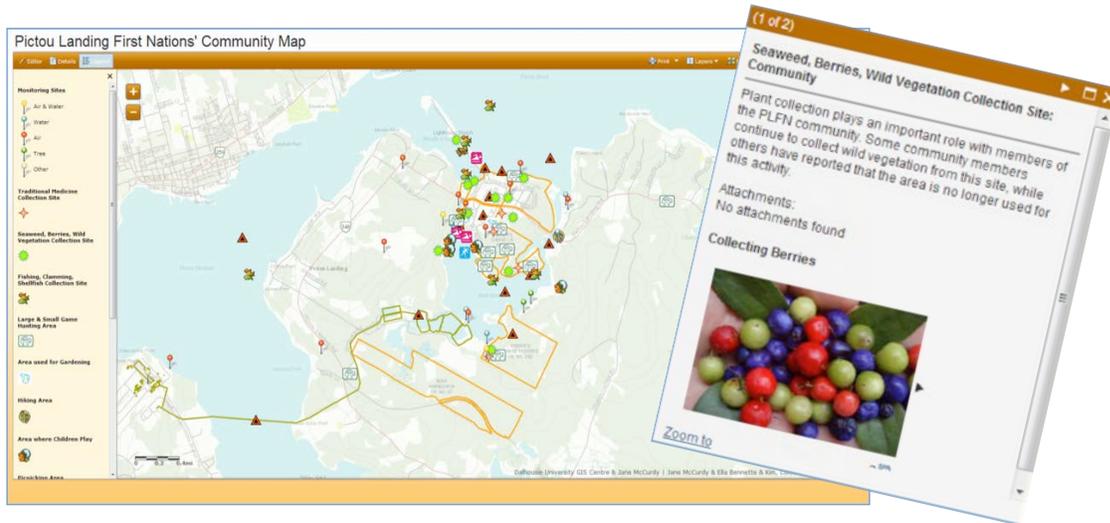


Figure 38. Map layer and informational pop-up.

You can also print and share the map via email, Facebook, or Twitter. And if revisions or additions to the map are needed, the PLNWG can contact Daniel Rainham to do so (Daniel.rainham@dal.ca).

13. Wet-Pro Water Monitoring

The CURA H₂O project (Community-Based Water Monitoring and Management, housed at Saint Mary's University; <http://curah2o.com>) is a community-university research alliance to establish volunteer water monitoring in Nova Scotia; **Heather Castleden** was a member of the CURA H₂O team. The project introduces communities to Wet-Pro, which is an online training course in water quality monitoring with an accompanying monitoring equipment toolkit for community-based water monitoring groups. In May 2013, **Sheila Francis, Kim Strickland, Colleen Denny, Lucie Francis, Emily Skinner and Heather** attended the CURA H₂O Community-Based Water Monitoring Program Design and Database workshop at Saint Mary's University to design a water monitoring plan for Pictou Landing. As a result of their training, the PLNWG received a Wet-Pro kit to begin collecting water samples. The Wet-Pro kits have benefited this research as a legacy piece of the project because the community now has three certified water quality monitors: Kim Strickland, Colleen Denny, and Lucie Francis. The PLNWG can access their Wet-Pro kit any time via CURA H₂O, which is the steward of this equipment.

Regular monitoring can characterize the health of the ecosystem, detect changes, and establish baseline data including conductivity, pH, and dissolved oxygen.



The Wet-Pro Liaisons, **Oliver Woods** and **Sarah Weston**, have supported the Wet-Pro initiative by attending meetings to discuss strategic water monitoring, supporting the individual water monitors, evaluating the functioning of the monitoring equipment from season to season, and facilitating workshops and sampling. For example, Oliver had to replace a probe in the equipment in the summer of 2014. Oliver, Sarah, and **Melissa Healey** also travelled to Pictou Landing in the summer of 2013 to support water testing and site selection with Kim, Colleen, **Chris Garda**, and **Geoff Kershaw**. In May 2014, Kim and Colleen, and subsequently Kim in 2015, attended the Atlantic Watershed Stewardship Showcase as part of the continuing training. The Wet-Pro team at Saint Mary's University are available to ensure water quality monitoring can continue in Pictou Landing and the equipment, while owned by the PLNWG, will continue to be stored there throughout the monitoring off-season. It will be up to the PLNWG to determine whether continued monitoring can and should occur.⁷

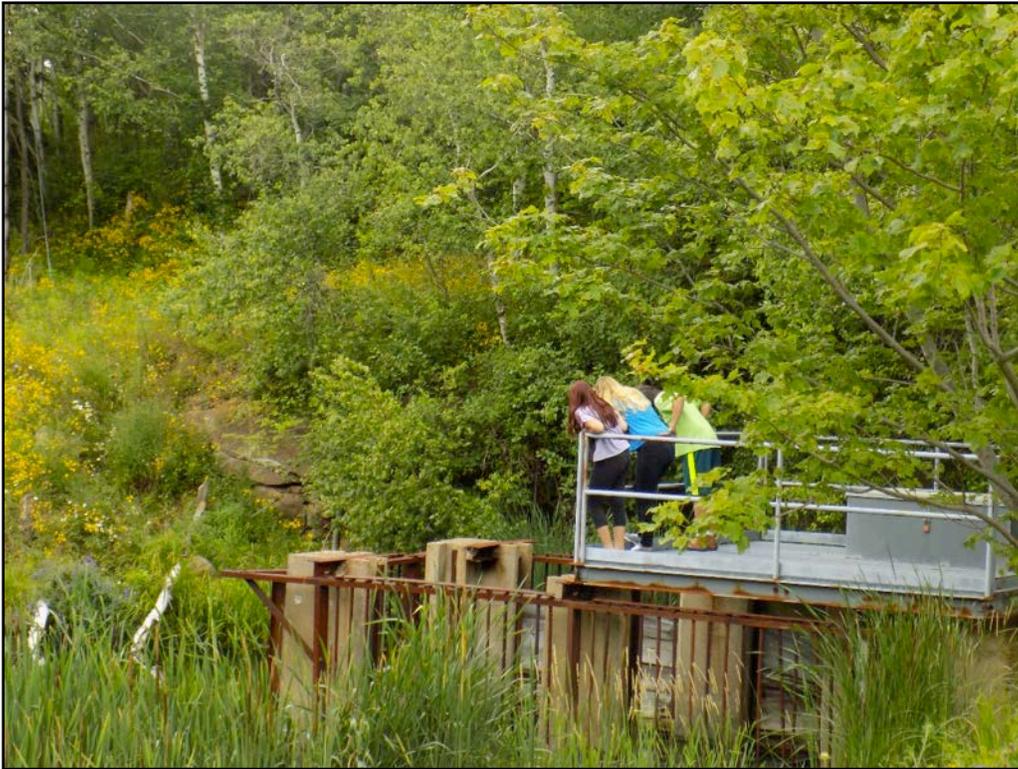


⁷ “The CURA H₂O project officially wrapped up in September 2016, and the Community-Based Environmental Monitoring Network continues to develop and maintain major CURA H₂O legacy pieces such as the training course and database. Partnerships with government agencies and major universities continue to examine how this data can be integrated into governmental water management and provide a more comprehensive set of data than would otherwise be available through government resources alone.” (<http://curah2o.com>)

14. Boat Harbour Youth Camp, July 2015

Throughout this research, the importance of multi-generational perspectives in understanding Indigenous health and environmental change was recognized. In the months approaching summer 2015, the Pictou Landing Native Women's Group (PLNWG) indicated it was time to engage and understand the perspectives of the youth, who represent the future leaders and decision-makers of the community and who have only ever experienced Boat Harbour as a toxic waste facility.

Over four days in July 2015, a group of five youth, **Laela Denny, Madison Nicholas, Hunter Francis, Alexandria Francis, and Carter Hatfield**, came together for the Boat Harbour Youth Camp, led by **Cecilia Jennings** (Heather Castleden's Master's student), **Kim Strickland**, and **Dakota Francis** (a summer student from Pictou Landing First Nation). The purposes of the camp were (1) to teach youth from Pictou Landing about the PLNWG's research project and (2) to gather perspectives from Pictou Landing First Nation youth about their experiences living with Boat Harbour. The group met for four days over two weeks, during which they learned about community mapping and water sampling, took a field trip to Halifax, and created digital stories.



Camp Structure

Day 1: Community Mapping and Learning About the PLNWG

The camp opened with introductions and watching the *A'se'k* documentary by **Christian Francis** and **Haley Bernard**. The documentary was the starting point for a conversation about the youths' impressions of Boat Harbour and what health means for them as individuals and for the whole community. Then, using GPS units borrowed from Dalhousie University, the group participated in a community mapping workshop. They went for a walk around the community, each taking GPS coordinates at places that represented good and negative effects on their health. Each participant was given a journal to take field notes throughout the camp and also used the journal to record notes about each GPS point.

Dee Lewis visited from Halifax and talked to the group about the PLNWG's participation in the project and screened the *Land & Sea* documentary about Boat Harbour as well as the digital stories made by herself, Kim, **Sheila Francis**, **Colleen Denny**, and **Darlene Bachiri**.

Day 2: Field Trip to Halifax

The camp group travelled to Dalhousie University, where they visited the Centre for Water Resources Studies. **Jenny Hayward** (Rob Jamieson's research associate) gave a tour of three different environmental engineering labs and talked about some of the sampling that has happened at Boat Harbour.



The group also visited the Health Geomatics Laboratory, where **Daniel Rainham** gave a lesson in map-making. Using the GPS points collected in the community walk during Day 1, each youth began a map to represent their own “health landscapes” in Pictou Landing.

Days 3 & 4: Wet-Pro Sampling and Digital Stories

On the third day, **Emma Wattie** and **Sarah Weston** from CURA H2O (Saint Mary's University) visited Pictou Landing First Nation to teach a Wet-Pro workshop. They taught the youth how to evaluate water quality and take measurements with the Wet-Pro kit. Everyone got a chance to try out the Wet-Pro kit, and the youth sampled and compared water from three sites around Pictou Landing First Nation.



In the afternoon and during the last day, the group worked on their digital stories, writing scripts in their journals, collecting photos from the Internet and from throughout their time at the camp, recording their voice-overs, and making final edits.

Sharing the Stories

For some of the youth participating in the camp, this was the first time they had been asked to share their feelings about Boat Harbour publicly. Three digital stories were made by youth during the camp, by Madison, Hunter, and Alexandria (Cecilia made one

as well). The narratives shared in the videos speak to the sense of loss experienced by youth in Pictou Landing, and the feelings of frustration at a legacy of broken promises. Even though these youth have never lived with a clean Boat Harbour, they carry the desire to be connected with A'se'k.



The youth camp sought to address and engage youth on questions of health and the environment. Overall, the camp opened up a space for learning and discussion among the group of participants. And it offered a chance for knowledge translation and for sharing the work of the PLNWG and research team over the past few years.



15. Knowledge-sharing Activities and Capacity-building

Throughout the project, reporting back to the community was important. Through discussions at Pictou Landing Native Women's Group (PLNWG) meetings, Research Retreats, and Community Dinners, changes were made to research protocols and goals. Examples of how information was shared include: monthly Chief and Council updates; PLNWG meetings; Community Dinners; annual retreats; documentary film and photography projects; Health, Environment, and Communities Research Lab website (heclab.com); media interviews; and a variety of publications including the Pictou Landing First Nation newsletter, academic journal articles, final reports, and booklets.

Event Participation and Conference Presentations

- **Heather Castleden, Dee Lewis, and Chief Andrea Paul** attended the Atlantic Policy Congress Atlantic First Nations Health Conference in Moncton, New Brunswick, to present on the process of developing the community-university research partnership in November 2012.
- **Ziyun Wang** presented her analysis of the Health Canada reports to the women at a PLNWG meeting before presenting "Pulling the Plug on Boat Harbor: A Synthesis Review and Gap Analysis of Existing Environmental and Health Studies" for her Master's degree in Environmental Studies in December 2012.
- **Ziyun** also presented at the Annual Atlantic Canadian Association of Geographers Conference in Halifax during the fall of 2012.
- **Dee** delivered a guest lecture titled "Gender and Culture: The Social and Health Impact Assessment in Environmental Assessment" to Heather's Socio-Political Dimensions of Resource and Environmental Management class in the winter of 2012.
- **Dee, Sheila Francis, and Heather** were invited to present at the Atlantic Aboriginal Economic Development Integrated Research Program (AAEDIRP) conference titled "Working Alongside Aboriginal Peoples in Research," hosted in Dartmouth February 5-7, 2013. Only Dee and Sheila could attend, and the subject of their presentation was the process of developing the community-university research partnership.
- In the summer of 2013, **Heather** brought her class to Pictou Landing as part of her course, Indigenous Perspectives on Resource and Environmental Management. **Colleen Denny** and **Kim Strickland** gave the group a tour of the community, introduced the project, and discussed their roles as Research Associates.

- **Sheila, Kim, Colleen, Dee, and Heather** presented their digital stories at the Community-Campus Partnerships for Health 13th International Conference, “From Rhetoric to Reality: Achieving Authentic, Equitable and Transformative Partnerships” (April 30–May 3, 2014) in Chicago, Illinois. The stories are about their personal journeys and project experiences and can be viewed online at www.heclab.com.
- In June of 2014, **Dee** and **Sheila** travelled to Happy Valley-Goose Bay; they were invited by FemNorthNet to participate in a process with other Indigenous women: those from Labrador who will be increasingly impacted by the Muskrat Falls project, and those from Nova Scotia who will be impacted by the Maritime Link.
- **Heather, Kim, Dee, and Darlene Bachiri** attended the International Network in Indigenous Health Knowledge and Development (INHKD) in partnership with the Manitoba Network Environment for Aboriginal Health Research (NEAHR) Conference in Winnipeg, Manitoba, from October 5 to October 10, 2014.



- **Dee** facilitated a session for Environmental Justice Alliances on November 22, 2014, at St. Francis Xavier University called “Building Alliances and Seeking Reconciliation with Mi’kmaq Women: A Day of Action and Dialogues.” **Sheila** served as a panelist. The session included a short overview of the project and a discussion about the issues and strategies to build alliances for positive actions to protect, uphold, and implement Indigenous rights.
- On January 23, 2015, **Dee** presented her PhD thesis proposal at Dalhousie University, titled “Tliinuo’liti’k – Weji-sqalia’timk – How We Will Be Mi’kmaq on Our Land: Working Together with Pictou Landing First Nation to Redefine a Healthy Community.”

- **Sheila, Heather, Kim, Colleen, Dee, and Darlene** presented their digital stories as a group at the Citizen Science 2015 Conference held February 11-12, 2015, in San Jose, California.
- **Dee** presented at Environmental Racism and First Nation Women – International Women's Week on March 4, 2015, at the Antigonish Women's Resource Centre.
- **Heather** presented a poster at the Community-Campus Partnerships for Health 15th International Conference, "Journey to Justice: Creating Change Through Partnerships," in New Orleans, Louisiana (May 11–14, 2016), where the poster presentation was awarded second place in the Viewers' Choice Award category.
- **Sheila, Kim, Dee, and Lexy Strickland** are scheduled to present at Dalhousie University's Indigenous Speaker Series in September 2016.

Peer-reviewed Academic Articles

- Given the remarkable response rate (approximately 60%) for the Environmental Health Survey, **Dee Lewis** led the development and submission of a manuscript on lessons learned from the process of conducting a survey using community-based participatory research methods. The article, authored by **Dee, Heather Castleden, Sheila Francis, Kim Strickland, Colleen Denny** and the **PLNWG**, is called "Increasing Response Rates on Face-to-face Surveys with Indigenous Communities in Canada: Lessons from Pictou Landing," and it was published by the journal *Progress in Community Health Partnerships* (2016).
- An article titled "'Put It Near the Indians': Indigenous Perspectives on Pulp Mill Contaminants in Their Traditional Territories (Pictou Landing, Canada)," authored by **Heather, Ella Bennett, PLNWG, Dee, and Debbie Martin**, has been accepted for publication by the journal *Progress in Community Health Partnerships*.
- A third peer-reviewed article is in preparation regarding the environmental monitoring components of the project: air, water, soil, and ecotoxicology.

Community Dinners

- The first Community Dinner was held on February 16, 2012. This dinner was a celebratory occasion as we had just received notice that our Canadian Institutes of Health Research Operating Grant had been approved.

- A second Community Dinner was held in Pictou Landing First Nation on January 15, 2013, to provide research activity updates. **Kim Strickland** and **Colleen Denny** organized and advertised the event and arranged for dinner to be served to about 40 people who attended.
- A third Community Dinner was held in Pictou Landing on June 18, 2013. More than 80 community members attended the BBQ organized by **Kim** and **Colleen**. Research activity updates were given by **Heather Castleden, Dee Lewis, Jane McCurdy** (on behalf of **Daniel Rainham**), **Mark Gibson, Rob Jamieson, and Ron Russell**.
- A fourth Community Dinner was held April 8, 2014. The agenda included a discussion about how the research project came to be and a summary of the first three years of working together, updates about the project components, and a presentation by **Kim** and **Colleen** about their roles as Community Research Associates.
- A fifth and final Community Dinner will be held to release this report to the community.



Awards

- **Haley Bernard** received an internship award from the Atlantic Aboriginal Health Research Program to work on the project in 2012.
- **Lucie Francis** received an internship award from the Atlantic Aboriginal Health Research Program to work on the project in 2012 with **Ron Russell**.
- **Diana Lewis** received a Canadian Institutes of Health Research Doctoral Research Award in May 2013 for three years to continue research with the PLNWG.

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- Information Morning Nova Scotia Interview with **Heather Castleden**. (2014, August 5).
- CBC/Global TV Interview with **Mark Gibson** (2014, August 7). *Northern Pulp newsmaker*. <http://www.cbc.ca/player/play/2483990998>
- **Martha Stiegman** and **Ella Bennett** filmed many aspects of the research before **Cathy Martin** and **Frank Clifford** joined the team to film research activities. We hope to obtain additional funding for Cathy Martin to produce a documentary using all the filmed material in the future.

Training

- **Dee Lewis** attended the Centre for Environmental Health Equity's National Training Program, "Knowledge Leaders in Children's Environmental Health," held in Vancouver, British Columbia, in 2012.
- **Kim Strickland** and **Colleen Denny** were hired as Community-Based Research Associates on the project on November 1, 2012. Colleen worked as a Research Associate until spring 2014 and Kim continued until June 2016.

- **Lucie Francis** and **Haley Bernard** were both awarded Atlantic Aboriginal Health Research Program summer internships to conduct research activities; respectively, they worked on ecotoxicology and oral histories.



- Thirteen women from the community administered Environmental Health Surveys: **Colleen, Kim, Pam Denny, Haley Bernard, Jordan Francis, Sheila Francis, Fran Nicholas, April Nicholas, Darlene Bachiri, Holly Francis, Heather Mills, Sylvia Francis, and Loretta Sylliboy** between 2012 and 2013.
- **Dee** gave two Environmental Impact Assessment (EIA) workshops in Pictou Landing in the fall of 2015 to inform the women about the language used in the Environmental Assessment process and case studies illustrating how they work. The first session involved learning the terminology specific to EIAs, and understanding the differences between types of EIAs and the basics of the process. The second session reviewed relevant case studies to put the previous learning into practice.

Theses, Reports, and Booklets

- “Final Report of Epitik Mawi-ta’jik: Pictou Landing Women’s Retreat” (2011), prepared by **Dr. Heather Castleden** and **Ms. Ella Bennett** (School for Resource and Environmental Studies, Dalhousie University).

- "Pulling the Plug on Boat Harbour: A Synthesis and Gap Analysis of Existing Environmental and Human Health Assessments Including Pictou Landing First Nation, 1968-2007" (2012), prepared by **Ms. Ziyun Wang** (School for Resource and Environmental Studies, Dalhousie University).
- "Community Report: Boat Harbour Water Quality" (2013), prepared by **Dr. Rob Jamieson** (Centre for Water Resources Studies, Dalhousie University).
- "The Pictou Landing Native Women's Association: Boat Harbour Project" (2013), prepared by **Mr. Chris Garda** and **Ms. Kim Strickland** (available at www.heclab.com). It is an eight-page brochure with beautiful photographs, a description of the research team, an introduction to the pulp mill's history and the subsequent PLNWG mobilization, Two-Eyed Seeing, and the components of the project (ecotoxicology, air monitoring, oral histories, environmental health surveys, water monitoring, and community mapping).
- "Third Annual Pictou Landing Women's Research Retreat: Final Report" (2014), prepared by **Dr. Heather Castleden**, **Ms. Ella Bennett**, and **Ms. Emily Skinner** (School for Resource and Environmental Studies, Dalhousie University).
- "Soil Sampling Results for Dioxins, Furans and Metals in Pictou Landing First Nation, NS" (2014), prepared by **Dr. Rob Jamieson** (Centre for Water Resource Studies, Dalhousie University).
- "Our Ancestors Are in Our Land, Water, and Air: A Two-Eyed Seeing Approach to Researching Environmental Health Concerns with Pictou Landing First Nation: Air Quality Report" (2015), prepared by **Dr. Mark Gibson** (Atmospheric Forensics Research Group, Dalhousie University).
- "Sediment and Plankton Sampling for PCBs, Pesticides, Chlorophenols, Polybrominated Diphenyl Ethers, and Polychlorinated Dibenzodioxins and Furans" (2015), prepared by **Dr. Ron Russell** (Department of Biology, Saint Mary's University).
- "Fourth Annual Pictou Landing Women's Research Retreat Report" (2016), prepared by **Ms. Catherine Hart** (Health, Environments, and Communities Research Lab, Department of Geography and Planning, Queen's University).
- "Community Report: Environmental Health Survey" (forthcoming), prepared by **Ms. Diana Lewis** (Health, Environments, and Communities Research Lab, Department of Sociology and Social Anthropology, Dalhousie University).

***“Not only are we going to do scientifically sound research...
but it’s going to come from us!”***

(First Research Retreat, 2010)



16. Concluding Comments

Our six-year community-based participatory research project to explore the potential mental, physical, emotional, and spiritual health impacts of Boat Harbour for the members of Pictou Landing First Nation was, at times, arduous, rewarding, emotional, and certainly a transformative experience for those involved. Mobilizing the women of Pictou Landing, through the Pictou Landing Native Women's Group (PLNWG), around an issue that concerned all of our community, is an example of how Mi'kmaq women are revitalizing our roles as leaders and protectors in our community. For the academic members of this research team, it was a privilege and an honour for us to be invited to work with the PLNWG and support the women's research goals.

A'se'k was a place of highly productive subsistence fisheries, with recreational and medicinal functions for the Mi'kmaq of Pictou Landing. Although the land has never been subject to a treaty beyond "Peace and Friendship," 50 years ago the Boat Harbour Treatment Facility began releasing approximately 85 million litres of pulp mill effluent into A'se'k daily. We do not know, with absolute certainty, how much pollution the Mill has released and continues to release into the local environment, but we know that respiratory illness (e.g., asthma) is substantial in the community. When the mill started operating, fish kills were immediate, and significant social, psychological, and cultural impacts continue to affect the community. This is, in part, due to the mill's continued operation and consequent pollution. But it is also due to a legacy of broken government promises through unfulfilled commitments to relocate the waste treatment facility and remediate the estuary. A'se'k/Boat Harbour has, undoubtedly, transformed into a place of dis-ease, anxiety, and unrest (Castleden et al., in press).

While this report marks the conclusion of our research project, it does not mark the conclusion of our relationships and our commitments to each other, and the lands, waters, and air around us. Our story is not over...



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