UNDERSTANDING SHIKAAPAASHKWH (ᔑᑳᐹᔥᒄᐦ)

Eelgrass Health and Goose Presence in Eastern James Bay

Summary and Key Findings

Eeyou Coastal Habitat Comprehensive Research Project (CHCRP)

Submitted to Niskamoon Corporation by Zou Zou Kuzyk, University of Manitoba, on behalf of the Research Consortium

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The Eeyou Coastal Habitat Comprehensive Research Project was overseen by Niskamoon Corporation (Robbie Tapiatac, Ernie Rabbitskin, and Marc Dunn) and received guidance from a Steering Committee (members listed in Introduction) and many Cree leaders and community members. We would like to thank all those who participated in this project including the Cree Nation of Chisasibi, Cree Nation of Waskaganish, Cree Nation of Eastmain, Cree Nation of Wemindji, Cree Regional Authority and Cree Nation Government, Cree Trappers' Association, Eeyou Marine Region Wildlife Board, and Canadian Wildlife Service.

Summary & Key Findings

This report brings together research results from the *Eeyou Coastal Habitat Comprehensive Research Project* (CHCRP), including scientific data and Cree knowledge, and historical information from previously published reports. It reviews and synthesizes information on the health (productivity and extent) of eelgrass meadows along the eastern James Bay coast and implications for goose presence and Cree hunting activities. It focuses on the eelgrass meadows along the east coast of James Bay, between Waskaganish and Cape Jones at the junction with Hudson Bay. Decreases in the distribution and density of eelgrass since the 1980s-90s accompanied by decreases in the waterfowl harvest have been a source of concern to Cree land users especially the Cree Nation of Chisasibi and the investigations reported herein reflect that concern. The report integrates the knowledge from these multiple sources to address the two overarching research questions of the project:

- *What are the main factors affecting the current state of eelgrass along the eastern coast of James Bay?*
- *What is the impact of the current state of eelgrass on waterfowl presence and consequently Cree hunting activities?*

The CHCRP was a Cree-driven project designed and conducted as a collaboration between university researchers and Cree land users. The research drew upon Cree knowledge and experience as well as established scientific methods at every stage. Cree land users worked with researchers to collect samples of river water, coastal water, sediment, and eelgrass, and to survey geese. Cree shared their knowledge during interviews, symposia, and community outreach events.

As directed by the Cree Nation Government and Hydro-Québec, the coastal habitat project was coordinated by Niskamoon Corporation. Niskamoon is a non-profit body established in September 2004 to address environmental and social issues arising from the La Grande hydroelectric development project. That project developed, over a roughly 35-year period between 1978

Diver on SCUBA examines the eelgrass. Photo credit: E. Lim.

and 2013, a series of dams, reservoirs, and river diversions towards the La Grande River, which discharges into northeast James Bay near Chisasibi.

In the Eeyou coastal habitat project, Niskamoon established linkages between scientists with a wide range of backgrounds and Cree land users interested in understanding the origins and nature of environmental changes along the James Bay coast. The team of investigators worked closely with Niskamoon Local Officers (NLOs) and collaborators from the coastal Cree First Nations to conduct the research. The NLOs gained permission and support for the research by contacting the tallyman (traditional family territory manager) and land users of each traditional family hunting ground (e.g., trapline) or trapline along the coast. More than 20 traplines participated in portions of the research, although three (CH4, CH5, CH6) withdrew before the eelgrass health studies were completed.

In this report, discussions of ecological changes or trends in the coastal environment of eastern James Bay consider the La Grande hydroelectric complex, which altered the spatial and seasonal distribution of freshwater inputs to the James Bay coast, as well as large-scale factors that may affect the eelgrass or the geese, such as climate change, land use changes, natural isostatic rebound, and events like wildfires. It is also recognized that current conditions of eelgrass ecosystems could very much depend on their history. Considering both the past and the present provides some perspective for the future.

Researchers and Cree land users prepare for eelgrass sampling near Wemindji in 2019. Photo credit: G. Mark.

Researchers and Cree land users conduct banding operations at Boatswain Bay in 2018. Photo credit: J.-F. Giroux.

Key Findings

WHAT ARE THE MAIN FACTORS AFFECTING THE CURRENT STATE OF EELGRASS ALONG THE EASTERN COAST OF JAMES BAY?

Eelgrass in eastern James Bay underwent a massive decline in the 1990s and failed to fully recover. The current state of eelgrass meadows along the coast is partly a consequence of these declines. Without large, dense eelgrass beds and meadows to keep the water calm and clear, the coastal waters are frequently turbid with mud stirred up off the bottom. The research results showed that the light available underwater for eelgrass is insufficient for optimal summer eelgrass growth and may reduce winter survival.

Eelgrass recovery is likely further impeded by large-scale stressors associated with climate change. The research showed there has been a browning of James Bay offshore waters over the past two decades, which further reduces the light available underwater for eelgrass. Also, there were extreme weather events, including unusually early ice breakup and warm June water temperatures in the late 1990s, which seem to be stressful for eelgrass; these extreme weather events have become more frequent since the 2000s.

In the La Grande River sector of the coast[1], a third stressor likely affecting some eelgrass beds is the regulated high river flows. Research results showed that both high flows from La Grande and warm water temperatures negatively affect eelgrass beds in this area.

WHAT IS THE IMPACT OF THE CURRENT STATE OF EELGRASS ON WATERFOWL PRESENCE AND CONSEQUENTLY CREE HUNTING ACTIVITIES?

The current poor state of eelgrass reduces the stopovers and use of the coastal habitat by geese, at least during fall. This makes the distribution of the geese less predictable, and impacts Cree hunting activities and associated cultural and socio-economic aspects of Cree society. Additional factors, both local and global, also impact waterfowl presence including changes to waterfowl feeding habits and hunting, and changes in habitat and wildlife distributions due to climate change.

Because the goose migration is ever changing and adjusting to environmental and climate shifts, it is impossible to predict with certainty whether the historically large numbers of Canada Geese that were observed in the 1970s will return.

1 The La Grande sector extends from approximately CH34 in the south to CH5 in the north, although the northern limits are difficult to fully determine due to lack of data collected in this area. Freshwater influence extends to CH7.

EELGRASS AND GEESE ARE AN ESSENTIAL PART OF COASTAL CREE CULTURE IN EEYOU ISTCHEE:

Waterfowl hunting is an essential cultural and economic activity for the coastal Cree of Eeyou Istchee. The most important waterfowl are Canada Geese, locally called short necks or *nisk* in Cree. During the 1970s, tens of thousands of short necks would stop and feed along the east coast of James Bay during their northward migration in spring and southward migration in fall.

The stopovers of the geese and thus the coastal Eeyou goose hunt was deeply interconnected with extensive and productive beds of eelgrass (*Zostera marina*), a marine flowering plant that grows in shallow subtidal waters. In fall, the geese fed extensively in eelgrass beds, and on wrack left on the mudflats by the tide and in upland areas on berries. Cree hunters found the geese to be a consistently available resource for many decades and they developed a system involving 'goose bosses' to manage a collective harvest that balanced short-term productivity and the goal of maximizing harvests for the long term.

Canada Geese fall migration along the coast near Chisasibi. Photo credit: M.L. Leblanc.

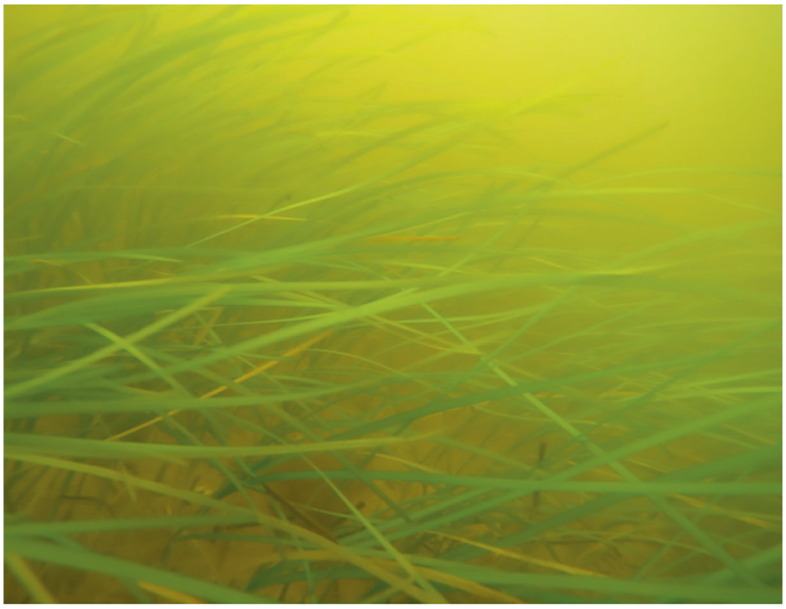
First project symposium in Chisasibi in January 2019. Photo credit: Z. Kuzyk.

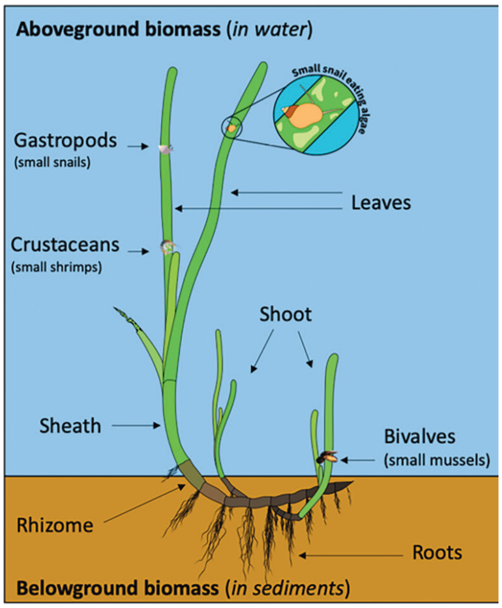
Photos from the symposium and workshop in Chisasibi in September 2022. Photo credits: M.L. Leblanc.

HEALTHY EELGRASS NEEDS A GOOD ENVIRONMENT:

Historically, eelgrass beds flourished along the Eeyou coast especially north of the Vieux Comptoir (Old Factory) River. They formed large, lush meadows that were considered to be among the most extensive in North America. Eelgrass needs clear waters so that a large amount of sunlight can reach the plants under the water. It also needs salty water and nutrients, but it can usually get enough nutrients from the bottom sediments using its roots. The northeast coastal environment must have provided excellent conditions for eelgrass growth.

Eelgrass that receives enough light and has its roots anchored in good bottom sediments will grow tall and spread and store up energy to survive the winter, which in James Bay extends for many months. Sometimes, diseases, animals, ice scour, or extreme events like storms can reduce eelgrass size and extent by removing or damaging the plants. Isostatic rebound (uplift of the land) can cause eelgrass to shift their distribution to stay submerged under the water. However, eelgrass is known to be tolerant of a wide range of conditions, and able to recover from minor disturbances or natural environmental change.





View of eelgrass underwater and diagram showing the parts of the plant. Photo credit: C. Peck. Illustration credit: M.L. Leblanc.

A COASTAL ENVIRONMENT BENEFITS FROM HEALTHY EELGRASS:

Large, dense eelgrass beds and vast meadows like those present in eastern James Bay in the 1970s serve other important functions in coastal ecosystems, in addition to attracting geese. According to the *Migratory Bird Habitat Task Force Report* prepared by community members of Chisasibi, "*A major indicator of healthy eelgrass is aayoshtinuuktícj, which means that as soon as the tide recedes the eelgrass settles and calms the water in the area of the eelgrass beds*".

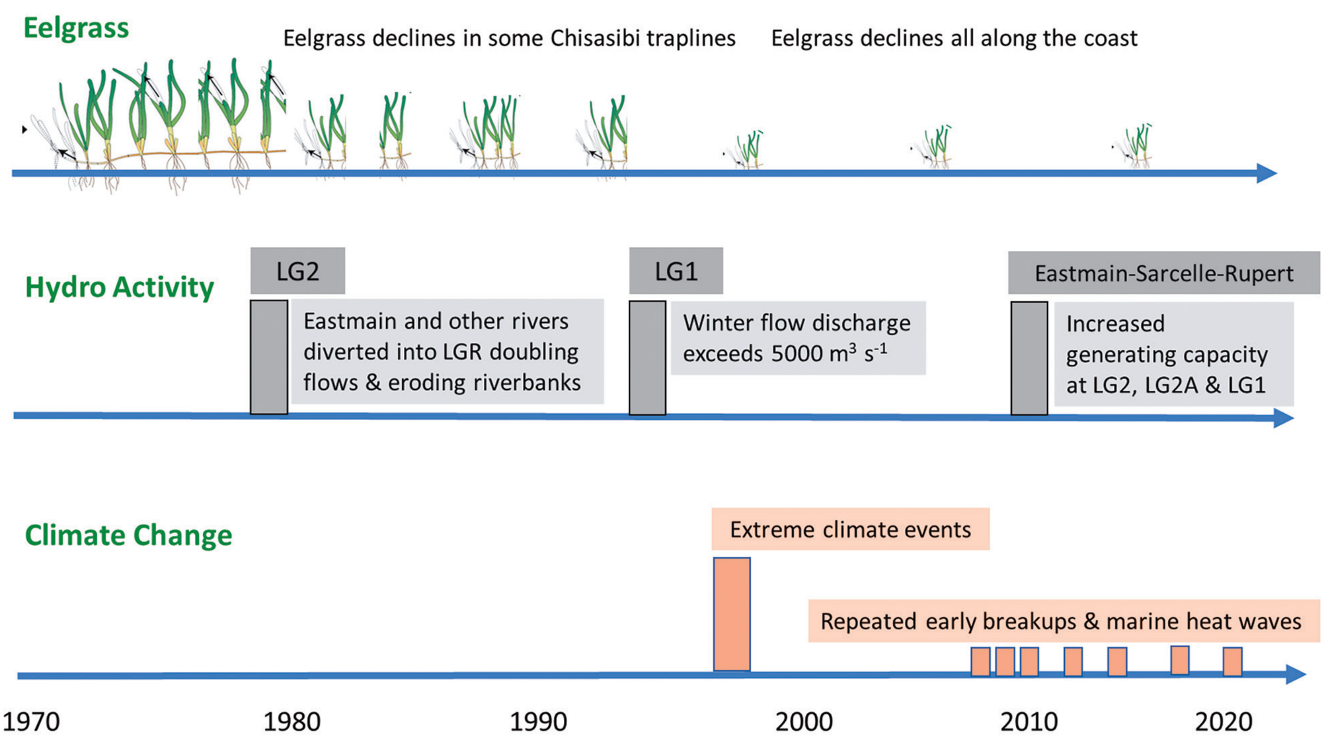
The calming effect of a dense, healthy eelgrass bed encourages small creatures (snails, small clams, and juvenile fish) to live there and promotes clearer water because the sediment does not get stirred up off the bottom during storms. Eelgrass roots help trap and hold sediment in place. Under these conditions, sunlight can penetrate more deeply into the clear water and the eelgrass is able to grow tall and spread. The more light that reaches the plants, the better it is for growth. Scientists describe this as a '*positive feedback effect*' of healthy eelgrass; that is, healthy eelgrass beds help keep the environment good for themselves and for other eelgrass beds around them, but when they decline, the environment degrades and becomes unfavorable for eelgrass growth

Chisasibi Cree technician Laura-Lee Sam sampling eelgrass. Photo credit: G. Mark.

EELGRASS DECLINED SEVERELY IN JAMES BAY IN THE 1980S AND 90S:

Between 1996 and 1999, an unprecedented, severe reduction in eelgrass occurred that affected the entire coast of eastern James Bay. Cree land users from Chisasibi saw uprooted plants and observed that most of the tall eelgrass growing in deep water had disappeared. In the La Grande sector of the coast, where Hydro-Québec crews had been monitoring eelgrass biomass since 1982, many eelgrass beds all but disappeared, decreasing 94% to 99% compared to 1995 conditions. A large-scale monitoring of eelgrass cover was carried out during summer 1999 all along the coast, after the discovery of the eelgrass losses in Chisasibi. The monitoring crew observed that *many* eelgrass beds had deteriorated.

For some Chisasibi land users, the decline in eelgrass in the late 1990s was not the first decline they had seen: some eelgrass beds in the La Grande sector had declined earlier, during the 1980s and early 1990s. Eelgrass biomass monitoring data collected between 1982 and 1995 in the La Grande sector of the coast showed decreases in the size or density of eelgrass over the period 1982-1995 at three of six sites. There was no eelgrass biomass monitoring in the other sectors of the coast prior to 1995.

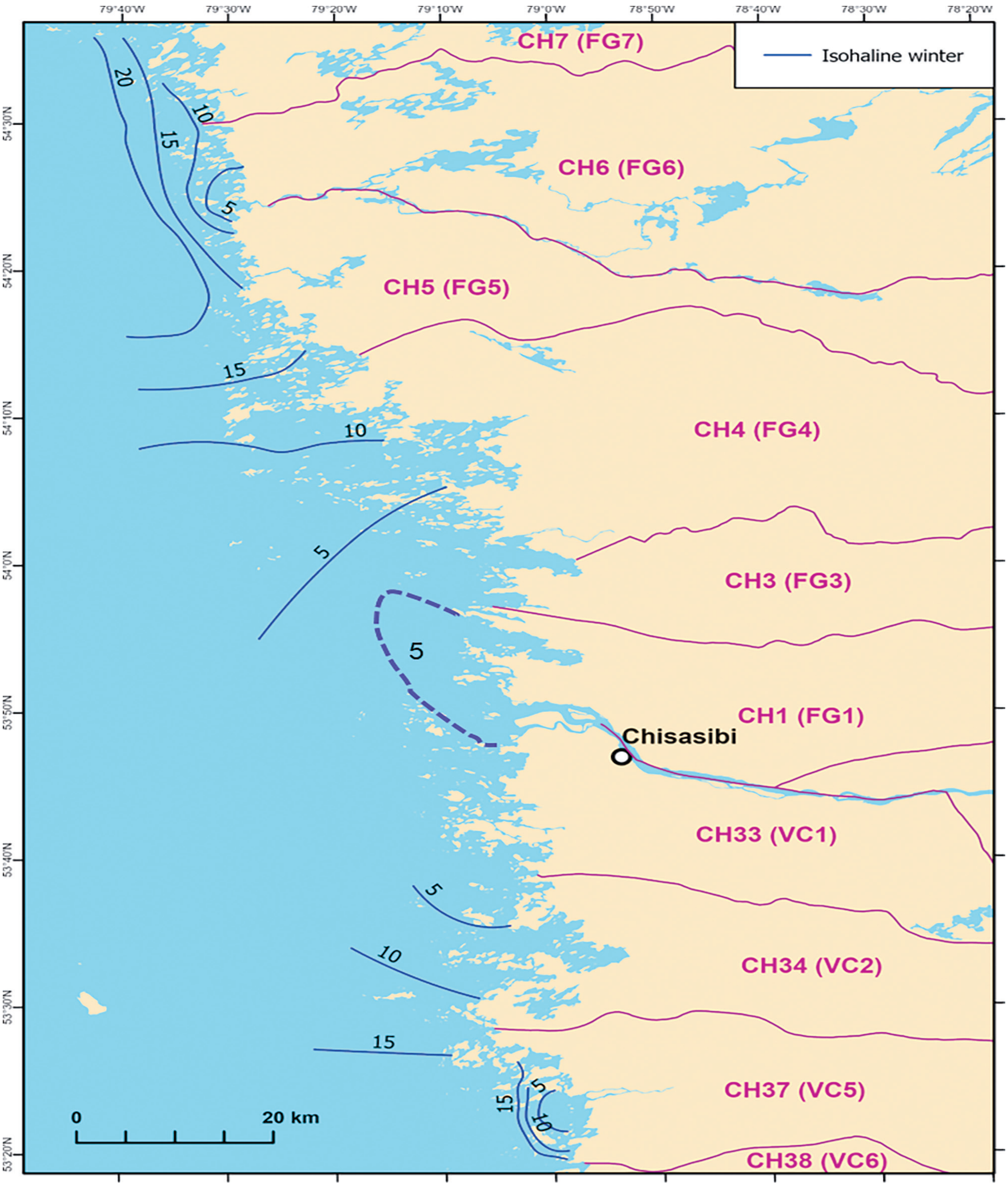


Timeline of eelgrass declines and environmental changes in the Eeyou coastal habitat.

As described by Cree land users interviewed for this project, and confirmed by various publications, hydroelectric development caused major coastal environmental changes around Chisasibi between 1978 and 1995. Increased flows of La Grande River led to coastal environmental changes due to increased transport of sediment from the newly flooded reservoirs and riverbank erosion into the bay, and the expansion of the freshwater plume along the coast during winter. As a result, there may have been changes in salinity, temperature, water clarity, and nutrient availability within the coastal areas influenced by La Grande River, each of which may have impacted the eelgrass beds in these areas.

Major climate-driven changes along the eastern James Bay coast first became apparent *during the late 1990s*. Between 1995 and 1998, there were several extremely warm springs, hot, dry summers, and low river flows both from natural rivers and La Grande. The winter of 1997-1998 was exceptional. In January 1998, an ice storm occurred that broke down Hydro-Québec power lines in southern Québec. The spring of 1998 was unusually warm and the sea ice in northeast

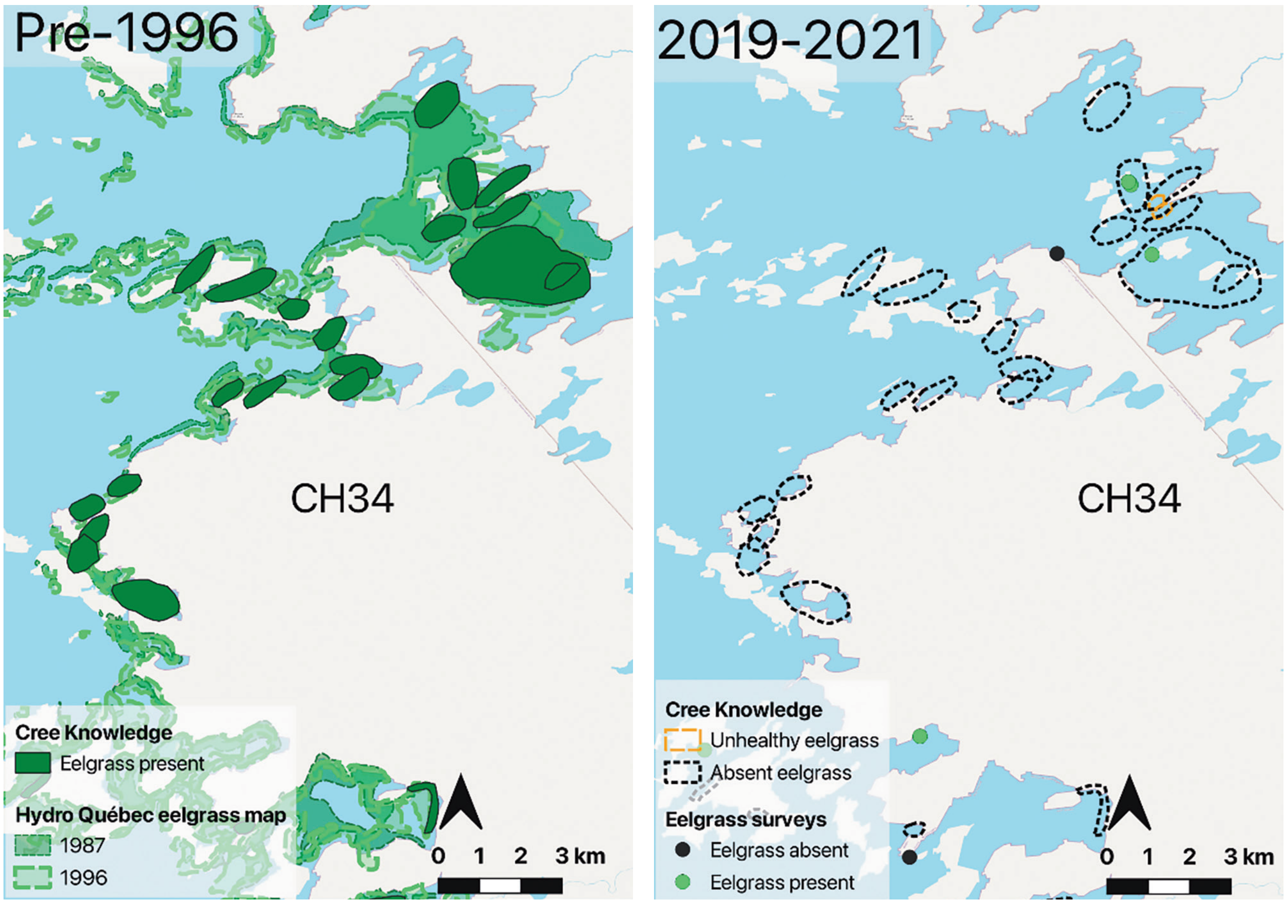
Studying the freshwater plume of the La Grande River during summer and winter. Photo credits: C. Peck, 2019 and J. Ehn, 2016.



Map showing how the winter freshwater plume from the La Grande River has expanded since hydro development. The dashed line shows the extent of the freshwater plume (salinity below 5) in winter 1975-76 and the solid lines show the extent of the plume (salinity below 5, 10, and 15) during winters 2018-2021. Smaller rivers that continue to flow in winter make small areas with salinity below 5. Image credit: U. Neumeier.

James Bay broke up in mid-May 1998, almost a month earlier than normal. The coastal waters warmed up rapidly, reaching unprecedented temperatures for June and July.

We conclude that changes caused by La Grande hydroelectric development started to affect eelgrass health in some monitored (and likely some unmonitored) traplines near Chisasibi before regional climate change effects become apparent in the late-1990s. In the late-1990s, climate change started to strongly affect James Bay, and there was a massive loss of eelgrass along the entire Bay. In the La Grande sector, these extreme weather events may have accelerated the decline of eelgrass that had been already weakened by environmental changes resulting from hydroelectric development and related river diversions. The onset of extreme weather events in the late 1990s therefore played a major role in extending the eelgrass



Eelgrass presence in 2019-2021 compared to pre-1996 in trapline CH34 (see full report for additional traplines). The maps include eelgrass beds known to Cree land users, eelgrass extent mapped by Hydro-Québec, and eelgrass absence/presence noted during eelgrass surveys by divers on SCUBA. Illustration credit: M.L. Leblanc.

decline to the entire eastern James Bay coast, expanding and accelerating the decline that had already started in some Chisasibi traplines.

There is insufficient information to know if early eelgrass declines like those that occurred near Chisasibi before 1998 also occurred in other sectors of the coast. Eelgrass biomass monitoring data from 1982-1995 are limited to the La Grande sector. The La Grande plume does not directly influence coastal waters south of the Chisasibi traplines but the Eastmain sector was affected at least locally by the 1980 river diversion. Some Eastmain land users recall losing eelgrass from the coastline immediately south of the Eastmain River after the river was diverted; they felt the circulation had changed. However, a Cree knowledge study completed in Wemindji in 1995 described eelgrass as stable or even flourishing in parts of that territory.

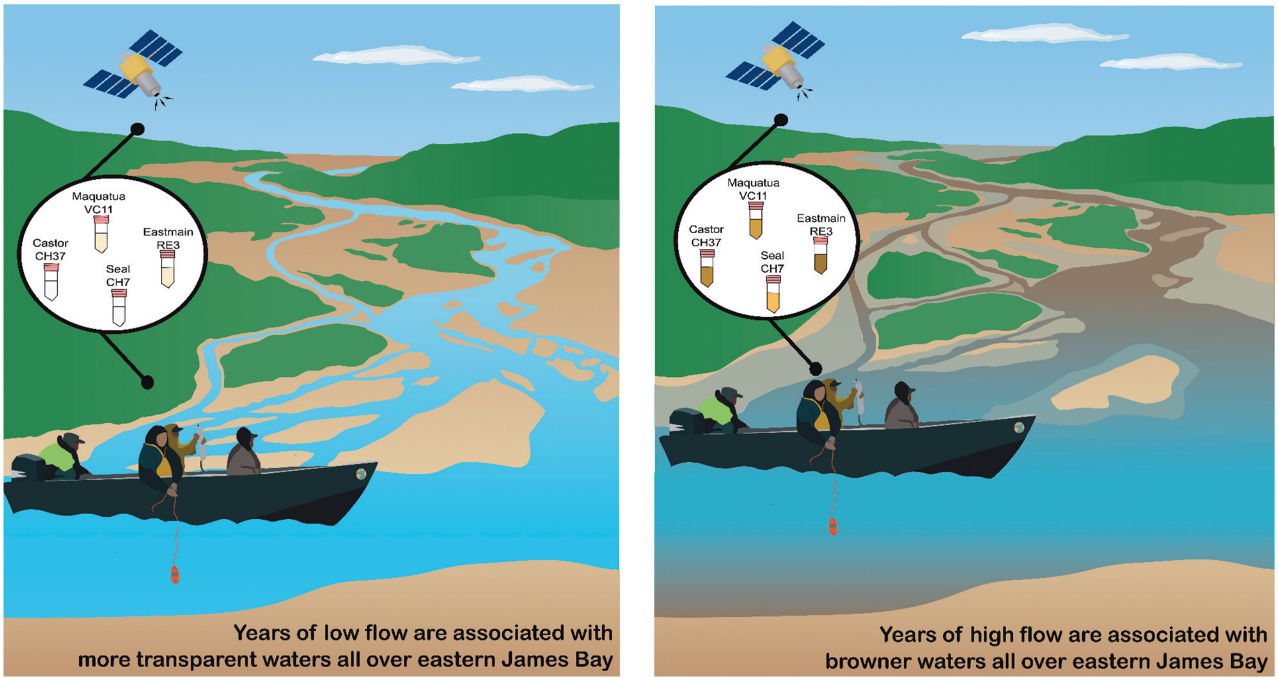
EELGRASS IN JAMES BAY HAVE FAILED TO FULLY RECOVER FROM THE DECLINES:

Eelgrass growth and extent is much less today than it was in the 1970s, 80s, and early 90s. There are small areas where eelgrass is doing better than it is in other areas, but large, dense meadows like those that once covered the large bays like Dead Duck Bay were not seen during the study. There appear to be some dense eelgrass beds in the region north of Chisasibi but the eelgrass team's SCUBA divers did not get permission to make measurements in these areas.

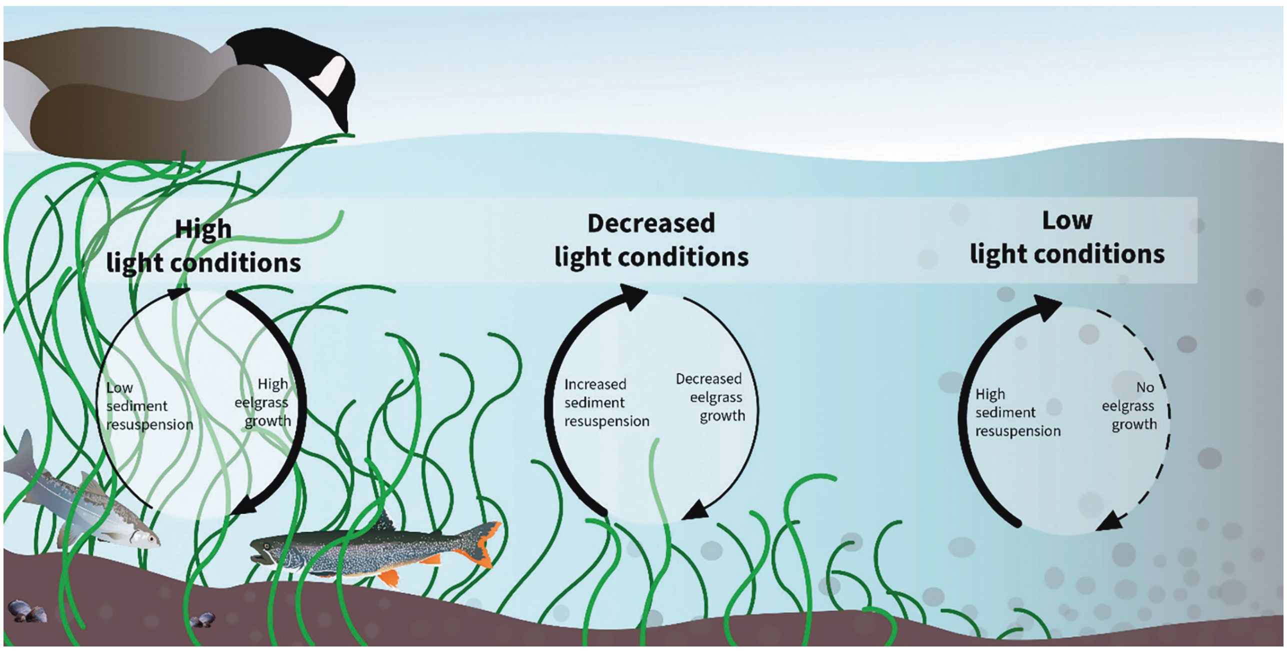
THE CURRENT STATE OF EELGRASS CONTRIBUTES TO LOW GOOSE PRESENCE DURING FALL:

Currently, the eelgrass is rarely more than 1 m tall, much shorter than the 2-m shoots seen in the 1970s-90s, and the eelgrass beds are smaller, patchy, and generally constrained to shallow waters (less than 2.5 m). Beds vary in quality year to year and the total area covered by eelgrass has decreased compared to 1988. *In this poor state, the eelgrass is likely less profitable as a food source for geese compared to the 1970s.*

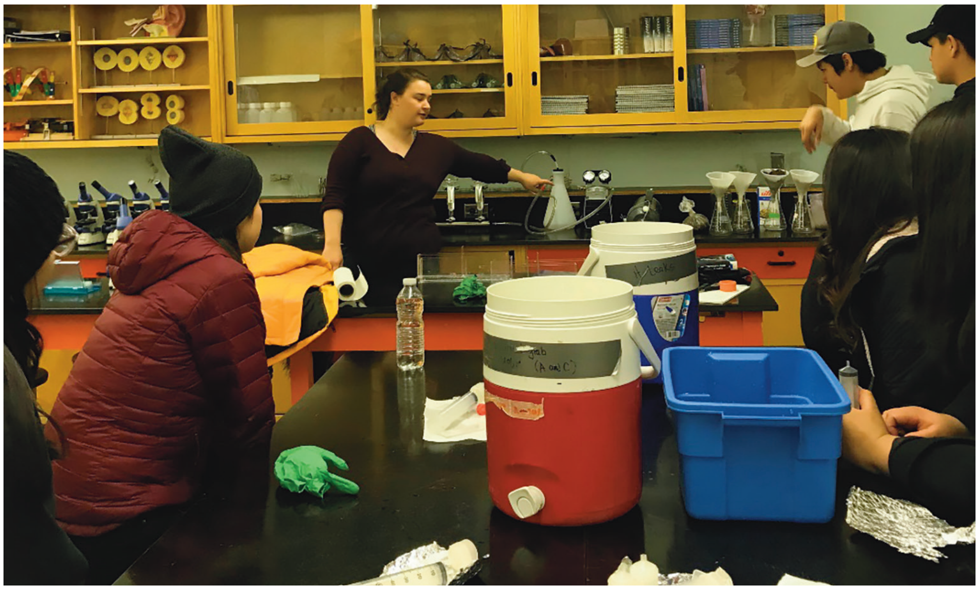
In addition to changes in eelgrass, goose feeding habits and hunting have changed all along their migration routes and in their wintering range. More long-necked geese now undertake molt migrations through eastern James Bay and may compete with short necks for local resources. Chisasibi and Wemindji Cree also attribute change in goose abundance to changes in local hunting practices and more noise pollution associated with the mechanization of hunting and air traffic in the area. There is increased hunting pressure around some of the remaining eelgrass beds.



Using satellite data validated by water sampling, we have detected a browning of James Bay waters over the past two decades, which may contribute to low light availability for eelgrass. The browning may be caused by increases in riverine inputs of coloured dissolved organic matter to the Bay. Years of high river inflow are associated with browner waters all over eastern James Bay. Illustration credit: C. Fink-Mercier.



Positive feedback effects of dense eelgrass beds and impacts of eelgrass loss. Healthy eelgrass beds help keep the environment good for themselves and for other eelgrass beds around them by calming the water and preventing the sediment from getting stirred up off the bottom by waves. But when eelgrass declines, the sediment can be stirred up off the bottom (resuspended) by waves, leading to murky water and low light conditions that hold back eelgrass growth. Image credit: M.L. Leblanc.



ABOVE: Cree describe eelgrass distribution in Wemindji in 2019 (left). Photo credit: G. Mark.

Outreach event demonstrating water sampling in Chisasibi school in 2019. Photo credit: A. Guzzi.

Outreach event demonstrating river sampling equipment in Chisasibi in 2019. Photo credit: P. del Giorgio.

A feast of goose and bannock is prepared in a traditional Cree way in 2019. Photo credit: J. Idrobo.

We conclude that the loss of large, dense, eelgrass beds partly explains changes in goose distribution along the coast and the negative effects on the fall goose hunt. The geese also changed their migratory habits in response to changes on the land along the bay (drying, more trees, fewer berries), and in the south (use of agriculture lands).

WHAT IS HOLDING BACK RECOVERY OF THE EELGRASS?

CHCRP results suggest that eelgrass recovery all along the coast is held back by *lasting effects of the eelgrass decline*. The positive feedback effects of healthy eelgrass have been lost. High levels of sediment resuspension now occur that cause *low light availability* under the water during the growing season. Eelgrass needs lots of light during summer, particularly in regions where there are many months of ice cover. When eelgrass does not get enough light during the summer, it is smaller, less dense, and less prepared to survive the winters. It is more vulnerable to stressful conditions such as warmer or fresher waters or low nutrient availability. Also, some areas that lost eelgrass and where the soft sediments were washed away by waves now have a *hard bottom* (seabed). If eelgrass cannot get its roots anchored well into the bottom, it has difficulties rooting and getting nutrients, and it is also at risk of being washed away by currents and storm waves.

The Cree have consistently reported that James Bay rivers and coastal waters have become murkier and more coloured over the years. This observation agrees with published scientific reports that northern inland waters have become increasingly browner and murkier during recent decades as climate has warmed. This is being called a *browning of inland waters*. Using satellite data, we have detected a *browning of James Bay waters* over the past two decades, which may also contribute to low light availability for eelgrass. The browning may be caused by increases in riverine inputs of coloured dissolved organic matter to the Bay. Large variability in ice breakup date from year to year *and* variation in water colour and turbidity cause the light availability for eelgrass to vary four- to five-fold from one growing season to the next.

In the La Grande sector of the coast, *high flows* from the La Grande River may also impede eelgrass recovery. The analysis of eelgrass biomass data from 1982-2009 showed that eelgrass biomass at some beds was reduced after high freshwater discharges from LG1 and warmer spring water temperatures out in the bay. It is also well known that low salinity (less than 5-10, where 0 is pure freshwater and 25 is typical James Bay water) impedes eelgrass growth. Other factors that are not yet quantified such as turbidity caused by sediment erosion could not be tested.

Near Eastmain, nutrient fluxes to the coastal habitat were reduced after the diversion and local sedimentation was changed. There were also temporary effects on turbidity of the river water in the months following an intense forest fire in the Eastmain and Rupert River watersheds in 2013. The fire followed three consecutive years of dry conditions in the southern James Bay watersheds. The oceanography of James Bay is not yet well enough understood to confirm how variations in river discharge alter the various properties of the water out in the bay.

THIS IS A CRITICAL TIME FOR THE FUTURE OF EELGRASS:

Although more turbid and browner water and other factors work against eelgrass recovery, eelgrass is still found in many areas, still growing, and still providing habitat for fish and birds. However, if human activities in the watershed further disturb the coastal habitat, or if climate change makes inland areas more susceptible to fires and erosion, the health of the eelgrass could decline further, or it could disappear from more areas along the coast.

This research was the first to seek a comprehensive understanding of recent environmental changes in eastern James Bay and impacts of the dam construction and diversion of rivers in the coastal habitat of Eeyou Istchee. Much was accomplished through the dedication of Cree land users, NLOs, and researchers, and the research stimulated a lot of interest in the communities. Unanswered questions remain, particularly about what could facilitate eelgrass recovery and a return to productive fall goose hunts. If the coastal habitat continues to change, it is difficult to predict how geese will adapt or respond to these changes. *Because eelgrass in eastern James Bay has persisted through major environmental changes in the past, perhaps it can recover but much depends on both how the climate varies in the coming years and future coastal management.*

Eelgrass has declined and recovered in other places. From these examples, we know the importance of long-term coastal monitoring and considering ecosystem health in environmental impact assessments and infrastructure development. The coastal habitat of Eeyou Istchee is large and complex. Some eelgrass beds may be more impacted by coastal development and others by climate change, and in places these stressors may interact. Although some impacts associated with climate change can be neither controlled nor avoided, there *is* potential to predict, manage, and mitigate potential effects of hydroelectric and other regional development as they impact coastal ecosystems.

Recommendations

In view of the importance of healthy coastal ecosystems for fish and wildlife, Cree way of life, and global processes, understanding and protecting the eelgrass ecosystems is important for the long term. It is our expectation that this report will help support future Cree-led monitoring and management. Based on our findings and discussions with Cree community members, we make the following recommendations:

The eelgrass beds are changing, as is the whole coastal ecosystem of the Bay, and even if they do not return to their past condition, these beds will remain very important ecologically. Monitoring the distribution and density of eelgrass meadows is complex and challenging, but vitally important from an ecological standpoint. A suitable monitoring strategy needs to include the following points:

- *Maximize community interest and involvement with local and regional governments and Hydro-Québec support,*
- *Employ several sampling techniques as developed in the CHCRP,*
- *Address knowledge gaps identified over the course of the CHCRP such as the influence of the high winter flows of the La Grande River on eelgrass and the influence of light-sediment resuspension on eelgrass,*
- *Assess eelgrass abundance and conditions annually to quantify spatio-temporal trends,*
- *Assess eelgrass health in areas not surveyed by researchers during the CHCRP especially north of the La Grande River.*

Monitoring the abundance and distribution of migratory waterfowl should include the following points:

- *Maximize community involvement while minimizing impacts on traditional hunting activities,*
- *Assess the changes of goose populations and track harvest success by collecting Canada Geese harvest booklets, determining the proportion of the two subspecies in the harvest (long- and short-necked geese), developing a protocol for the return of goose bands, and promoting the use of CTA's harvest phone app,*
- *Assess how the Cree waterfowl harvest has changed by compiling information on where goose camps operate, and how hunting activities are coordinated,*
- *Address knowledge gaps about the breeding grounds of the short necks hunted in fall along the coast,*

- *Assess the success of different habitat enhancement measures during the fall goose hunt by working closely with land users,*
- *Continue to assess the relationship between geese and coastal habitats, including eelgrass, by building on knowledge already compiled during the first phase.*

Discussions should continue on the feasibility and desirability of site-specific measures to restore eelgrass meadows in selected areas. An eelgrass restoration expert should be called on for advice about feasibility, and requirements for monitoring and evaluation in such an initiative.

Future development activities in the territory should recognize the vulnerability of eelgrass to sediment releases and sediment disturbance that affect water clarity in the coastal environment and if feasible include strategies to minimize and monitor these potential impacts.