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The "Turning Point" for the Fall Goose Hunt in Eeyou Istchee: A Social-Ecological Regime Shift from an Indigenous Knowledge Perspective

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Abstract
We present a perspective on how the Eeyou (James Bay Cree) from Eeyou Istchee (Eastern James Bay, Québec) understand the transformation of their traditional fall goose hunt system as a consequence of social and environmental changes across marine and terrestrial ecosystems with drivers operating at the local, regional and continental scales. Eeyou land users from the Chisasibi and Wemindji First Nations report that their traditional fall goose hunt underwent a "turning point" during the early 2000s. Not only did the abundance of Canadian geese reach a historical low, but their feeding and migratory behavior became unpredictable. Eeyou land users associate such abrupt changes with the massive eelgrass die-off of the late 1990s, the onset of the effects of climate change on coastal habitats experienced since the 1970s, and agricultural development along geese flyways. This manuscript is an outcome of the Eeyou Knowledge component of the Coastal Habitat Comprehensive Research Project (2016–2022) and followed a community-based case study approach that included 28 semi-structured interviews and 14 mapping interviews with Eeyou research contributors. The findings presented here underscore the capacity of Indigenous knowledge to make sense of the multifaceted impacts of environmental change across various dimensions and layers of their social-ecological system, including management strategies and values.

Keywords Social-ecological Regime Shift · Indigenous Knowledge · Canada Goose Hunting · Environmental Change · Eeyou (Eastern James Bay Cree) · Eeyou Istchee (Eastern James Bay · Quebec) · Canada

Introduction

A regime shift is a sudden and enduring transformation wherein a system transitions to a distinct state with unique characteristics (Rocha et al., 2015). When regime shifts occur, dynamical processes that historically stabilized systems can cross thresholds and lead to new, different states. Such shifts involve reorganizing internal controls and feedback mechanisms, ultimately altering the underlying structures and functions of the system. Regime shifts can stem from natural processes, human activities, or both, leading to significant ecological, economic, and social implications (Folke et al., 2004).

In the context of social-ecological systems, a regime shift implies a significant reorganization that usually leads to permanent changes in its biophysical properties and the functions, services, and management structures associated with them (Biggs et al., 2012; Maciejewski, 2019). When a social-ecological system undergoes a regime shift, the conditions that existed before the shift may no longer be applicable, and existing institutions become less effective in managing the new state of the system. These changes can lead to less efficient or less sustainable uses of resources, which create further feedback loops and exacerbate the stresses on the system (Lade et al., 2013; Lyver et al., 2019). The effects of these shifts go beyond the loss of access to food and harvesting practices to include long-term disruptions to relationships with ancestral territories. Although few examples refer explicitly to social regime shifts in the context of Indigenous Peoples in Canada (Burt et al., 2020; Mulrennan & Bussières, 2018), irreversible changes in the social and cultural domains following environmental

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changes are commonly reported (Cuerrier et al., 2015; Reid et al., 2022; Turner et al., 2008; Turner & Clifton, 2009).

Eeyou hunters have long recognized the relevance of eelgrass meadows on goose feeding patterns and stopover length during the fall migration, bringing predictability to these patterns (Berkes, 1978). Eeyou from the Chisasibi and Wemindji First Nations in Eeyou Istchee, Québec, perceived a "turning point" in their traditional fall goose hunt during the early 2000s, indicating a social-ecological regime shift. Declines in the hunt targeted Brant (*Branta bernicla*) and Canada geese (*Branta canadensis interior*) populations reliant on eelgrass while migrating along the Eeyou Istchee coast began more than a decade earlier in the region (Ettinger et al., 1995; McDonald et al., 1997). Brant became scarce, and Canada goose abundance hit a historical low between the late 1990s and early 2000s, exhibiting unpredictable feeding behaviour and migratory patterns (Peloquin & Berkes, 2009; Royer & Herrmann, 2013). Eeyou attribute these abrupt changes to the extensive die-off of eelgrass along the coastal region in the late 1990s (Leblanc et al., 2023a), as well as other factors, including hydroelectric development, climate change and agriculture in the south impacting goose habitats over the past 50 years. We examine the transformation of the fall goose hunt as a social-ecological regime shift, exploring its effects on harvesting activities, management practices, and relationships with the land through the lens of Eeyou's knowledge, stories, and experiences.

The Cree Nation Government, Niskamoon Corporation, and Hydro-Québec created the Coastal Habitat Comprehensive Research Project (CHCRP) to understand how changes in eelgrass health and distribution affected goose distribution and goose hunt productivity from 2016 to 2022 (Kuzyk et al., 2023). The study used a comprehensive approach incorporating scientific (coastal and river biogeochemistry, eelgrass, and goose ecology) and Cree knowledge components. The research presented here stems from the Cree knowledge component and focuses on the fall goose harvest in two northern Eeyou communities, Chisasibi and Wemindji, which share similar topography and hunting strategies and have experienced similar changes in eelgrass and waterfowl abundance. Table 1 explains terms and concepts frequently used throughout this manuscript.

Table 1 Terms and concepts frequently used in this manuscript

Term/ Concept	Definition
Niskamoon Corporation	Niskamoon is a non-profit organization that facilitates collaboration between the Eeyou (Cree) and Hydro-Québec to address the social and environmental impacts of Hydroelectric Projects in James Bay (JBHPs), a succession of hydroelectric projects in the Eeyou Istchee territory whose construction spanned between 1971 and 2012 (*Niskamoon Corporation*, n.d.)
Hydro-Québec	A government-owned utility company in Québec, Canada, that specializes in hydroelectric power generation.
Trapline (*Indoh-hoh Istchee*)	The Eeyou hunting territories or traplines are the fundamental units of governance in Eeyou Istchee; they are areas where traditional harvesting activities are conducted under the supervision of a tallyman (Awashish, 2018).
Eeyou/Eeoyuch	This is the preferred self-identification of the Indigenous people known in mainstream, Euro-Canadian society as the Eastern James Bay Cree (Awashish, 2018)
Eeyou Istchee	The traditional territory of the Eeyou (Eastern James Bay Cree). It means "the land of the Eeyou" (Awashish, 2018)
Tallyman (*Indoh-hoh Ouje-maaoo*)	Knowledgeable hunters designated by their families to oversee and steward harvesting activities in their respective hunting territory or trapline according to traditional Eeyou law and customs (Awashish, 2005)
Goose Boss (*Paasd-heejeh Oujemaaou*)	Refers to the hunter, often the tallyman or someone appointed by them, who oversees and coordinates the goose hunting territories and the hunting activities therein. A knowledgeable and respectable hunter typically assumes this role within each trapline. Goose Bosses are crucial in overseeing goose hunts, enforcing rules, prioritizing the ethical treatment of animals and participant safety, and preserving traditional knowledge (Awashish, 2018)
Short-necked goose	*Nisk - Branta canadensis interior;* subarctic breeding Canada goose
Long-necked goose	*Nisk - Branta canadensis maxima;* moult migrant Canada goose
Brant	*Iiwaapuweu - Branta bernicla*
Snow goose	*Waapawehweu - Chen caerulescens*

Setting the Scene: Eelgrass, Waterfowl, and Waterfowl Hunting before the Eelgrass Decline

Waterfowl hunting in Eeyou Istchee intertwines goose ecology with values integral to Eeyou identity, culture, and environmental stewardship (Awashish, 2018). While the spring hunt historically served to secure food during times of scarcity and limited mobility, the fall hunt united families and communities across the region and allowed the harvest of essential resources for the winter (Berkes, 1986; Scott, 1986). Among the species harvested, Canada goose contributed a third of the total weight of all harvested species in the Chisasibi First Nation community and a fifth in the Wemindji First Nation during the 1970s. Between 1972 and 1979, Eeyou harvested, on average, 31,770 birds/year in Chisasibi and 8848 in Wemindji during the fall season. Of these, 55% and 47% were Canada geese (James Bay and Northern Québec Native Harvesting Research Committee 1982).

Eelgrass (*Zostera marina*), a marine flowering plant found in shallow coastal waters in Eeyou Istchee, creates expansive meadows that serve as vital habitats for fish and provides a significant food source for migratory waterfowl (Leblanc et al., 2023b; Murphy et al., 2021). Eelgrass, rich in soluble carbohydrates, is a preferred food for Canada Geese during the summer and fall when building up energy reserves is crucial (Buchsbaum & Valiela, 1987).

Eelgrass played a crucial role in geese feeding and social behaviour in Eeyou Istchee, much like in other areas along the Atlantic coast of North America. In addition to providing soluble carbohydrates, healthy eelgrass meadows in these regions are typically undisturbed and safe, making them ideal goose habitats during migration stopovers (Buchsbaum & Valiela, 1987; Dignard et al., 1991; Hanson, 2004; Leblanc, 2021; Seymour et al., 2002). Thousands of Canada geese staged along Eeyou Istchee's shores from early September to late October, sometimes even early November. They aggregated in eelgrass meadows to graze and rest during low tide, while smaller flocks flew to rocky heaths to feed on berries and to high salt marshes to feed on marsh vegetation during high tides (Curtis & Allen, 1976; Dignard et al., 1991; Reed et al., 1996). Eelgrass meadows were once abundant and thriving along protected bays in coastal Chisasibi and Wemindji. They started declining in the mid-1980s, experienced a massive die-off in the late 1990s, and have not recovered to their pre-1990s abundance (Leblanc, 2021).

The Eeyou perceive geese as intelligent, social animals capable of learning to avoid and anticipate hunters and communicating behavioural responses and migration routes among themselves (Scott, 1986, 1989). Geese are also known to avoid areas with signs of human presence during the hunting season (Leblanc et al., 2023b). In response, the Eeyou developed a hunting system based on their knowledge, values, and worldview based on the interconnectedness of a Goose Boss, their family, and their hunting territory (Berkes, 1986; Scott, 1986). The family hunting territory is the basis of the Eeyou land tenure system. and is managed by a tallyman, who supervises harvest activities within the territory (Awashish, 2018). In the context of goose hunting, the tallyman, or someone they assign, assumes the role of Goose Boss to manage the goose hunting territories. The Goose Boss, a knowledgeable and respected hunter, plays a crucial role in managing the goose hunt by enforcing rules, prioritizing animal respect and participant safety, and ensuring the continuity of Eeyou knowledge (Cree Trapper's Association, 2009).

Goose hunting worked as a common pool resource management system that prevented geese overexploitation while managing Eeyou access to the hunt and its outcomes (Berkes, 1986). The practices and rules of this hunting system are geared towards controlling its users' excludability and geese substractability (Cox et al., 2010). While excludability is the capacity to restrict or control access to a resource or the area where it can be harvested, subtractability is the ease with which the available resources can be depleted or reduced. Excludability works in this system because there are clearly defined hunting areas (family territories) and clearly defined users (family members and their guests). Subtractability is facilitated by rules that restrict users' access to hunting sites. Hunting territories have multiple hunting spots used on a rotating basis chosen by the Goose Boss according to weather, usage, and migration timing. During the goose hunting season, hunters and their families gather in camps near the hunting grounds where men plan their hunting journeys and women and children process the catches. The night before a hunt, the Goose Boss decides on the hunters' position and shooting sequence to minimize disturbance to geese and increase hunting efficacy. Successful hunts require the Goose Boss' expertise, knowledge of the hunting territory, and trust of the hunters.

Additional rules govern behaviour and interactions with geese to address their high sensitivity to human disturbance, prevent overexploitation, and ensure hunters' safety (Cree Trapper's Association, 2009). For example, firearms should not be used before sunrise or after dusk to avoid alarming the geese with muzzle flash. Hunting on calm days is discouraged due to the long-distance carrying of shotgun sounds. Shooting geese within a reasonable range is advised to prevent alerting other flocks. Near the goose camps, measures like minimizing noise, concealing canoes and equipment, and avoiding motorized equipment or open fires help maintain a quiet presence. The Goose Boss's spouse can halt the hunt based on the number of birds to process or the harvest's sufficiency.

Abundant eelgrass and geese enabled a communal fall goose hunt in Chisasibi (Berkes, 1986) and Wemindji (Scott, 1986), necessitating coordination and organization. Goose hunting camps thrived, uniting Eeyou of all ages from coastal and inland territories in goose-related camp activities that contributed to family exchange, social bonds, and intergenerational knowledge transmission. Youth learned hunting, processing, patience, and environmental awareness in these camps.

Research Context: Eelgrass and Goose Declines in Eeyou Istchee

In the 1970s, the Eeyou signed the James Bay and Northern Québec Agreement (JBNQA) to mitigate the impacts and enhance the benefits of the James Bay Hydroelectric Projects (JBHP). This agreement catalyzed significant transformations in the Eeyou Istchee territory and Eeyou society,

economy, and relationship with the land (Fig. 1). Between 1980 and 2009, the JBHPs diverted several rivers—including Caniapiscau, Opinaca, Eastmain, and Rupert—and built nine generating stations and seven reservoirs, nearly doubling the average annual discharge of the La Grande River (Turgeon et al., 2019). During the same period, major infrastructure development improved connectivity between Eeyou Istchee and southern Québec (e.g., Billy-Diamond Highway and airports in each community) and within the territory (Airlift Program and access roads).

Amid all these changes, Eeyou noticed a slight decline in eelgrass and geese as early as the mid-1980s, which became more severe in the late 1990s (Idrobo, 2023; Leblanc et al., 2023b). The decline of eelgrass in the early 2000s coincided with a decline in goose abundance, prompting speculation among the Eeyou that the eelgrass decline may have contributed to the decrease in goose numbers. The goose decline was specific to coastal Eeyou Istchee, as the overall population of Canadian geese in the Atlantic flyway increased during the same period (Giroux et al., 2024; Peloquin & Berkes, 2009).

Methods

Driven by Eeyou's concern over the decline of eelgrass and waterfowl populations and their impact on harvesting practices, we employed a community-based case study approach (Parlee, 2016). The project's steering committee, comprising Eeyou from the study communities, and Hydro-Québec and Niskamoon representatives, actively developed the approach, objectives, and data-gathering strategy. Throughout the data-gathering and analysis phases, a collaborative effort was maintained with tallymen, active hunters, eelgrass ecologists, wildlife biologists, and the project's steering committee. Their continuous feedback was crucial in shaping the conceptual framework, refining interview guides, and interpreting the gathered data in ways sensitive to Eeyou land users' perspectives and information needs. Data collection methods included semi-structured interviews, mapping interviews, and participant observation. Fieldwork was conducted between June 2019 and June 2022.

We conducted 28 semi-structured interviews (18 in Chisasibi and 10 in Wemindji) between August and September 2019 with selected Eeyou from each trapline, including its tallyman, male and female elders, and active hunters. Participant selection followed a snowball sampling strategy in which each tallyman suggested interviewing specific Eeyou research contributors based on their knowledge and experience of the decline of eelgrass and waterfowl. Data from interviews were analyzed and categorized using ATLAS.ti.

Participatory mapping interviews registered the location of waterfowl hunting camps, hunting grounds, eelgrass beds, and other spatial features associated with eelgrass and geese before and after their decline (Tobias, 2009). We conducted eight mapping interviews in Chisasibi (November 2021) and six in Wemindji (March 2022) with representatives from each trapline involved in the study. We used 1:50,000 base maps that included the boundaries of each trapline and waterways. Data from participatory mapping were digitized, processed, and analyzed in ArcGIS. The areas reported were calculated using ArcGIS geoprocessing tools and based on eelgrass meadows' polygons and under a NAD83(NSRS2007)/UTM zone 18 N projection.

These methods allowed Eeyou elders and active hunters to contribute to the research in diverse ways. The results from this component were shared and verified with research contributors throughout the data collection period and analysis. We shared the research findings with Eeyou contributors through individual meetings, focus groups comprising members from the same trapline, and community forums. Throughout these interactions, we ensured that our interpretations resonated with the experiences and knowledge of the research participants. This study carries limitations associated with recounting 40 years of history, including potential memory fades or personal interpretations that could introduce inaccuracies or gaps in the data.

Due to the Covid-19 pandemic, the original research design underwent modifications. Adhering to guidelines from the University of British Columbia, as well as the Chisasibi and Wemindji Public Health Officer, which mandated a 14-day self-isolation upon arrival to the territory along with recommended testing, the research team opted to conduct participant observation with selected families in each community as the most secure method for data collection. In fall 2020, we spent eight days with a Chisasibi Eeyou family to learn about fall waterfowl hunting. In fall 2021, we spent seven days in Chisasibi and four in Wemindji to gather information on hunting practices, their connection to gender roles, and the intergenerational impact of eelgrass and goose decline. As restrictions eased in November 2021, researchers conducted mapping interviews and met with Eeyou to supplement their findings. Research contributors consented to be identified wherever direct quotations of their contributions are included (Last Name, Trapline, Year).

Results

Eelgrass after the 1990s Decline

Chisasibi and Wemindji Eeyou shared detailed knowledge about eelgrass's physical attributes, distribution, ecological

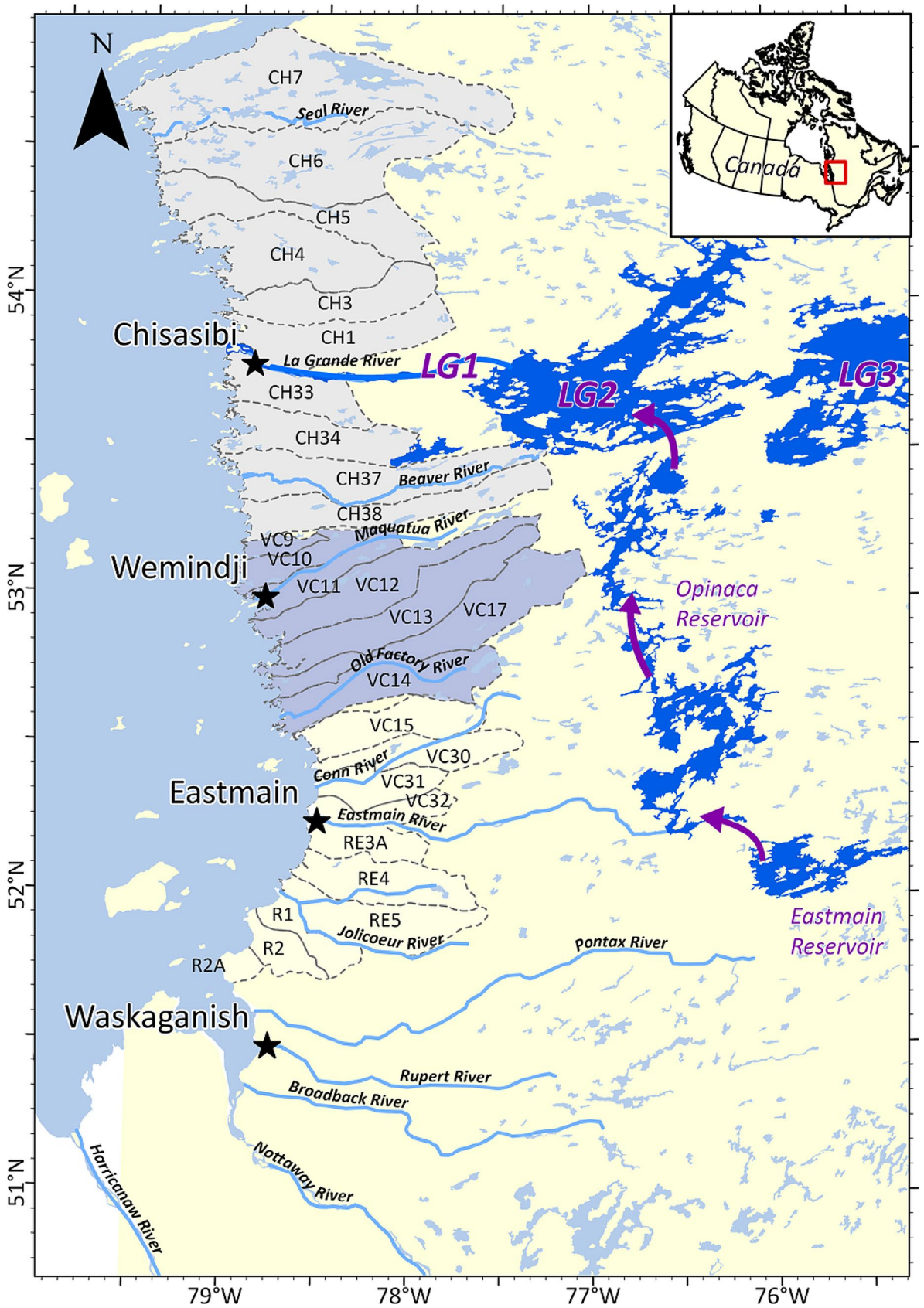

Fig. 1 Location of study area and general context

importance, the drivers behind it, and the consequences of its decline. According to their accounts, pre-1990s eelgrass meadows were abundant, dense, and uninterrupted, featuring deep-green leaves that ranged from 1.5 to 3 m long. In contrast, they reported that present-day meadows are discoloured, sparse, and fragmented.

Participatory mapping highlights eelgrass change in Chisasibi (Figs. 2 and 3) and Wemindji (Fig. 4) before and after the 1990s decline. According to our findings, Chisasibi, north of the La Grande River, experienced an eelgrass coverage loss of 97% of its area before 1990, with the remaining 3% considered unhealthy. South of La Grande, the loss amounts to 76%; 22% considered unhealthy and 2% healthy. In Wemindji, eelgrass has a loss of 58%, with 38% considered unhealthy and 4% healthy (Table 2). While the left columns in Figs. 2, 3 and 4 indicate that eelgrass was abundant and continuous before the 1990s, primarily located in protected bays and coves along the coastline, the right columns reveal a significant reduction in both the area and quality of eelgrass as observed in 2021.

Before it declined, Eeyou research participants report that eelgrass was a key component of waterfowl habitat and had an ecological function as a sediment filter. Eelgrass meadows calmed wave action wherever they were found. However, in its current state, eelgrass lacks the density to buffer the energy from waves and calm the water. A Wemindji research contributor recalls how eelgrass used to calm the shore's waves:

> The eelgrass meadows used to smooth and scatter the waves so they wouldn't break on the shoreline. That's how the eelgrass was seen, almost as if there was oil on the water that calmed the sea. Even if a big wave that created ripples in the water came, it became calm as it touched the eelgrass. That's how you could tell where the eelgrass was (H. Steward, VC14, personal communication, March 9, 2019).

Eeyou research contributors from the southern (CH38) to the northernmost (CH07) traplines in Chisasibi indicated that eelgrass became less abundant during the mid-1980s and disappeared suddenly in the late 1990s. They associate the hydroelectric development with eelgrass of lesser abundance and quality. These changes, in turn, have impacted waterfowl and subsequently affected the productivity of their hunt:

> There have been vast changes in [waterfowl] hunting activities since growing up since the hydro development project started in the early 1970s. We noticed vast changes in the early 1990s when LG1 began to operate. The waterfowl disappeared on account that the eelgrass was disappearing. That is when we started having a hard time getting geese, especially in the fall, as they primarily feed on eelgrass and berries. We started feeling the changes in the 1970s, but they became much stronger in the 1990s (L. Kanatewat, CH38, personal communication, August 27, 2019).

While our findings reveal agreement among the Chisasibi Eeyou who contributed to this research regarding the eelgrass decline, it is more challenging to establish a timeline for Wemindji. Some report that eelgrass declined suddenly in the late 1990s, while others say that eelgrass began to decline slowly between the early 1980s and the mid-1990s before crashing between 1995 and the early 2000s. Wemindji Eeyou refer to indirect clues, such as waterfowl abundance, to describe the process. Reports on Eeyou knowledge of eelgrass from Wemindji indicate that eelgrass was abundant and in good health in 1994 (Ettinger et al., 1995). A Wemindji Eeyou shares his perspective:

> People still went to hunt along the coast in the early 1980s when the eelgrass was plenty. In the early 1990s, it all started to fade away. The eelgrass started to fade away. We didn't realize what was going on, that the birds seem to be fewer and fewer, just gradually, fewer, and fewer every year […]. At the same time and suddenly [1995, when the access road to Wemindji was opened], the eelgrass began to disappear, and we didn't know what was going on with it. I always thought it was there, but there was no washed-up eelgrass when I went duck hunting in the VC14 area. We used to see rolls of tumbled eelgrass sitting along the beach, but there were no more. We had no more eelgrass and no more brant. The geese became very scarce (H. Steward, VC14, personal communication, March 9, 2019).

Eeyou research contributors attributed eelgrass changes to salinity, water clarity, seabed consistency, and the presence of slime to the eelgrass decline and its lack of recovery. Even though eelgrass declined along the Eeyou Istchee coast, its associated factors have not occurred or experienced homogenously (Table 3).

Eeyou contributors commented that salinity decreased from the northernmost coastal trapline in Chisasibi to VC12 in Wemindji, likely associated with the diversion of major rivers during the 1980s. They noticed the decrease in salinity because the bay had less brine smell, boats and motors lacked salt build-up, and they experienced less eye irritation while boating. Reduced salinity is a significant factor Eeyou associate with the current state and limited recovery of eelgrass:

Fig. 2 Eelgrass bed distribution before the 1990s (left) and current (right) north of La Grande River in Chisasibi

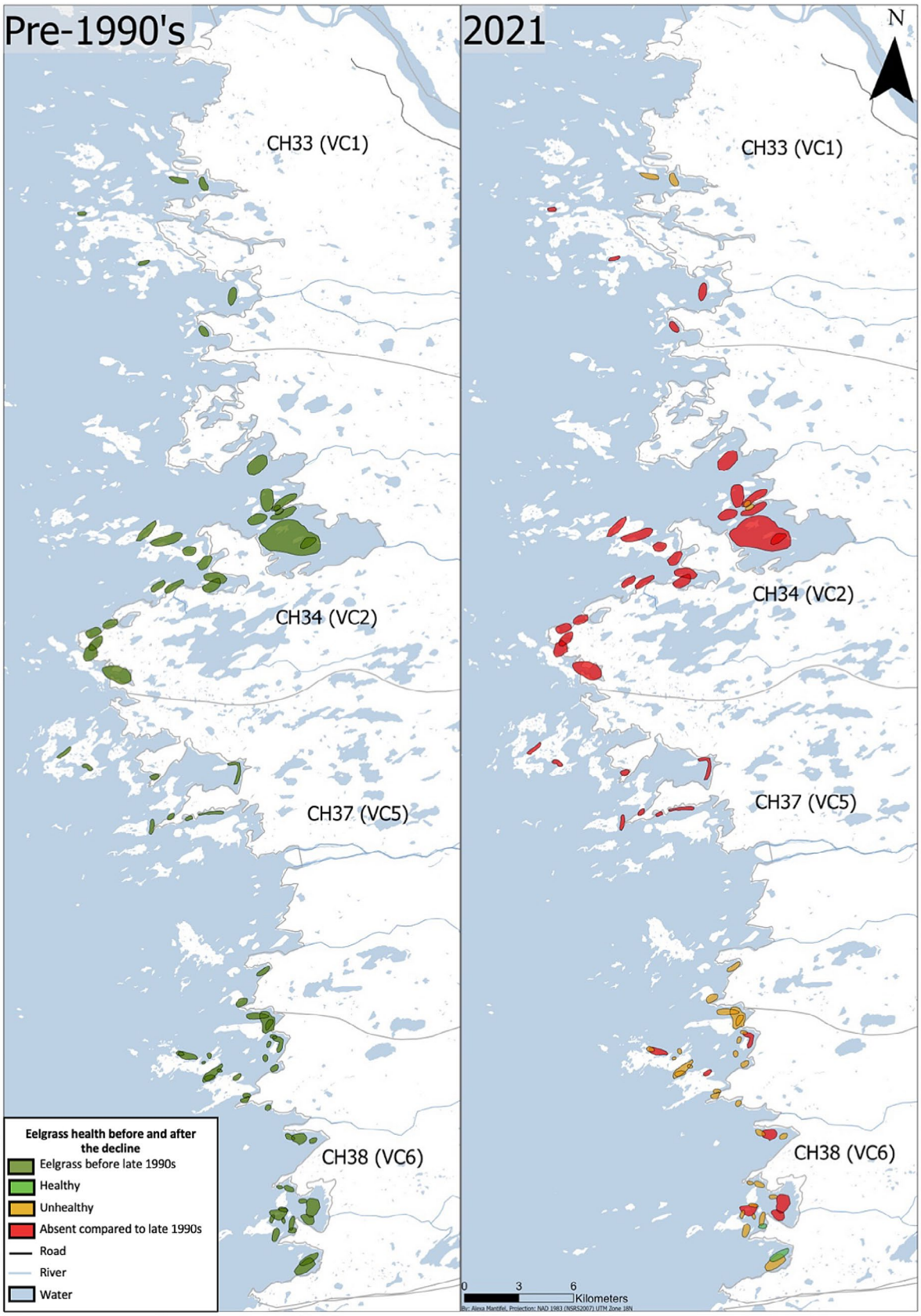

Fig. 3 Eelgrass bed distribution before the 1990s (left) and current (right) south of La Grande River in Chisasibi

Fig. 4 Eelgrass bed distribution before the 1990s (left) and current (right) in Wemindji

Table 2 Current eelgrass coverage relative to before the late 1990s distribution

Region	Absent	Unhealthy	Healthy
North of La Grande	97%	3%	0%
South of La Grande	76%	22%	3%
Wemindji	58%	38%	4%

> Because there is more freshwater in the bay, eelgrass is not as healthy as it used to be. One way we can tell there is less salt in the water is that we used to have white faces from saltwater after riding our boats in the bay. We don't get that because the water is not salty anymore (J. Sam, CH33, personal communication, August 23, 2019).

Research contributors report that they witnessed that the increased discharge of the La Grande River associated with hydro development resulted in riverbank erosion and sediment release into the bay, which they link to murkier water and seabed hardening. For Eeyou contributors from Chisasibi (except CH03 and CH34) and Wemindji (except VC09 and VC13), the persistent sediment accumulation has hardened the seabed in the areas where eelgrass used to grow:

> Before my dad passed away, we used to go out in the boat. There is a place where we couldn't go through in the boats with the motor. We had to stop and push the boat there. It used to be soft. Around 15–20 years ago [circa 2007–2012], my dad mentioned that it turned hard and was not soft anymore. It's changing that way. The bottom is so hard that the eelgrass won't grow. Now we see it: the eelgrass is not there anymore (A. Chiskamish, CH37, personal communication, August 26, 2019).

Eeyou research contributors also associate water murkiness with the eelgrass decline and its lack of recovery. Coastal marine water changed from transparent blue to murky brown in Chisasibi between 1986 and the early 1990s and a decade later in Wemindji. Contributors from Chisasibi and Wemindji consider the current murkier coastal waters a new normal from the northernmost (CH07) to the southernmost trapline (VC14) in the study area, except for VC17 (Fig. 1; Table 2). For them, current water murkiness contributes to eelgrass' lack of recovery: "The water is not as clear as it used to be when there was eelgrass. Eelgrass likes clear water; now you don't have that" (J. Kanatewat, CH38, personal communication, August 29, 2019).

Finally, slime and algae have become common along the coast: "We have noticed more algae. We can see algae growing on top of the water and covering everything" (D. Hughboy, VC17, personal communication, September 3, 2019).

Why Have Geese Declined?

> It was sudden. Geese and brant were nowhere they used to be. They just left. They didn't stop like it used to be. They used to have a stopping point around, but once the eelgrass stopped growing, they were gone; they flew by (P. Atsynia, VC11, personal communication, September 4, 2019).

Table 3 Biophysical factors influencing eelgrass growth in Chisasibi and Wemindji before and after the late 1990s decline according to Eeyou research contributors

Community/ Trapline (from North to South)		Salinity[1]	Seabed consistency[2]	Murkiness[3]	Slime and algae[4]
Chisasibi	CH07	Less salty	Hardened	Murky	No response
	CH04, CH05, CH06 - Did not participate in the study				
	CH03	Less salty	No Response	Murky	Present
	CH01	Less salty	Hardened	Murky	Present
	CH33	Less salty	Hardened	Murky	Present
	CH34	Less salty	No Response	Murky	No response
	CH37	Less salty	Hardened	Murky	No response
	CH38	Less salty	Hardened	Murky	No response
Wemindji	VC09	Less salty	No Response	Murky	Present
	VC10	Less salty	Hardened	Murky	No response
	VC11	Less salty	Hardened	Murky	No response
	VC12	Less salty	No change	Murky	Present
	VC13	No change	No change	Murky	Present
	VC17	No change	Hardened	No change (only when windy)	Present
	VC14	No change	Hardened	No response	Present

[1]Less salty, No change, No response; [2]Hardened, No change, No response:

[3]Murky, No change; [4]Present, Absent, No response

Although pivotal, Eeyou explained that the role of eelgrass in the short-necked goose decline is only one piece of a larger ecological puzzle. The migratory waterfowl have declined during living memory along coastal Eeyou Istchee. While snow geese declined due to the drying up of the coastal habitats due to isostatic rebound (Mulrennan & Bussières, 2018), brant geese became rare as eelgrass declined. According to the Eeyou, ecological and social factors significantly impact the migratory behaviour, abundance, and distribution of short-necked geese in both terrestrial and marine environments and at local, regional, and continental scales.

The Eeyou who contributed to this research agree that climate change is causing significant transformations in waterfowl habitats, impacting the resources on which short necks depend. Climate change manifests in longer growing seasons, accelerating vegetation growth. As a result, salt marshes, tidal flats, and rock heaths are transforming into densely covered areas dominated by reeds, cattails, and willows. Climate change has also affected the production of the berries on which short necks feed in the fall: "There are changes in the growth of the vegetation. There are more willows growing along the coast where the geese used to eat berries" (John and Judy House, CH34).

Vegetation overgrowth along the coastal ecosystems brings new fauna and flora and changes native species abundance. Eeyou from both communities shared their perspectives on the evolving Eeyou Istchee coast and its interdependence with waterfowl:

> The bays used to be full of short-necked and snow geese. They had good areas to graze back then, but the land is covered with reeds and cattails today. There's a lot of moose now because what is now growing is their food (J. Sam, CH33, personal communication, August 23, 2019).

Eeyou commented about the growing number of bald eagles (*Haliaeetus leucocephalus*), a species native to Eeyou Istchee, and the increasing numbers of relatively newly arrived species, such as Sandhill cranes (*Grus canadensis*). These species compete and predate on geese: "We have got new species in recent years, lots of sandhill cranes and bald eagles. The bald eagles kill the geese, the cranes scare them" (J. Sam, CH33, personal communication, August 23, 2019) and affect goose behaviour: "The geese are now flying at night and are harder to hunt. This change might be related to the avoidance of cranes and eagles. We had no cranes in the 1960s and 1970s, we saw a few in the early 1990s, but today there are lots"(D. Hughboy, VC17, personal communication, September 3, 2019). Additionally, long-necked geese started visiting Eeyou Istchee in the 1970s during their moult migration and have become as abundant as short necks.

The expansion of industrial agriculture in Québec and Ontario has also become a driver operating at the continental level that is changing the behaviour and distribution of geese. The relative abundance of corn and other cereals in the south has changed migration patterns and contributes to explain the shorter waterfowl staging periods:

> The geese still fly. They come from the corn fields very fat [in spring]. They fly really high. We almost don't see them. We can see flocks of geese migrating north using telescopes. They are now invisible to the naked eye. When the eelgrass was abundant, the short necks used to stay until the end of October. Now, they come and go by the first week of September. There are hardly any geese at the end of September. There's no food here, and they prefer to eat in the fields in the south. Forty years ago, it wasn't like that. (J. Kanatewat, CH38, personal communication, November 21, 2021).

During the last five decades, human disturbance related to air traffic and the mechanization of hunting and travelling on the land have also affected goose abundance and distribution patterns. Traditionally, people were not allowed to fire guns or make open fires after dusk and had to hide their canoes in the bush during hunting season. Transgressing these rules would scare the geese away from a particular hunting ground: "Our grandparents told us that in the 1950s, a priest was hunting at a key site in the evening. He ruined that site because he shot geese with black gunpowder. The geese saw the flare and never returned to that site" (J. Kanatewat, CH38, personal communication, November 21, 2021). Likewise, before boats with outboard motors became common, hunters used to paddle in groups from the community to the hunting camps and then go on foot to the hunting grounds:

> Our fathers and grandfathers really respected the idea that geese are bothered by human noise, smoke, and fire. One had to go from the camp to one bay and to the next, walking in the tree line, away from the water, so that the geese wouldn't notice (H. Steward, VC14, personal communication, March 9, 2019).

Research contributors agree that a bustling coast is unsuitable for migratory geese. Commercial flights, airlift programs transporting Eeyou to their traplines for spring goose hunting, and the use of snowmobiles have amplified noise levels in the area. Boats with outboard motors remain used for as long as favourable navigation

conditions exist. Likewise, hunting camps using electric generators are now closer to the waterfowl feeding grounds than ever before. Eeyou are aware of human noise's effects on geese: "The planes are louder now. They scare the geese. Once they have been scared, they don't return, they go somewhere else quieter" (S. Mistacheesik, VC12 et al., personal communication, September 3, 2019).

Goose migration routes in spring and fall began to shift from along the eastern coast of James Bay to inland in the 1990s (Ettinger et al., 1995). Research contributors attribute these changes to the decline of eelgrass and other resources along the coast: "Even if there is north wind, the geese do not come because their food is scarce" (M. House, & S. House, CH01, personal communication, August 24, 2019); and the availability of open water after the reservoirs were built: "Ever since they build the dams there is more water inland. That has changed the geese flight patterns" (D. Hughboy, VC17, personal communication, September 3, 2019). The evidence informing current migration routes relies on observations and information exchange among Eeyou throughout the territory. Chisasibi Eeyou report observing geese flying along the coast up to key points in the northernmost trapline (CH07) close to Hudson Bay during the fall migration to then fly southeast: **"**Short necks are now flying inland, and we don't see them anymore. People see them around Cape Jones and Seal River (CH07) in the fall and spring. We don't see them around here anymore*"* (E. Sam, CH33, personal communication, August 27, 2019). Observations of geese flying inland in more southern traplines support the changing migration patterns (VC14):

> When the access road became operational [in 1994], people talked about fewer geese, even during the spring migration. Some people mentioned that the flocks began heading more easterly than northerly. The flocks were not following the coast anymore; they were going inland (H. Steward, VC14, personal communication, March 9, 2019).

Other studies about waterfowl and data from satellite telemetry corroborate current Eeyou observations and inferences about the changing migration routes (Malecki et al., 2001; Peloquin & Berkes, 2009). Since the late 1990s, geese tagged in Hudson Bay have predominantly abandoned their traditional fall migratory route along the coast, opting to fly directly inland towards agricultural areas. This change was not as noticeable during the spring migration, as many geese continue to follow the northward coastal path.

What Happened to the Fall Goose Hunt?

Eeyou consider that their traditional fall hunt underwent a turning point, from fruitful to unsuccessful, linked to declining goose abundance and habitat degradation. Fewer geese and their unpredictable behaviour transformed goose hunting practices, management, and institutions. The hunt's productivity hinged on the authority of goose bosses, who organized the hunt to capitalize on the predictability of geese. A successful hunt reinforced respect for the Goose Boss and effective hunting practices. The turning point is evident in current behaviours and attitudes, as people increasingly rely less on the goose boss, abandon collective hunting, dedicate less time to hunting, and shift focus to other targets: "We had a Goose Boss back in the 1990s. These days, people just go and hunt anywhere they want but inform each other. With fewer geese to hunt, we don't collaborate as much*"* (E. House CH01 et al., personal communication, November 22, 2021).

Hunting success relied heavily on predicting goose feeding behaviour, contingent on undisturbed habitats with healthy eelgrass and abundant berries. Before the goose decline, Eeyou hunters intercepted geese strategically during their flights between eelgrass meadows at low tide and terrestrial ecosystems at high tide (Fig. 5a). Following the eelgrass decline, the fewer geese migrating along the coast became unpredictable (Fig. 5b). Eeyou hunters express uncertainty regarding geese' timing and staging duration during current fall migrations: "Before eelgrass disappeared, geese stayed in our trapline until the freeze up in November. Now they don't even stop here" (M. House, & S. House, CH01, personal communication, August 24, 2019). Furthermore, hunters often find they have lost access to the geese as they fly outside their shooting range or at night (J. Sam, CH33, personal communication, August 23, 2019). Although Chisasibi and Wemindji Eeyou still hunt geese in the fall, this practice has changed dramatically.

For the Eeyou who contributed to this research, the traditional hunt hit a turning point in the early 2000s:

> I stopped hunting in the 2000s. I realized it wasn't worth it to go hunting anymore. I used to spend about two weeks hunting in the camps. The geese used to be around even until November. I would take two weeks off from work and go hunting. The last time I spent two weeks hunting was in the 2000s. Before that, I used to go every year, every fall. I went hunting for the last time in the 2000s because there were no more geese. There are hardly any geese anymore (E. Sam, CH33, personal communication, August 27, 2019).

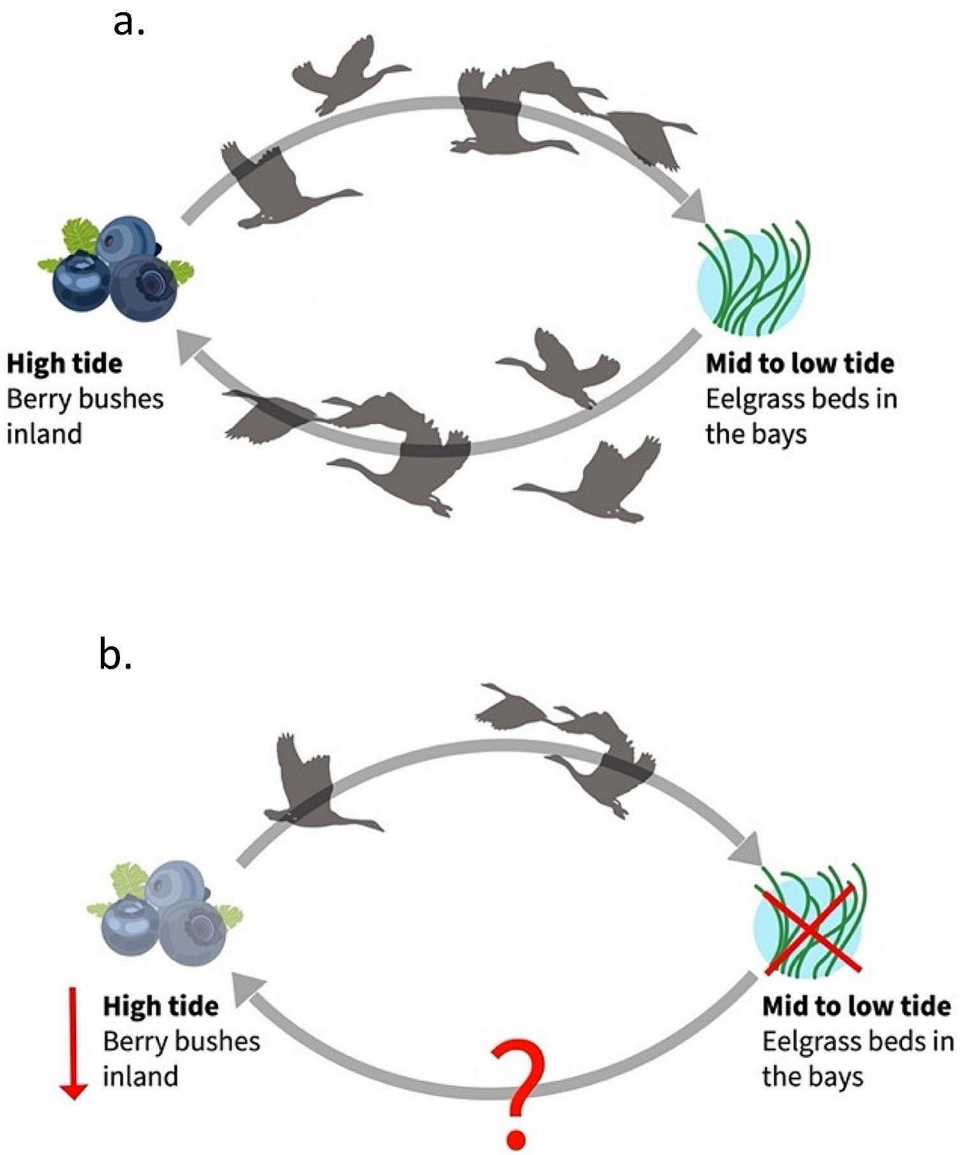

Fig. 5 Goose feeding behaviour before (**a**) and after (**b**) the decline of eelgrass along the coastal Eeyou Istchee

Following this turning point, the fall hunt became an opportunistic practice. As the hunt became less productive and unpredictable, hunters no longer followed the traditional institutions and practices associated with it. Hunters now prefer to gather in smaller groups, embark on two or more boats and venture towards the known locations of geese. Scott (2011) reports this strategy was implemented in Wemindji during the late 1980s and early 1990s as wage labour reduced the time available for some hunters but provided more access to money, promoting the mechanization of hunting. Hunting became spatially differentiated back then. While collective hunting depended on eelgrass meadows, day trip hunting happened in nearshore islands. As eelgrass and waterfowl declined, Eeyou contributors shared that day trip hunting became more frequent and, eventually, the most common waterfowl hunting strategy in Chisasibi (H. Scipio, CH07, personal communication, August 25, 2019) and Wemindji (R. Swallow & C. Matches, VC09, personal communication, September 4, 2019). A Chisasibi Eeyou hunter explains how they adjusted their hunting strategies in response to the waterfowl's new feeding behaviour:

> We just go to the islands and wait for the geese to fly over […] We don't go where we used to go in the bays. We don't hunt as we used to. Now we check where they [Geese] are. Geese don't really stay like they used to. It's different now. Before, we used to wait for the geese; now, we look for them (R. Scipio, CH07, personal communication, August 28, 2019).

Hunters and their families used to hunt geese in their traplines for at least two weeks during the fall hunting season. The hunters that remain in their traplines now target moose, a more abundant species because of vegetation overgrowth, and rely more on small birds and fish. These are regular practices in Chisasibi (J. Sam, CH33, personal communication, August 23, 2019) and Wemindji:

> Before the decline, we used to go for two weeks to our camps. I find that people rarely go goose hunting anymore. People are hunting moose instead. There are more and more moose in the bays. We are replacing the geese with other game. Moose is very abundant these days (Ryan Swallow and David Matches, VC09).

The current uncertainty and reduced outcomes of the goose hunt are additional signs of a turning point. Engaging in fall hunting has become increasingly rare. Even when people participate, they often encounter meagre results, sometimes capturing no geese. It is common to hear about hunters returning empty-handed or with the same shotgun shells they had before the hunt:

> I used to get between 30 and 40 geese in a day. Now I'm lucky if I can get one. Some people don't even get one in the spring or fall hunt. Some people don't even get the chance to shoot (L. Kanatewat, CH38, personal communication, August 27, 2019).

As eelgrass disappeared, the role and authority of the Goose Boss transformed:

> People do not respect the goose boss anymore. Before the eelgrass disappeared, the goose boss used to tell us where and when to hunt. Now, without eelgrass, we have lost the order that there used to be, and people don't respect the goose bosses as much as they used to (M. House, & S. House, CH01, personal communication, August 24, 2019).
>
> The goose bosses have lost their jobs because there are no geese. The goose bosses should get after Hydro for losing their jobs (L. Kanatewat, CH38, personal communication, August 27, 2019).

Social Relations and Values after the Eelgrass and Goose Declines

> There is no anticipation anymore. Before the decline, people felt sad to see the geese go in the late fall. Now, there is no motivation to go out to hunt. People have lost interest in being outside (Lameboy, 2020).

Geese and eelgrass brought Eeyou together in the fall. Before the decline, Eeyou recall that the goose hunting camps were thriving places where families, relatives and friends spent time together and shared food and stories. There is a deep sense of sorrow when people reflect on the social meaning geese and eelgrass had with the camps:

> Losing eelgrass means losing friendships with people from other traplines and other communities that used to hunt with us. We don't see them anymore […] We're losing our way of life. Things have changed a lot. [Before the eelgrass decline,] everybody was out in the bay from the middle of September until the middle of October. If you check how many people are out there at those times now, maybe one family in each trapline, some traplines are empty. It's very touching to go back and find very few families there. In my trapline, we used to have families, brothers, kids. All the traplines were like that, but not anymore. It's sad to see. I don't know what's going to happen. I don't know if they want to go back there. I'm still going there, and I know some people are still going. My brother is always in the trapline fishing. In the spring, everybody is out, not in the fall anymore. We miss the eelgrass (A. Chiskamish, CH37, personal communication, August 26, 2019).

Eeyou's relationship with the land is intricately tied to their traditional practices. Fewer available geese to hunt results in less time spent on the land. This shift has important implications for transmitting knowledge and values critical to the continuity of Eeyou culture. The erosion of traditional practices and the corresponding loss of respect for animals and traditional foods has a significant gender dimension. Older women feel their roles and contributions are not being passed down to future generations:

> We women cleaned the animals, dried our food and spent much time in the tipi. Girls were taught to clean food early, and women knew their roles and worked very hard. No food was spoiled. Today, we see a lot of spoiled food at the garbage dump, and women do not seem to take their roles as seriously as in the past. It hurts me to see this happening. We spend less time in the bush due to the waterfowl decline. The animals we used to receive were more abundant, but we rarely see them anymore. We're losing our livelihoods because of the lack of geese. We're losing our culture and practices, and, most of all, we are losing respect for the traditional foods and animals (M. Scipio, CH07, personal communication, August 25, 2019).

Older Eeyou men express similar concerns about the erosion of values and skills among male youth. Patience is key to learning to behave and act under variable circumstances in a changing environment cultivated by spending time with experienced harvesters. Older Eeyou, who grew up in times of abundance, learned to be patient from being on the land under the guidance of their goose boss. The younger generations' lack of exposure to structured opportunities has hindered their development of patience in reading animal behaviour and understanding the land. Eeyou elders express concern about this absence of patience leading to further disconnection from the land.

> One of the biggest changes we have experienced in our hunting practice is that younger generations have lost patience to hunt. Current hunters lack the patience to wait for the entire day without seeing geese […] The role of the goose boss was to transmit a sense of patience during the hunts. That has changed because younger people are not patient anymore. There are no geese to hunt. This is a huge loss for us (Kanatewat and Kanatewat, CH38 2021).

This disconnection leads to additional losses regarding exposure to and acquisition of land knowledge. According to John Lameboy (2020), "Children won't learn the knowledge, skills, and language related to the fall hunt. They won't learn the knowledge of topography, movement, or tides." Losing the collective hunt also translates into a loss of motivation to be out on the land: "All the family used to go hunting during the Spring and Fall break. We are losing our culture. People don't go out anymore. Children stay watching TV and playing videogames" (L. Kanatewat, CH38, personal communication, August 27, 2019). The younger Eeyou generation grew up with a distinct baseline for geese abundance, differing from that of their older relatives: " When they [younger generations] see 200 geese, they think it's a lot, but it was a lot more in the past. For me, it's like there's no geese now" (J. Sam, CH33, personal communication, August 23, 2019). Furthermore, alongside the decline, the younger generations were exposed to a time when formal education and wage labour grew in importance alongside the land-based economy (Salisbury, 1986). With fewer geese and more wage labour jobs available, the older generations and the current younger generations have less time available and less motivation to hunt. Eeyou comment on the effect that the eelgrass loss has had on their way of life:

> The eelgrass disappeared slowly, and then everything else went away: the geese, the hunters, everything. We hardly stay there like we used to. We stay less these days now. We need to work, we need to feed our family (F. Scipio, CH07, personal communication, August 23, 2019).
>
> I feel sorry for my children because there are no geese. Now, people rely on wage jobs because living out on the land would not sustain them. There is nothing to depend on in the bush. How do we continue this way of life if there is nothing to eat and animals we depend on as food no longer exist? So, in return, this way of life might become extinct. Too much damage has been done already (House and House, CH34 2019).

The decline of eelgrass and changes in goose populations along coastal Eeyou Istchee have impacted waterfowl hunting practices, resource access, and the continuity of the traditional Eeyou way of life. This loss goes beyond the physical aspects and threatens cultural continuity and the community's relationship with the land. Recognizing the social-ecological implications of environmental change is crucial for preserving the resources and ways of life essential to the Eeyou community. The decline of eelgrass is often seen as akin to losing a cherished relative:

> We were surprised when the change happened. These days, everything is dead. There's nothing there. It's like getting your heart broken and losing someone you love. We have the same feelings about what is happening there (F. Scipio, CH07, personal communication, November 20, 2021).

Discussion

Our research illustrates a case of how Eeyou's understanding of environmental change involves a systematic process of reasoning that intertwines empirical observations and experience with complex reasoning. For the Eeyou, the term "turning point" is a metaphor for a regime shift that links changes to the coastal environment to their traditional fall goose hunting system and that has far-reaching implications for hunting practices, institutions, values, and the worldview underlying Eeyou's relationship with the land. Eeyou's understanding of this regime shift involves a detailed examination of changes in each social and ecological component of the fall goose hunting system, including eelgrass, geese, hunters, and the relations among them (Fig. 6).

The Eeyou who contributed to this research provided a systemic assessment of eelgrass health and distribution before and after the late 1990s decline. Although eelgrass is not a species they actively use, Eeyou understands its ecological role, the conditions that enable its growth, and

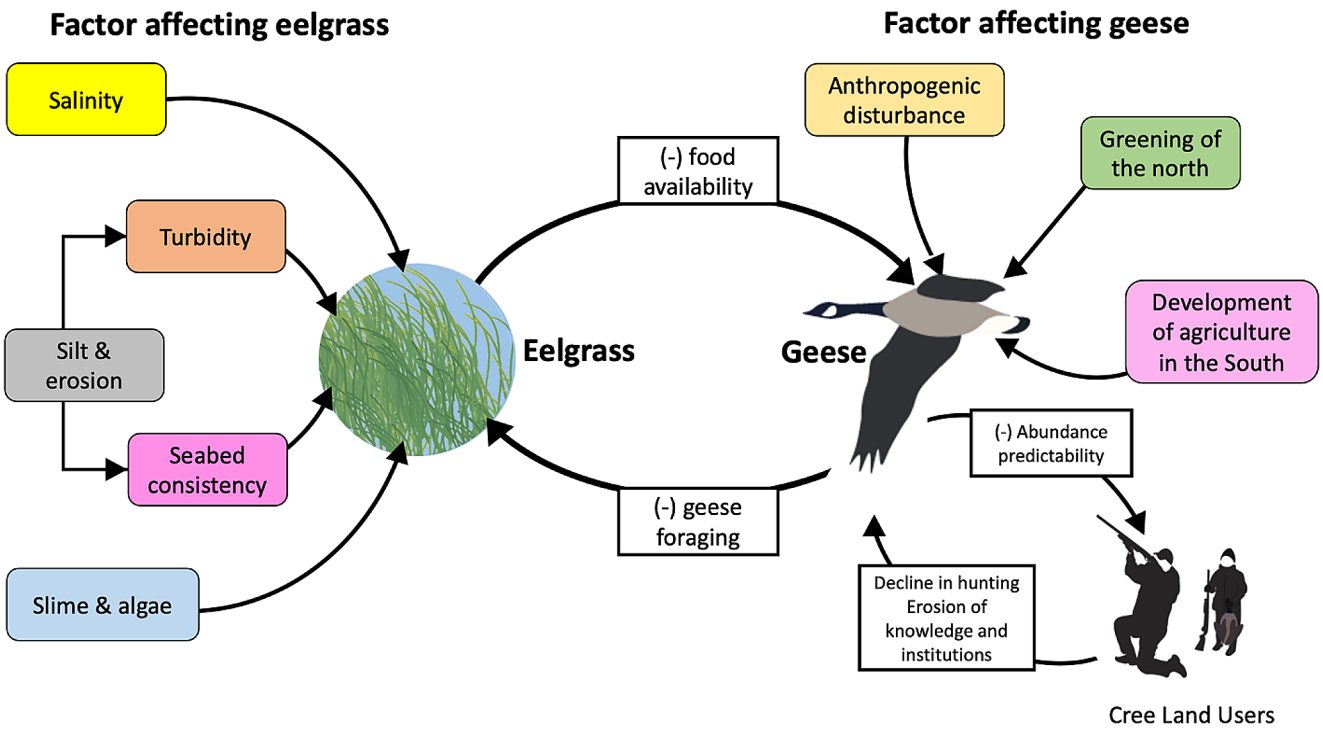

Fig. 6 Synthesis of factors that affect eelgrass and goose hunting according to Eeyou knowledge

how these changed to cause its decline and hinder its recovery. Eeyou research contributors established a connection between past and current eelgrass health and biophysical factors whose condition has strayed from their normal range of variation. The conditions described before the decline are characteristic of thriving eelgrass ecosystems (Maxwell et al., 2017; Unsworth et al., 2015). While clear waters and muddy seabeds are signs of functioning sediment-trapping feedback mechanisms, extensive and continuous meadows with plants with long, deep green leaves are indicators of healthy eelgrass ecosystems. Sediment input and resuspension cause murkiness that deteriorates light conditions and inhibits eelgrass growth, leading to further murkiness that worsens eelgrass growing conditions (Moksnes et al., 2018). The proliferation of algae after the decline suggests suboptimal water quality. Most seagrass declines, including eelgrass, have been linked to chronic processes that reduce light availability (i.e., eutrophication, water pollution, sedimentation) and inhibit eelgrass growth, leaving the meadows vulnerable to other environmental stressors (i.e., climate change) (Unsworth et al., 2015; 2022). Eeyou's descriptions of eelgrass's current distribution and condition in Eeyou Istchee speak about a system under sustained stress that shifted into a simplified state with limited productivity. The Eeyou attribute this phenomenon primarily to hydroelectric development, drawing from their everyday observations of increased discharge and erosion flowing into James Bay related to the construction and operation of hydroelectric dams. Although Chisasibi and Wemindji experienced slightly different processes of eelgrass decline, the consequences on goose abundance and behaviour are similar.

The explanation for the waterfowl decline involves a more complex set of variables. For the Eeyou who participated in this study, the late 1990s eelgrass die-off is pivotal in explaining the goose decline. Even though the Canada goose is generally known as a generalist species, Eeyou observations align with the scientific literature documenting the importance of eelgrass in the diet and migratory behaviour of Canada goose in Eeyou Istchee (Curtis, 1973) and along the Pacific and Atlantic Coasts of North America (Kollars et al., 2017; Leblanc et al., 2023b; Ward et al., 1994), and goose population declines following eelgrass collapse in migration stopovers (e.g., Antigonish, Nova Scotia (Seymour et al., 2002). Eeyou's understanding of goose declines also incorporates changes to terrestrial habitats associated with the greening of the north as a local manifestation of climate change (Berner et al., 2020).

Indigenous knowledge about the effects of climate change on flora and fauna has been widely reported across eastern and western James Bay (Peloquin & Berkes, 2009, Lemelin et al. 2010, Herrmann et al. 2012, Tam et al., 2013). Indigenous peoples across the Arctic report northward expansion of the treeline and the uncertainty it poses to their livelihoods and ways of life during the early 2000s (Downing & Cuerrier, 2011). Our findings highlight Eeyou's observations of

a shifting ecosystem characterized by replacing heath and tundra habitats with shrubland and its impact on waterfowl. The feedback from this transformation affects habitats and leads to the extended distribution range of other species that compete with or prey upon waterfowl. Factors such as the overgrowth of shrubby vegetation in berry and high marsh areas, the increased presence of predators like bald eagles, and the emergence of potential new competitors like long-neck geese contribute to deterring goose presence. Ecological change in Eeyou Istchee impacts the local flora and fauna and reverberates into the social fabric.

Regime shifts often significantly impact the management and governance of natural resources, disrupting established use patterns and making it difficult for existing management institutions to respond effectively to the new conditions (Lade et al., 2013; Maciejewski, 2019). Management institutions function within a specific range of variation in the social-ecological system. When the variation exceeds this range, the institutions become ineffective, leading to less efficient resource utilization and detrimental feedback loops (Lyver et al., 2019).The goose decline challenges the traditional fall goose hunt, whose institutions and associated practices do not fit with Canada geese's current abundance and behaviour. In the past, the hunt's social and ecological aspects relied heavily on the guidance of the goose boss and collective resource management. As hunting transforms into an individual and opportunistic activity, the hunting effort is scattered across the landscape based on goose availability. This scattered approach disrupts the geese's presence and further undermines social interactions and platforms for passing knowledge and values from elders and experienced hunters to the new generations.

Transgression of hunting institutions in the form of noise pollution linked to the mechanization of the hunt, increased air traffic, and improper hunting practices also impact goose presence. These trends align with earlier studies that highlighted the effects of human disturbance on goose behaviour and the disruption of hunting patterns in Eeyou Istchee during the 1990s (McDonald et al., 1997) and 2000s (Peloquin & Berkes, 2009). Although the changing of migration routes was already reported in Eeyou Istchee (McDonald et al., 1997) and western James Bay (Tam et al., 2013), its attribution to the development of agriculture further south along the Atlantic Flyway signals the incorporation of socio-economic and environmental factors across scales into Eeyou's understanding of the local ecology. Previous studies in Wemindji (Peloquin & Berkes, 2009) hinted at the early 2000s turning point, but this was likely not fully understood due to the inherent variability of northern ecosystems.

As the traditional goose hunting management institutions dwindle, Eeyou find themselves experimenting with new hunting techniques, sites, management practices and targets to cope with the current conditions. At the individual level, some use corn as bait to attract geese, while others travel south to hunt near Ottawa or inland along the access roads. At the community level, initiatives exist to create and maintain goose ponds, flyways, and other goose-feeding areas. Moose hunting fall has become widespread, replacing the traditional goose hunt. Replacing the goose with the moose hunt entails different practices, knowledge, and relations with the land and among hunters. While traditional goose hunting is a collective practice, current goose and moose hunting are not. Older land users worry that new generations of hunters will not see the abundance with which they grew up and will not learn to hunt and associated knowledge and values. In the case of this regime shift, the erosion of management institutions can make it difficult for a system to return to its pre-decline state and can have long-term impacts on the management and governance of natural resources in a possible alternate state (Lyver et al., 2019).

Eeyou cosmology is aligned with the core concept of resilience thinking, which emphasizes the connection between social and ecological systems and recognizes that change is an intrinsic aspect of life (Berkes, 2011). Eeyou's understanding of the magnitude and origin of change in their territory and its ripple effects on multiple interconnected systems aligns with this social-ecological perspective. Metaphors such as the turning point of the hunt and goose bosses losing their jobs emphasize the importance of management institutions and values in a system's overall functioning and regulation. This perspective goes beyond understanding regime shifts as sudden and persistent changes in patterns and processes to including disruption of relationships with the land, intergenerational knowledge continuity, management institutions and values.

Conclusions

Examining a regime shift from an Eeyou knowledge perspective reveals the explanatory power of indigenous knowledge to account for environmental change from specific species and their ecology to the broader social-ecological system level. This assessment also unveils how environmental change resonates across ecological, social, and cultural dimensions of social-ecological systems. This inclusive approach enhances our understanding of regime shifts and contributes to developing more effective environmental management, emphasizing the crucial role of Indigenous knowledge and leadership in times of unprecedented environmental change and uncertainty.

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Author Contributions CJI, MLL and MIC jointly contributed to the conception and design of the manuscript, data collection, analysis, and the production of diagrams. CJI was primarily responsible for conceptualizing the study, gathering and analyzing data, and drafting the manuscript. MLL contributed to data collection and analysis, production of diagrams and assisted in the writing process. MIC contributed to the conceptualization of the manuscript and provided critical feedback during the writing process. All the authors reviewed the manuscript and approved the final version submitted for review.

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Data Availability The data produced and analyzed in this study cannot be accessed by the public to maintain the privacy and confidentiality of the research contributors. All information shared and collected during the study remains the collective property of the Cree Nation where it was gathered and can be consulted upon request.

Declarations

Ethical Approval The Behavioural Research Ethics Board of the University of British Columbia approved this research (H20-02942) and fully complies with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 22018). The ethical obligations surrounding informed consent in research involving Indigenous Peoples align with Article 9.1 of the TCPS. Additionally, this study adhered to the principles outlined in individual Research and Information Sharing Agreements executed between the principal investigator and the respective First Nations Governments.

Competing Interests The authors declare no competing interests.

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