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Learning from the past to deal with the future: Using different knowledges to ensure food security in the Tsá Tué biosphere reserve (Northwest Territories, Canada)

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The community of Déłıneᕿ, located in the UNESCO Tsá Tué Biosphere Reserve, is experiencing the impacts of climate change on the lands surrounding Great Bear Lake, in Northwest Territories, Canada. These impacts are limiting the community's ability to access the land to support their food system, which depends on harvesting traditional foods. This article details a participatory action research approach, driven by the community, that used on-the-land activities, workshops, community meetings and interviews to develop a community food security action plan to deal with the uncertainties of a changing climate on the food system. Data was analyzed using the Community Capitals Framework (CCF) to describe the complex nature of the community's food system in terms of available or depleting capitals, as well as how the impacts of climate change affect these capitals, and the needs identified by the community to aid in adaptation. For Déłıneᕿ, the theme of self-sufficiency emerged out of concerns that climate change is negatively impacting supplies from the south and that building and maintaining both social and cultural capital are key to achieving food security in an uncertain future. Learning from the past and sharing Traditional Knowledge¹ was a key element of food security planning. However, other types of knowledge, such as research and monitoring of the health of the land, and building capacity of the community through training, were important aspects of adaptation planning in the community. This knowledge, in its many forms, may assist the community in determining its own direction for achieving food security, and offers a glimpse into food sovereignty in Northern regions.

KEYWORDS

climate change adaptation, food systems, indigenous, North, food security, traditional knowledge

¹There is no universally accepted definition of Traditional Knowledge but it is used here to describe the collective knowledge of traditions used by Indigenous people to sustain themselves and the environment over time, which is unique to communities and rooted in the rich culture of its peoples ([Assembly of First Nations, 2009](https://www.assemblyofnations.com/)).

Introduction

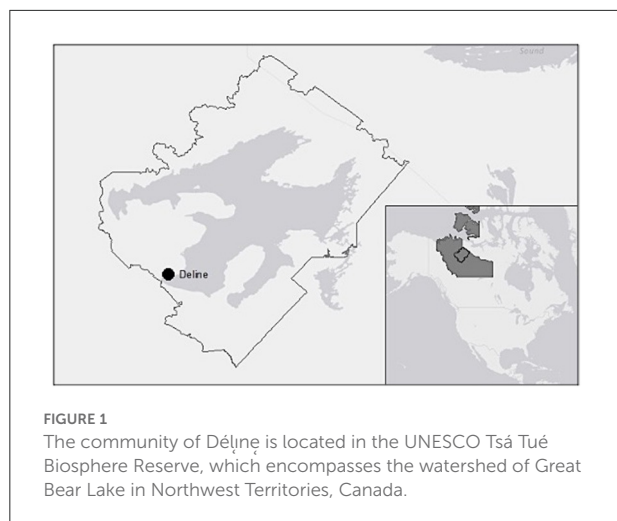
Food security has emerged as a growing concern in communities across northern Canada. Individuals face multiple, and often complex barriers, to achieving food security, where rates of food insecurity can range from 24 to 48–69% more remote areas, dramatically higher than the national average of 15.9%² (Rosol et al., 2011; Council of Canadian Academies, 2014; Tarasuk et al., 2016, 2022). Indigenous communities have faced decades of social, cultural, and political changes, on multiple scales that have had negative impacts of community health and well-being (Power, 2008; Council of Canadian Academies, 2014). As a result of these impacts, Indigenous communities in the North, and across the globe, have shifted away from traditional food systems, that relied on hunting, fishing and harvesting foods from the land, toward a reliance on food purchased from stores where the high cost and transportation of goods to remote locations leads to the lack of affordable, nutritious (Kuhnlein et al., 2004; Damman et al., 2008; Council of Canadian Academies, 2014). However, as many communities strive to maintain cultural and traditional practices inherent in the traditional food system, northern regions are now being profoundly impacted by global climate change. The region as seen an increase in temperature of roughly 4 to 5 times greater than the global average (IPCC, 2018). Impacts such as decreased sea ice thickness, permafrost thaw, changing migratory patterns of animals, and the increased intensity and frequency of weather events are affecting the access to and availability of traditional food sources, which are the staple of food systems in northern communities (Ford et al., 2006a, 2008, 2010; Guyot et al., 2006; Nickels and Furgal, 2006; Pearce T. et al., 2009; Andrachuk and Smit, 2012; Spring et al., 2018). As Indigenous Peoples have a deep connection to the land and depend on it for their food, health and cultural and spiritual well-being; they therefore are vulnerable to the impacts of changes to the ecosystem (Smit and Wandel, 2006; Costello et al., 2009; Cunsolo-Wilcox et al., 2012). Understanding and adapting to the impacts of climate change is essential for the long-term sustainability of northern communities.

To better understand the vulnerabilities and issues behind food insecurity in northern communities, there is a need to examine food systems through a different lens, one that accounts for the complexities, uncertainties, but also strengths in the community (Wesche et al., 2016). In this research the Community Capital Framework (CCF) is used to define the food system in a remote Indigenous community in the NWT. Developed by Flora et al. (2004), the CCF illustrates the interactions of seven types of capital contained within a community, including: natural, social, cultural, political,

built, financial, and human. This framework has already been modified to describe northern food systems (Spring et al., 2018). The CCF is based on the Sustainable Livelihoods (SL) (Scoones, 2009) but is used here to describing the food systems of communities in the North. This framework complements other emerging definitions of food systems, including complex adaptive systems (Stroink and Nelson, 2013) and systems-of-systems approaches (Hipel et al., 2010; Blay-Palmer et al., 2015). Systems approaches are important for addressing issues of resilience, the ability to recover from a shock or stress, that are key to the sustainability in the face of climate change (Gunderson and Holling, 2002; Olsson et al., 2004; Walker et al., 2004; Folke, 2006). The CCF can be appropriate for food systems in the North as Indigenous communities have a diverse set of economies, and therefore capitals, accessed to maintain their way of life, including the social, traditional and wage-based economies (Usher et al., 2003; Abele, 2009; Dombrowski et al., 2013; Harnum et al., 2014; Simmons et al., 2015). The Dene Way of Life describes the close relationship to the land, being on and living off the land but also includes elements of self-governance, practicing cultural and spiritual traditions the social network and support of families and the community (Bartlett, 2005; Parlee et al., 2007)—again describing many of the capitals present in the CCF, including natural, cultural, social and political capitals. The addition of financial and built capitals reflect the needs for tools, equipment and infrastructure required to access the land, and support community services including food purchased at the stores (Council of Canadian Academies, 2014).

The research presented in this paper draws on a project, initiated at the invitation of the community of Délı̄nę, in Northwest Territories (NWT), Canada, which is a part of the recently designated Tsá Tué Biosphere Reserve. Délı̄nę is a small of community of ~600 people, the majority of which are Dene, it is the only settlement on Great Bear Lake, the largest lake entirely within Canada and eighth largest in the world (Figure 1). The Sahtúot'ine Dene, or Bear Lake People enjoy a close relationship with the lake and the surrounding landscape and rely upon it for their health and spiritual well-being. Hunting, fishing, trapping and gathering remain important activities and the basis of the community's food system and livelihood. In 2016, the community work to recognize the lake and its watershed for its unique ecological and cultural heritage was achieved through a designation by United Nations Educational, Scientific and Cultural Organization (UNESCO). Biosphere Reserve designation show a commitment by local organizations to sustainably manage the resources in these areas and showcase these living laboratories to the world. However, this region, as with much of the northern regions of Canada, is under threat from the impacts of climate change and the community of Délı̄nę is concerned about how changes to the ecosystem will affect food security and well-being in the community. These issues have become increasingly pressing with the significant and

² National average updated using Tarasuk et al. (2022), however, this report does not contain data for the territories.



rapid decline of the Bluenose East caribou herd (Adamczewski et al., 2012; Boulanger et al., 2014) which the community has relied on as an important source of food. The community faces the prospect of reduced caribou harvesting and may face other uncertainties due to the impact of climate change such as access and availability of other traditionally harvested species. However, the impacts of climate change on the community's food systems needs to be put in a broader context of food system transition. Like many northern communities, Deline is remote and accessible only by air, boat, and winter road. Therefore, the majority of supplies, including fuel, food and other materials are shipped into the community during the window of winter road operation, typically from mid-January to late March. Fresh food stuffs and other necessary supplies are delivered to the community on a weekly basis through air cargo flights. The supply of food and other goods to communities like Deline is vulnerable to the impacts of climate change as the reliability of winter and ice roads and infrastructure will be affected (Prowse et al., 2009). A community plan was needed to build a more resilient food system. The purpose of this research was to: (1) understand the role of traditional foods and practices in the community's food system; (2) understand impacts of climate change on the availability of capitals of traditional foods system; and (3) identify capitals required to develop a food security adaptation strategies and programs to ensure food security and community self-sufficiency for the future.

Methods

This research details a collaborative Participatory Action Research (PAR) approach used to explore climate change vulnerability and adaptation strategies for the community of Deline in the Tsá Tué Biosphere Reserve. Community members were concerned about the impact that climate change is having

on their most important food source, caribou. This concern triggered a broad discussion about climate change, health and well-being, and food security in the community. University researchers were engaged in 2014 to help secure project funding and help facilitate and document the discussion with community members to develop a plan. This ensured that the research would be community driven, is responsive to the needs of the community stakeholders and furthers the goals of social science through co-learning and building a collaboration of researcher and community (Gilmore et al., 1986; McTaggart, 1999). As community members in Deline have experience with social science studies, the community-based organizations that were partners in this research, including the Sahtú Renewable Resources Board (SRRB) have their own protocols. Much of the research methodology builds on existing frameworks to foster community collaboration, engagement, and trust building throughout the process (outlined in Caine et al., 2007; McGregor et al., 2010; Tondu et al., 2014; Simmons et al., 2015). This approach has origins in community empowerment, social action and community health and development (McTaggart, 1999; Altrichter et al., 2002).

A key principle of the approach was to encourage as much opportunity for community engagement and participation as possible (Minkler and Wallerstein, 2011). Throughout the process of developing the proposal for this project in 2014, information was sent, via emails or letters, to various decision-making bodies, organizations, and the broader community to raise awareness of the project. This was done to help solicit support, interest, and input from the community for the project. Community partners identified and recruited a diverse group of participants to take part in planning meetings, including Elders, youth, and active harvesters, who were able to share their knowledge of the changes observed on the land. This group became informally known as the steering committee and was involved in all aspects of the research planning, including meetings and conference calls that were aimed at making committee members familiar with the research process and the researchers themselves, approve research questions and approaches, and help foster broader community engagement. These meetings served as a valuable opportunity to share insights into the research and develop community-relevant questions and methodologies that reflected how the community wanted to be involved in the project. These actions served to build trust and foster open and transparent communication between all parties (Pearce T.D. et al., 2009; Tondu et al., 2014; Spring et al., 2018, 2020).

Other integral aspects of the project were two on-the-land camps that were planned to coincide with the fall and spring research visits. These camps were planned to help facilitate meaningful opportunities for community members, particularly youth, to be on-the-land learning skills from their Elders and harvesting foods to bring back to others in the community. Furthermore, this learning environment allowed the researchers

to gain a deeper understanding of the culture and traditions of the community (McGregor et al., 2010; Bartlett et al., 2012; Simmons et al., 2015). These opportunities also facilitated informal discussion around research topics and the building of trust and relationships (Tondu et al., 2014) and embody the spirit of PAR as these experiences can achieve both research and community goals. The camps, however, proved difficult to facilitate, with weather and dangerous conditions limiting the success of the fall camp, and planning and timing issues impacting the spring camp. As such, research process was delayed many times throughout the process. This experience highlights the ongoing evolution of community-based research in the North. The process of building trust and spending time and sharing experiences in the community is valuable, as is a highly flexible and patient approach to the research. Sometimes, the pressures between data collection, funding and reporting deadlines, community commitments, and the weather do not always come together. But building good relationships with community partners and good communication with research participants, helped to modify plans to accommodate for last minute changes. PAR was, therefore, the goal and the spirit of the research conducted in the community and may eventually be achieved through ongoing collaboration and communication with community members.

In all, 13 community members participated in semi-structured interviews with each interview taking ~1 h and conducted in the language of their preference (North Slavey or English). As most people in Délı̄nę are fluent in both languages, English was predominantly used, but an interpreter was available to consecutively translate both questions and responses when needed. Interviews were mostly conducted in the Délı̄nę Land Corporation offices, but some were conducted in other locations if this was the preference of the participant. Interviews were structured around questions on health, food, changes witnessed over time to the land, and what solutions participants would they like to see to ensure access to food for future generations. The questions were open-ended to further explore specific experiences and expertise of the participant (Hay, 2000). All interviews were digitally recorded, and participants were reimbursed for their time, as per community protocol. Interviews were transcribed and shared with participants for their approval, and to ensure their accuracy. The data were thematically coded using the capitals of the CCF as a structure of the community's food system. This enabled the results to tell the story of the impacts of climate change on the food system, and what capitals can be used, or are needed to adapt to these impacts. A results workshop was held in 2017 after the data was analyzed and was open to all members of the community. This workshop allowed for the opportunity to discuss the project, validate key themes and observations that emerged from the interviews, and begin the planning of the community's food security action plan. Follow up conference calls and community visits were conducted between 2017 and 2019 to further validate

findings of the study and plan and propose future projects as determined by the study results. A community report and action plan called *Dene béré belarewı́lé: Ensuring food security for future generations in Délı̄nę* were given to community leadership and served as the basis for future work in the community. This research approach and methodology was approved under Research Ethics Board of Wilfrid Laurier University and through the Aurora Research Institute (License number 15746), the research licensing organization for the NWT.

Results and discussion

The capitals of Délı̄nę's food system

In Délı̄nę, like many other communities in the North, health and well-being are linked to the health of the ecosystem—the land, animals and water but also access to traditional foods (Parlee et al., 2007; Loring and Gerlach, 2009; Parlee and Furgal, 2012; Spring et al., 2018). In general, participants described how they feel that Délı̄nę is a healthy community because the relationship to the land remains strong, as many people depend on the land for their livelihoods and their diets are maintained by traditional foods.

“Health in Deline, well, from knowing from way back from our grandparents, they lived on the land and had traditional food and they were always healthy. And you could see that, they were always up early every day, going, working, they were always energized...Health is going out on the land, having that fresh air, being with nature. Living off the land and taking care of your water and the animals, and that's health.” ~Joey Dillon

The land, waters and surrounding ecosystem play an important role in the lives of the community and is fundamental in their identity and sense of place, and food system. Due to the location of Délı̄nę, on the shores of Great Bear Lake, water became a common theme throughout the interviews. The lake was identified as the most important asset in the community; it is what makes Délı̄nę the place where people want to live and plays an important role in their lives, physically, mentally and spiritually. The lake is also woven into stories and prophecies told in the community, making it important, not only to natural capital, but also to cultural capital. It is the main method of transportation in all seasons to harvest food but is also the source of much of the community's food supply, as fish is an important staple. Many participants commented on how easy it is to just get in a boat (an important, but expensive tool for harvesters), get onto the lake and go catch fish, and the escape the lake provides to life in town.

“The water is gold to Délı̄nę people. The Elders say is our freezer, Great Bear Lake, with all those fish in there”
~Bertha Kenny

Having access to traditional foods is perceived as the basis of the community's preferred food system. However, there is a concern amongst participants that the community is not as reliant on traditional food as it once was, and that is having an impact on peoples' health. Participants discussed the many changes that have occurred during recent decades that have influenced health in the community, including the changing relationship with the land and water. Transition into permanent housing, water delivery, fuel heating, the need for jobs, moving away from dog teams to skidoos and the dependence on food from the store all play a role in changing the way the community members maintain their livelihoods.

“That’s when everything changed, when they brought up all this government housing, in 1968. I know, they left everything. Everyone left their dogs, and their bush life. Everything.” ~George Kenny

The changing relationship with the land that has happened over time is illustrated now through concerns for the future of food in the community. The younger generation, generally, do not have the same relationship to the land, know the language nor possess the skills and experiences needed to survive on the land or bring back food for the community. There are concerns about where their food is going to come from if there is a lack of skills needed to maintain traditional foods as part of their livelihood in the future. Global and societal changes are having an impact on Délı̄nę, particularly their food system.

The capitals influencing Délı̄nę's food system (both positively and negatively) are outlined in [Table 1](#) and were determined through interviews, conversations, and other background descriptions of the community. In Délı̄nę, the social economy is strong, and the community has done a great deal to maintain and build cultural capital through community-based programming and food sharing networks ([Harnum et al., 2014](#); [Simmons et al., 2015](#)). Natural capital is abundant, with a pristine environment providing access to traditional food sources. These capitals are the drivers of the food system, where Traditional Knowledge and social practices allow community members to access food from the natural capital. But, as discussed, the ongoing social and cultural changes in the community may serve to limit the replenishment of these capitals over time, which is the cause for concern regarding the lack of skills for the next generation of harvesters. Financial capital is now needed to pay for gas, equipment and supplies to access food from the land and required for the increased reliance on food from the store. As financial capital may not be available for some individuals, the pursuit of employment to pay for supplies or other costs of living can take away from time in the community and on the land, further limiting social and cultural capitals. Human capital is now required to service modern harvesting tools, such as skidoos and small engines, and is not always accessible in the

community, especially when technological advances in such equipment requires new skills and more technical equipment to service. The community's food system also relies on winter roads and weekly airplane food deliveries (built capital) to bring fresh food supplies, as well as other goods into the community. Délı̄nę does possess a great deal of political capital, achieved through the Comprehensive Land Claim and advanced through many community-led initiatives, and now as a self-governed community. This community power and influence over management of natural resources is currently being tested in ongoing discussions regarding caribou conservation, land use planning and protected area strategies. Although a brief snapshot of the community's food system, one can see the levels of complexity and interactions between the capitals, and the reliance on certain capitals and infrastructure to maintain the food system. Now, and maybe most importantly, the pressures of climate change on community's natural capital, and impacts on other capitals, will add more pressure on that food system.

Climate change impacts on the community capitals

Climate change is having a noticeable impact on the ecosystem; through interviews, participants described how these changes to the land are impacting the community. Community members spoke of changes in temperature, noting that it is not as cold as it has been in the past; they have also seen a change in the temperature of the lake, particularly in the past few years. People notice that the fish they catch in their nets spoils much faster than before. As one interviewee commented:

“Way back, people set their net and they could go check it two days later and all the fish would be still fresh. But now, the old people have been mentioning it for a few years now, that if you don't check your net you get some spoiled fish on there because the water's getting warmer.” ~Freddie Vitale

Therefore, adaptation in this case means more trips on the lake to check the nets and taking more resources in the form of human and financial capital to harvest similar amounts of food. Lower water levels on the lake and surrounding rivers were also noted as an area of concern as was a change in the availability of some fish species. Some species of fish have declined in numbers and are no longer available in some of the locations where they were traditionally found.

“[Some fish] go someplace else but all the big trout they all go there, but they're all gone now. There used to be lots of fish there. The herring, I don't know where they moved.” ~George Kenny

TABLE 1 Summary of the community's food system based on capitals, and how key findings, as identified through interviews and background research, either add to (+) or deplete (-) these capitals.

Capital	Key findings
Social	(+) Strong social economy (e.g., food sharing) (+) Close-knit community (+) Experience with networks outside of community (-) Social change due to global pressures
Cultural	(+) Reliance on traditional foods (+) Maintaining traditional practices and activities (+) Many are fluent in their traditional language (-) Language as barrier to transfer of Traditional Knowledge (-) Some youth not as engaged in traditional foods and activities (-) Changes to relationship with land
Natural	(+) Abundant sources of country food (fish, moose, and others) (+) Great Bear Lake (-) Declining caribou herds
Financial	(+) Access to community funding and government grants (+) Comprehensive land claim (-) Limited availability of jobs in community (-) High cost of living (food, gas, and supplies)
Political	(+) Multiple layers of government (+) Comprehensive land claim (+) Self-government (+) Co-management of resources (+) UNESCO biosphere reserve designation
Human	(+) Engaged community (+) Educational opportunities in community (+) Employ consultants to fill capacity voids
Built	(+) Community services (water, wastewater, and health) (+) Access to stores (-) Fly-in community (winter road access only)

Furthermore, some people have noticed changes in fish health, including parasites and changes in taste. Key informants also shared their observations that travel on the lake has also become more unpredictable. The wind can change rapidly, bringing waves and unsafe conditions that can have severe implications on travel plans, as experienced by the research participants as travel to the fall on-the-land camp was postponed several times due to the sudden, and dangerous, change in conditions. Although rapidly changing weather has always been a risk associated with travel on such a big lake at certain times

of the year, members of the community reported that it is now more difficult to predict.

“It is riskier, especially in the fall and spring when the wind starts picking up and it gets cold and freezes. It's way more dangerous to travel on the lake.” ~Ted Mackenzo

There are many stories and experiences by community members of being delayed or stuck on the land due to weather. One story involved an Elder that was stranded on the lake due to a mechanical breakdown. He survived through severe weather, drifting on the lake, and ultimately fashioning a sail to make his way to land. In this more extreme example, it was through the years of experience and the combination of having the right tools and quick thinking that led to his survival. Participants remarked that if it had happened to anyone else, it might not have ended as well, again underlining the importance of learning a diversity of skills and spending time on the land in all types of conditions. The community is aware of the dangers of travel, especially during lake freeze-up and break-up, where travel plans may not go as expected. Bringing extra supplies, traveling with small groups, and being more cautious when traveling are some of the adaptations used to enhance safety, but these are not necessarily practiced by all community members.

The overall changes in weather observed by the community, including rain events in December and difference in timing of freeze/thaw cycles in the fall and spring is limiting access to the land. These changes are known to impact animal foraging, particularly in caribou, vegetation, and human activities in other regions (Bokhorst et al., 2016). Although significant changes to the landscape through the impacts of permafrost thaw are minimal, the community did report instances of slumping of some riverbanks and hillsides around the lake as well as changes in the freezing of muskeg, increasing the risk associated with travel in certain areas. Most importantly for the community are the changes they have witnessed in animals, particularly species that are important food sources to the community, including caribou. The community has seen the numbers of caribou decline and commented on how far they need to travel in search of caribou now.

“There was a lot of caribou across the North shore. They don't come here. This time of year there were lots out there, but now they're all gone.” ~George Kenny

Their accounts, paired with reports regarding the significant decline of Bathurst East caribou herd, as well as other barren-ground herds in the NWT (Adamczewski et al., 2012; Boulanger et al., 2014), have led to a deep concern in the community as to what to do to help the caribou. At this point, the research intersected with the community's caribou conservation plan, known as *Belare wile Gots'ę ʔekwé – Caribou for All Time* (Dél̄n̄ę ʔekwé Working Group, 2016) which was being developed

concurrently to this research. The community's plan proposed to limit the harvest of caribou for the next 3 years to ceremonial purposes only, outlined key approaches to conservation based on Traditional Knowledge and relationship with the caribou, and enforced their decision-making and monitoring rights as outlined in the Comprehensive Land Claim Agreement (Dél̄ı̄ne ʔekwé Working Group, 2016). This synergy, between the food security and the caribou plan, offered an interesting insight into community conversations about the importance of caribou, and the difficult decision to restrict the harvest of caribou, a right outlined in the land claim agreement and a polarizing issue within the community and amongst the other communities and regions that depend on that resource.

Making the difficult decision to limit the caribou harvest is an example of the community using its political capital to determine its own food system and offers a unique insight into food sovereignty in the North. Food sovereignty is a concept where communities define their own food system, and is largely based on the right to food (Patel, 2009, 2012). While the right to food, in this case subsistence food resources, is granted through the Sahtú Dene and Métis Comprehensive Land Claim Agreement, the community is invoking the right as stewards of the land to protect this important resource for future generations. Although this may have short term consequences on food availability in the community, the long-term health of the caribou and other animals, is in the best interest of everyone, including future generations.

“[If we] hunt all the caribou or fish out the lake, then what would happen to this unborn generation? How they survive but all these things disappear? And the trapping, no one's going to teach them how to do it. So what I'm looking at is to try to save as much as we can for the next generation.
~Paul Modeste

What emerged during discussions with participants was the language of self-sufficiency, where the community would not have to rely so heavily on goods, particularly food, being transported from the south. Although many community members admitted that they will still need that link for many commodities (fuel and some food for example), they also observed that links to the south would not be as reliable due to the impacts of climate change in the future. This point was highlighted during the research visit in February 2016 where the condition of the ice road was so poor that it had yet to open to heavy truck traffic. This was a major delay from previous years and led to an increased sense of anxiety in the community about whether supplies would reach the community that year. A week later, the road was opened to heavy truck traffic and a fuel truck fell through the ice on its crossing of the lake (CBC News, 2016). Although the fuel was safely removed and the truck was lifted out of the ice, it was a stark reminder of the need to promote

the solutions that community members wanted to see to build a more sustainable food system for the future.

Adaptations based on past experiences

Making changes to the community's food systems involved two key themes that emerged during interviews: learning from the past and gaining new knowledge from outside the community. Learning from the past involved sharing Traditional Knowledge and skills within the community and thereby strengthening the social and cultural capitals within the community. This also encompasses how the community has adapted to past events, such as fluctuations in climate (Ford et al., 2006b) or, in the case of Dél̄ı̄ne, changes in food availability. For example, the current situation with the Bluenose East caribou herd and the limits to harvesting that species is not unlike a situation the community experienced in the past. During interviews Elders shared stories of the time there were no barren-ground caribou around Dél̄ı̄ne for the community to harvest for 30 years. When asked how the community coped with the loss of caribou, Elders highlighted a variety of other animals that the community used for food sources and the importance of sharing food.

“Moose, lots of moose... and fish, trout, whitefish... the other caribou, woodland...” ~Charlie Neyelle

Elders acknowledged that it was not an easy time for the community, but they worked together, shared food, and adapted by being flexible in what was harvested. Fast forward to today, there is a concern regarding the community's dependency on caribou and the lack of variety of species harvested. And that knowledge of when and where other food sources were traditionally harvested in and around the area is not readily available. It is therefore a priority of the community to document and map these important locations with Elders, and ultimately share this knowledge with community members and harvesters. This will ensure a more sustainable harvest of traditional food sources by increasing the variety of both species and locations, but also by visiting sites they have not returned to in years and even returning to species they have not harvested in years as well. This will help to increase self-reliance and available food for the community, and hopefully lead to less reliance on food from the store. This shift to a broader range of locations and species does come at a cost, of both fuel and supplies and time (predominantly human and financial capitals) (Brinkman et al., 2014). Although the local agency, the DRRC, will help with some of the financial burden by providing gas to land claim beneficiaries for the harvest and sharing of food with the community, it will take a more coordinated effort to shift harvesting practices back to those used in the past. This

shift toward traditional harvesting timing and location is also not without risk. Traveling to places farther away from the community adds costs and makes harvesters more vulnerable to the risks associated with the changes in climate described earlier. Furthermore, as some of these locations have not been visited for years, it is unknown what the health of the land or species availability might be in these areas. Families that harvested at these locations in the past also maintained cabins and spent a great deal of time in those areas and knew those areas well. Recapturing that information from past experiences and revisiting and assessing these harvesting locations will be important for the future of the food supply in the community.

What is also important, then, is that community members have the knowledge to properly harvest and respect a variety of animals along with safety and survival skills. With the new challenges and risks associated with the changing climate, harvester safety and being respectful of cultural traditions on the land are paramount as the community chooses to continue to utilize traditional foods as the basis of their food system. Young harvesters must be provided with the opportunity to learn and practice skills on the land, under the guidance of community Elders and knowledge holders, and be encouraged to become harvesters, trappers, food providers and positive role models in the community.

“We have to start teaching our young people to live off the land by themselves. Like in the old days, people used to make their own homes, tents with spruce, and even how to make fire out there on the land. That’s what we need to teach our young people” ~Leon Modeste

There was interest in integrating on-the-land learning into the school and creating more opportunities for the youth to learn the language. Getting youth interested in cultural practices and activities was seen as important to do at an early age, but many participants highlighted barriers to implementing some of these changes. Young children do not, generally, speak the language. Although there are some language programs at the school, it is not being taught or spoken at home. It seems that young parents with young children do not generally speak the language as they were brought up in schools that taught in English only. Providing community members experience on the land as families or large groups was seen as the ideal way to learn skills and reestablish bonds with each other and the land as well as reconnecting with the language. Language is the key to understanding Traditional Knowledge and skills.

“They have to learn their language, then they’ll know everything.” ~George Kenny

Language was a key component of the community’s approach to self-government and caribou conservation. And participants wanted to see programming aimed at incorporating

language education and Traditional Knowledge and skills into programming, either through the school or through another organization in the community. The possibility that self-government may provide a vehicle to deliver a more culturally appropriate education in the community was raised as part of several interviews. In Délı̄ne, perhaps, political capital may be the key to building and maintaining cultural capital, and the community appears to be allocating other capitals within the community to achieve this goal. Learning and sharing Traditional Knowledge from within the community also requires bonding social capital to support the maintenance of cultural capital and therefore, the food system of the community, something the community has been working on through their vision of self-governance as well (Bayha and Spring, 2020).

Adaptations through creation of new knowledge

Although community priorities for adaptation relied on the building of capitals through strengthening of community bonds (social capital), sharing of Traditional Knowledge (cultural capital) and through their political capital, there was also an emphasis on bringing new knowledge into the community to help build a more sustainable food system. And sometimes the combination of the two were seen as solutions for the community. Through interviews, growing food was identified as a key way forward for Délı̄ne to become more self-sufficient and food secure in the future as well as for decreasing their dependence on expensive store food.

“Because everything here is so expensive. If we do our own garden, if people want some stuff they can just get some. Share.” ~Bertha Kenny

Potatoes were a key food source that people wanted to see grown in the community, but many cited the lack of knowledge around gardening in the community amongst the Dene people. Although gardening has been done in the community, most of it has been through people from outside the community who grow food for a while and then leave, taking the skills needed with them. The current garden is operated behind the community’s nursing station and provides food to a small portion of the community. There are Sahtı̄ot’ı̄ne currently involved and even more are interested, so scaling up the existing community garden, while working to build capacity, knowledge, and interest in the community around growing food, is important. If the capacity to grow food already exists in the community, creating more opportunities to learn and share this information within the community may be a way forward. Local food production is a key adaptation that many communities across the North are investigating (Spring et al., 2018; Chen and Natcher, 2019)

so there are opportunities to learn and share information with others.

Building the food system to be more self-sufficient also does not always have to rely on new skills and knowledge either. Many community members mentioned that muskox are now present, and even plentiful, in the area but are unsure of the viability of the species as a substitute for caribou in the community diet. Often muskox were described negatively, as competition for caribou for food and space on the land, or the fact that caribou dislike and avoid musk-ox, a story supported in other NWT communities (Wesche and Chan, 2010). However, there was some interest in trying it, mainly if it would help the caribou. As one participant noted:

“I have a buddy from Nunavut and says the meats the same. But if I get a chance I’ll try to get a calf there. The meat should be nice and tender, just to try it. There are lots of people saying that they’re all over.” ~Freddie Vital

Although there are examples of climate change creating opportunities for other species to become important food sources for communities in the North, these cases have involved harvesting more of a traditionally less-harvested species (Ford et al., 2006a; Wenzel, 2009). Muskox, in particular, has not been harvested much, if at all, in Délı̄ne in the past, so there was concern that there was a lack of skills to properly harvest them, or if it was appropriate to do so, since the community had no experience with this species. Food substitutions, therefore, may not be culturally acceptable for some communities. However, the community was interested in learning more, with the possibility of talking to other communities and harvesters to bring in this knowledge. In a sense, it would be sharing Traditional Knowledge from other communities to aid in adaptation: communities learning from other communities. The community will have to decide if this is an appropriate substitution for them³.

Many of the solutions proposed by the community involved monitoring the lake and the resources around the lake to ensure the entire ecosystem is healthy and protected. The basis for this is not only the dependence on the lake for their livelihoods, but the role that Great Bear Lake plays in community beliefs and culture. Monitoring, it was felt, gave the community the voice as the protectors of the lake, and the ability to assert their rights to the land and fulfill their wish to be stewards of the lake. However, much of the monitoring, of water quality for example, was done by outside institutions, and participants noted that much of

the findings are not shared with the community. Community members indicated the need for more participation in ongoing monitoring initiatives but highlighted the importance for better communication of results to the community.

“Non-Dene researchers and scientists, we need to work together and help each other learn about the land, learn about the animals. We know for a fact that right now the caribou is in decline. And we have to deal with it, we have to work with it. Not only that, but we know for a fact that the water level is also low. So those kind of things we need people, scientists that are knowledgeable about that to come and work with us, and share information with us.” ~Leon Modeste, Elder

Making the scientific knowledge more available would help community members better understand the changes on the land and the health of the ecosystem, and aid in adaptation and decision making (Armitage et al., 2011; McCarthy et al., 2011). With increasing uncertainty around the impacts of climate change on species, such as caribou, and the realization that some Traditional Knowledge may no longer be applicable in the changing climate, the need to supplement traditional ways of knowing with evidence-based decision-making through scientific knowledge becomes critical. Participants wanted to see scientific knowledge and studies focus on important issues for the community and wanted to see the community also contribute to, if not lead, this research. Research in with the Tsá Tué Biosphere Reserve is now focusing on building stronger relationships with researchers to support a research and monitoring network to align with the community’s vision of protecting Great Bear Lake.

Building a food system that is resilient to the impacts of climate change will be a challenge to all northern communities. By examining the food system in Délı̄ne, one can see that multiple stresses, including climate change and other social and cultural changes, are impacting the capitals of the food system. The community, however, is actively adapting their food systems in the face of climate change and has a vision for building a more resilient food system through the building of capitals that support the community. A detailed list of the capitals required to build a more sustainable food system are given in Table 2. For Délı̄ne, the emphasis has been put on building social and cultural capitals through promoting intergenerational knowledge transfer and emphasizing quality time together on the land. The building of bridging and bonding social capital and the sharing of knowledge across scales can help in the formations of new linkages and opportunities for the food system (Levkoe, 2011; Blay-Palmer et al., 2015). As witnessed in this research, adding new knowledge was vital to moving these community-defined projects forward to meet the vision of the community’s food system. Equally, there was a focus to relearn, rediscover and share information already present in the community,

³ A food processing workshop was held in 2019 to showcase different ways of preparing and preserving different types of food. Muskox meat was harvested and made into burgers and sausages for a community event and proved a popular food choice. Follow up discussion are ongoing as to how food processing infrastructure can make foods more available in the community.

TABLE 2 Community capitals required to build a sustainable food system in Délı̄ne.

Capital	Adaptations
Social	More community hunts (involving families) and time together on the land Increase communications amongst harvesters to report conditions on the land Create relationships (outside of the community) to bring in new knowledge
Cultural	Learn from past experiences and share Traditional Knowledge Language programming Promote on-the-land camps/events when possible Engage youth and create mentorship opportunities
Natural	Increased research and monitoring
Financial	Resources needed to fund community-defined programs Self-government able to allocate funding to community initiatives
Political	Continue to build through self-government and Biosphere Reserve Monitoring lands
Human	Skills and training needed for initiatives (gardening, mapping, etc.) Promote harvester safety
Built	Infrastructure and tools required programs and initiatives (gardens, etc.)

allowing the reemergence of a sustainable food system used in the past. This does involve strengthening relationships within the community, but also requires harnessing the community's cultural capital as key elements of a more sustainable food system lie in the Traditional Knowledge of the community. Accessing stored cultural capital to learn from the past should be the basis for culturally acceptable adaptations (Adger et al., 2009, 2012; Pearce et al., 2015). As communities define their food system based on place and local circumstance (Marsden, 2012; Blay-Palmer et al., 2015), in the context of the CCF, it emerges out of the capitals that are available to the community. It is, however, cultural capital that emerges as a defining capital in the food system in northern Canada. Cultural customs, practices and Traditional Knowledge play a major role in these food systems as well as in their sense of place and identity (Wilson, 2003; Cunsolo-Wilcox et al., 2012) and is becoming the focus of adaptation strategies in the region (Crane, 2010; Pearce et al., 2015; Spring et al., 2018). The importance of cultural capital is what makes the food systems here unique and is captured within the CCF as a lens to examine the system of food systems in Délı̄ne.

While this study represents the beginning of a participatory action research relationship between researchers and the community, there are limitations to this study and its findings. First, funding timelines meant that data collection needed to start in the initial phases of community engagement. With no previous relationship in the community, lack of trust and familiarity with researchers may have limited responses to questions and overall engagement. Although the broader research team did consist of regional and community representatives, researchers were ultimately limited in how much time they could spend in the community during the course of the project. Finalizing community reports and recommendations also felt rushed due to these time constraints. Second, our relatively small sample size means we may not have captured enough community voices on the impacts and adaptations. Building relationships with the community has been the focus of the researchers over the past few years and so continuing the discussion about food security and

climate change adaptation with more community members and continuing to validate and implement this work has occurred. However, much of the progress of this academic publication has been slowed by the implementation of self-government in the community of Délı̄ne, as well as by the pandemic. The research team has worked closely with the community to ensure that the impacts and actions presented in this study are still relative today.

Conclusion

Climate change is a reality for northern communities and brings changes to the land, water and animals communities depend upon. Through a dialog with community members this research highlighted the needs for different types of knowledge to flow within and into the community to enhance adaptation and secure food for the future. As traditional foods are the basis of the preferred food system for Délı̄ne, knowledge to support the harvesting and gathering of these foods is central to the community's plan moving forward. A community vision of self-sufficiency also emerged as part of this research. Self-sufficiency, as described by participants, involves not having to rely on goods coming from the South, but also focusing on building capacity in the community for people to feed themselves from the land as they have done in the past and through new skills such as growing food. By maintaining traditional foods as the foundation of the community's food system and increasing local production or gathering of other foods, the community envisions a future with continued access to safe, affordable and culturally appropriate foods, meeting the criteria of community food security (Hamm and Bellows, 2003). To achieve this goal, however, relies on building and strengthening capitals as part of the food system. Key to building capitals is the transfer of knowledge, both in terms of traditional skills and knowledge from within the community (social and cultural capitals) as well as other types of knowledge, including education, skills, as well as monitoring and science, from outside the community.

In the UNESCO Tsá Tué Biosphere Reserve, there is the opportunity to watch food sovereignty unfold. Due to the presence of such high amounts of political capital in the community, and thanks to self-government and the comprehensive land claim agreement. The community is reimagining their food system as one rooted in both their cultural values and Traditional Knowledge and new knowledge from outside the community. As another example of the food politics of the possible (Blay-Palmer et al., 2015), this community has the opportunity to shape their food system to be based upon cultural capital and the Traditional Knowledge systems of the people. Utilizing the CCF, this research has identified community strengths, as well as gaps in the food system and offered insights into how to develop capitals to build resilience into the food system. Recent work continues to examine how the community's high level of political capital, that is still changing with the recent implementation of self-government, shapes the food system as issues concerning rights to lands, resource development and food sovereignty continue to evolve in Canada and globally. More recent community-led research in Tsá Tué has involved youth engagement through supporting cultural and language programming (Bayha and Spring, 2020) as well as assisting in the community's vision to protect Great Bear Lake for all time through protected area legislation, Indigenous Guardians initiatives and research and monitoring programs. It is hoped that through this process, the Tsá Tué Biosphere Reserve will offer a unique case study in both northern-specific, and contemporary food studies to share with the world.

Data availability statement

The datasets presented in this article are not readily available because Data is owned by the Indigenous community involved in the project. Requests to access the datasets should be directed to aspring@wlu.ca.

Ethics statement

The studies involving human participants were reviewed and approved by Wilfrid Laurier University. The patients/participants provided their written informed consent to participate in this study.

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Author contributions

AS: writing, methodology, data collection, and validation. DS, MN, and WB: methodology, community engagement, data collection, and validation. AB-P: supervision, review, and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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