3 Taking care of the land

An interdisciplinary approach to community-based food systems assessment in Kakisa, Northwest Territories, Canada

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Introduction

Food insecurity in Canada's north¹ has received national and international attention in recent years. In many northern communities, 17 per cent to 69 per cent of households report moderate to high food insecurity, which is dramatically higher than the national average of 8 per cent (Rosol et al., 2011; Council of Canadian Academies, 2014; Tarasuk et al., 2016). This discrepancy highlights the failure, at multiple scales, to ensure the availability, accessibility, and adequacy of food in northern communities. The right to food was guaranteed through Canada's commitments to the Universal Declaration of Human Rights and the International Covenant on Economic, Social, and Cultural Rights, but the lack of policy restricts enforcement of these rights (De Schutter, 2012). For communities in Canada's north, the right to food is more complex as issues of remoteness and lack of economic opportunities and infrastructure contribute to high rates of food insecurity. These issues are further complicated by external pressures of development, politics, and globalization (Power, 2008; Loring & Gerlach, 2009, 2015; Blay-Palmer et al., 2014; Council of Canadian Academies, 2014; see also Chapters 4 & 10, this volume). Factors contributing to food insecurity in Canada's north are numerous, complex, and subject to history, scale, and place. Redefining the discussion of food security, ensuring the socio-cultural aspects of place are included, while empowering communities to define their own food system, is critical (see Chapters 1 & 12, this volume). However, many of the essential ingredients that have been a part of northern communities' food systems for generations are poorly understood and not well represented in current measurements, metrics, or literature.

Food systems are defined by place and local circumstances (Marsden, 2012; Blay-Palmer et al., 2015; see also Chapter 6, this volume). In the Northwest Territories (NWT), the boreal forest is the most widespread

ecosystem and Indigenous communities rely on this ecosystem to support their way of life. Traditional foods,² obtained through harvesting – hunting, fishing, and gathering – from the land and waters form the basis of the communities' food systems. These food systems have been sustainable for generations, and have adapted to changes in seasons, migrations, and availability of animals. It is a close connection and relationship with the land, and an understanding of natural variability that has enabled communities to thrive. The passing down of traditional knowledge through generations allows for youth to continue to access the land and provide food for the community. Being on, and living off, the land also includes elements of self-governance, practicing cultural and spiritual traditions, the social network, and support of the community (Bartlett, 2005; Parlee et al., 2007), as all are essential parts of the food system.

Food systems across the North have been, and continue to be, impacted by issues of colonialism, including forced placement in settlements, and other government policies, infrastructure, and the wage-based economy. As reliance on the formal economy increases, less time spent on the land has led to a decreased dependence on harvesting food, furs, and other products. Economic development, land rights, and management and protection of natural systems are all part of the complex situation that has developed in the North and have direct impacts on food security. The need for wage-based income is now crucial due to the high cost of living in the North, but employment opportunities are still sparse and leave less time to participate in traditional activities. With less time spent on the land harvesting traditional food, communities have become more dependent on market foods. As a consequence, diets of Indigenous communities in the NWT, consistent with changes across the globe, have moved away from traditional food sources to food purchased from stores (Kuhnlein & Receveur, 1996, 2007; Drewnowski & Popkin, 1997; Popkin, 2002; Kuhnlein et al., 2004; Damman et al., 2008). While the high cost of food and lack of affordable, nutritious options are often cited as major barriers to food security in the North, this does not tell the full story for this complex food system.

Currently, there is a lack of tools to assess food systems in the northern context and no existing tool that captures the complexity of northern food systems (see Chapters 4, 5, 9, 10, & 11, this volume). In part, this challenge stems from the existence of a mixed economy where traditional food systems and market food systems operate in parallel to supply sustenance, and other benefits to well-being, for people living in the North. The metrics that are available primarily focus on measuring the market food system. For example, the National Nutritious Food Basket (NNFB) and the Revised Northern Food Basket (RNFB) are standard tools accepted by statisticians, governments, and academics, among others, to monitor the price of food purchased from retailers. The NNFB and RNFB were created as survey instruments to measure the cost of a basic diet that met current nutrition recommendations and reflected average consumer purchasing

patterns (INAC, 2007; Ministry of Health Promotion, 2010). The NNFB was created by Health Canada and the RNFB by Indigenous and Northern Affairs Canada specifically to monitor the cost of food in remote northern communities. The NNFB and RNFB each include their own unique list of 67 standardized food items and their purchase size (Ministry of Health Promotion, 2010). These food costing tools serve as one method to estimate much more complex food practices in households. They are not meant as a weekly shopping list or household budgeting tool; do not reflect food preferences; assume ability within the household to prepare meals from scratch; and do not include pre-packaged food, food eaten at restaurants, or locally sourced foods. As such, this metric does not capture the complexity of food systems in Canada's north, but only adds to the false argument that food security in the North is a purely economic and market-based issue.

We have little knowledge of, nor the infrastructure to track, traditional food procurement by communities, nor do we know what contribution traditional food has on local economies or livelihoods. Metrics for costing traditional food procurement have received even less research attention and there is no definitive methodology for costing harvested food. There are a few examples of discrete studies that have tried to estimate these costs. Harvester surveys have been used to quantify the amount of traditional food harvested by communities and also can monitor the number of harvesters. These tools can be applied to measure changes over time, which can have both policy and co-management implications for food species (Usher & Wenzel, 1987; Berkes, 1990; Wenzel et al., 2016). For example, Pal and colleagues (2013) asked active harvesters in Wapekeka and Kasabonika First Nations in northern Ontario to keep detailed logs of harvesting costs and recorded yields of hunts. They estimated the average cost of traditional meat was \$14 per kilogram and that the annual cost for an active hunter was approximately \$25,000. This assessment method is intensive and cannot be generalized to other harvesters or to communities in other northern regions. The 'Paying for Nutrition' project used the RNFB to assess market food costs in remote communities in northern Ontario (Veeraraghavan et al., 2016), and to acknowledge the mixed economy and the importance of traditional food systems (Skinner et al., 2016). The research team had many discussions about how to measure the costs of harvested foods and decided to use a proxy measure of hunting costs by gathering data on a short list of harvesting equipment (i.e., snare wire, fishing net, fishing line, and shotgun ammunition) as well as the cost of gasoline in the participating communities (Skinner et al., 2016). These items only consider some of the more frequent costs of going out on the land and water for food, but not some of the larger (and more expensive) equipment that might be required, such as a shotgun, boat and motor, all-terrain vehicle, or snowmobile. The amount of time spent on the land during harvesting should also be factored in, as it is time away from participating in the wage economy. Most importantly,

there needs to be an acknowledgement that harvesting is not always fruitful, and hunters and harvesters may return home with no food. Combined, high costs associated with being on the land and the decline of harvesters has contributed to issues of food insecurity across the North where some cannot afford food either from the land or the store (Lambden et al., 2006; Ford et al., 2010; Ford & Beaumier, 2011; Brinkman et al., 2014; Loring & Gerlach, 2015). Additionally, the items that would need to be included in a more broadly relevant traditional food-costing assessment tool for the North would need to be appropriate and reflective of the diversity of local harvesting practices.

While the high cost of market food and other items in the North has been a major focus of a small number of previous studies, current food costing methods in northern environments have not considered the informal or social food economy. Food sharing is widely practised in northern environments and is an integral part of Indigenous culture and traditions (Condon et al., 1995; Collings et al., 1998; Chabot, 2003; Abele, 2009; Collings, 2011; Dombrowski et al., 2013; Skinner et al., 2013). Typically, harvesters return to the community and share food with immediate family members and community Elders, and sometimes these sharing networks extend to more distant kin and friends, including intercommunity connections. Communities therefore share the burden of costs and labour of harvesting by lending equipment, providing supplies, or assisting in meat processing. As selling of traditional food is not permitted in many communities (small commercial fisheries excluded) based on treaty or comprehensive land claim agreements, or social and cultural norms, it is thus only permitted in some jurisdictions (e.g., Nunavut) and also happens informally (Chan et al., 2006; Damman et al., 2008; Gombay, 2009). Currently people in some communities sell traditional food through social media platforms. However, with no formal system to measure or collect information on how food is distributed through social and informal economies, a large portion of the food system remains unmeasured.

Finally, the health of the ecosystem and its relationship to food systems requires attention in food system assessment. As the traditional food system is closely tied to the health of the ecosystem, protecting the land, and therefore the food system, has been prioritized by many communities and has been the subject of numerous natural science studies throughout the North. Research done in partnership with the community of Kakisa, NWT has combined natural sciences and community-based research with a food system approach. This intersecting research has enabled the community to lead and build a vision of a food system that relies on maintaining a healthy ecosystem in the face of climate change, growing foods, and developing opportunities for food sharing and economic benefits. As such, Kakisa offers valuable insight in rethinking how multifaceted food system evaluation should be done in Canada's north.

Community-driven food system metrics

The community of Kakisa is located approximately 400 km from Yellowknife, the capital of the NWT, Canada. Home to the Ka'a'gee Tu First Nation (KTFN), this community has a population of approximately 50 people, and is so small that it is often excluded from most maps of the region. The KTFN's traditional territory occupies approximately 10,000 km² within the northern boreal forest and is comprised of a mixture of forest, peatlands, wetlands, rivers, and lakes. The area includes two large lakes, Kakisa and Tathlina, which are connected by a series of rivers to the Mackenzie River. Community members enjoy a close relationship with the land and use the area for a wide variety of harvesting purposes including hunting, fishing, and gathering, all of which form a crucial component of their food system. The community's most important food source is fish, but moose and other large animals, such as woodland caribou, are harvested. Kakisa is a migratory stop for many species of waterfowl, which are typically hunted in the spring. As the community is small, it lacks a great deal of infrastructure and therefore depends on services offered in surrounding communities. The nearest grocery store is located approximately 150 km away, therefore additional resources, time, and money are required to access these services. Importantly, food from the store is perceived to be unhealthy (Spring et al., 2018).

Kakisa, like many communities in the North, faces several complex issues that impact the health of their food system, including climate change, development, and other political and socio-economic factors. This community is actively partnering in many research initiatives to help to understand these impacts and maintain their livelihoods for future generations. One such project was a climate change adaptation initiative, initiated by community members in 2014, and detailed in Spring et al. (2018). Through a participatory action research approach (see Chapters 2, 6, & 10, this volume), community members were able to identify barriers to accessing traditional foods and opportunities to overcome those barriers and build a food system that fitted their needs and vision. Much of the progress that has happened since 2014 has been through partnerships between the authors and community members working towards this vision. With gardens being installed, on-the-land camps that focus on youth–Elder knowledge transfer, a waste management programme, as well as different research and monitoring initiatives, much of the work has focused on protecting the land, improving access to fresh, healthy foods (both locally grown and traditional foods) and sharing knowledge with youth, Elders, and others around traditional skills and stewardship of the land. Reflecting on this work, the authors and community members, wanted to evaluate these past experiences as part of a process to assess the impact of these projects on the community's food system. In the following section, we examine aspects of the food system that the community is actively evaluating through research partnerships. This includes

evaluation of the health of the ecosystem, and how that informs the basis of other food systems research in the community.

Health of the ecosystem

A healthy food system in a changing environment

In Kakisa, as well as all other northern communities, the connection to the forest is a critical part of the food system as a direct source of food. However, in food system evaluation discourse where agriculture is the dominant food source, the natural environment is considered to play a small role in the overall health of the food system. This disconnect is problematic for understanding and evaluating northern food systems. For members of the KTFN, the health of the natural environment is closely linked to the health of the people (Spring et al., 2018). While there is no formal assessment of the health of the KTFN Territory, researchers have been working closely with the community for years, in an endeavour to understand various components of the ecosystem, particularly in the context of anthropogenic climate change. This information is key to understanding the context for food system well-being through the lens of the changing climate.

Climate warming is amplified in the North; in the NWT, temperatures have increased approximately 3°C in the last 60 years, and more so during the winter months (Marshall & Baltzer, 2015), a rate that is 3–4 times the global average (IPCC, 2018). Responses of northern ecosystems to this change are already evident and are expected to become more severe in coming decades causing concern for the impacts on communities and their food systems. Rapid climate change in northern Canada has impacted and will continue to impact the health of northern ecosystems. Climate change is altering forest productivity directly while simultaneously accelerating large-scale disturbance processes including permafrost thaw, wildfire, and insect pest outbreaks (Gauthier et al., 2015). Overlain on these effects of climate change are the direct human impacts on forest health, including forest management decisions and the introduction of invasive species. Our knowledge of these issues remains incomplete in the region as these are novel or rapidly changing disturbances (Turetsky et al., 2017). However, for the community, these are pressing issues that need to be understood to support adaptation and planning for the protection of their livelihoods and food security for future generations. Here we provide a brief overview of these issues with a focus on impacts for Kakisa's community food system. These changing environmental conditions should be considered in the design of a healthy food system, ideally with long-term monitoring via community observations to determine their impacts on local food systems.

*Disturbances influenced by climate change**Drought*

Because the productivity of northern forests is thought to be limited by temperature, boreal productivity was predicted to increase with climate warming (Hogg & Bernier, 2005). However, growth responses of high latitude forests have been variable, with many forests showing reduced productivity in recent decades in response to warming temperatures (Walker & Johnstone, 2014). This has been largely attributed to decreasing water availability, which is expected to occur with warming despite increases in precipitation in many places (Price et al., 2013). This imbalance means that in many places trees are experiencing water limitation, particularly in northwestern North America (Hogg & Bernier, 2005). Tree growth also can decline with permafrost thaw (Patankar et al., 2015; Walker et al., 2015; Sniderhan & Baltzer, 2016). Permafrost containing ice can directly affect soil moisture through its control on the water table position.

Gradual versus abrupt thaw of permafrost

Permafrost thaw is one of the main challenges facing communities in the North. Approximately 70 per cent of the entire boreal forest is underlain by permafrost, a term given to soil, rocks, and sediment that remains at or below 0°C for two consecutive years. In the NWT, permafrost ranges from continuous coverage in the north where permafrost is thick, to discontinuous coverage of thinner permafrost further south. In part because of permafrost, the dominant tree species in the NWT rely on a shallow rooting zone to support growth. Warming leads to thickening of the active layer (seasonally thawed soil near the surface), a process that gradually affects surface permafrost over decades. In response to gradual permafrost thaw, plant productivity may be stimulated by a thicker rooting zone and increased nutrient availability. On the other hand, drying of surface soils may lead to declining tree growth (Walker et al., 2015; Sniderhan & Baltzer, 2016).

Where permafrost is ice-rich, it can thaw abruptly leading to a variety of surface expressions that include erosional features (retrogressive thaw slumps, active layer detachments, gullies), thaw lakes, or thaw wetlands. All of these surface expressions involve thermokarst (ground subsidence) and instability as a result of the abrupt thaw of ice-rich permafrost. The development of thermokarst features alter the local hydrology, ecology, and biogeochemistry (Jorgenson & Osterkamp, 2005; Quinton et al., 2011; Kokelj & Jorgenson, 2013; Baltzer et al., 2014; Olefeldt et al., 2016). Rapid rates of climate warming have already pushed parts of the southern NWT across critical thresholds for maintaining permafrost. For example, the southern limit of discontinuous permafrost was shown to have migrated northward by approximately 120 km between 1964 and 1989 (Kwong & Gan, 1994),

likely transitioning KTFN territory from extensive discontinuous to sporadic discontinuous permafrost.

The region surrounding Kakisa is dominated by low-lying and poorly drained land with a mosaic of permafrost-free wetlands and slightly elevated permafrost peatlands that are better drained and support black spruce-dominated forest (Baltzer et al., 2014). Abrupt thaw in these systems leads to surface subsidence and associated waterlogging of the soils, resulting in ‘drunken trees’ and rapid tree mortality associated with inundation (Baltzer et al., 2014; Patankar et al., 2015). This is representative of the forest-to-wetland conversion occurring across the southern NWT and also around the circumboreal region (Baltzer et al., 2014; Helbig et al., 2016; Turetsky et al., 2019). This fundamental change in land cover and ecology leads to issues of food access and availability for communities as well as concerns about harvester safety. Large-scale conversion of forested ecosystems to wetlands will decrease habitat for some important species, including caribou, through loss of spruce-lichen forests (Joly et al., 2012). Abrupt thaw and thermokarst also results in biogeochemical changes that can affect the safety of food resources, for example mobilization of mercury (St. Pierre et al., 2018). Finally, changes in topography can make it more difficult for harvesters to access the land and uneven terrain can contribute to safety concerns for land users (Kokelj & Jorgenson, 2013; IPCC, 2014).

In response to all of these landscape changes in their region, the community has responded by developing an innovative web map, referred to as the Ka’a’gee Tu Atlas, in partnership with researchers. This Atlas was constructed for the community, collecting data layers from various sources that contained information on traditional land uses, culturally significant places as well as environmental information. Through focus groups, interviews, and modified photovoice techniques community members have compiled images and descriptions of what the land looked like before many of the impacts of climate change. This initiative has created a baseline for future monitoring initiatives that will record how the land is changing and provide the opportunity for community members to record current conditions, hazards, to share and discuss areas of concern on the land that may require monitoring or future research, and track impacts to their food system.

Wildfire

Fire is a critical part of the natural renewal of the boreal forest. However, climate warming is accelerating the frequency and intensity of wildfires. In 2014, the NWT experienced an historically unprecedented fire season, both in terms of area burned (2.85 million hectares; Walker et al., 2018) and impacts on communities (Dodd et al., 2018). Wildfires also have an immediate impact on wildlife habitat, as large areas are cleared during a fire, however patterns of regeneration of forest following wildfire has meant

that these impacts are temporary. Many communities, including Kakisa, are concerned with whether the current impacts of climate change will allow the forest to recover to its original state. Severe wildfires, in both Alaska and the Yukon, have demonstrated the potential for fast-growing, deciduous species to become dominant after an intense fire where combustion of the organic soil layer is complete (Johnstone et al., 2010b). This can occur in response to very severe (deep burning) ground fires or those returning within short time intervals and can impact tree and ground vegetation recovery (Johnstone et al., 2010a; Hollingsworth et al., 2013). Understanding the nature of this shift is important with respect to the availability of wildlife habitat under an accelerated fire regime.

To answer these questions researchers established a network of permanent sampling plots in fire scars from 2014. These plots are unique in that they provide a co-located set of measures of fire severity (canopy and soil), permafrost conditions, pre-fire stand age and structure, detailed characterization of post-fire soil conditions (residual organic matter, soil carbon content and loss, bulk density, and nutrient status), and post-fire vegetation recovery, which will provide novel insights into the impacts of the 2014 fires. Some of these locations were on the traditional lands of the KTFN, which was important as the community was evacuated, and nearly lost, during the 2014 fires. Researchers helped to facilitate on-the-land learning events with the community to provide a demonstration on how the impacts of forest fire are measured, and how forest regeneration is monitored. Community Elders participated in identifying plants, sharing the Dene language names and traditional uses with youth and researchers, and providing insights into what animals might come to the areas. Together, this research and community experience with fire can help inform and educate other regions impacted by forest fire along with future research directions in affected communities.

Fish, water, pests, and contaminants

One of the challenges facing a warming north is the loss of temperature limitation on the distribution of species that have previously been unable to expand their ranges into these regions. The introduction of new species can have detrimental impacts on the balance already present in the ecosystem (Walther et al., 2002). Furthermore, new species have the potential to bring diseases or parasites into new systems and impact the health of wildlife populations. Ticks and other diseases causing death in a variety of animal species have been recorded and will likely continue to spread across the north (Kutz et al., 2009). Changes to species' migratory patterns, populations, and health will ultimately have negative impacts on the community as well. If country food is no longer readily available, harvesters will have to invest more time and money into the pursuit of food, increasing the cost to the harvester. In Kakisa, a range of new species has appeared in past

years. Deer have been spotted in the southern parts of their territory (Spring et al., 2018). There is evidence of cougars in the area. Most concerning for the community is the presence of pelicans on both Tathlina and Kakisa lakes due to the potential impact of this new species on fish populations on which the community depends both for commercial and subsistence harvesting.

Contamination of country food species, particularly fish, is a major concern for communities in the North. Pollutants, mainly produced at lower latitude, are transported northward and can be deposited into marine or terrestrial environments where they can build up in food webs and reach high concentrations in top predator species. At high enough concentrations, human consumers of fish can face health risks due to exposure from contaminants. Detectable levels of mercury have been recorded in various fish species from lakes around the NWT (Lockhart et al., 2005), and levels in several lakes and fish species have led to development of site-specific consumption advisories. As climate changes, there is an increased risk to communities as pathways of contamination, both biological (species and processes) and physical (transportation of contaminants) intensify (Kraemer et al., 2005; Stern et al., 2012). Although restrictions on chemical applications and controls on global emissions of chemicals in other regions of the globe may help lower future risks of contamination, there is a concern that contaminants locked away in frozen sediment could be made biologically available due to climate change (Loseto et al., 2004; Stern et al., 2012) and permafrost thaw can release stored mercury into downstream aquatic systems (Klaminder et al., 2008). The issues of contamination are critical to the food security dialog in the North. Quantifying both risks (e.g., contaminant concentrations) and benefits (e.g., nutritional quality) of traditional foods, and how these risks and benefits may be altered with climate change, is thus of paramount importance.

The KTFN has been involved in monitoring the health of waters around the community as well as fish populations for years as food fished from Tathlina and Kakisa lakes are of significant commercial and subsistence importance to the community. Mercury has been recorded in different species in both lakes, including walleye and northern pike (Laird et al., 2018). Some samples have been measured at levels that often exceed Health Canada guidelines for safe consumption. Researchers are looking to find the cause behind these elevated levels by increasing fish sample sizes in both lakes, augmenting sampling and the understanding of mercury accumulation in lower trophic levels in the food web (e.g., algae and plankton) and determining the amount of mercury in sediment that is available for uptake into the food web. Furthermore, research has been ongoing to understand the levels of contaminants in community members. This would help to better understand community fish consumption habits and lead to improved communication and warnings about certain fish species, sizes of fish, and community impacts of contaminants.

Supporting community participation in food system evaluation

One of the most important aspects of the research conducted in Kakisa is how it is driven by the community. The community, through the Band Council and the Environmental Coordinator, has a great deal of experience working with researchers from universities and government departments, as well as other organizations, to conduct a variety of research projects on their lands. The community has the vision for ecosystem and food system protection and works with researchers to achieve their goals of stewardship of their lands. For many of the researchers that work with the KTFN, the research began at the invitation of the community, either directly or through other direct relationships. Being a small community there is the understanding that there is a limited capacity to do research, and a great deal of questions and concerns about how climate change and other developments are impacting the ecosystem. Partnering with researchers therefore became the way for the community to learn more about these changes, build local capacity to participate in, and support research and benefit from, project funding and employment opportunities.

Another unique element of the research is the partnership, and personal relationships, built with the KTFN's Environmental Coordinator. This individual has been involved in environmental monitoring projects through government departments and non-governmental organizations, and has coordinated field sampling for fish, water, and wildlife monitoring and social science research in the community. This position is critical to ensuring that all research is conducted alongside representatives of the community (Berkes & Jolly, 2002; Pearce et al., 2009; McGregor et al., 2010; Armitage et al., 2011; Tondou et al., 2014). Of most benefit to the projects are the connections this role has in the small community that have allowed for easy communication and connections to community members, Elders, and local decision makers as well as fostered a bridge between all parties to build trust and transparent communication, so all research directly benefits the community (Angell & Parkins, 2010; Tondou et al., 2014). This role helps to overcome several major barriers for researchers working in the North, specifically the limited time one has to spend in the field, and builds upon the social capital of an individual or partner organization within the community (Caine et al., 2007). What emerged as a powerful driver behind the research and projects is the coordinator's personal drive to conduct work that makes a positive impact in the community. This drive not only enabled them to champion much of the research being conducted, but pushed much of the research, beyond mere participatory and collaborative, to action research.

The impact that community participation has on the research goes much further than logistics and relationship building, it ensures the research meets the needs of the community. This includes fostering a two-eyed seeing approach that emphasizes both traditional and Western knowledge, and research methodologies (Bartlett et al., 2012; Martin, 2012). The research

being conducted with the community all builds towards the KTFN's vision to establish a legally protected conservation area in line with the environmental and cultural values of the community. The proposed Protected Area encompasses much of KTFN's traditional territory including valuable hunting and fishing areas used by community members. Part of the planned management of the area will be accomplished through the establishment of a local Indigenous Guardian programme to promote stewardship of the land and waters through improved environmental monitoring (Trant et al., 2012; Social Ventures Australia, 2016). Guardians will be community members who will act as the eyes and ears on the land as they patrol, monitor, report, and manage a range of research and monitoring activities. The establishment of local, regional and national Indigenous Guardian initiatives is an emerging effort to reclaim sovereignty over traditional lands and promote self-determination (Roburn, 2018). In the context of food systems, this is the realization of what food sovereignty looks like in the North, providing rights to lands, decision-making, management, and protection of ecosystems for future generations.

To achieve the goals of the Guardian programme, the community requires additional capacity in various areas to be fully and properly engaged in research and monitoring programmes. Capacity needs include training, equipment, infrastructure, administrative support, and other aspects of programme development and delivery. Assessing the training needs and building in links to the opportunities available to address those needs is another important aspect in maintaining the community's food system. For the KTFN, it is critically important to engage youth in research and give them the opportunity to learn all the skills they need to participate in monitoring the land, but also to survive and harvest food from the land. Youth are important stakeholders in the North, and opportunities to learn from both Elders and researchers while on the land shapes their abilities to be future leaders in their communities. Several on-the-land camp experiences have been facilitated in Kakisa and surrounding communities to give youth the opportunity to learn traditional skills, see the land from both the traditional knowledge and Western science perspectives, and encourage their involvement in environmental monitoring initiatives in their communities. Through on-the-land training in both scientific and traditional knowledge methods of studying environmental change, participating youth develop as leaders in food system stewardship and research. But as the opportunities for this training are typically funded through external programmes, we have limited knowledge about how to effectively engage youth in these skills, let alone continue to develop these skills over time. Schools are incorporating on-the-land learning into the curriculum and facilitating more programmes to be on the land, and learning traditional skills are critical to the long-term health of the food system and well-being of communities, and therefore becomes an important aspect of measuring the food system.

Local food production

Kakisa, like many other communities, has identified growing food as a key way forward to building a more resilient food system (Chen & Natcher, 2019; Spring et al., 2018; see also Chapter 9, this volume). Not only will local food production provide fresh, healthy food to Kakisa and potentially other nearby communities, it also avoids the high cost of purchasing food from the store and the environmental impacts of transportation to northern communities (Chen & Natcher, 2019). The story of growing food in Kakisa is long and influenced by both positive and negative experiences with government programmes, residential schools, and people who have come through the community in the past (Simba & Spring, 2017). Growing food in Kakisa most recently started in 2015 with the creation of small raised-bed gardens and has expanded over the years to include another small plot of land for potatoes. Recent conversations in the community have asked about the impact of the gardens, and it was noted that not enough food is being produced to make a significant impact on the community's food system. Although the gardens are a source of pride for community members, scaling up to small-scale agriculture is envisioned as the next step in building a more sustainable food system in the community. Across the North, but particularly in the southern part of the NWT where Kakisa is located, climate change causing warming temperatures and soils as well as faster nutrient cycling may support more productive growing environments for food crops. However, the potential for local food production in the NWT more broadly depends on many factors, such as long-term capacity to grow food, the support for community initiatives and policies, and environmental factors including soil fertility and whether those soils will become wetter or drier with climate warming.

For Kakisa, scaling up production of gardens, and expanding growing opportunities in the community's planned fire break are opportunities to grow enough food to feed the community, and likely create economic opportunities for some community members. For larger communities, however, more land will need to be developed for agriculture to meet the needs of the population, and potentially, when policy barriers are mitigated and distribution networks are created, feed other communities in the NWT and beyond. There is potential for agricultural expansion into the boreal forest to have negative impacts on the ecosystem and potentially release carbon into the atmosphere to further contribute to climate change. Thus, the impacts of local food production on the health of the northern food system will need to be assessed as will methods of growing food that may reduce some of these potential impacts.

If local food production is to increase in the future, it is important to identify the areas that will become more suitable for agriculture, build capacity to grow food, and develop policies and practices that help protect the land, soils, and atmosphere (see Chapter 4, this volume). The northern food system and agroecology share many commonalities, but the deeply place-based nature of traditional and agroecological food systems means that experiences from other jurisdictions cannot be directly imported into

Canada's NWT. That said, knowledge generated through international agroecology research and practice still holds relevance for conversations about how to move forward in communities such as Kakisa. Specifically, insights can be gleaned from examining how regions and communities with long histories of engagement with agroecology are assessing the functioning of their food systems.

Agroecology has been defined as the ecology of the food system (Francis et al., 2003; Gliessman, 2007) and an agroecological lens requires attention to be paid to all elements of that system. This includes the complex web that exists amongst food production, procurement, processing, transportation, consumption, and waste management, as well as the interrelated elements of ecological soundness, economic viability, and social justice (Gliessman, 2007, 2013). Francis et al. (2003, p. 103) argue that agroecology compels us 'to evaluate food systems in new ways, to recognize the need to balance the system with available resources, and to accept a moral obligation to manage outputs from the system in an equitable manner.' While this complex, whole systems approach renders development and application of simple assessment tools difficult, if not impossible, efforts have been made to explore the links between agroecology and various measures of a food system's sustainability. One of the important contributions of the agroecological approach to food system assessment is that it explicitly centres on ecosystem health, thus addressing a gap in many of the more commonly applied assessment methods that focus more heavily on socio-economic metrics. Many ecosystem elements have been considered in agroecology-based impact assessments, including specific metrics of soil health and water quality (Altieri et al., 2017), and Francis et al. (2003) suggest employing a range of tools, including life cycle analysis (Clift et al., 1997) and environmental footprint calculations (Wackernagel et al., 1999). In recent discourse, two of the most important components that have emerged as central to agroecological approaches to food system assessment are biodiversity and climate change resilience.

Conserving biodiversity – particularly that of locally adapted species – is a cornerstone of agroecological practice (Gliessman, 2007; Altieri & Nicholls, 2012). As a result, rather than taking individual species yields as a measure of success, agroecology-based assessment seeks to capture the synergistic benefits associated with more diversified food ecologies (Badgley et al., 2007; Altieri & Nicholls, 2012). In Cuba, a recognized global leader in agroecology, Leyva and Lores (2018) have developed a biodiversity-based method for measuring agroecosystem sustainability that evaluates species populations destined for human and animal consumption, soil nourishment, and broader socio-ecological functions such as carbon sequestration or inclusion in spiritual ceremonies and traditions. This method involves communities establishing baselines for productive potential and comparing potential diversity against actual levels of diversity. One reason for using biodiversity as a metric, or even proxy, for food system sustainability is that more diversified systems have been found to be linked to increased resilience in the face of climate change (Holt-Giménez, 2002; Rosset, 2011;

Altieri et al., 2015). Much of this work on assessing agroecological systems in the context of a changing climate and threats to the world's biodiversity highlights the fact that

farmers living in harsh environments in Africa, Asia, and Latin America have developed and/or inherited complex farming systems managed in ingenious ways. These systems have allowed small farming families to meet their subsistence needs in the midst of environmental variability without depending on modern agricultural technologies.

(Altieri et al., 2015, p. 874)

The traditional knowledge held by food producers in these 'harsh environments' is essential to agroecological food system assessment, as is a focus on evaluating priorities determined through participatory, community-driven processes. As a result, many agroecology-based food system evaluations are grounded in participatory methodologies such as farmer-to-farmer learning (see Kangmennaang et al., 2017) or Participatory Rural Appraisal (Arnés et al., 2018). Such methods allow for holistic assessments that consider the inter-relationships between various socio-ecological metrics, including biodiversity, resilience to climate change, food security and sovereignty, energy efficiency, and community well-being, all of which are fundamental to an agroecological food system. Attention to the political realities within which food systems are located is also necessary, as policies at various scales have been shown to 'lock in' unsustainable practices, while also having the potential to incentivize healthier alternatives (IPES-Food, 2016).

For Kakisa, working with partners to learn more about agroecological methods fits within the community's desire to protect the land. As agriculture is, and will remain, a small portion of the community's overall food system, ensuring it does not compromise the health of the boreal forest is critical. In fact, learning how agroecology can be carried out in the NWT in a way that can help to build resilience into the boreal forest, sequester carbon and provide access to fresh, healthy food in a context specific to Kakisa is part of a larger collaboration led by the community over the next few years. This could shape policies that will ensure that agriculture is developed in a way that meets the needs of local residents and does not diminish the overall health of the ecosystem. Through learning from other regions, such as Cuba, and sharing experiences and knowledge with other communities, Kakisa can benefit from, but also enrich the global dialogue around food systems evaluation and research.

Conclusion

Food system evaluation and research in Canada's north is complex as factors that drive the health and sustainability of food systems are diverse,

multidisciplinary, and place-based, but subject to issues of scale. For the most part, evaluation tools that exist do not capture the unique and complicated food system that continues to thrive in the NWT (see Chapters 2, 4, 5, & 9, this volume). In the small community of Kakisa, examples are shown of how a community is championing efforts to protect their food system for future generations by partnering on a variety of research initiatives with academic and government institutions and other organizations. The community's participation in research is critical not only to the success of these initiatives and capacity building for community-led research, but a part of their desire to enhance control over their own food system. The environmental and climate change research in and around Kakisa shows that food systems need to be better understood in holistic terms, and that the most important element is the health of the land. This is the guiding principle for all development, including agriculture, for the community. This sends an important message to those who conduct research in the North, that is, that all changes to the ecosystems impact community food systems, livelihoods, and well-being. Most, if not all, researchers are part of an ongoing evaluation of the health of food systems across the North, but research disciplines silo those results. As food systems researchers, we cannot be bound by research disciplines but need to work to connect disciplines. Research efforts like those in Kakisa strive to create multidisciplinary approaches to environmental challenges and their impacts on community livelihoods, but connecting those results and initiatives remains a work in progress. There are other examples to learn from (Wolfe et al., 2011; Crate et al., 2017), however all involve building meaningful relationships and fostering partnerships with the communities where the research takes place. Indigenous world views see these links across disciplines, and their involvement in research is critical for the future of their food systems. Therefore, supporting community-driven research and fostering stronger inclusion and communication of research processes on ecosystem change become a critical element of self-determination and food sovereignty.

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Notes

- 1 Canada's north can be defined as comprising the three Northern Territories of Yukon, Northwest Territories, Nunavut as well as Nunavik (northern Quebec) and Nunatsiavut (in Labrador). However, this definition may also include Indigenous communities from remote and Northern regions of the provinces, such as Ontario and Alaska, who rely on the boreal forest for their livelihoods.

- 2 The authors use the term ‘traditional foods’ to describe foods that are harvested or gathered from the land and waters, but literature and other sources will use terms like country or wild foods.

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