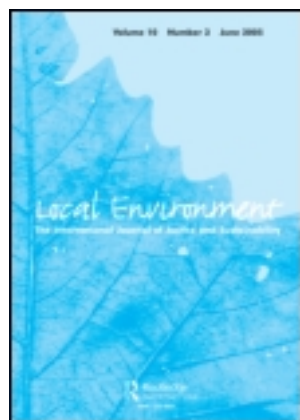


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Complexity and food hubs: five case studies from Northern Ontario

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This paper reports findings from the Northern region of a province-wide initiative aimed at better understanding local food hubs in communities throughout the province of Ontario. Drawing on case studies of five key hubs in the emerging Northern local food system, we explore from the theoretical framework of complex adaptive systems theory the emergence and development of each hub as they collectively give shape to a regional local food system. This analysis focuses on the four phases of the adaptive cycle which describes the typical developmental sequence of complex systems and reveals how they emerge, self-organise, adapt to change and harness innovation for new cycles of growth within the shadow of the dominant food system.

Keywords: complex adaptive systems theory; local food; adaptive cycle; food systems

Introduction

The local food system has been emerging and growing worldwide in the shadows of the dominant agri-industrial food system (Blouin *et al.* 2009, Nierenberg and Halweil 2011). This local food movement embraces a host of indigenous, locally adapted food practices, and is gaining momentum internationally (Pretty *et al.* 2010, Weis 2010, Nelson and Stroink 2011, Nelson and Stroink 2012). Its growth is driven in part by people's increased awareness of the effects of the industrial food system and its high-efficiency production on environments (soil fertility, water availability) and communities (diet-related health issues, local economies). People are also becoming increasingly aware of the vulnerabilities of the industrial food system, such as the decrease in crop diversity and its dependency on petroleum-based fertilisers (Allen and Wilson 2008, Altieri and Nicholls 2008, Nelson and Stroink 2011). As food consumers in each community seek out more local food options, others respond by organising a diversity of local food production and distribution solutions, together forming a community-based local food system. Given the scope and potential impacts of these local food systems, it is particularly critical to understand their dynamics as they emerge through innovation, and develop and evolve in response to their surroundings within a wider-systems context that is primarily geared toward the dominant agri-industrial system.

This paper reports findings from the Northern region of a province-wide initiative aimed at better understanding local food systems in communities throughout the province of Ontario (Blay-Palmer *et al.* 2013). For the purposes of this initiative, food hubs were defined as community-based initiatives that link producers and consumers as directly as possible (Blay-Palmer *et al.* 2013). This definition is similar to, but broader than, the United States Department of Agriculture definition which sees food hubs as mechanisms for working with

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local producers to create large, consistent and reliable supplies of local food while having a positive economic, social and environmental impact within their communities (Barham *et al.* 2012). This greater breadth reflects the more initial stages of development in which most Ontario food hubs, and certainly Northern Ontario food hubs, find themselves relative to those in the USA.

Drawing on case studies of five key hubs in the emerging Northern local food system, we explore the systems dynamics underlying the emergence and development of each hub. Collectively these Northern food hubs give shape to a regional local food system that is itself developing and adapting in the shadows of the dominant food system. These five Northern food hubs represent activities of production, marketing and distribution, or some combination that have a place-based focus on strong linkages between food and health, social justice and building social enterprise operations within local communities. These food hubs contrast with the dominant industrial food system that focuses primarily on efficiency in production and profit to the general neglect of social, health and community outcomes. While there is this commonality in focus among the Northern food hubs, their distinct approaches reveal the complexity of local food hubs and their patterns of emergence in a local food system.

Following an introduction to the theoretical framework for our analysis and an overview of the Northern region, the methodology and case studies, we present an analysis of the case studies that explores the patterns of change over time, which occur within these food hubs and the local or regional food system they comprise as they emerge, organise and grow within the wider context of the industrial food system.

Theoretical framework

Our study builds on research that has applied complex adaptive systems (CASs) theory to various complex social-ecological systems (Holling 2001, Gunderson and Holling 2002, Homer-Dixon 2006, Walker and Salt 2006, McCarthy *et al.* 2011). Food hubs and both the local and industrial food systems can be considered interacting CASs that are co-evolving. In other words, each food system is a dynamic and evolving complex system in its own right, but they interact with each other in such a way that they mutually shape each other's evolution. As complex systems they are characterised by change that is dynamic and not always linear and predictable (Polis and Strong 1996). A complexity perspective is thus particularly suited to understanding the emergence and development of food hubs as it provides a framework in which to understand complex interactions across scale and both change over time and change that occurs as a result of a co-evolving dynamic context where not all connections are known.

CAS is a group of interacting elements that form a complex whole displaying emergent properties (Mitchell 2009). In other words, through dense interactions, the complex system as a whole produces outcomes that could not be predicted from the behaviour of the individual elements. In other words, the whole is greater than the sum of the parts.

Importantly, CASs exist at multiple scales and are nested within one another (Westley and Antadze 2010). Each of these levels is thus both its own CAS and an individual element within a broader CAS (see also reference to Swyngendouw in Blay-Palmer *et al.* 2013). As a result of interactions across these scales or levels, CASs are both affected by and affect emergent properties at different scales. The widespread use of CAS concepts arises from Holling's (1973) early work on forest ecosystems. More recently, many human and natural systems have been described as CASs, including the financial system, the human brain, ant colonies, human communities and the climate (Miller and Oage 2007, Mitchell 2009, Goldstein *et al.* 2010).

Consistent with other work (Folke *et al.* 2010, Simmie and Martin 2010, McCarthy *et al.* 2011), we argue that food systems can also be understood as CASs. For example, the dense interconnections and interactions among a diversity of individual consumers, producers, distributors and policy-makers produce the emergent patterns that we know of as the dominant food system. As a CAS, the dominant food system is inclusive of numerous lower-scale CASs, such as individual farms or organisations. It is also itself contained within other CASs, such as the ecological, social and financial systems that provide the climatic, geographic and human conditions into which it has adapted. While generally much smaller, alternative local food systems can also be understood to be CASs and the local food hubs that form the subject of this paper are lower-scale CASs nested within the broader local food system as a whole, which is itself nested within other ecological, social and financial systems, and to some degree the dominant food system.

An important point to note about how patterns emerge in a complex system is that there is no central command or plan that designs the emergent outcome of the whole system. Rather, it is through the rich interactions among the elements and their individual efforts to follow simple rules that collective properties of the whole system emerge. This is known as self-organisation, and this process, the lack of top-down command, is evident in the case studies. Specifically, in each of these cases the impetus for forming a food hub did not originate with an authority or government agency, but rather emerged from grass-roots concerns.

This analysis of the Northern local food system will be particularly oriented around the four phases of the adaptive cycle. The adaptive cycle, shown in Figure 1, describes the

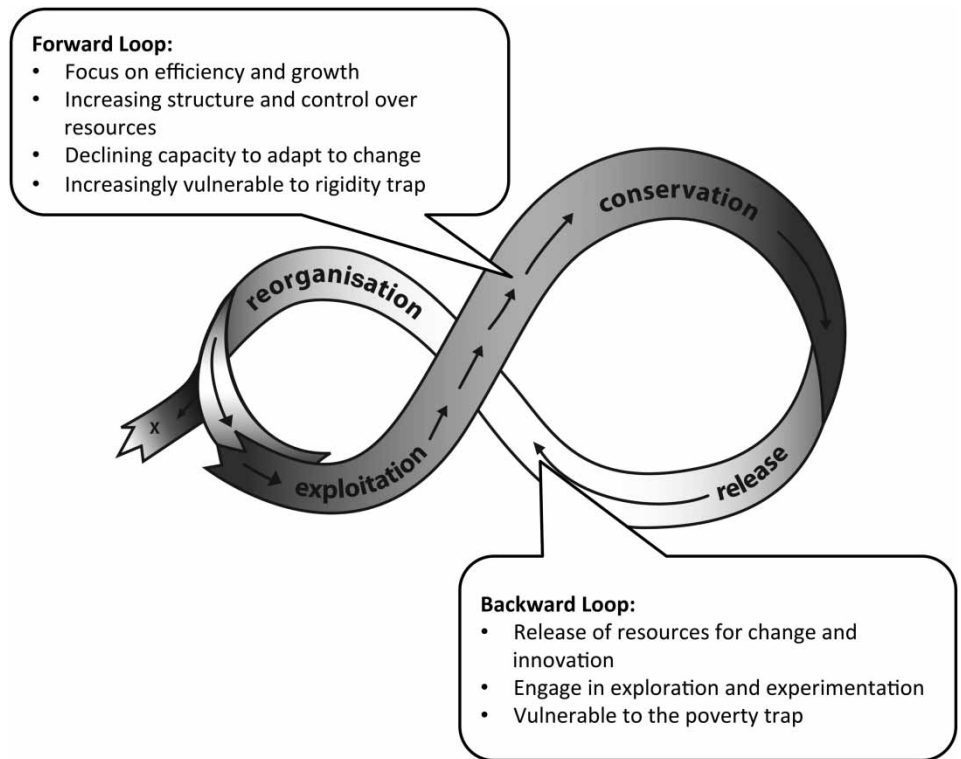


Figure 1. The adaptive cycle.

dynamics of how complex systems undergo change over time. The notion that complex systems are not static but rather adapt and evolve is a hallmark of the complex systems framework. The adaptive cycle is depicted as having four phases – the backward loop comprises a release phase and a reorganisation phase and the forward loop includes an exploitation phase and a conservation phase. The characteristics of each phase, and some of the associated challenges, will be presented in the context of the analysis that follows. In particular, the poverty trap, which is associated with the reorganisation phase, occurs when there are a large number of small initiatives attempting to form under certain conditions. This concept and its impacts on the emerging local food hubs will be discussed.

From a complexity perspective, all systems eventually move through these phases with the speed of movement dependent on the system's turbulence and scale. However, recent research has demonstrated that social systems may abort in their developmental progression through the adaptive cycle and return to an early phase or cease to exist before reaching the conservation phase (Walker and Salt 2006, Simmie and Martin 2010). In other words, progression through the cycle is not necessarily sequential. Studying local food hubs through the lens of the adaptive cycle phases can reveal insights into how they adapt to a changing environment and evolve over time, as well as some of the pressures and risks that they face. However, how and when a system will move into and through each phase cannot always be predicted, and a shift from one phase to the next is gradual and perhaps only identifiable after the fact.

Overview of the study region, methodology and case studies

Northern Ontario comprises 11 districts in total and has a land area of 802,000 km², which constitutes about 87% of the land area of Ontario (Figure 2). Thus, Northern Ontario is a significant component of the geospatial area of Ontario with potential for both cultivated and forest food sources including fish, blueberries and mushrooms. Two-thirds of this land-mass is traditional territory of First Nation peoples through Treaties 3, 5, 9 and Robinson-Superior Treaty. Aboriginal peoples comprise approximately 3.8% of the Ontario population and approximately 20% of Northern Ontario's population.

The Northern region is unique in a number of ways that ultimately helps shed a different light on the emergence and development of local food systems. Examples include unique non-agricultural food sources, place contamination and the effects of climate change.

Northern Ontario has a diversity of abundant food sources that typically are not considered by the mainstream food system to be eligible for current agriculture funding support or training. These food sources include an abundant array of native fish species – speckled trout, brook trout, pickerel, whitefish, bass, pike and lake trout, plentiful lakes flourishing with native wild rice, indigenous wild blueberries and mushrooms, and wild meats such as moose, geese and spruce grouse. Moreover, food gathered from the informal economy through fishing or hunting moose, grouse or caribou cannot be “sold at the gate”, for there is no legally registered farms that have a regulatory-protected farm gate to facilitate these activities. This is of special concern to urban aboriginal organisations that wish to serve traditional foods to their client base. It may also limit opportunities to develop the culinary aspects of Northern tourism.

Current agriculture and forestry practices and mining processes impact soil health that is critical for food quality (Stroink and Nelson 2012; Nelson and Stroink 2013). Place contamination like flooding of land associated with hydroelectric energy projects, leakage of toxic substances from improper mine closures and limitations in environmental safety of current mining processes and forest management practices like herbicidal spraying has added challenges to the revitalisation of the mixed economy that blends cultivated and

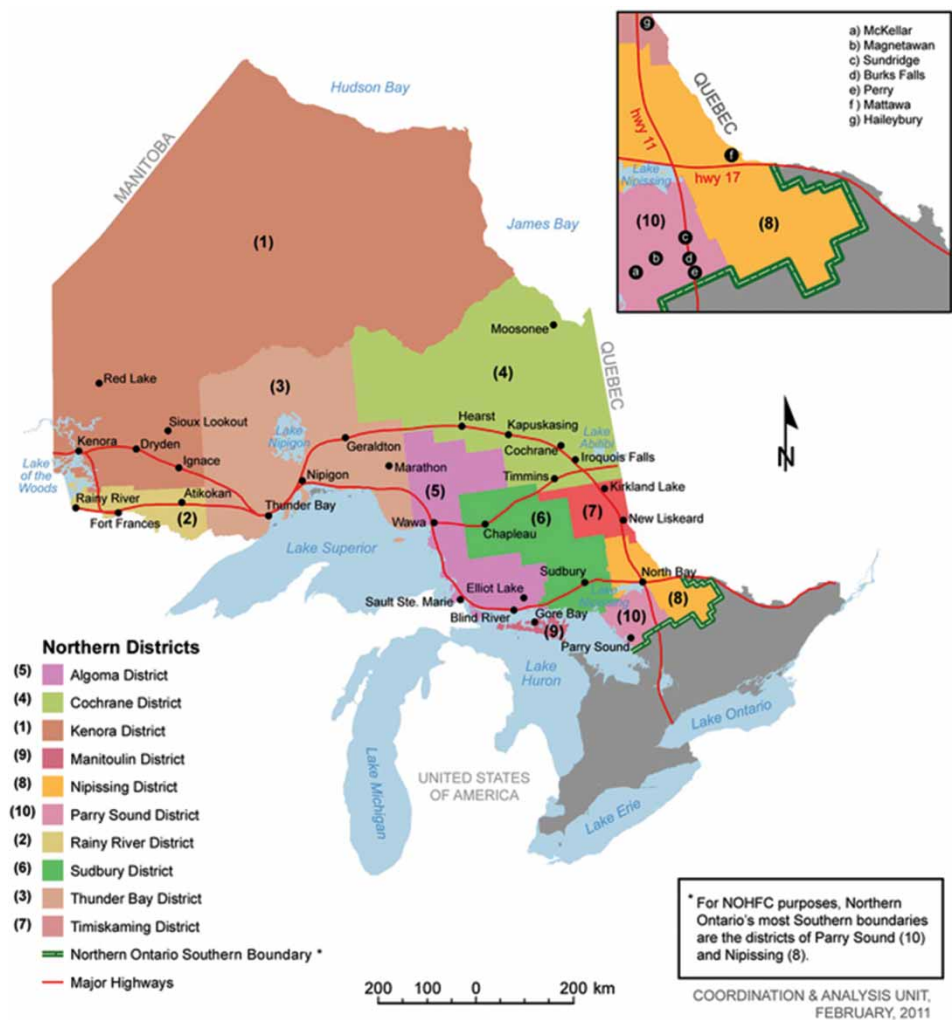


Figure 2. Districts of Northern Ontario.
Source: Northern Ontario Heritage Fund Corporation: <http://nohfc.ca/en/about-us/northern-ontario-districts>

traditional food acquisition practices of Northern Ontario's aboriginal peoples (Stroink and Nelson 2009).

For Northern cultivated agriculture food production, climate change is expected to have major implications for the length of the growing season, the variety of crops grown as well as grain yields in Northern Ontario. It is predicted that climate change will increase growing days in Northern Ontario by 30–45 days by the mid-century pointing to emerging growing opportunities due to earlier springs and later falls (Qian *et al.* 2005, Cummings and Associates 2009a, 2009b, 2009c).

For the present study, we scanned the local food system environment through contacts with 40 key informants in all Northern Ontario districts. From these key informants, phone and face-to-face interviews were conducted with 26 food hubs, entities that are particularly active or well known in the Northern local food system. A structured interview was used

with the opportunity for follow-up questions. From these recorded interviews, five case studies that represented diversity in the Northern local food system were selected for more in-depth investigation including longer telephone and in-person interviews and site visits. The sample of case studies includes one blended profit and public-benefit model, two co-ops, one arm's length government-initiated organisation and one university-community network. Basic details on these case studies are presented in Table 1.

Table 1. Case studies from the Northern region local food system.

Case study	Description
LMV	LMV began as a public benefit organisation in 1982 by a women's group in Hearst, Ontario, with the mandate to create financial opportunities and promote well-being for local women. LMV started as a greenhouse operation funded by 70 local investors and the provincial government. It secured contracts from the Ontario Ministry of Natural Resources and later from forest companies. They were innovators providing employment to women in an industry traditionally employing only men. In the 1990s, with a sharp and sudden downturn in the forest industry, LMV lost 80% of its seedling business. The reorganisation phase began in 1994 with production of tomatoes and later addition of cucumbers
ELS	ELS was incorporated in November 2007 as the first food co-op in Northern Ontario. They started as a board comprising equally farmers and consumers. ELS began as a stall at the farmer's market and based on that success opened a storefront location in downtown Sudbury. They received federal funding in 2007 to conduct the feasibility study for ELS; and then in 2008 to open the local food retail outlet
TNCC	The co-op runs out of a storefront location in downtown Thunder Bay. They are the only food hub in Northern Ontario that focuses on the entire region including both road accessible and fly-in First Nation communities. The co-op has three different levels of membership: individual level with 298 members, 51 producers and 8 commercial/organisational members. Products carried by the co-op can include food and anything that is produced in Northern Ontario by their producer members. As TNCC was emerging Indian and Northern Affairs Canada (INAC; now Aboriginal Affairs and Northern Development Canada) revised its food mail subsidy programme to create the Nutrition North programme. The co-op is an active participant in the Nutrition North Programme; of 33 national suppliers they are the only non-profit organisation that was accepted into the Programme, and the only one focused on local food
FSRN	FSRN began in 2006 with a focus to bring together a unique blend of resources from the academy and the community to introduce community service learning credit courses across all disciplines and research initiatives that focus on building capacity in a resilient local food system for Northwestern Ontario. Projects include the first Northwestern Ontario flour mill, first community supported agriculture farm, developing a blueberry co-op, training for reclaiming traditional cultivated food practices in First Nations, marketing of local beef, exploring the establishment of a poultry abattoir, exploring marketing of new chick pea production in Northern Ontario and expansion of community gardens
Northern Ontario DHUs	There are seven DHUs in Northern Ontario. The focus for this study is on the DHUs – Northwestern Health Unit, Thunder Bay DHU and Sudbury DHU as a food hub catalyst. These health units are established under provincial legislation that provides partial funding from the province and mandates the rates for municipal contributions. These units are considered to be at arm's length from either the provincial or municipal government levels as each unit has its own elected Board of Directors

Case study analysis

The purpose of this paper is to explore the systems dynamics underlying the emergence and development of each of the five Northern local food hubs represented in the case studies and the interconnectedness among them. We present the analysis of the case studies in the light of the four phases of the adaptive cycle, a key concept in CASs theory (Figure 1). Through this lens, we explore the emergence of the food hubs, the processes of organisation and growth, and the impacts of the wider industrial food on these processes.

Release phase: innovation and emergence

The backward loop begins when the energy and capital absorbed in maintaining an established system in its conservation phase are released. During this release phase, the chaotic collapse of “business as usual” has a creative aspect where human capital (e.g. skills and knowledge) and physical capital (e.g. processing facilities and greenhouses) can be released. For example, in the 1990s, with a sharp and sudden downturn in the forest industry, La Maison Verte (LMV) lost 80% of its tree seedling business (Table 1). LMV’s dependence on existing structures had increased their vulnerability to disturbance – the collapse of the forest industry. LMV abruptly moved into the release phase of the adaptive cycle and the human and physical capital of the tree seedling business were made available to local food initiatives. This process was experienced as disruptive to the women who navigated LMV through the loss of the tree seedling business, as it had been an important source of employment for many local women. In the case of food systems, the dominant agri-industrial food system is not collapsing, yet there are small pockets of release occurring, as diverse individuals and organisations find human and physical capital where they can form connections to develop innovative new local food hubs. Thus, LMV and the dominant food system demonstrate two distinct patterns of undergoing release, either suddenly as a tipping point or threshold event with implications for the whole system, as in the case of LMV, or more gradually and in smaller doses, as in the case of the dominant food system (which is also on a much larger scale than LMV). The latter pattern testifies to the greater resilience of the system.

The release phase may be a time of confusion, lack of clarity and direction, but also a time of hope and excitement for a new beginning. During this phase, resources, ideas and individuals are maximally free to interact and connect with diverse others in novel ways. The collapse of, or absence of, traditional structures, silos and routines enables diverse individuals with different perspectives to exchange ideas and information, increasing the likelihood of innovation.

Examination of the case study interviews and other information reveals that the impetus for the hub usually began as a group of people came together and interacted around shared or overlapping goals. Diversity of perspectives can be seen in these individuals alongside a common bond of shared vision. For example, Eat Local Sudbury (ELS) began as two farms came together to discuss a community-supported agriculture (CSA), which then evolved into a local food retail outlet. True North Community Co-Op (TNCC) began as three individuals came together around a shared desire to increase the availability and accessibility of local food in Northern Ontario. In each case there was excitement among the project organisers as all options were considered as possible approaches to enhancing local food as an alternative to industrial agriculture food sources. Relative to those in larger urban centres, these Northern food hubs are new pioneers in providing an alternative to the dominant food system in the region. The individuals who formed these hubs were thus acting to disrupt the singularity of the dominant system and introduce variability and innovation, triggering small releases of its capital.

The Food Security Research Network (FSRN) began as a number of university faculty and their connections in the farming and urban communities came together to explore ways they might work together to build the local food system. FSRN was the disturbance that began to unbind resources and release faculty to engage the community as an integral part of the student-learning environment (Harrison *et al.* in press) in relation to food security. By transcending traditional disciplinary silos and focusing on food security, the FSRN freed up resources and energy and enabled faculty to develop novel and innovative interdisciplinary courses, learning opportunities and research projects.

According to recent research on innovation in complex systems, innovative developments arise during this phase as a diversity of individual elements, in this case people with different perspectives and ideas, form connections with one another and openly exchange information. Thus, both connectivity and diversity among individuals and organisations participating in a food hub are important in the early-stage emergence of innovative ideas (Moore and Westley 2011). Factors such as trust and communication play key roles in facilitating connectivity in human systems, which at times can be challenged by the equally important component of diversity.

For example, the model for the TNCC developed through the exchange of information and ideas among its founding members and their interactions with other individuals and organisations in the Northern food movement, including ELS and FSRN. Interestingly, additional local food initiatives continue to emerge as community members interact with, and exchange ideas with, those involved in TNCC. The release phase is thus associated with an abundance of new ideas and possibilities.

The District Health Units (DHUs) are unique among the food hubs studied as they are not entities organised around a local food mandate but rather provide institutional supports and other resources to numerous local food initiatives being launched at the community level. For example, supports are offered by the health units to community programmes including food boxes and baskets, farmers' markets, community gardens, food access programmes, directories, school nutrition programmes, partnership building initiatives and food policy groups. Thus, as arguably the most institutionally structured of the five hubs and the most closely associated with government, they are still not leading or directing the organisation of the local food system, so much as supporting its emergence at the community level, under a health-related mandate. Interviewees emphasised extensive connections with volunteers and other community organisations in the food hub work being supported by health unit staff. Similarly, there is no designer organising the whole local food system in which these five hubs interact. Instead, certain fundamental motives (i.e. social justice, healthy food, socio-economic opportunities and a sustainable environment) drive individual people to form connections, which in turn create the conditions for the emergence of different forms of food hubs and the overall local food system.

Reorganisation phase: taking shape

The release phase is often quickly followed by a period of reorganisation. Entering into this phase there is an abundance of new and novel entities or ideas. There is an emphasis on experimentation, cross-fertilisation, flexibility and the adoption of novel solutions in response to uncertain conditions. The key task of this phase is to organise activities and resources around these new ideas. The five Northern food hubs can be viewed as experiments themselves and as entities engaging in multiple experiments as they seek novel solutions to concerns raised by the industrial food system.

For example, ELS was the first Co-Op in Northern Ontario and served as a catalyst and inspiration for TNCC. TNCC is the first food co-op in Northwestern Ontario and the first food co-op in Northern Ontario to have an expressed goal to work towards serving all Northern First Nation communities. FSRN is nationally unique in bringing university resources and the community together to build a more resilient Northwestern local food system. For LMV, the reorganisation phase began in 1994 with production of tomatoes and then cucumbers. Novelty thrived during this phase as LMV diversified both in its products and in its distribution. Tomatoes and cucumbers were distributed both locally and regionally. Locally, they were sold to individual community members and local businesses, including grocery stores and restaurants.

The novelty associated with the reorganisation phase allows for the development of approaches that take into consideration broader social, economic and health issues impacting on food health. For TNCC there is a broad focus on not only selling and consuming local food, but also education, community development and a strong focus on social justice issues relating to local food accessibility. TNCC seeks to provide a fair and stable market for local producers; to improve access for consumers to healthy, local food; to connect producers and consumers; to cluster and share resources with other businesses; and to facilitate the equitable distribution of food to underserved, remote Northern Ontario communities. LMV contributes to the community with their partnership with a local youth group who buys their green tomatoes at the end of every growing season to make green tomato relish and sells it as a fundraiser. LMV's reorganisation stabilised employment for women within their home community, provided new sources of local food for Northeastern Ontario communities and enhanced community well-being. Moreover, LMV is exploring partnerships with the local Health Unit to get local food baskets to young families, single mothers and other individuals who may be marginalised economically.

Not all of these newly emerging initiatives can be successful however, and this phase is also characterised by numerous false starts and failed experiments. The main challenge for a system seeking to move from the reorganisation phase of the cycle to the next phase, the exploitation phase, is known as the *poverty trap*. A poverty trap occurs when a system is able to exist in a given, limited state but unable to accumulate sufficient potential and capital to form larger structures and grow (Holling 2001). Systems in a state of poverty trap are characterised by low potential and low connectedness. Systems with low potential lack the necessary resources to change or grow along any number of possible directions. In a system with low connectedness, internal variables that affect the shape of the system (controlling variables) are not sufficiently inter-connected with the processes of the system. For example, the policies affecting the activities of an organisation may be disconnected from the reality of the actual activities of that organisation. Therefore, systems with low connectedness are less able to control their own destiny and are more susceptible to external variability. Thus, in a poverty trap there are not enough resources available in the system to equally support the development of all of the new ideas that exist in the reorganisation phase. People and organisations may spread themselves too thin attempting to develop and launch too many new initiatives, or available funding may be divided among too many projects, so that none of them achieves an adequate level of capital to actually succeed (Westley *et al.* 2006).

Analysis of the five Northern food hubs suggests that each hub struggles with challenges associated with a poverty trap, and that the Northern food system itself may be caught in a poverty trap, unable to move forward to the next phase of the cycle. Low potential can be seen where representatives of the food hubs report a lack of consistent funding,

and thus paid staffing, as a major challenge. Given that lack of funding is also a major challenge for initiatives in the exploitation phase, this will be discussed further in the section that follows. Other factors resulting in low potential include the vast distances between “local” communities in the North, and a lack of relevant knowledge in Northern communities. Low connectedness can be seen in the disconnect between provincial food policy and local food initiatives. The inappropriateness of provincial food policies to regulate the local food system, particularly in the North, is well known and was raised as an issue by 12 of our original 28 interviewees. Given that the controlling variables (policies) that shape the local food system are poorly connected with its processes, the capacity of the local food system to emerge out of reorganisation and grow into the next phase is limited. These factors of low potential and low connectedness combine to create the conditions of a poverty trap for these Northern food hubs and will be discussed further in the remainder of this section.

For example, the vast distances between “local” communities in the North and rising transportation costs means that LMV is limited in the number of surrounding communities that they can reach, thwarting further expansion to their business. Thus, in order to further expand their product distribution in 2010 they introduced barcoding so they could place their produce into a new market channel of local grocery stores rather than expanding outward geographically. This demonstrates the adoption of novel solutions, a quality also typical of the reorganisation phase. Many of the community-based local food programmes supported by the DHU are also reporting that distance presents a unique challenge in the North as many of the existing local producers travel significant distances to access markets. It is not uncommon for individuals to refer to food that has travelled upwards of 500 km from another Northern Ontario community as “local”. For TNCC, there is a myriad of uncoordinated and limited distribution options for food in the North. They also report that due to climate change, winter roads are an increasingly short season option for delivery of bulk meat supplies; and cargo shipments are exorbitantly expensive. These challenges presented by distance are a form of low wealth, a lack of potential with which to expand and grow the initiative into the exploitation phase.

The knowledge contained within a human system can also be considered a form of potential (similar to human capital as noted by Blay-Palmer *et al.* 2013), as it is a resource with which a system can grow. Interviewees from the DHUs reported the need to preserve the Northern knowledge base of food production and local harvesting through training specific to Northern needs. Interviewees from LMV also noted that the lack of sustained knowledge in the North could be a challenge. The North currently lacks a sustainable way to preserve community food production and harvesting knowledge that is geographically and climactically relevant, and this lack of potential may exacerbate conditions of a poverty trap. These issues are particularly problematic given the need to adapt food practices to a changing climate. FSRN is a unique food hub in that it acts as a catalyst for mobilising community food knowledge so that it is respectfully utilised and made accessible for interactive community, academic and student exchanges in understanding the dynamics of food system issues.

Finally, “one size fits all” policies are also creating a poverty trap for the Northern food hubs by undermining connectedness. Provincial food policies are critical controlling variables affecting the shape of the overall food system, including local food systems. Where there is a disconnect between these policies and the processes contained within the local food system, the capacity of the entities within that system to control their own outcomes is limited. This low controllability or connectedness then contributes to the state of poverty trap. Several food hub interviewees emphasised this challenge of developing a local food

hub in the context of food policies that are geared towards the dominant, industrial food system. For example, LMV feels that there are unrealistic expectations on small, local producers who do not have the same resources available to them as do large-scale producers. LMV feels that the policies that affect them do not necessarily reflect the reality of what is happening on the ground. DHU also recognises the constraints for local producers from provincial and federal policies. In addition, DHU reports that because the health units have enforcement powers/responsibilities, it is identified that there are at times challenges in dealing with local producers, whose efforts they ultimately want to support. Although some government policies may not be entirely applicable or relevant for small producers, it is the Health Unit's responsibility to uphold these regulations. FSRN reports that policies associated with the forestry sector make it difficult to access funding and licensing to grow forest food industries, such as blueberry or mushroom harvesting (Ontario 1994).

The reorganisation phase is thus both an exciting time characterised by an abundance of new ideas and initiatives, and a vulnerable period for local food hubs and the local food system itself. The challenges associated with the poverty trap, including uniquely Northern aspects, result in a situation where each food hub is able to offer a few small programmes but none is able to achieve major impact on the food system. Some strategies for alleviating the poverty trap that have emerged from this analysis include increasing the connectedness or relevance of provincial food policies to the local food system, adopting unique or creative solutions to leveraging more resources from public or private sources, or through partnerships as discussed below, and pooling efforts so that limited funding can be used to invest more heavily in a smaller number of initiatives.

Exploitation phase: leveraging resources for growth

This phase begins the movement into the forward loop of the adaptive cycle, which is characterised by growth and the accumulation of potential and capital. Competitive processes begin to narrow down the abundance associated with the reorganisation phase, resulting in the dominance of those species, organisations or ideas that can best take advantage of the resources available in the system. In human systems, capital such as funding is invested in the growth of the emerging dominant initiatives. Other forms of potential, such as networks of relationships, knowledge and skills, is also increasing throughout this phase and is invested in the increasing growth of the emerging initiatives. The key task of this phase, which is often referred to as the startup phase, is to leverage resources to support the development of the initiative while removing any structural barriers to its growth (Moore and Westley 2011).

Each of the five hubs studied is arguably at some point in this exploitation phase of the cycle, with some just emerging from the reorganisation phase, and others closer to the next, conservation phase. For the local food hubs we studied, this phase is characterised by the effort to secure key resources such as funding, staffing, skills and knowledge to support the growth of small initiatives. Specifically, there are many small-scale local food initiatives in each community and each struggles to cobble together sufficient funding to achieve consistency in staffing and stability for growth. The limited resources and resulting competition of this phase can lead to mounting anxiety about the viability of the food hub initiative.

For example, ELS funding remains transitory due to short-term contracts. Currently, ELS receives an NOHFC-funded intern, who acts in the capacity of Institutional Purchasing Coordinator, a Canada summer job student, who acts as Market Produce Assistant, an ONFresh/GreenBelt Fund-funded part-time employee for deliveries, and a Wikwemikong First Nation – funded position to run the store. They essentially have five positions in

the summer, which drop down to three in the fall. In addition to combining diverse forms of funding support, ELS also demonstrates creativity in coping with a challenging fiscal environment by developing partnerships. From the opening of their retail store in 2008, ELS has reorganised around various ways of marketing local food including sharing office space with the Good Food Box Coordinator and institutional purchasing with Science North and Laurentian University; acting as a business incubator for existing and aspiring local producers; and providing consumer education. For ELS, the challenge of leveraging resources for themselves and other food-related initiatives is partially resolved through collaborations and partnerships.

Within organisations, the exploitation phase is associated with increased demands for productivity and efficiency. LMV is well into the exploitation phase where they continue to diversify in both delivery and productivity. In 2011 LMV started a local food basket programme. It is similar to CSA, in that individuals purchase a share/weekly basket in advance. Thirty-two people purchased shares in 2011, and received 15 weekly baskets over the course of the growing season. LMV is planning to increase the shares to 50 in 2012. Any extra produce that is grown is brought to the weekly farmers market. They are also exploring developing a multi-producer CSA, of which they can be one producer.

TNCC is emerging into this phase of the cycle. One of the primary challenges they face is the lack of operational funding. The co-op has an operating budget of about \$10,000 per year. They have managed by having their storefront operation partnered with a private business that provides them with consistent staffing and shared rental space costs. TNCC also depends on volunteers and minimum wage employees who share TNCC's vision. Most of the financial resources are derived through the storefront sales and membership sales. This co-operative creates a structure that allows producers to set their own price for their products; this supports the viability of local food production and ensures that neither producers nor consumers are exploited. Through true value pricing, prices are consistent regardless of where the product is sold. They are thus not only attempting to grow their own initiative, they are attempting to deliberately support the scaling up of the wider local food system as a whole (Moore and Westley 2011).

As an institutional resource to numerous community-based local food initiatives, the DHU is attempting to assist these initiatives to move from the reorganisation phase to the exploitation phase. These community-based programmes have been largely funded with external grants. By providing what they can in the form of staff hours and other resources the DHU plays a critical role in maintaining these initiatives and supporting the local food movement inasmuch as it meets the DHU's health mandate. By receiving this small support from the DHU, these initiatives are able to continue their services (e.g. good food box). However, because of the constraints faced by the DHU, such as lack of secure and consistent programme funding, lack of dedicated and consistent staff time, the enormity of the geospatial area served and the inherent conflict that arises with the food safety and enforcement responsibilities of the DHU, they are generally unable to provide the level of support needed to launch initiatives into the exploitation phase of growth. In 2010, the DHU as a set of food hubs came together for strategic planning. This collective action holds future potential to enable the regional DHUs to have a greater impact in scaling up the regional local food system.

In addition to leveraging resources for growth, another key task of this phase of the cycle is to eliminate structural barriers to growth (Moore and Westley 2011). FSRN is tackling a number of structural barriers such as working with local entrepreneurial investors who are promoting a local poultry abattoir. Investing in local chicken processing means that related issues must be addressed such as the lack of chicken quota in the North

which limits the number of chickens per registered farm that can be processed and the need for the province to modify current regulations to allow for a mobile abattoir platform so pivotal to meeting the needs of multiple communities spread over the vast Northern region. Similarly, FSRN is working on the structural issue of a comprehensive Northern distribution system to facilitate access to local foods throughout the region including fly-in First Nation communities.

Conservation phase: the industrial food system

The final stage of the adaptive cycle is the conservation phase. In this phase, the complex system has matured, and growth slows as capital is accumulated by a few dominant species or entities. Thus, opportunities for new growth are limited at this stage as the system's capacity is consumed in maintaining existing structures. In human systems such as an organisation or business, this is the stage of maximum return on initial investment. The mature project or organisation is successfully producing outputs and the focus is on optimising performance and enhancing efficiency. However, as the system becomes increasingly structured and efficient, it also becomes increasingly rigid and unable to absorb disturbance. This challenge of the late conservation phase is known as the *rigidity trap*. Rigidity trap is a key concept in the forward loop of the adaptive cycle. Systems in a rigidity trap become homogenous, resistant to change and rigid, and are thus more vulnerable to major disturbances. In human systems, it is thus important to allow the release of capital from the mature system to invest in new cycles of reorganisation and exploitation (Moore and Westley 2011).

None of the five studied food hubs have reached the conservation phase, although several have had specific projects enter into the conservation phase. For example, LMV has achieved conservation in its storefront business and spinoff projects such as the flour mill and Roots to Harvest youth initiative of FSRN have also reached conservation. However, as a whole, each of these food hubs is located in and developing through the exploitation phase of the adaptive cycle.

Discussion

The local food system as a whole in the North is in the reorganisation phase with an abundance of new ideas and initiatives emerging. However, it is emerging under the shadows of the mainstream industrial agri-food system, which is well into the conservation phase. Consistent with the conservation phase, the resources available to the food system, including public and private dollars, skills, knowledge, training and infrastructure are almost entirely consumed in maintaining the existing activities of the mainstream system. A small number of successful initiatives have carved out niches of capital from the mainstream system to support innovative new growth, but these pockets are limited and kept largely isolated by a policy framework that is structured to support the mainstream system. For example, some local food and organics enterprises have been successful in attracting investment capital and developing through exploitation, but these are still restricted in certain ways such as by a training and infrastructure environment that has co-evolved to support only the mainstream system. The mainstream industrial agri-food system is bolstered and protected by legislation that produces a homogeneous and "one size fits all" food regulatory system policy that supports large-scale processing and marketing systems, and training practices that teach people how to practice agriculture as production that is disconnected from the impact of food on health and disease.

Therefore, the context in which the local food system is emerging is a mainstream industrial food system that is deep in conservation and possibly experiencing some aspects of a rigidity trap. This rigidity of the mainstream food system, and people's awareness of the associated vulnerabilities, is a major factor supporting the emergence of local food hubs. However, given this context, one of the primary challenges faced by the hubs in the Northern local food system is to leverage resources out of the dominant system to support their own growth while navigating an infrastructure and policy environment designed to support the mainstream system. Like undergrowth in an old forest, these hubs have worked hard to eke out small patches of daylight and have found creative ways to extract capital from aspects of the dominant system to fuel their own growth. For example, the DHU, itself an institution in its own conservation phase, offers institutional support and resources to numerous small community-based local food initiatives. These initiatives thus extract resources from the provincially funded health system in order to support their growth as part of a local food system. Similarly, FSRN is a food hub that extracts resources from the university system (also in its own conservation phase) in order to support local food initiatives. Finally, ELS, TNCC and LMV have carved out resources from the dominant food system, attracting consumers to the local food system as well as drawing funding from various entities to support staffing and other costs. These findings are key to further investigation of how local food hubs in various phases may influence both the resilience of the local food hubs as well as the stability of the mainstream agri-industrial system

Conclusions

The CASs approach and the adaptive cycle have been useful as a framework for understanding the dynamics and emergence of local food hubs in Northern Ontario. Concepts such as the rigidity trap and poverty trap can further aid in understanding some of the challenges faced by these hubs. Nevertheless, there are also some limitations to our analysis of the CAS and adaptive cycle for conceptualising our data (see also Abel *et al.* 2006). For example, knowing where an organisation lies on the adaptive cycle may allow us to understand the context of its challenges and to leverage interconnections for growth, but it does not allow us to predict with any accuracy what shifts or developments are likely to occur in the future, as these remain the emergent outcome of many complex interactions. In addition, while we now better understand the cycles of change in the complex food system, further analysis is still required to understand how some hubs are able to adapt to changing circumstances and others do not. Research and theory on the concepts of resilience and transformation may be useful here (Moore and Westley 2011).

Our five food hub case studies demonstrate diverse adaptive approaches to spark novelty and innovation in an alternative food system. Our analysis suggests that further investigation of local food hub movements within the adaptive cycle may be a useful way of conceptualising and analysing the dynamics of a local food system both its internal characteristics and its surrounding environment. Food hub emergence has arisen from connectivity that has self-organised in a diversity of ways that uniquely blends local resources to encourage vibrant community-based food systems. This Northern diversity has promoted interconnectivity within community that appears to provide an emergent shadow system to the mainstream commodity-based food system. Identifying the adaptive cycle stages for each of these case studies supports an understanding of both the vulnerabilities and the innovative and creative release strengths of local food hubs as an alternative to the mainstream food system. Local initiatives can have a profound impact on the entire food system (Folke *et al.* 2010, Nelson and Stroink 2011).

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