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Original Research Article

Mapping food policy groups: Understanding cross-sectoral network building through social network analysis

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Abstract

Over the past decades, there has been a rapid expansion in the number of Food Policy Groups (FPG) (including food policy councils, strategies, networks, and informal alliances) operating at municipal and regional levels across North America. FPGs are typically established with the intent of bringing together food systems stakeholders across private (e.g., small businesses, industry associations), public (e.g., government, public health, postsecondary institutions), and community (e.g., non-profits and charitable organizations) sectors to develop participatory governance mechanisms. Recognizing that food systems challenges are too often addressed in isolation, FPGs aim to instill integrated approaches to food related policy, programs, and planning. Despite growing interest, there is little quantitative or mixed methods research about the relationships that constitute FPGs or the degree to which they achieve cross-sectoral integration. Turning to Social Network Analysis (SNA) as an approach for understanding networked organizational relationships, we explore how SNA might contribute to a better understanding of FPGs. This paper presents results from a study of the Thunder Bay and Area Food Strategy (TBAFS), a FPG established in 2007 when an informal network of diverse organizations came together around shared goals of ensuring that municipal policy and governance supported healthy, equitable and sustainable food systems in the Thunder Bay region in Ontario, Canada. Drawing on data from a survey of TBAFS organizational members, we suggest that SNA can improve our understanding of the networks formed by FPGs and enhance their goals of cross-sectoral integration.

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Introduction

Over the past decades, there has been a rapid expansion in the number of Food Policy Groups[1] (FPG) operating at municipal and regional levels in North America. FPGs are typically established with the intent of bringing together food systems stakeholders across private (e.g., small businesses, industry associations), public (e.g., government, public health, postsecondary institutions), and community (e.g., non-profits and charitable organizations) sectors to develop participatory governance mechanisms. Recognizing that food systems challenges are too often addressed in isolation, FPGs aim to instill integrated approaches to food related policy, programs, and planning. Paralleling this expansion, there has been an increase in research to document their efforts (Santo et al., 2020). However, despite this growing interest, there is little quantitative or mixed methods research about the relationships that constitute FPGs or the degree to which they achieve their goals of cross-sectoral integration. Social Network Analysis (SNA) is an approach for understanding networked organizational relationships. It has been used in food movement scholarship to document the quantitative and qualitative features of networks and for understanding the comparative successes and impacts of these efforts (Dharmawan, 2015; Levkoe & Wakefield, 2014; Luxton & Sbicca, 2020). In the broadest sense, SNA can be described as the investigation of relationships among individuals and/or groups in order to identify and interrogate social structures. In this paper, we utilize a case study approach to explore how SNA might contribute to a better understanding of cross-sectoral network building in an FPG with the aim of enhancing participatory food systems governance.

Our research and analysis focus on a case study of the Thunder Bay and Area Food Strategy (TBAFS), an FPG located in Northwestern Ontario, Canada. The establishment of the TBAFS can be traced to 2007, when an informal network of diverse organizations came together around shared goals of ensuring that municipal and regional policy and governance supported healthy, equitable, and sustainable food systems in the Thunder Bay region. In 2008, the Thunder Bay Food Charter was endorsed by the Thunder Bay City Council, the District Social Services Board, and thirty-three other local governments, organizations, and businesses. This became the foundation for the TBAFS that eventually received official endorsement from the City of Thunder Bay and five rural municipalities in 2014.

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[1] We use *Food Policy Groups* in this paper as an inclusive term to refer to the diverse range of groups addressing food systems governance (e.g., policy, planning, and programming) at various scales. This includes those using terminology such as “council”, “committee”, “commission”, “alliance”, “coalition”, “advisory”, “network”, “strategy”, “charter”, and “roundtable”, among others.

Drawing on data from a survey of TBAFS organizational members, we suggest that using SNA can improve our understanding of the networks formed by FPGs and can enhance their goals of cross-sectoral integration. In this paper, we highlight the results from our SNA and point to its effectiveness along with its limitations. This research speaks directly to the Food: Locally Embedded, Globally Engaged (FLEdGE) good food principle, food policy at all levels (see fledgeresearch.ca).
As alluded to in the introduction to this themed issue of *Canadian Food Studies*, FPGs are an essential part of developing multi-scale and cross-cultural collaborations within food systems governance and are rooted in the place-based needs and assets of communities.

Food policy groups

Building networks and integrating across sectors

The concept of an FPG engaging stakeholders from a wide range of sectors and employing a food systems approach emerged in the early 1980s with the establishment of the Knoxville/Knox County (Tennessee) Food Policy Council. In the 1990s and early 2000s, similar alliances were established across the United States, Canada, Australia, and the United Kingdom with the goal of developing participatory governance mechanisms to advance a comprehensive approach to food systems challenges (Harper et al, 2009; Schiff, 2007). In the past two decades, however, the number of FPGs has grown substantially. As of March 2020, the Food Policy Networks project (operated through the Johns Hopkins Center for a Livable Future) identified well over 350 Food Policy Councils across North America[2] (Centre for a Livable Future, n.d.). Recognizing the value of FPGs, following the Federal Government's launch of the Food Policy for Canada in 2019, a Food Policy Advisory Council was established and announced in early 2021 to support collaboration and cross-sectoral engagement.

FPGs differ in their structures and activities. Some are embedded within public institutions, while others operate independently as non-profit organizations or alliances. Some focus explicitly on policy and planning, while others focus on coordinating and amplifying their membership or supporting the design and implementation of new programs. However, most FPGs share some key defining characteristics that distinguish them from other types of food systems organizations or networks (Schiff, 2007). First, FPGs use a cross-sectoral or "whole of food systems" approach, with a focus on integrating programs and/or policy across its membership and the various sectors of the food system.

[2] This is a directory that includes primarily food policy councils and not all groups meeting our broader description of FPGs.

This entails moving beyond singular issues and/or elements to consider the entire food chain along with associated social and environmental factors. Second, FPGs bring together a wide range of representatives from a diversity of sectors. FPG members aim to have equitable decision-making roles and work towards a food systems agenda. Third, FPGs are place-based, meaning that each member brings specific experiences to collectively address a range of issues related to their municipality
and/or region.

FPGs can be considered a type of social networking organization, meaning that they facilitate inter-organizational collaboration and aim to identify a common agenda among their diverse membership (Levkoe, 2014; Schiff, 2008). Members typically work towards their organization's mandate while also committing to an overall goal of more equitable and sustainable food systems. The existing body of literature on FPG partnerships reveals valuable insights about building networks and contributing to integration across food systems sectors. Despite common food systems goals, diversity among the partnerships and within the group's composition is essential (Walsh et al., 2015). Having cross-sectoral engagement is a vital part of cultivating a broad range of perspectives and skills and is essential for fostering critical analysis. Studies of FPGs have demonstrated that diversity in experience and perspective can lead to greater innovation and increase social capital (Ilieva, 2016; McCartan & Palermo, 2017).

Many FPGs struggle to build a diverse membership (Bassarab et al., 2019; Boden and Hoover, 2018; Sands et al., 2016). For example, workers across the food chain, Indigenous peoples, and anti-racism groups are often missing in FPG membership. The absence of these important voices creates several challenges for FPGs, including the potential for a lack of ideological diversity, an inability to address issues of equity, and a limited understanding of community needs. Additionally, studies have shown that many FPGs are predominantly composed of white, middle-class professionals from similar socioeconomic and educational backgrounds (Packer, 2014; Sands et al., 2016). Packer (2014) argues that, when combined, these limitations can lead to an "alienating form of 'participation'" (p. 10) that appeals to a specific group of individuals and limits the FPG's ability to represent the community, therefore decreasing its impact. Overall, ensuring FPGs have a diverse membership has been identified as a significant contribution to their success (Clancy et al., 2008; De Marco et al., 2017; Dharmawan, 2015; Schiff, 2008).

FPGs also benefit from diverse extra-organizational partnerships (De Marco et al., 2017; Ilieva, 2016). Building strong relationships within existing networks and with groups beyond those networks has multiple benefits. These include, for example, advancing government involvement and increasing financial support (Coplen & Cuneo, 2015; Clayton et al., 2015; Ilieva, 2016; Sands et al., 2016; Schiff & Brunger, 2015). Partnerships with government leaders may be especially valuable in increasing legitimacy and supporting policy-related objectives (Bassarab et al., 2019; Clayton et al., 2015; Gupta et al., 2018; Packer, 2014).

FPGs that had the support of government agencies reported more collaboration with government than independent groups, and they cite this engagement as a key factor in their success (Clancy et al., 2008; Schiff, 2007). Furthermore, partnerships with policy experts can be valuable for engaging in high-level policy work (Clayton et al., 2015, Ilieva, 2016). Health-related organizations can also play a central role in FPG activities. In fact, many FPGs originated from within areas of public health and nutrition (Dahlberg, 1994; Schiff, 2007; Yeatman, 1994). Ensuring strong relationships with health-related organizations has also been identified as a successful strategy for many FPGs via greater integration (Jablonski et al., 2019; Neff et al., 2015; O'Hara & Palmer, 2014; Sands et al., 2016).

Overall, strategic partnerships with government and health-related organizations can broaden an FPG's network with access to key stakeholders and support structures (Gupta et al., 2018). Mobilizing stakeholders from diverse sectors, the Holyoke Food and Fitness Policy Council (HFFPC) and the Toronto Food Policy Council (TFPC) were able to have greater impacts in their communities. In the case of the HFFPC, change involved working with local farmers, parents, and non-profits to improve the school food system (Sands et al., 2016). Similarly, the TFPC collaborated with other organizations on projects such as rooftop gardens to affect change and provide new opportunities to a range of community members (Blay-Palmer, 2009). These examples are a testament to what can be achieved through intentionally building integrated networks. Thus, it appears that the effectiveness of FPGs is impacted by the extent and composition of the social networks in which they operate. As such, assessing and understanding the social networks that constitute FPGs could provide valuable insight for more effective configuration and operation. SNA can be an effective tool for doing so (Scott, 1988).

Social network analysis

As the effects of social context on human behaviour have become more apparent, many social science scholars have included SNA in their research (Borgatti et al., 2009; Carrington et al., 2005). For example, in social movement studies, SNA has been used to explore the mobilization of resources and the ways that organizations cultivate collaborative networks to advance their goals (Diani, 2002; Diani & McAdam, 2003; Krinsky & Crossley, 2014). In most cases, SNA involves mapping a social network as a group of actors (or nodes) whose relationships are represented by the lines (called ties or edges) between them (Scott & Carrington, 2011). A node may represent an individual person or a group of people (an organization, company, etc.). Network maps are compiled by uploading data into network analysis software, where layout algorithms present them visually in the form of a sociogram. The software is further used to model and display various statistical measurements that analyze the structures of the network.

These statistics are based on a branch of mathematics known as graph theory (West, 2001). SNA shows how a diverse set of actors is connected. The pattern of their interactions reveals information about individual node behaviour as well as the structure of the network as a whole. Network statistics quantify this information. The number of ties a node has with others in the network is called its *degree*. In an *undirected* network, these ties are reciprocal. In a *directed* network, such as the TBAFS, this is further broken down into *indegree* (relationships named by other network members) and *outdegree* (relationships named by that actor). *Path length* measures the number of steps between any two nodes in the network. Two nodes connected by a tie have a path length of 1. The *average path length* is applied across all pairs of nodes in the network. A node's *neighbourhood* includes all nodes to which it is directly connected (Newman, 2003).

Other statistics examine the way nodes group together. The *clustering coefficient* measures the proportion of a node's neighbourhood that are also connected with each other. If they are all interconnected, the clustering coefficient is one. On the other hand, if none of the neighbouring nodes are connected, the clustering coefficient is zero. When this calculation is applied across the whole network, it results in the *average clustering coefficient*. When the average clustering coefficient is high, there are many clusters of members who are connected to each other, and therefore they are more likely to interact (Newman, 2003).

Communities are clusters of nodes that have many ties within them but fewer ties with other clusters in the network. The *modularity* statistic reveals these communities by comparing the pattern of connections in the network to what it would look like if the ties were randomly distributed. The algorithm does this by retaining the number of connections that each node has but distributing them randomly. In a structured community within the network, there are more connections among particular nodes than in the random distribution (Newman, 2006). Modularity scores can range from negative one to one. A value greater than zero means that there are more ties between nodes in the identified communities than would appear by chance while negative values mean there are fewer (Newman & Girvan, 2004). The higher the value, the more isolated the community is from the rest of the network. Previous studies have shown that small networks with optimal community divisions have modularity scores in the 0.381 to 0.526 range (Newman, 2006; Zachary, 1977).

Two additional measures used in our case study are *cohesion* and *centrality*. Network cohesion, or the interconnectedness of a network, is measured in three ways – *distance*, *reachability* and *density* (Hawe et al., 2004). Network distance is the shortest path between any two nodes and when applied to the most distant two actors is known as the network's *diameter*. Reachability refers to whether or not all actors have access to one another via pathways of links. Density is one of the most commonly used measures and can assess the total number of ties in a network relative to the number of all possible ties.

Centrality measures can reveal important nodes. For example, nodes with a high *betweenness centrality* lie on pathways between nodes which are otherwise unconnected (Newman, 2005).

These nodes can act as bridges. Identifying actors with a high betweenness value allows for the identification of those in a strategic position to help build relationships. Migliore et al. (2014) conducted a study on social embeddedness in Italy to understand the success and growth of food community networks. They found that the betweenness statistic identified which groups contributed most to mediating information. Betweenness centrality can also identify bridging organizations with more (or less) control of resource flow in uneven collaborative networks. For example, Sbicca et al.'s (2019) study of the Denver municipal food movement illustrated where member organizations differed in their power and influence.

SNA can also reveal weaknesses and gaps which can inform further decision-making in network-building. A study from Bright et al. (2019) on a public health equity coalition in the United States used SNA as an evaluation tool to establish key recommendations for improving network function. This research contributed to improving integration amongst a diverse membership. In another study, Ernstson et al. (2008) argued that SNA should be incorporated into research on social networks where government alliances are important. Their social networks helped uncover the source of ecosystem management problems in Stockholm National Urban Park. Through an analysis of the interactions between civil society organizations working to protect the green space and its eventual co-management, they identified opportunities and constraints to collective action. Specifically, they found that a division had developed between administrators with strong government ties and the stakeholders at the forefront of a growing urban movement. The lessons learned from the study can be applicable to FPGs where the objective is for the stakeholders to have ongoing influence on policy makers and governance structures.

Understanding how individuals and organizations connect and interact with each other is at the center of social network theory (Borgatti et al., 2009). Given the strong focus on building relationships and the value of integration for achieving their goals, FPGs that are able to build strong relationships and achieve cross-sectoral integration have increased their likelihood of success (Dharmawan**,** 2015; Ilieva, 2016; Liang & Brown, 2019). Thus, SNA is a useful tool for analyzing FPGs' efficacy and for planning their improvement. However, despite the potential usefulness of SNA as a tool for understanding social networks, there has been limited application of this model in FPG research. In one example of SNA used to compare networks between four FPGs in the state of Missouri, research uncovered insights about the network's operations, particularly in relation to geographic dispersion of membership and diversity (Dharmawan, 2015). The study results suggested that SNA was a valuable tool for understanding the nature of FPG networks and changes over time. In this paper, we use SNA as a tool to explore the relationships and structures constituting the TBAFS.

Study context: The Thunder Bay and Area Food Strategy

Thunder Bay is a mid-sized city in Northwestern Ontario located on the north shore of Lake Superior (Figure 1). It is situated on the traditional lands of Fort William First Nation, signatory to the Robinson Superior Treaty of 1850. The city has a population of approximately 110,000[3] and serves as a regional hub for a number of rural townships and First Nations that are accessible by road, as well as communities in the far north that are accessible by air. These regional communities rely on Thunder Bay for a range of social services, healthcare, retail, and other essential services. While it is the largest city in the region, Thunder Bay is relatively isolated from other population centres.

Figure 1: Map of Thunder Bay and Area (created by Reg Nelson)

The TBAFS was established after decades of collaboration and community-led efforts to create a more healthy, equitable, and sustainable food system for the region. Leadership from the Food Action Network brought together a diverse range of actors from the public, private, and non-profit sectors to draft the Thunder Bay Food Charter. This document served as an overview of the collective vision for a healthy, equitable, and sustainable food system and a framework for policy, planning, research, and program development at the municipal and regional levels.

[3] The majority of the population are of European and Scandinavian descent with almost 13% made up of Indigenous peoples, the highest proportion of urban Indigenous peoples per capita in Canada (Statistics Canada, 2016).

It focused on five key priorities: 1) building community economic development; 2) ensuring social justice; 3) fostering population health; 4) celebrating culture and collaboration; and 5) preserving environmental integrity (TBAFS, 2008). In 2008, the Charter was endorsed by the City of Thunder Bay, the District of Thunder Bay Social Services Administration Board, and thirty-three other municipalities and organizations in the region. In 2012, community leaders gathered at a regional food summit and agreed to develop a food strategy as a way to identify strategic action priorities and implement the Charter. After extensive consultation and deliberation, in 2014, the TBAFS was launched and endorsed by seven municipalities in the Thunder Bay area.

The TBAFS is guided by a Strategic Action Plan that promotes regional food self-reliance, healthy environments, and thriving economies through an integration of existing efforts. The Plan was developed through multiple rounds of consultation with community leaders and stakeholders in order to meet the region's food system needs (TBAFS, 2014). The TBAFS is built on seven key pillars that are intended to integrate the core elements of a healthy, equitable, and sustainable food system in the region: food access, forest and freshwater foods, food infrastructure, food procurement, food production, school food environments, and urban agriculture.

Today, the TBAFS functions as an independent FPG that is housed within a community-based non-profit organization. Its members represent key sectors from across the food system, including agriculture, Indigenous communities, economic development, policy, public health, non-profit, research, and education, as well as regional governments (urban, rural, and First Nations). Its primary work is to collect, integrate, and disseminate information, and to support food systems initiatives in the region. An Executive Committee provides overall direction and guidance to a staff coordinator and the Council, which is made up of 46 organizational representatives and regional municipalities. The TBAFS Council includes representation from additional sectors, including government, advocacy, institutional, environmental, and emergency food providers. The Council meets biannually to share information and ideas across sectors and to provide oversight and strategic advice regarding the implementation of the Strategic Action Plan. These characteristics of the TBAFS align closely with features of FPGs as described previously.

Methods

Research for this paper was conducted in partnership with faculty, staff, and students at Lakehead University, along with the TBAFS coordinator. It was part of a broader research project that aimed to explore ways that the TBAFS could have greater impact on municipal and regional food policy and planning in the Thunder Bay area. In order to gain a better understanding of the TBAFS network, a survey of TBAFS members was conducted to gather information about the strength and types of relationships among the membership.

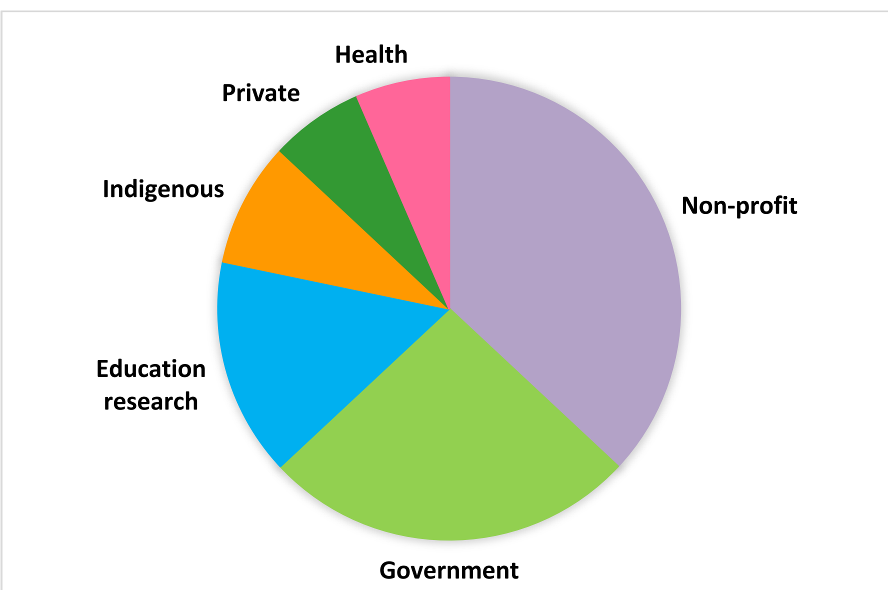
The survey was a revised version of one used by Schiff (2019) and was adapted from SNA surveys used by Fleury et al. (2014) and Keast et al. (2008). Each TBAFS member was asked to indicate the strength of their relationship with every other organization using a four-point scale (1=never; 2= rarely; 3=sometimes; 4=always) for three types of relationships: shared information, shared resources, and joint planning and programming. The types of relationships were identified and selected by the TBAFS Executive in coordination with the research team as areas of specific activity and interest.

The survey was administered online using Qualtrics, and an invitation was emailed directly to all forty-six TBAFS member organizations based on the most up to date contact information. A total of twenty-eight responses were received. Following data cleaning, five responses were deleted (one was anonymous, one was not a member, and three were duplications from individuals at the same organization). Survey data were analyzed using Gephi, an open-source network analysis and visualization software package (Bastian et al., 2009).
Gephi hosts a variety of layout algorithms useful for visually displaying the relationships captured in the data. Such network visualizations can then be used to map and explore network attributes interactively.

Results

Respondents were organized by their location in six sectors (Figure 2): non-profit organizations (37%), government (26%), education/research (15%), Indigenous organizations (9%), private businesses (6.5%), and health (6.5%).

Figure 2: Distribution of Sectors Across the Whole TBAFS Network



Survey data was transcribed into node and edge file spreadsheets. Each node in the TBAFS network represented one of the organizational members. The node file captured attributes such as node ID and organization type. Four edge files were created, each representing a type of relationship between the nodes. Three of the edge files captured relationship types (shared information, shared resources, and joint planning and programming); strength of relationship was documented as an edge weight (1= rarely; 2=sometimes; 3=always). From these data, a fourth 'whole network' edge file was compiled which showed all of the connections between nodes in the TBAFS network regardless of relationship type. The edges in this file all received the same weight of one, and if two organizations interacted on all three relationship types, it was still counted as one connection. The spreadsheets were uploaded into Gephi, and four networks were created. A directed network format was chosen as not all relationships were reciprocal.

For each of the three relationship-type networks, statistics were run for the entire network and for each portion of the network, organized by strength of relationship. This resulted in independent statistics for the 'rarely', 'sometimes', and 'always' connections, enabling us to compare the value and role each type of relationship played in the network. Due to the exploratory nature of this study, the statistical methods used to analyze data were not chosen in advance.

Network statistics

Statistics were run on the unweighted whole network to get an overall sense of how the organizations were interacting. Among the forty-six TBAFS member organizations, 492 relationships were reported. Each link represented either one, two, or three relationship-types. Most of these connections involved the sharing of information (483 edges, 98%). The next most common type of interaction was sharing resources (425 edges, 86%). Finally, three quarters of the edges were from organizational collaboration on joint planning and programming (376 edges, 76%). Analysis revealed an overall network density of 0.24. In other words, an almost 25% rate of connection compared to if all nodes were connected with each other. Furthermore, our analysis revealed that the TBAFS network had a diameter of three. Recall that the diameter is the number of path lengths between the two most distant nodes in the network. This means that the organizations least connected within the TBAFS network were separated from each other by only three path lengths. Table 1 provides a summary of the network statistics.

Table 1: Summary of Network Statistics

Statistic	A. Whole Network	B. Shared Information	C. Shared Resources	D. Joint Planning & Programming
Nodes	46	46	46	46
Edges	492	483	425	376
Percentage of Edges	100	98	86	76
Density	0.24	0.23	0.21	0.18
Diameter	3	3	3	4
Connected Component	1	1	2	2
Average Clustering Coefficient	0.61	0.60	0.57	0.53
Average Path Length	1.57	1.58	1.64	1.73

Small-world effect

The small-world effect is a concept that describes two nodes that are not directly connected to each other but have only a small number of path lengths between them. In other words, it indicates that two organizations who may not know each other directly can be connected through a short chain of relationships with other organizations in the network.

The small-world effect is calculated by considering both the average path length between nodes and the clustering coefficient.

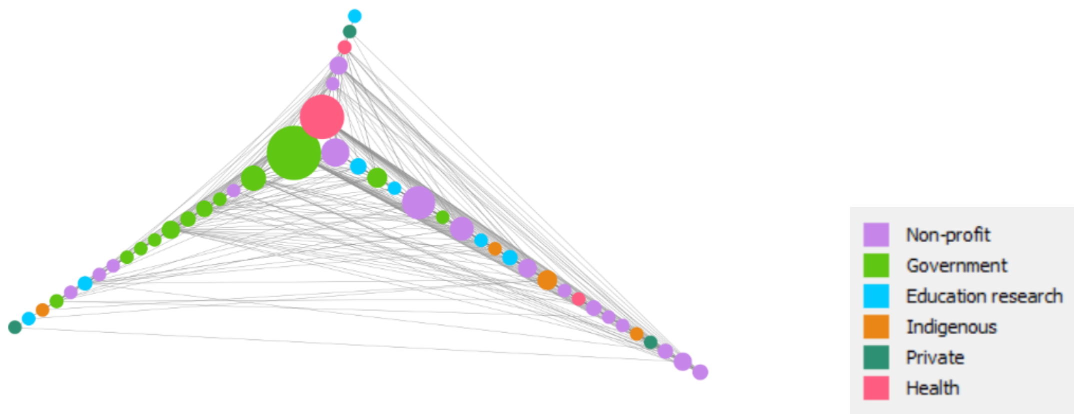
The TBAFS network can be described as exhibiting a small-world effect. The clustering coefficient of the whole network was 0.61, meaning that the organizations were, on average, 60% connected with each other. Besides this high degree of connectivity, the TBAFS network had a very low average path length of 1.57. In other words, for each member, reaching any other organization in the network is only a few connections away. In summary, the small-world effect illustrates that a high degree of advantageous connectivity exists within the TBAFS network.

Modularity

To explore the community structure of the TBAFS network, we conducted a modularity analysis on the whole network (regardless of relationship type). Figure 3 shows a visualization of the modularity in the TBAFS network using a radial axis layout to explore the different communities. This layout places the nodes from each community into one of three arms radiating from a central point. This enabled us to see which nodes, and, more specifically, which type of nodes, made up these different communities.

Figure 3: Modularity in the TBAFS Network

Nodes are sized by betweenness centrality and coloured by organization type. They are ordered from the centre according to each organization's indegree score (the number of times they were named by other organizations).



The modularity analysis of the TBAFS network reveals that each arm (community) appeared to be quite integrated, as exemplified by the different sectors represented in each group.

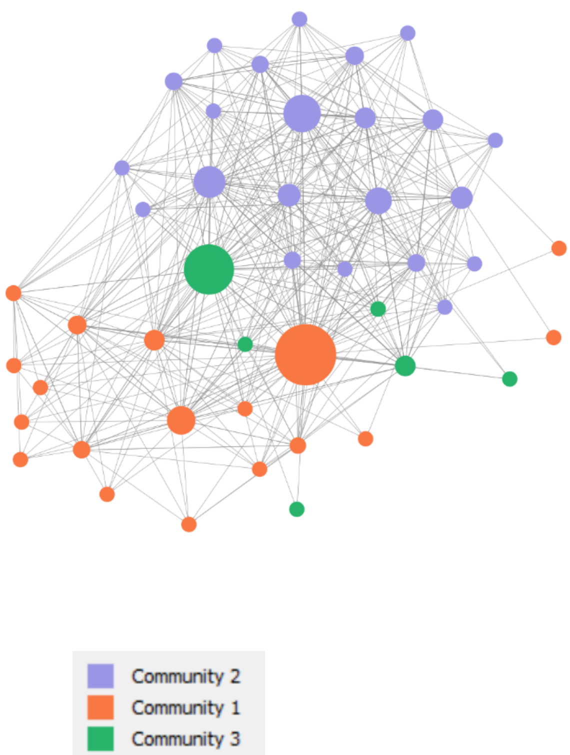
We note that each time modularity analysis was conducted it resulted in a different number of communities (either two or three) and a slight alteration in the modularity value (between 0.129 and 0.147). This is because each time modularity is run it compares the network to a different random network. To verify the membership of these seemingly changing communities, we ran twenty-five iterations of the modularity statistic and recorded the ID number and type of nodes that made up each of the two or three communities that resulted each time. From this, two communities emerged with nodes that were consistently grouped together (80%-100% of the time) – eighteen nodes in one community and fifteen nodes in the other. Community One contained organizations from the following sectors: ten government, three non-profit, one Indigenous, and one education/research. Community Two consisted of nine non-profit, four education/research, two Indigenous, one government, one private, and one health. The remaining thirteen nodes varied in their group membership with each modularity iteration. They either fell into one community or the other or made up a third community that had no apparent pattern.

We also ran a different layout algorithm to see how these communities came together within the context of the network as a whole. We chose the Forced Atlas 2 (FA2) layout, which draws connected nodes together and pushes those which aren't connected further apart. When the nodes were coloured according to these results, the connections amongst nodes in each community were more apparent (Figure 4).

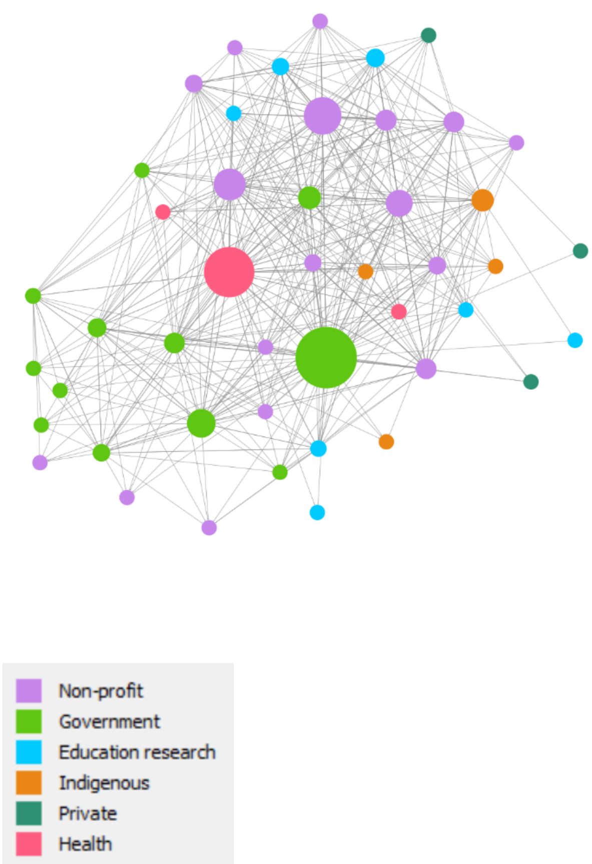
Figure 4: Community Distribution in the TBAFS

A shows the nodes coloured by modularity class, with each colour representing a different community. The same image is presented in **B** with nodes coloured by organization type. Nodes are sized by betweenness centrality.

A



B



In summary, the modularity shows that, within the structure of the TBAFS network, there are two groups of organizations with stronger connections. While both groups show an integration of organization types, Community One has a large number of government organizations whereas Community Two has a large number of non-profit organizations as well as four of the seven education and research organizations. The modularity value is low (*M* = 0.142), meaning that these groups still maintain many connections with the rest of the network. The groups, however, are persistent, which means they are definitive of the TBAFS network structure.

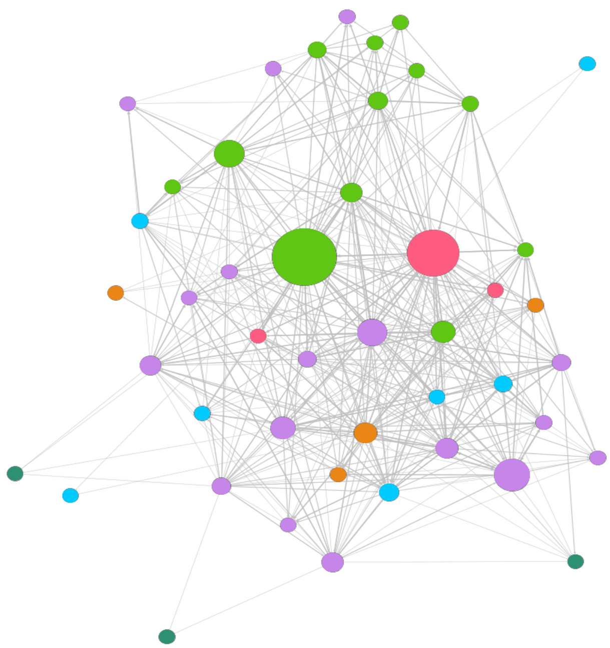
Strength of ties

We visualized the three relationship-type networks using the Forced Atlas 2 layout algorithm (Figure 5).

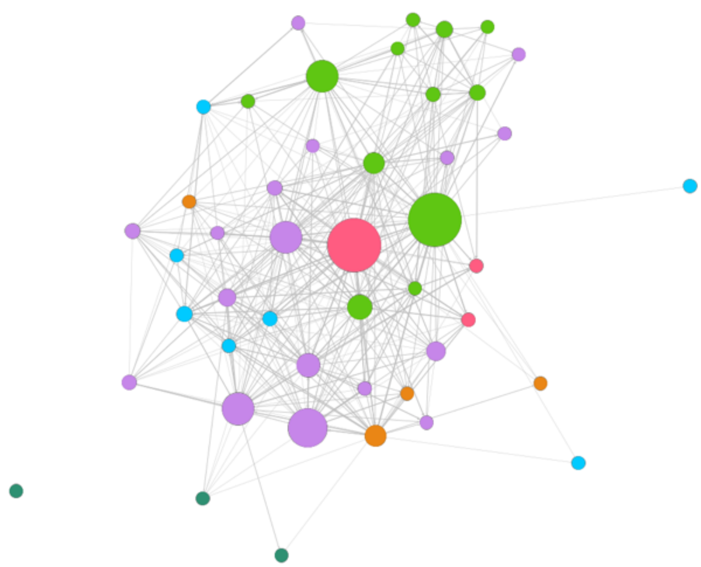
Figure 5. Distribution of network links by relationship type

The nodes are sized by betweenness centrality. Darker edges represent more frequency of interaction. **A** depicts shared information, **B** shared resources, and **C** joint planning and programming.

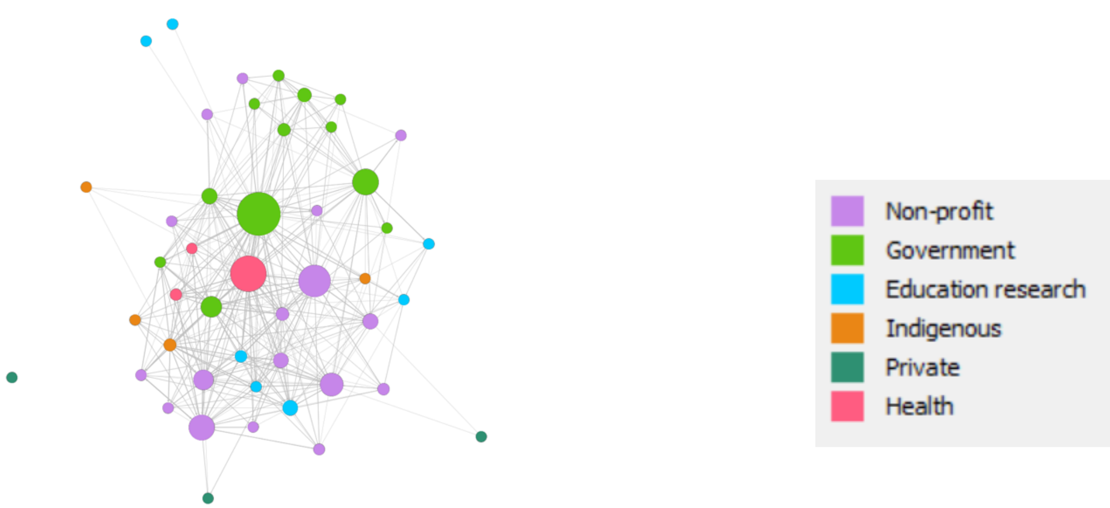
A



B



C


Non-profit
Government
Education research
Indigenous
Private
Health

Betweenness centrality (nodes bridging two unconnected nodes) varied in each network, as shown by node size. We found that more organizations played bridging roles in sharing resources and joint planning and programming than in sharing information. Nodes on the periphery represent organizations that have less involvement with the network. For example, one private business participated in sharing information only.

To investigate the relationship types and the roles they played in the TBAFS network more closely, we considered the strength of the ties. In SNA, both strong and weak ties have value. Strong ties represent cohesion and trust, but they can also be associated with network fragmentation when the ideas and resources are confined to smaller portions of the network. While we might assume that weak ties have less value, new ideas and innovative information are more likely to emerge through weaker ties than stronger ones (Granovetter, 1973; Ruef, 2002). In social capital literature, strong and weak ties also exhibit bonding and bridging (Newman & Dale, 2005; Woolcock, 2001). Bonding ties are exemplified by those amongst close friends and family who form strong, connected relationships. These bonds create trust, but over time they can result in strict rules and exclusivity. The resulting loss of diversity leads to decreased resilience in the overall network (Newman & Dale, 2005). To increase resilience, weak ties, like those of acquaintances and more distant friendships, act as bridging relationships offering new opportunities, ideas, and access to different resources.

Table 2: Summary of relationship-type by strength

	Shared Information			Shared Resources			Joint Planning & Programming		
Frequency	Sometimes/ always	Rarely	Total	Sometimes/ always	Rarely	Total	Sometimes/ always	Rarely	Total
Edges	326	157	483	282	143	425	257	119	376
Percentage of Edges	67.49	32.5	100	66.35	33.65	100	68.35	31.65	100
Diameter	5	5	3	5	6	3	6	6	4
Density	0.16	0.08	0.23	0.14	0.07	0.21	0.12	0.06	0.18
Connected Component	5	3	1	4	2	2	6	5	2

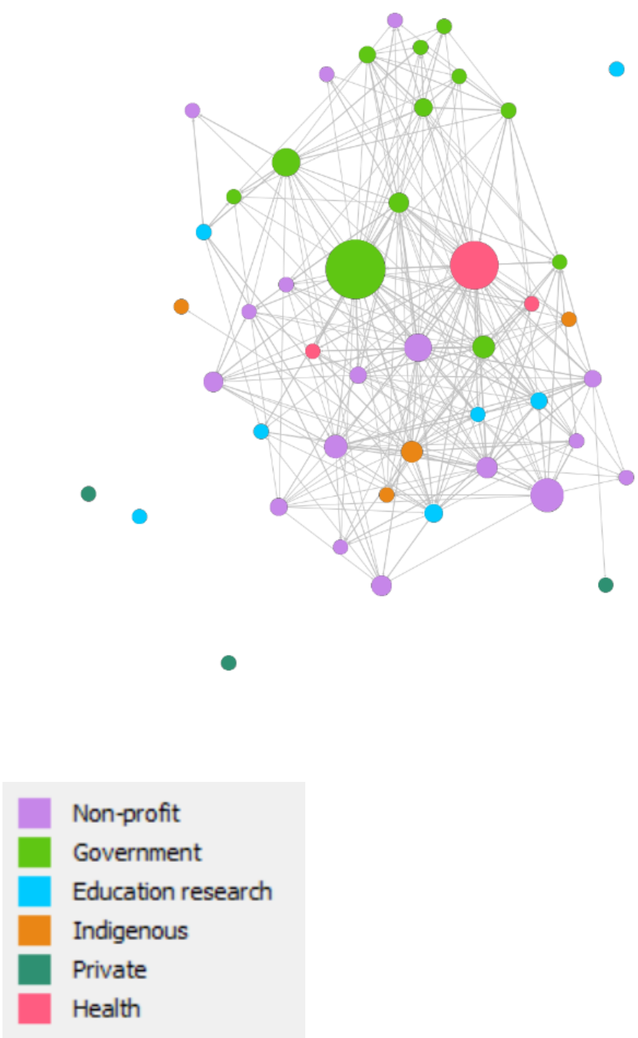
Average Clustering Coefficient	0.42	0.15	0.60	0.37	0.17	0.57	0.39	0.13	0.53
Average Path Length	1.85	2.26	1.58	1.97	2.39	1.64	2.05	2.52	1.73

Table 2 shows a breakdown of the network statistics by strength. For this analysis, the 'rarely' interactions were considered as weak ties and comprised 1/3 of the edges in all three relationship-type networks. 'Sometimes' and 'always' connections were combined to highlight the additive effect of the weak 'rarely' connections on the total. Although less frequent, these weak connections added statistically to the architecture of each network. Network density increased by 6-8%, meaning that a larger portion of the network was connected. The average clustering coefficient increased by 14-20% and the average path length decreased, making the claim of small-world effect more robust. Network diameter dropped by two path lengths, meaning that the nodes that were most distant were brought closer together. In the case of the shared information network, if the 'rarely' ties were eliminated, four nodes would have become isolated, as seen in Figure 6. Weak interactions represented an acquaintanceship connection and structure in the network as opposed to no connection at all.

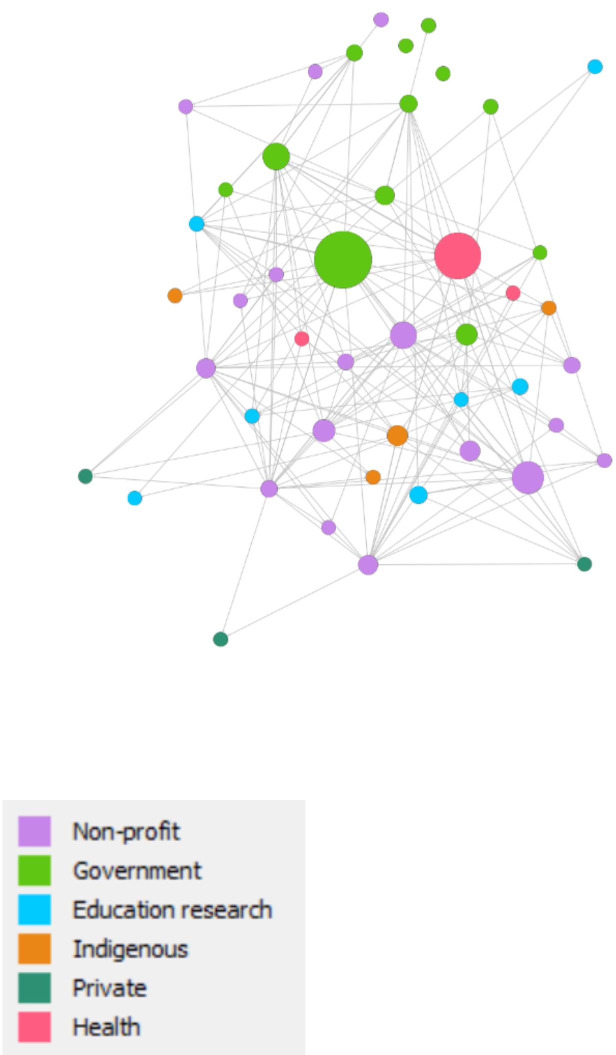
Figure 6: Strength of shared information ties

A shows 'sometimes' and 'always' interactions, while **B** shows 'rarely' interactions.

A



B


Non-profit
Government
Education research
Indigenous
Private
Health

The role of individual organizations in the network

Separate statistics were also considered for the role that individual organizations played in the TBAFS network. To measure this, we looked more closely at betweenness centrality and clustering coefficient.

Betweenness centrality

Our analysis of betweenness centrality (*BC*) brought attention to two particular organizations that stood out: one government (*BC* = 133.91) and one health organization (*BC* = 101.48). To test the influence of these organizations on the overall functioning of the network, an analysis was conducted with these nodes removed (Table 3). The result was that the clustering coefficient decreased by 12%, meaning that these two organizations had a significant impact on the way that the remaining organizations grouped together. Both were high degree nodes and the loss of their edges meant a decrease in overall network density. Of note, removing only the government organization had a more significant effect on the diameter, which increased one path length. With both organizations removed, one node became an isolate (as seen with the connected component statistic in Table 3). While the centrality of these two organizations can be shown via analysis, it is important to note that they are not deterministic of the network structure overall, as the small-world effect still holds with the removal of either. In summary, the influence of the government and health organizations are substantial, but the TBAFS network would still function, albeit differently, should they be absent. These results confirm Gupta et al.'s (2018) findings that strategic partnerships with government and health organizations can increase the impact of a network.

Table 3: Influence of high betweenness organizations

	Connected Component	Average Clustering Coefficient	Avg Path Length	Density	Diameter
Whole Network	1	0.61	1.57	0.24	3
Government Node Removed	1	0.53	1.63	0.22	4
Health Node Removed	1	0.56	1.60	0.22	3
Both Government and Health Removed	2	0.49	1.69	0.20	4

Clustering

We explored what clustering patterns could tell us about the integration of the network to answer the question: Were organizations interacting with others from different sectors? From the nodes with the highest clustering coefficients, we examined those with an indegree of ten or more. The logic was that it would be unusual for nodes with a higher degree to cluster than with a lower degree. We found that this resulted in a variety of organization types (Table 4).

Table 4: Highest clustering coefficient values for organizations with an indegree <9

TYPE	Survey Participant	Clustering Coefficient	Indegree
Private	No	0.822	10
Non-profit	No	0.818	11
Indigenous	No	0.818	11
Health	Yes	0.780	12
Non-profit	Yes	0.750	12

We then looked at the clustering of these nodes' neighbours and found them to be very highly connected (75% to 82%). We investigated the organization types which made up each cluster for signs of integration (Table 5) and found that the majority of interactions were with non-profits, followed by government. None of the clusters included private businesses, although one of the five nodes investigated was itself a private business, and it demonstrated the highest clustering coefficient.

Table 5. Integration of high clustering organizations by organization type

Type	Private	Non-profit	Indigenous	Health	Non-profit
Government	20%	9.1%	27.3%	33.3%	25%
Non-Profit	50%	63.6%	54.5%	50%	41.7%
Indigenous	10%	9.1%	9.1%*	8.3%	8.3%
Education/Research	10%	9.1%	0	0	16.7%
Health	10%	9.1%	9.1%	8.3%*	8.3%

Discussion

Initial results from the SNA survey were shared with the TBAFS Executive members and provided valuable insight into the relationships occurring within the network. Previous knowledge about TBAFS relationships was based primarily on anecdotal perspectives of the Executive and those members attending biannual meetings.

The SNA study provided a systematic and structured approach to collecting details about relationships to understand the network interactions in a new way for future planning. In addition, the SNA results point to a number of specific directions for future research to strengthen the network. While there are many insights that could be garnered from the SNA results, in this section we highlight a few key learnings.

Much insight was gained from the exploration of network modularity. The identification of two clusters of organizations with strong internal connections was unexpected. Although these organizations had strong ties among them, they did not break off into separate modules which would typically be characteristic of a higher modularity value. Instead, many of the organizations remained highly connected with the rest of the network. This signifies strong working relationships within two core elements of a well-integrated network. From this, further research could help to understand the value of this revelation and the roles of these connections within the network.

It was helpful to look at the placement of the health and government organizations that had the highest betweenness centrality scores with respect to the modularity results. The government organization was part of a community with strong connections to other government organizations, many of which were municipalities. Within this community, this particular government organization appeared to act as a bridge between these interconnected organizations and the rest of the network. This was in contrast with the health organization that also had a high betweenness score. It was not a member of either community, giving it a more neutral placement in the community and bridging connections between the two. From this, future research could explore whether mutual benefit could be gained by more direct contact among the different organizations that these health and government organizations are currently bridging.

As described above, the SNA revealed a small-world effect, which is a valuable characteristic in a network desiring a substantial flow of knowledge and information. Our analysis showed a high average clustering coefficient and low average path length. This speaks to the effectiveness of the TBAFS structure as a less centralized network with many nodes connected not directly but through a short chain of acquaintances. The alternative would be a more centralized network where information and resources are controlled by only a few organizations, thus affording a high level of power to a small number of individuals. As the TBAFS aims to ensure independent decision-making and equity within the network, its current structure is highly desirable. For example, the Indigenous Food Circle (IFC) is a member of the TBAFS with the goal to build Indigenous food sovereignty and self-determination in the region. The IFC advocates for food systems decision-making to be within the control of those that produce and harvest food and believes that food should adhere to the cultural values of the different Indigenous communities (Levkoe et al., 2019). The IFC's relationship with the TBAFS is predicated on having an independent voice at the table. If the TBAFS network were more centralized, the IFC would be less likely to participate. This is supported by other research on FPGs that suggests the importance of maximizing structural autonomy (Dubé et al., 2009; Gupta et al., 2018).

Another interesting finding was the diversity of the five organizations with the highest clustering coefficients amongst those with 10 connections or more. These represented four of the six types of organizations – non-profit, education/research, Indigenous, and private business. Most of their interactions were with non-profit organizations and government organizations, with some interactions with all other types except private businesses. The results were a good example of integration amongst organizational sectors.

Some previous studies have suggested significant value for an FPG structure closely related to government as a way to increase resources, legitimacy, and visibility (Baldy & Kruse, 2019; Bassarab et al., 2019; Clayton et al., 2015; Jablonski et al., 2019). Others suggest that more structural autonomy is better (Gupta et al, 2018.). It appears that the TBAFS might have struck a healthy balance, with an independent structure that effectively negotiates and utilizes the role of the government in the network as an important bridge between sectors and organizations. The SNA results might be particularly informative to TBAFS members by helping to identify pathways that could be used to better serve their needs.

To better understand cross-sectoral integration, we can look to signs of network cohesion as determined by reachability, distance, and density. Looking at all ties regardless of the reason members are connecting, the TBAFS is one connected component, meaning that reachability is very good. Distance is related to diameter, and the diameter results could be interpreted in different ways. In a large network, a diameter of three would be considered very good (Wasserman & Faust, 1994, p. 17-19). But in a network like the TBAFS that exists within the relatively small population of Thunder Bay, where the goal of the network is integration, a diameter of three may still seem too high. Having to make a connection through three separate members brings attention to those members who might be more distant from the core group. Further research could consult these members to see if and how their involvement in the TBAFS is helping them achieve their goals. However, another interpretation would be that it is not necessary for all members to be in direct contact with one another. The diversity of organizations reflects a diversity of activities and needs, and the most distant members are likely interacting only with others that share common goals or with whom they find support.

In respect to density, the survey showed that almost 25% of possible connections amongst the TBAFS membership are being utilized. This is a structured network, but it still has room for growth and innovation. Considering that one third of all interactions are 'rarely' connections, the TBAFS might benefit from further investigation into the nature of these particular relationships. Overall, the TBAFS is a cohesive network, which is also made apparent through the small-world effect. All members in the TBAFS are participating, with many connections in active use, the potential for others to be utilized at any time, and a broad horizon possible for movement and growth. For the TBAFS, network cohesion appears to be different from most FPGs that struggle to create a connected and diverse membership (Bassarab et al., 2019; Boden & Hoover, 2018; Sands et al., 2016). This is particularly important for FPGs because active engagement of diverse community members (and organizations) can have a positive impact (Sands et al., 2016).

Limitations

The TBAFS SNA survey received only a 50% response rate. While this was not ideal, indegree is stable at lower response rates when the network boundary is defined (Costenbader & Valente, 2003). Further, the average path length is tolerated at 50% response rates (Kossinets, 2006). In a defined network like the TBAFS, it is highly likely that relationships reported by one respondent are reciprocal (Kossinets, 2006). In SNA, online survey delivery is known to have lower response rates than face to face interviews (Borgatti et al., 2013), which could be improved in future research by using a mixed methods approach.

The findings from the SNA survey represent a snapshot in time. The survey was conducted at a particular moment, and many of the respondents are dynamic organizations that are constantly changing and adapting to new circumstances. This involves building new and different kinds of relationships as circumstances evolve and change. In the case of our study, the survey was conducted prior to the COVID-19 pandemic in 2020. In response to new economic constraints, physical distancing requirements, and increased food insecurity in Northwestern Ontario, many of the TBAFS members were forced to cancel programming and turn their attention to emergency food provisioning. Likewise, this has had a significant impact on many of the organizational relationships. Moreover, the TBAFS Executive took on a more central role in leadership by connecting and coordinating its membership in addition to engaging with new organizations. Conducting the survey again would inevitably yield different results and tracking and comparing those changes would be valuable.

A further limitation is that the SNA survey was completed by individuals that represent their organizations. Thus, the results might speak more to individual perspectives as opposed to those of their organizations as a whole. In fact, there may have been disagreement on some of the responses if others from the organization had completed the survey. Based on the methodology used in this study, we were not able to capture those tensions adequately. Additional surveys or follow-up interviews would be valuable to better understand particular perspectives.

Conclusion

Based on this research, we regard SNA a useful tool that has elucidated the relationships and structural characteristics that make up the TBAFS. This approach moves beyond relying on speculation and assumptions by providing a set of tools that can enhance the work of cross-sectoral integration. The desired structure of a network depends on the specific goals of the network members, and SNA can enhance strategic decision making by better understanding the distribution and flow of organizational relationships. Moving forward, we suggest that SNA surveys might be repeated on a biennial basis to provide comparable data that can reveal the evolving structure of the network as its context and members change.

These comparable results could help to understand the impact of specific actions as well as progression and change over time. SNA results can and should be explored interactively with network members to gain further insights from the statistical analysis and visualizations relative to a member's position within the network. It would be valuable for participants to locate themselves on the maps and to identify the gaps that exist, along with existing and potential connections that could be better utilized. Further, the more that members recognize the value of SNA, the more likely they are to participate wholeheartedly in the data gathering process and act on the results. This would be essential for increasing the survey response rate. SNA, however, is not the only way to understand relationships within FPGs. We also suggest expanding the SNA to include other qualitative components, such as case studies and interviews, as described by Luxton and Sbicca (2020). These kinds of tools would complement survey findings to explore the nature of various affiliations along with what they mean for the goals of network development.

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