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Traditional knowledge in food activism and governance

Edited by
Andrea Pieroni, Michele Filippo Fontefrancesco and Ina Vandebroek

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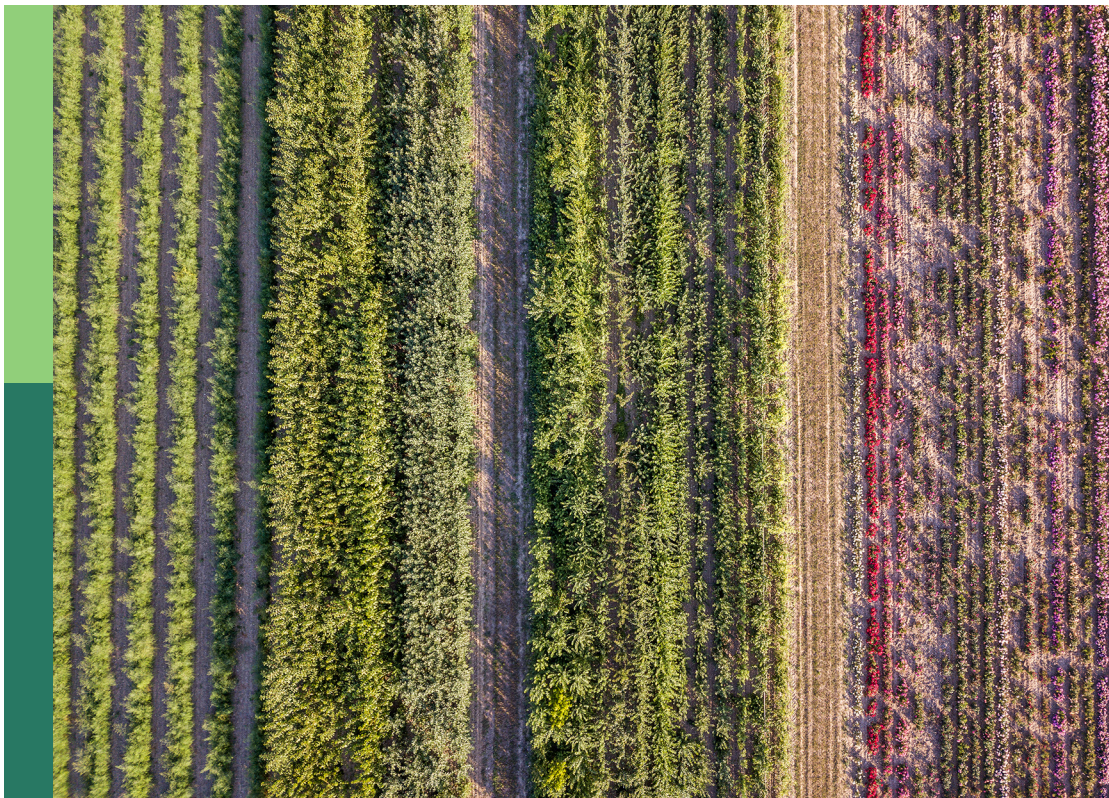

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Traditional knowledge in food activism and governance

Topic editors

Andrea Pieroni — University of Gastronomic Sciences, Italy

Michele Filippo Fontefrancesco — Catholic University of the Sacred Heart, Italy

Ina Vandebroek — The University of the West Indies, Mona, Jamaica

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EDITED AND REVIEWED BY
Albie F. Miles,
University of Hawaii–West Oahu,
United States

*CORRESPONDENCE
Michele F. Fontefrancesco
michele.fontefrancesco@unicatt.it

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Editorial: Traditional knowledge in food activism and governance

Michele F. Fontefrancesco[1]*, Ina Vandebroek[2] and Andrea Pieroni[3,4]

[1]Department of Sociology, Catholic University of the Sacred Hearth, Milan, Italy, [2]Department of Life Sciences and Caribbean Centre for Research in Bioscience (CCRIB), Faculty of Science and Technology, The University of West Indies, Mona, Jamaica, [3]University of Gastronomic Sciences of Pollenzo, Bra, Italy, [4]Department of Medical Analysis, Tishk International University, Erbil, Iraq

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Editorial on the Research Topic
Traditional knowledge in food activism and governance

"Traditional Knowledge" (TK) refers to the knowledge, insights, practices, abilities, skills, beliefs, worldviews, and perspectives passed down through generations by Indigenous and local communities and traditional societies. For specific natural places, "Traditional Ecological Knowledge" (TEK) encompasses local communities' understanding of the environment and their methods for managing it to meet their needs while maintaining its dynamic equilibrium (Berkes, 2012). Therefore, TK and TEK are deeply embedded into the co-evolution of specific environments and their inhabitants, serving as a crucial asset for environmental stewardship and cultural preservation.

Still in the recent past, TK and TEK were marginalized in public discourse under the weight of a universalistic imposition of the modern Western scientific model of science and academic knowledge (Latour, 2013). More recently, however, awareness of the value of TK and TEK have grown significantly. Several initiatives have emerged through which institutions and enterprises have begun incorporating TK and TEK into their policies and projects (Zocchi et al., 2021). This outlines an emerging process of knowledge pluralization, which promises greater participation in developing a collective vision for the future (Couee, 2024).

TK and TEK have found practical applications in food and food systems. Numerous initiatives have been launched to preserve and develop traditional foods and their underlying knowledge. These initiatives have demonstrated TK's and TEK's value in conserving biodiversity and cultural diversity and paved the way for sustainable development. This practical aspect of TK in food and food systems makes it a compelling topic for study.

Scientific discourse has extensively examined TK and TEK in terms of perceptions, utilization, and management of various environmental and biological food resources, local food processing methods, and their associated socio-cultural significance (Pieroni et al., 2021). However, there needs to be a better focus on how TK and TEK connect groups of individuals, communities, social movements, and economic and political institutions, as well as networks of practices involving entrepreneurship, production, consumption, and governance. Understanding these connections is essential for fostering concrete applications of TK and TEK and, ultimately, for achieving food sustainability and sovereignty. This Research Topic seeks to address this gap by bringing together insights from the global community to illuminate the diverse ways in which TK and

TEK related to food can serve as a vital tool for entrepreneurship, management, and development planning. Specifically, the contributions to this Research Topic revolve around three main overlapping themes: (1) food sovereignty, (2) indigenous governance, and (3) sustainable development.

Food sovereignty is the right of communities to define their food systems, ensuring access to healthy, culturally appropriate, and sustainably produced foods (IFSM, 2007). In their paper on "*Embroidering care and reciprocity*", Pontes et al. examine the contributions of rural farmer feminism and agroecology to food sovereignty among female coffee growers in Veracruz, Mexico. The authors use embroidery as a metaphor to illustrate how TK and practices related to health, food gathering, and bartering extend from families to territories, thereby promoting general Earth stewardship.

From a different perspective, Hanke et al. illuminate the link between food sovereignty and TK in their article "*Supporting inuit food sovereignty through collaborative research of an at-risk caribou herd*." The authors investigate the issues concerning caribou herding in the Canadian Arctic, a critical component of Inuit food systems, utilizing the lens of Inuit TK. They provide a novel account of six dimensions of environmental health relating to caribou in support of Inuit food sovereignty, laying the basis for a collaborative approach to caribou conservation.

These two articles also revolve around the concept of Indigenous governance, which consists of strategies and practices of Indigenous management that emphasize self-determination, TK and TEK, and sustainable resource management. Paul et al. also investigate the intersection between Indigenous governance and TK. In their article "*Blackfeet innovation pathways to food sovereignty,*" they focus on the Blackfeet Nation's Agriculture Resource Management Plan in northwestern Montana, USA, highlighting how Indigenous-led sustainable agriculture can provide a way forward to prioritize economic development, health, and ecological sensitivity, and achieve food sovereignty through community-based planning and strategic partnerships.

In another contribution, Young et al. also explore the link between TK and TEK, food sovereignty, and governance. In their paper "*Indigenous values and perspectives for strengthening food security and sovereignty*," they collaborate with Canada's Bloodvein River First Nation community. Employing qualitative methods guided by Indigenous research protocols, the study centers on Indigenous values and teachings, underscoring the significance of language revitalisation, intergenerational transmission, and local leadership involvement in achieving Indigenous food governance, sovereignty, and revitalisation of their Indigenous food systems. The authors reiterate the importance of documenting oral history in Indigenous communities to identify challenges in achieving food security and sovereignty and to pass on the teachings of elders to younger generations.

The concept of sustainability, specifically sustainable development, is also a recurring theme in this Research Topic collection (WCED, 1987). Grenz and Armstrong explore this concept in their article "*pop-up restoration in colonial contexts.*" The authors look at the limitations of current mainstream restoration strategies, which they describe as "pop-up restoration," widely deployed by environmental NGOs to mitigate environmental injustices and disproportionate harms to Indigenous communities in Canada. They advocate for integrating Indigenous food systems and knowledge into ecological restoration planning and aligning it with community values to effectively confront and counter settler colonial impacts.

Finally, Kalenjuk Pivarski et al. explore the link between TK and development in their article "*Traditional food products on the local market - consumption conditional on the characteristics of management and restaurant facilities in tourism of Vojvodina (Serbia).*" Using a survey of restaurant workers in managerial positions and statistical analysis, the authors examine the role of traditional food products in Vojvodina's hospitality and tourism industry. They identify management attitudes toward these products and the key factors influencing their procurement, including the field of education and management.

The various contributions and insights in this Research Topic provide an entry point for those interested in exploring TK's and TEK's role in contemporary governance and entrepreneurship. These papers reaffirm TK's and TEK's multiple values for future development while underscoring the ongoing need for social justice.

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EDITED BY
Steffanie Scott,
University of Waterloo, Canada

REVIEWED BY
Christopher M. Bacon,
Santa Clara University, United States
Alex Russ,
Cornell University, United States

*CORRESPONDENCE
Mariaelena Huambachano
mhuambac@syr.edu

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Knowledge networks to support youth engagement in sustainable food systems

Mariaelena Huambachano[1]*, Indika Arulingam[2], Evan Bowness[3], Anna Korzenszky[4], Catherine Mungai[5,6], Paola Termine[4] and Hannah Wittman[7]

[1]Department of Nutrition and Food Studies, Native and Indigenous Studies Program, Syracuse University, New York, NY, United States, [2]International Water Management Institute, Colombo, Sri Lanka, [3]Food and Agriculture Institute, University of the Fraser Valley, Abbotsford, BC, Canada, [4]Food and Agriculture Organization of the United Nations, Rome, Italy, [5]International Union for Conservation of Nature, Nairobi, Kenya, [6]Consultative Group on International Agriculture Research, Nairobi, Kenya, [7]Faculty of Land and Food Systems and Institute for Resources, Environment and Sustainability, University of British Columbia, Vancouver, BC, Canada

Young people are on the front lines of transforming agriculture and food systems, coping with the social and economic impacts of COVID-19 as well as environmental and climate change effects which are likely to accelerate and intensify during their lifetimes. At the same time, young people across global contexts are increasingly emerging as visible agents of change in food systems, especially through networks that create, transform, and distribute food systems knowledge. This policy and practice review examines the role of youth as actors through food systems knowledge networks. Increasing youth participation in creating sustainable food systems for the future requires policies and practices that support food systems-related knowledge in two ways: (1) democratizing formal education systems; and (2) strengthening horizontal networks of grassroots research and innovation, including through traditional, ecological, local and community knowledge (TELCK). Food systems policies should be developed through dialogue with diverse knowledge systems, experiences, place-based needs, and aspirations of young people to maximize their participation in food systems policy development and evaluation.

KEYWORDS

sustainable food systems education, traditional ecological knowledge, cultural knowledge, knowledge networks, youth engagement, food systems policy

Introduction

Globally, youth have the potential to play a more active role in sustainable food systems than they currently do. Yet, today's youth live in a world facing a confluence of crisis, including climate and environmental change, and growing global inequalities in food security, nutrition, employment, and human wellbeing. These existing trends have been highlighted and exacerbated by the COVID-19 pandemic, adding urgency to the need for a radical transformation of global and local food systems. To control

and mitigate the impacts of the current crises unfolding across food systems, global institutions and policy frameworks urge actions that advance simultaneously, at global, national, and local levels, context-specific solutions that place young people at the forefront (HLPE, 2020a,b; IPES-Food, 2020). We build on the recent efforts by the High-Level Panel of Experts on Food Security and Nutrition (HLPE) to examine the role of youth as actors in diverse food systems knowledge networks and to identify pathways toward a food system in which all young people can engage with meaning and dignity (HLPE, 2021). We review global interdisciplinary food systems literature and case studies particularly in (1) formal sustainable food systems education (SFSE) programs, and (2) place-based and grassroots horizontal learning drawn from diverse regions of the world. We argue that to prepare and enable youth to exercise agency in the future of food systems requires investment and support for inter- and intragenerational learning across diverse knowledge systems.

Across globally diverse contexts, it is urgent to make agri-food systems engagement both more appealing and more accessible to young people to secure the future of global food security and nutrition. According to a definition provided by the Food and Agriculture Organization of the United Nations (FAO):

> a sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO, 2016, 1).

The definition postulates the aim of a food system that is economically viable; that provides broad-based benefits for all members of society; and that does not deplete the natural environment. However, food systems livelihoods continue to remain precarious for many of the world's food providers, and food production is the single largest cause of, and is profoundly impacted by, global environmental change (Willett et al., 2019; HLPE, 2020a). Youth are particularly vulnerable to these challenges. Prior to the COVID-19 pandemic, young people were growing up in a world not on track to achieve the targets of the Sustainable Development Goals (SDG) related to food security; currently, a third of the global population is affected by at least one form of malnutrition (Amiot, 2020; SOFI, 2021). The social and economic impacts of the COVID-19 pandemic have put lives, jobs, and livelihoods at risk and continues to affect both food supply and demand worldwide (HLPE, 2020b; ILO, 2021). This is especially concerning for youth. Youth unemployment is itself a crisis (HLPE, 2020a; ILO, 2020), which globally is almost three times higher than adults, and youth face significant inequities in access to resources and support for sustainable livelihoods across regions, gender, ethnicity, class, and other markers of difference and diversity (ILO, 2020).

Nevertheless, youth, as agents of change, are mobilizing to lead and participate in local, sub-national, national, regional, and international initiatives to address pressing global concerns such as the climate and employment crises. Youth agency is increasingly visible in alterative food politics; for example, youth participants from across the globe engaged in consultation processes responding to the United Nations Food Systems Summit in September 2021. At the Summit, youth made it clear that the top priority for them is for everyone globally to have access to healthy and sustainable diets. Many young people are already acting upon this priority in their own lives and communities. For example, they are reviving traditional agricultural practices, engaging in activism for socio-ecological justice and advocating for the democratization of knowledge production to recognize Indigenous/local knowledge on an equal footing as western knowledge (Battiste, 2013; Pimbert, 2017). These efforts are complemented by the creation of grassroots health and sustainability-oriented organizations, and the preservation of Indigenous and local knowledge and biocultural heritage through grassroots and youth-led start-ups (UN, 2021).

In this paper, we focus on a topic of increasing relevance to supporting youth engagement in sustainable food systems: the democratization and extension of knowledge networks (Battiste, 2013; Pimbert, 2017). Local knowledge is defined as "knowledge held by a defined group of people" and "embraces traditional knowledge (passed down from one generation to the next) and Indigenous knowledge that is culturally bound and locally derived knowledge from contemporary learning based on local observation and experimentation" (Sinclair and Walker, 1999, and Sinclair and Joshi, 2004, cited in HLPE, 2019, p. 47). Native science or Indigenous traditional ecological knowledge (TEK) is a knowledge–practice–belief complex that connects living beings with each other and the environment. It is adaptive, constantly evolving and culturally transmitted through generations, although naturally, certain practices could become maladaptive over time (Berkes et al., 2000; McGregor, 2004). To emphasize the legitimacy of these diverse forms of knowledge, and to democratize other forms of local knowledge that are often marginalized by formal scientific disciplines, in this policy paper we adopt the term "traditional ecological and local community knowledge" (TELCK). It should be underlined here that traditional does not, in any way, mean static, as the concept of "traditional" embodies ways of creating new local knowledge as well as passing on existing knowledge. For example, empirical studies of TELCK related to sustainable food systems highlight the wealth of ancestral TELCK in agrobiodiversity as the foundation of our food systems (Pierotti and Wildcat, 2000; McGregor, 2004; Berkes,

2012; Huambachano, 2018; The Intergovernmental Science-Policy Platform on Biodiversity Ecosystem Services (IPBES), 2019). Thus, TELCK can play an essential role in the continuity of ancestral wisdom of agrobiodiversity, culinary practices, and leadership in preserving healthy food systems as youth engage in transforming food systems (McGregor, 2004; Whyte, 2017; Huambachano, 2019).

Understanding the relationality aspect of knowledge production and transfer is key, because each cultural group has context-specific knowledge. Speaking from an Indigenous standpoint, Opaskwayak Cree Scholar Sean Wilson argues that "relationships do not merely shape reality; they are a reality" (Wilson, 2008, p. 7) alluding to the importance of a relationality or kinship-centric approach centered on being interconnected to land and in relationship with nature and to each other (human and non-human) to live in a harmonious life. Also, a generation's identity is shaped by its relationships with older and younger generations, and these relationships are central to the process of socialization and social reproduction. Cultural norms, as well as negotiations, struggles, and outright conflict between generations, define the mutual rights and obligations of each generation in relation to others—an "inter-generational contract"—as its members progress through their life course (Huijsmans, 2016).

The cultivation of food not only provides us with food security but also represents a suite of practices and stories carrying seeds of knowledge, sovereignty, and self-determination (Huambachano, 2020). For example, the practice of agroecology and Indigenous biocultural heritage demonstrate how knowledge of ancestral practices and traditions related to agricultural biodiversity are held and transferred from one generation to the other. Indigenous bicultural heritage conveys not only agrobiodiversity knowledge and techniques concerning the plant species and animals found within Indigenous peoples' territories, but also a rich cultural component embodied in stories, rituals, songs, recipes, and ceremonies (UNESCO, 2008). Some Indigenous peoples and local communities in North America, Africa and South America have also embraced the notion of "biocultural heritage" to revitalize and preserve their crops, knowledge, practices and ancestral territories for future generations (UNESCO, 2008).

The relational aspect of intergenerational learning is important to analyze in terms of addressing mutual expectations of older generations and youth; access to and transfer of resources such as land and finance as well as wisdom, practices, and experiences that can be passed on across generations (Osano and Adam, 2014). In the context of food systems knowledge networks, young people are both "active" recipients of knowledge and part of a continuum of learning built from intimate relationships with nature, other humans and nonhuman (mountains, rivers and deities), and institutions, making up a reservoir of local knowledge or traditional ecological knowledge (TEK) (McGregor, 2004; Huambachano, 2019). For example, in farming, youth learn agricultural skills by participating in multi-generational families or farming networks. While actively working the land together with older members of the community, youth can obtain skills and knowledge, which have been adapted to the local environmental and socioeconomic conditions over centuries. This knowledge that elderly farmers have collected from their ancestors is an invaluable heritage of the peasantry and the base of sustainable agri-food systems. The multi-generational setting on the farms provides an opportunity to harmonize in-and outflow of generation-specific knowledge (Neumeier, 2012), allowing for innovative, still locally rooted agricultural solutions. In this context of intergenerational learning, youth are given the opportunity to test their novel ideas in a protected environment, guided by more experienced farmers (Korzenszky, 2019). While youth and children experience firsthand the complex dynamics of farming systems, they acquire diverse traditions, knowledge, beliefs, and practices (both practical and technical skills) in the field. This intimate learning experience allows them to value and better understand their surroundings and environments as they move forward in roles as producers, recipients, or keepers of knowledge (Setalaphruk and Price, 2007).

Innovation is often understood simply as referring to new technologies. Instead, we define innovation as developing assemblages of old and new practices, recognizing technological and social innovations in diverse intergenerational knowledge systems, including Indigenous/local knowledge systems. Complexity arises when innovation is put into contemporary socio-economic contexts to improve agriculture in the absence of an understanding of how Indigenous peoples and local communities define it and their knowledge-based practices related to it. For example, Indigenous peoples' innovation (technologies) of, for example, crop rotation and agricultural moon and solar calendars emerge from knowledge obtained from their intimately connected relationship with the land and the environment. They are heavily dependent on intergenerational learning, passed down mostly through oral history from one generation to the next, and are rooted in family and community labor (McGregor, 2004; Whyte, 2017; Huambachano, 2019; Nemogá, 2019). Innovation is thus not something that happens suddenly, but rather is a continual process; in this case, we focus on how youth apply agency to extend intergenerational knowledge networks and/or adopt new ways of doing things, such novel digital networks and platforms.

How should we judge innovations, to decide whether they play a worthwhile role in the transition to inclusive and sustainable food systems and to better opportunities for young men and women to engage productively with them? As Anderson argues, "if the rationale for an innovation is only increasing yields, productivity, profits or economic growth, it is likely to aggravate rather than ameliorate existing problems" (Anderson, 2020, p. 34). Although we usually refer to technological innovation, we need to also

recognize the importance of "social" innovations such as in institutions, ownership regimes, networks, organizations, knowledge production, which encourage people to act in ways that promote conviviality and collaborative problem solving (Haxeltine et al., 2018; Anderson, 2020, p. 31) as well as more equitable access to resources. In this regard, understanding of innovation should draw from the vast array of knowledge and practices from all stakeholders involved in food systems to foster social innovation, that is — progress for the benefit of humanity and not for profit-making solely (HLPE, 2012, 2019). In summary, providing equitable foundations for intergenerational knowledge transmission, dynamic learning, and sustainable innovation, or what Michel Pimbert calls "expanding knowledge democracy" (Pimbert, 2017), is critical for supporting youth employment and engagement in the future of food systems.

What follows is a review of opportunities and challenges for policy and guidelines to support investment in (1) inclusive food systems knowledge and training in formal educational systems, including technical and vocational training, new curriculum developments in sustainable food systems education and (2) supportive horizontal knowledge sharing based on regional and intergenerational grassroots and intergenerational knowledge networks. The policy and practice review is based on a systematic review of policy and practice literature related to the role of youth in food systems and intergenerational knowledge networks (cf. HLPE, 2021). We include illustrative examples from regional case studies with the aim to represent regional and global diversity of food systems practices and policies.

Formal food systems education

Formal modes of education can be defined as institutionalized, chronologically graded and hierarchically structured (La Belle, 1982, cited in McCarter and Gavin, 2011). Formal education is widely associated with many benefits, including the potential to unlock human capabilities, improve individual freedoms as well as enhance human health, social capital and institutions that promote inclusion (World Bank, 2018). For countries, it is associated with the potential to enhance human capital, productivity, incomes, employability, and economic growth (World Bank, 2018).

Inequalities in access to formal education are determined by location, gender and poverty, among other factors. In low-income countries, only about a quarter of the poorest children are able to complete primary school, in comparison to three-quarters in the richest countries of the world (World Bank, 2018). In 2018, nearly 31% of children, adolescents and youth of primary, lower secondary and upper secondary age from Sub-Saharan Africa were considered to be out of school, which in Southern Asia was 21%. In comparison, only 3% of the same demographic was considered out of school in Europe and North America (UNESCO (United Nations Educational, Scientific, and Cultural Organization) and UIS (UNESCO Institute for Statistics), 2019). Similar disparities are visible in higher education enrollment. In 2018, the gross enrollment ratio in higher education (defined as the percentage of the population who are in the 5-year age group span immediately following secondary school graduation, typically ages 19–23), was nearly 9% in Sub-Saharan Africa and 77% in Europe and North America (UNESCO (United Nations Educational, Scientific, and Cultural Organization) and IESALC (International Institute for Higher Education in Latin America and the Caribbean), 2020).

Schooling enrolment and schooling to work transitions are also shaped by other intersectionalities; for example, gender plays a role in shaping educational enrolment and occupational aspirations, with girls often doing better in school but stopping school earlier, than boys (Elias et al., 2018). The declining trend in youth labor force participation worldwide reflects the longer time that young people are spending in school but also the growing number who are not in education, employment or training, among whom are disproportionate numbers of young women, increasingly discouraged by the grim job prospects (ILO, 2020). This should not be thought to imply that all or most youth with non-education, employment, or training status are "idle," as many are engaged in forms of work or other activities, such as unpaid work within the household, that may not be captured in conventional employment statistics.

The assumption that investment in formal education will provide lifelong economic benefits in the form of secure employment and higher incomes is thrown increasingly into question in the light of current trends in education and youth employment, which show both increasing educational attainment and increasing precarity of youth employment. While many young people aspire to acquire an education and move into formal sector blue-collar and white-collar jobs, these aspirations are not matched by labor market realities. Young people may find difficulty in obtaining formal sector jobs without the relevant diplomas, but in today's overcrowded labor markets, having these diplomas does not in any way guarantee access to such jobs (Bessant et al., 2017). Thus, it is important not to interpret young people's difficulties in finding employment as being due to individual inabilities or endowment deficits with regard to education, as opposed to political economic shifts or neglect (Naafs and Skelton, 2018). For example, rates of "return to education," the standard metric employed in the context of human capital theory – the proportional increase in an individual's labor market earnings from each additional year of schooling completed – were decreasing over the past decade prior to COVID-19, and this has particularly affected young or early-career workers worldwide (ILO, 2020, p. 119).

Rather than focusing primarily on preparation for jobs in formal sectors, formal education systems can provide an opportunity to develop critical life skills that enable students to pursue a range of livelihood options, including within and beyond food systems. Along these lines, the UNESCO Delors

Commission Report calls for education to be structured around the four pillars of "learning to know, learning to do, learning to live together, and learning to be" (Delors, 1996, cited in McCarter and Gavin, 2011). This approach considers education important not – or not only – as job preparation but as a human right of children and young people for the role it can play in preparedness for active citizenship and potentially as an important stimulus to enhancing their active role in promoting sustainable food systems.

Our review of formal food systems education programs (HLPE, 2021) found that these programs often follow linear cause and effect models that focus on a limited range of objectives; for instance, agricultural yield, micronutrient intake or return on investment (Jordan et al., 2014). However, in preparing young people for food-related engagement and careers, educators must address complex issues of ecological sustainability, food safety and security, food sovereignty, food consumption and health, and emerging changes to food systems such as digitalization, in addition to entrepreneurship, profitability and livelihoods. This requires training programs to address new capacities, dispositions and skills needed to take integrated action to address complex and interconnected problems in food systems (Hamm, 2009), with learning outcomes including systems thinking, critical reflection, practical skills, and collaboration and communication skills (Ebel et al., 2020).

In response, within the last decade, formal food systems education programs in many countries, including in Europe, Latin America and North America, have begun to take a "food systems approach", starting with primary and secondary school and leading into the university sector (Valley et al., 2018). New sustainable food systems education programs that help students understand processes of the whole food system and support the development of agronomists, nutritionists, crop breeders, policy advocates and food entrepreneurs who are capable of "systems thinking" (Jacobsen et al., 2012; Jordan et al., 2014; Valley et al., 2018). Critical food systems education programs also engage with broader themes of food justice, food sovereignty, and agroecology (Gliessman, 2014; Meek and Tarlau, 2016) as well as other forms of resilient, climate-smart agriculture, data-driven and digital technology and other forms of sustainable agriculture (Rose and Chilvers, 2018). One can observe the growing prominence of training programs in food technology, food processing and cellular agriculture in university curricula, for instance, as well as nutrition, dietetics and public health-related programs that take an integrated systems approach through a focus on functional nutrition. The recently released United Nations Environment Programme (UNEP) publication "GEO 6 for Youth" suggests there will be an increased demand for people skilled in conservation agriculture, climate–smart agriculture, organic farming, precision agriculture and urban farming, in the context of a green economy (UNEP, 2021).

Increasingly, formal education programs involve experiential learning formats, as part of training on a spectrum of sustainable agricultural practices, from conventional to ecological, to organic, to agroecological. Both formal and experiential technical training in agroecology is offered through the Latin American Institutes of Agroecology (IALAs) and in over 50 different locations globally in a network affiliated with La Via Campesina (LVC, 2021). These programs are designed to aid young people who aim for careers not just in farming but also in agricultural extension, environmental monitoring, and other food systems professions, to support transitions in agricultural systems that are more knowledge-intensive, rather than capital-intensive (HLPE, 2019), as a way of reducing barriers to youth participation in food production. In France, the action plan "Teaching to Produce Differently" (Ministère, d. e. l'Agriculture et de l'Alimentation, 2019; Laventure du Vivant, 2020) encourages agricultural education institutions to promote agroecological transitions by undergoing curricula and pedagogical reform in agricultural education institutions, as well as tools for demonstration and experimentation. The plan also includes actions to train the trainers needed for a transition toward more sustainable production systems.

As it has been shown in the growing field of food literacy, schools are important agents of socialization – often competing with the different messages coming from advertising media – in shaping children's food habits and other forms of engagement with food systems, including aspirations related to their future employment (Rojas et al., 2011). Food literacy and food citizenship programs in primary and secondary schools aim to reconnect students with the source of their food, to use food to teach other curricular goals (e.g. school gardens are used as experiential methods to teach biology, mathematics, culture, botany, ecology, nutrition and climate change), and to "support school and community connectedness" through sharing knowledge between children, parents, teachers and community members (Powell and Wittman, 2018).

One example of such a program is the School Plus Home Gardens Project (S + HGP) of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), in collaboration with the University of the Philippines Los Baños (UPLB) and the Laguna district of the Philippines' Department of Education. In this project, school gardens support school-based feeding programs and are used for demonstration and training gardens to scale the gardening–feeding model to student homes. The program aims to increase both students' and their parents' understanding of nutrition in household diets while reducing food expenses (Calub et al., 2019). The project's conceptual framework puts into context how the school and home gardens can contribute to the goals of food security and nutrition and, similarly, to the economies of wellbeing. In Kyrgyzstan, a project jointly implemented by FAO, the World Association of Girl Guides and Girl Scouts (WAGGGS) and the Youth and United Nations Global

Alliance (YUNGA) works to increase children's awareness of and participation in biodiversity conservation. Teachers across Kyrgyzstan use playful and creative individual and group methods, such as singing, drawing and writing poems, to achieve these objectives (FAO, 2011). As a result, Kyrgyz school children, like in the AKBeketov secondary school in the Kemin rayon of Chui province, involved members of their community in establishing a school garden, plant trees and collect waste paper (FAO, 2019).

However, formal food systems education programs, particularly at the tertiary level, often are characterized by disciplinary silos evident in traditional agriculture, food science, plant science, animal biology, economics and nutrition programs (Jordan et al., 2014). They are also not always inclusive of all social groups. Garibay and Vincent (2018) show that in the United States of America students of color remain underrepresented in environmental and sustainability degree programs and in environmental careers. Despite the expansion of these programs in US colleges and universities, many are yet to fully integrate environmental justice perspectives, which focus on the disproportionate distribution of environmental harms experienced by low-income communities and communities of color (Garibay et al., 2016). Garibay and Vincent (2018) suggest that greater inclusion of environmental justice and community engagement in environmental and sustainability curricula, as well as greater student compositional diversity, are likely to lead to a greater number of students of color enrolling in these programs (Garibay et al., 2016; Garibay and Vincent, 2018).

Recent data shows that women's participation in formal agricultural studies at the tertiary level is also significantly lower than that of men (Mukembo et al., 2017). This holds true even in regions where women participate in tertiary education in nearly equal numbers as men. In addition, there are considerably fewer women than men enrolled in science and engineering, which also has a bearing on agricultural planning and policy in all regions (GO-SPIN, 2019). This gap has been connected to a diversity of factors, including the lack of female role models, gender stereotyping, and gender bias (Enns and Martin, 2015). For example, in sub-Saharan Africa, the shortage of female professional agriculturists (Kanté et al., 2013; Beintema and Marcantonio, 2019) has been attributed to low enrollment and high attrition rates (Beintema, 2006), as well as social norms.

Efforts to encourage girls to enroll in science-based subjects such as agriculture at the elementary and high school levels may facilitate greater diversity in science-based programs of study at college and university, including courses related to food production (World Bank, 2009). Muñoz Sastre and Mullet (1992) posited adolescents begin to become aware of their career aspirations and interests as early as 14 years of age, and this is a particularly important period to explore a wide range of skills development (Super, 1990). As such, some studies suggest that systemic changes in agricultural policy, governance and education systems will be required to support the effective participation of women and girls in agriculture and food systems globally (Glazebrook et al., 2020). Gender training for instructors themselves would facilitate early career awareness about the diverse opportunities available in agriculture, which may in turn also support increase female participation (Mukembo et al., 2017). Female students' interactions with same-sex role models and peers can also influence their career aspirations (Kracke, 2002; World Bank, 2009). Mukembo and others note that field trips to agricultural research organizations, trade fairs and universities as part of students' training programs can provide opportunities to interact and network with professionals and peers who share similar interests (Mukembo et al., 2014; Mukembo and Edwards, 2016). The development of horizontal social networks among youth and adults with similar career aspirations is another way to create more inclusive pathways for careers in agriculture and food systems (Kruijssen, 2009).

Technical and vocational education and training

Technical and vocational education and training (TVET) has, since WWII, provided an applied and experiential approach to education and job training in both developed and developing countries. TVET is defined as "those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life" (UNESCO, 2001, p. 1). With consistent emphasis on education for occupational skills, TVET programs in developed countries have been largely situated as either an addendum to secondary education or within the postsecondary education context, as an alternative to university training. In developing countries, the situating of TVET has historically been less clearly defined, with programs and institutions ranging from alternatives to general primary and secondary education (including nonformal educational settings like field-based training), to job-specific skills training, to more traditional vocational colleges and certification programs (King, 2011). According to the (UNESCO-UNEVOC, 2022) International Center, TVET has the potential to promote the productive participation of women in the labor market, equipping them with the necessary skills to undertake the jobs of the future. However, this potential remains challenged in certain occupational sectors, particularly those requiring training in science, technology, engineering, and mathematics (STEM).

The perception that TVET programs remain overly theoretical and "academic" (Chea and Huijsmans, 2018) has led some employers to develop the required skills "in house" or actively create private or commercial TVET institutions, according to Richard Hawkins, a senior adviser for the

BOX 1 Access to resources and knowledge for livestock shepherding

In Spain, as in several other European countries, there has been an increase in both the supply and demand for training for young (prospective) shepherds. Catalonia's Shepherding School and similar initiatives are shaping what is considered "the first generational renewal seen in the world of shepherding in the last 40 years." For some, the return to agriculture is seen as an alternative to unemployment. But for most, it is about living their lives in accordance with their principles and their interest in producing healthier and locally grown foods. The students (around 20 in each course) receive 2 months of theoretical training and 4 months of hands-on training on livestock farms in Catalonia and the French Pyrenees. Students come from Catalonia and other parts of Spain, as well as other countries. Many are young, in their late 20s and early 30s. In addition to training, the school offers the students access to a land bank, a job pool, advice on new agricultural products and artisanal-product marketing. The proportion of female students has recently reached 41%, thus breaking the mold in what is otherwise a highly masculinized sector. With close to 80% of students turning to livestock farming after completing the course, the school plays a vital role in reviving the rural sector. Former students may set up their own farms or projects from scratch or work as salaried mountain shepherds during the summer transhumance period (Alvado, 2018).

International Center for Development-Oriented Research in Agriculture at a plenary session on skilling African youth (Ligami, 2018). Other experiential learning programs have been developed to increase training and participation in food sector activities facing challenges to generational renewal (see Box 1).

The state can also be a key player in supporting applied and experiential learning. In Andhra Pradesh in India, the state-led community-based Natural Farming Programme develops institutional partnerships, hiring young agricultural graduates and placing them for a period of 3 years in communities to work jointly with farmers on developing context-sensitive methodologies and practices which are at the same time economically profitable. Such hiring subsidies are central to collaboration and partnership across formal and informal knowledge systems (HLPE, 2019, p. 42). Morocco's national strategy for youth (2015–2030), which includes a strong education and training axis, is another example of state-led interventions. In the agricultural sector, training and knowledge acquisition are part of the "Green Morocco Plan" which aims to develop technical, vocational and managerial skills for the integration of young people into working life. Technical and vocational training in the food sciences and food manufacturing sector is also increasingly offered by the private sector, which faces an aging workforce and the ongoing perception of food industrialization as providing poor quality employment. Some large companies have placed food ambassadors on university campuses in Europe and North America to "build a more positive image," while others have created technical apprenticeship schemes leading to postsecondary employment in food manufacturing companies (West, 2016). While young people as a demographic are widely considered to be active participants in and consumers of the internet and online media, these opportunities are not equally accessible to all young people, and therefore a digital divide can further exacerbate inequalities (Rotz et al., 2019). Addressing the practical digital divide given the emerging trend of digitization is also crucial, where the inclusion of technical tools for digital learning in curricula from early years of schooling to higher education is key to narrowing the gap. The necessity for more inclusive and equitable youth access to these digital technologies could facilitate not only greater participation in education but also could strengthen the role youth play in democratically shaping formal education systems from the ground up.

Horizontal networks for intergenerational learning

Knowledge and innovation in food systems happens through both formal and horizontal knowledge networks in a dynamic process through which farmers, pastoralists, fishers, food workers, retailers, and other stakeholders involved in food systems improve the way food is grown, processed, distributed, and consumed. This may include planting new crop varieties, combining traditional methods with modern scientific knowledge, applying new integrated production and post-harvest practices, or engaging with markets in new, more efficient, and sustainable ways. This has created an opportunity for increased participation of young people in food systems networks especially given the increase in innovative approaches and tools. Furthermore, if these learning networks, both formal and horizontal, increase youth engagement in food systems, this provides a potential positive feedback loop whereby the increased engagement can further strengthen the knowledge networks, although further research on this possible feedback loop is needed. However, since formal education is increasingly perceived as an important accomplishment for young people, as they spend more time and focus on schooling, their daily interactions with the environment and in helping with household livelihoods decline. This transition has the potential to weaken traditional livelihood and ecological skills and knowledge these experiences help transfer (Punch and Sugden, 2013). Outmigration is another phenomenon widely discussed in relation to weakening intergenerational cycles of TELCK transmission (Robson, 2009; Punch and Sugden, 2013; Iniesta-Arandia et al., 2015). At the same time, not all young people have access to formal education, despite its designation as a human right. Thus, informal knowledge networks remain a vital tool for youth engaging in agriculture and food systems, in particular for the maintenance and transmission of place-based agroecological production methods for climate resilience (e.g., Heckelman et al., 2018).

BOX 2 Participatory education and agroecology in Malawi

Using participatory education and agroecology in Malawi, thousands of rural families have seen dramatic improvements in maternal and child nutrition, food security, crop diversity, land management practices and gender equality. Central to the success of this long-term program has been iterative, participatory and transdisciplinary research methods that have used multiple measures to assess and improve farming and social change with participating farmers (Bezner Kerr and Chirwa, 2004; Nyantakyi-Frimpong, 2017). Agroecology education has been integrated with nutrition and social equity issues through interactive, dialogue-based methods, such as recipe days, discussion groups and theater (Satzinger et al., 2009; Bezner Kerr et al., 2016, 2018), (quoted from HLPE, 2019, p. 43). As a pedagogical tool that aimed to draw out indigenous farmer knowledge, generate discussion and foster transformational change toward food sovereignty, there was some evidence of success. Around half of the farmers interviewed felt that the drama, story-telling and small group discussions gave them an opportunity to share their own experiences and innovations around curriculum topics, and for others to do the same, increasing overall knowledge sharing. Many of the participants reported sharing information from the training with other farmers through the use of drama, with some having traveled to up to 12 villages, and others reported being invited to come to neighboring villages that had learned about the teaching and dramas (Bezner Kerr et al., 2018).

Grassroots training programs

In addition to other forms of intergenerational knowledge transfer, some training programs offer alternative modes of knowledge exchange to those delivered through formal education systems. These include grassroots training programs such as farmer-to-farmer field schools across a number of contexts. An example of this is "Education of the Countryside" curriculum developed by the Brazilian Landless Rural Workers Movement (MST), which offers place-based education as a counterpoint to the neoliberal model that generates inequality and social exclusion. This model of education aims to train a critical citizenry capable of understanding the social, economic, and political contexts of their home community and its relation to the state, contributing to family subsistence, community life and regional sustainability (cited in Meek and Tarlau, 2016). Another example of the important potential of agroecology training, education and information is the successful agroecology program in Malawi (Box 2).

Other social movements globally have been pursuing a wide range of critical food systems education projects, programs and initiatives – in both urban and rural contexts – to raise awareness of the challenges to sustainability in current food systems and to advocate for agroecology, food sovereignty and food equity (Gliessman, 2014; Meek et al., 2019). Examples of such models that encompass agroecology as a science, a practice and as a social movement include farmer-to-farmer training initiatives (Holt-Giménez, 2006; Rosset and Martínez-Torres, 2012; Martínez-Torres and Rosset, 2014; Bezner Kerr et al., 2018), training on local solidarity partnerships between producer and consumer networks (Urgenci, 2020), the Slow Food movement, internships, volunteer programs, intergenerational mentorships (and critical views thereof) (Ekers et al., 2016; Weiler et al., 2016; Levkoe and Offeh-Gyimah, 2020), and learning journeys that connect producers and consumers (Nyasimi et al., 2017; Sustainable Food Lab, 2019). Another application of the farmer-to-farmer learning approach is the Climate Change Agriculture and Food Security (CCFA) Consultative Group on International Agricultural Research (CGIAR) "Farms of the Future", which aims to provide experiential learning to face climate change (see Box 3).

Apprenticeship and mentorship

Apprenticeships can act as a hybrid training tool that allows young people to learn directly from the experience of others by working in a company or a farm while simultaneously enrolled in academic training. In Europe, the Erasmus+ program promotes international apprenticeship training to foster an exchange of pedagogical practices, the development of social and learning networks and other innovations (European Commission, n.d). Youth participate in such movements not only as recipients of knowledge transfer but also as generators and facilitators of horizontal transfers of knowledge between traditions and communities and with other groups of young people. The rapid development of ICT online/virtual platforms has created new opportunities for young people to learn and pass on knowledge, especially evident in the face of COVID-19. The ability to access asynchronous learning platforms can also help bridge gender gaps in access to knowledge (OECD, 2018). However, barriers such as inadequate infrastructure needed for access to online systems remain a challenge. Many global locations still lack sufficient levels of electricity and Internet connectivity infrastructure. Improving this digital divide requires financial and political commitments (Mehrabi et al., 2020).

Intentional mentoring programs can also serve as knowledge exchange spaces as explored by face-to-face, online, in-conference and peer-to-peer models. A review of the Young Professionals for Agricultural Development (YPARD) mentoring program found that some young people were able to "unlock life skills that they never thought they had" as they explored personal development trajectories with their mentors and peers (YPARD, 2017). The Purpose Road Map is an example of a tool which mentees develop with their mentors' guidance; it plots a trajectory from where they are to where they want to be, while identifying what they need to develop to reach their goals, all in their respective fields of agriculture and food systems such as agribusiness, research, extension. As a result, positive outcomes in terms of employment were reported by mentees due to their engagement through the mentoring program. It was noted, however, that such programs could deliver more impact if barriers in policies or in accessing finance, land

BOX 3 Farms of the future: a CCAFS-CGIAR approach

The CCAFS "Farms of the Future" project uses the climate analog tool to connect farmers to their possible climate futures via farm visits. Through this novel anthropological approach of farmer-to-farmer exchanges between spatial analogs, CCAFS aims to establish, test and validate a methodology enabling identification of social, cultural and gender-specific barriers to improving adaptive capacity. The visits provide an opportunity for farmers to learn about the practices and technologies that other farmers use in areas that are similar to the climates they will soon face. Farmers can then go home and start to implement them on their site and improve their adaptability. This approach has been implemented in West Africa: Burkina Faso, Ghana, Mali, Niger and Senegal. In East Africa the visits were carried out in Kenya and Tanzania. The exchanges showed that while the "farms of the future" approach enables farmers to learn adaptation practices and technologies from people on similar sites, the hosting farmers can also learn lessons from their visitors. Notably, there are limits to what can be achieved by a study tour. To achieve adaptation may require structural and broader policy and institutional changes beyond the local. However, as a learning process a study tour can enable farmers to learn to begin to read the world differently. It can help them to think critically about their future and encourage them to act (Gonsalves, 2013).

BOX 4 Agriculture and arts

A Filipino YPARD mentee wrote a musical play that explored how theater can communicate the need for youth in agriculture. In 2017, YPARD Philippines partnered with UP Broadway Company and received funding from the Office for Initiatives in the Culture and the Arts of the University of the Philippines Los Baños (UPLB) to produce "Agra: A New Musical" (Cano, 2017). Filipino youth from different fields of study (agriculture, engineering, biology, environmental science, communication arts, theater, development communication) came together to produce the musical. Around 2,000 high school students watched the play. As a result of the mentoring program in 2018, the mentee has pursued graduate studies in theater arts, a distinct turn from her background of genetics, to further develop the skills that would allow her to better communicate through the arts her advocacy for youth in agriculture.

and education were removed. Several recommendations on how to better implement mentoring programs for youth in agriculture were provided (YPARD, 2017, p. 45–46). These include ensuring clarity in mentoring-pair goals; creating a conducive environment where mentees can freely ask for help; bridging mentees to funding and practical opportunities, for example, partnerships, internships, and scholarships; long-term monitoring and evaluation to assess the real impact of mentoring which is not observed in the short term. The assessment of the mentoring programs led to a subsequent pilot of a YPARD country chapter-led mentoring program in the Philippines (del Valle, 2018) (Box 4).

Some of the recommendations addressed were the need to (1) source mentors locally for the mentees that had a better chance of meeting them regularly, and (2) provide some travel and communications stipends to facilitate face-to-face mentoring sessions. Mentors were selected based on the needs and aspirations of the selected mentees. Mentoring pairs represented various fields in agriculture (agricultural extension, agribusiness, entomology, research in general) and, most notably, included a pair that focused on developing the agriculture-arts interface. The lessons learned from the different iterations of mentoring helped YPARD shape the YPARD Mentoring Toolkit (Kovacevic, 2018) along with its organizational partners – the International Forestry Students' Association (IFSA) and African Women in Agricultural Research and Development (AWARD). Funded by the Global Forum on Agricultural Research and Innovation (GFAR) and the European Union, the toolkit helps organizations develop mentoring programs from planning and designing them to implementing and sustaining them.

Young people engage in learning about food systems through their roles in inter-generational and other forms of knowledge transfer, as generators of knowledge themselves and as knowledge brokers and intermediaries within social networks and institutions. Food systems in which all young people can engage with meaning and dignity require an inclusive and participatory knowledge paradigm, one that respects and legitimates diverse forms of knowledge systems and recognizes young people as important actors in these systems. Young people's roles in food knowledge systems, including place-based and Indigenous knowledge networks, should be understood in the context of increasing access to both formal and grassroots horizontal and experiential education and skills and knowledge sharing networks, including through novel digital networks and platforms. Formal education systems should equip young people with the systems thinking, critical reflection, and theoretical and practical knowledge to engage with a range of livelihood options in food systems and more broadly as actors in driving the transformation of sustainable food systems.

Policy recommendations

The following policy recommendations provide avenues for both state and non-state actors and institutions to strengthen knowledge generation and transmission pathways so that youth can be better prepared to shape future food systems in a context of complexity and uncertainty.

- Revitalize inter- and intra-generational knowledge networks for biocultural heritage in sustainable food systems. This requires an understanding that knowledge is context-based and unique to specific societies and geographic areas. Knowledge is vital in assessing the needs, for example, upskilling/training young people and aspirations such as revitalizing intergenerational agricultural learning of young people when developing policies concerning youth in agriculture and food systems. We can achieve this by engaging youth in research, promoted by formal, accredited research and academic institutions, related to sustainable food systems and resource conservation. Equally important is strengthening opportunities for youth to participate in community-based research partnerships through developing methodologies that integrate diverse ways of knowing. Thus, the development and implementation of policies that include the myriad of knowledge systems, innovation, and practices of sustainable food systems emerging from Indigenous and local communities will enable young people from these societies to be active actors in developing more resilient and holistic food systems. Therefore, national and sub-national government agencies and public institutions should construct an enabling policy environment with supportive legal and financial measures, such as appropriate financing for the operation of horizontal and intergenerational learning networks and programs by grassroots movements and formal institutions such as schools, gardens, and study tours. Working in collaboration and in partnership with the state, NGOs and other civil society organizations such as farmers' and Indigenous people's organizations play an essential role in shaping these enabling policy measures, ensuring the access of relevant actors from different generations to these programs. In addition, the private sector can provide complementary services for the operation of food systems training programs and networks, for example, by designing digital platforms enhancing more comprehensive connectivity and inclusivity.
- Promote the recognition and application of agroecological knowledge and practices in food systems by young people in both rural and urban settings. Using agroecological methods in food production systems involves continuous experimentation and adaptation, in which young people can take a more active approach to develop alternative strategies for sustainable agriculture. This requires that governments value and prioritize sustainable agricultural methods and practices when designing public policies shaping the future of their food systems, including establishing or providing extension services promoting agroecological practices for the next generation of food producers. In addition, as described above, states must again ensure that already existing agroecology schools run by farmers' movements can flourish.
- Strengthen food literacy educational programs, experiential learning (e.g., immersion agricultural, land-based, an incubator farm, and practicum programs), and grassroots initiatives to democratize education for young people. Research and academic institutions should support educational curriculum (co-)development and reform in primary and secondary schools, including agroecology, food literacy, food systems, and health. Reform vocational training curricula to develop community education business partnerships developed in collaboration with local community members, focusing on the topics of interest to youth, such as agroecological production, nutrition and dietetics, food value chains, marketing, innovation, ICT, and food systems education.
- Implement curriculum reform to develop close community-education-business partnerships based on collaborative assessments of local community needs through mobilizing resources for communities and youth. Educational reform by the state also requires strengthening community-based research partnerships through the development of methodologies that are more culturally sensitive and tuned into the ways of how knowledge is acquired, shared and disseminated within different contexts. In turn, the active engagement of well-organized communities and their pro-active dialogue with the state educational institutions are essential, so they can meaningfully shape those curricula co-constructed based on local needs and knowledge.
- Promote the recognition of knowledge acquired through informal, local and Indigenous exchange processes in labor markets to facilitate job entry for youth and to facilitate uptake of traditional ecological and local community knowledge (TELCK) in food systems. This could occur through expanded considerations within accreditation and regulatory bodies and formal training programs.

Conclusions

Food systems in which all young people can engage with meaning and dignity require an inclusive and participatory knowledge paradigm, one that respects and legitimates diverse forms of knowledge systems and recognizes young people as important actors in these systems. This would require recognizing the value of developing knowledge networks where context- and location-specific knowledge and diverse epistemologies, including Western science and TELCK, provide youth opportunities to transform food systems. Young people engage in learning about food systems through diverse forms of knowledge transfer, as generators of knowledge themselves and as knowledge brokers and intermediaries within social networks and institutions. Young people's roles as carriers

of knowledge and learning in food systems, including place-based and Indigenous knowledge networks, and their role in democratically shaping these networks, should be understood in the context of increasing access to both formal and grassroots horizontal knowledge sharing networks, including through novel digital networks and platforms. Governments and civil society must promote the intergenerational and intragenerational exchange of information, knowledge and practices through experiential learning, and encourage youth to practice agroecology and other sustainable innovations by connecting knowledge that is locally specific such as traditional and intergenerational with horizontal and formal training and education programs, as well as advisory and extension services, to improve the resilience of agriculture, farming systems and food systems to environmental and social crises.

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EDITED BY
Michele Filippo Fontefrancesco,
University of Gastronomic Sciences, Italy

REVIEWED BY
Zlati Monica Laura,
Dunarea de Jos University, Romania
Raffaella Pergamo,
Council for Agricultural and Economics Research (CREA), Italy

*CORRESPONDENCE
Bojana Kalenjuk Pivarski
bojana.kalenjuk@dgt.uns.ac.rs

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Traditional food products on the local market - consumption conditional on the characteristics of management and restaurant facilities in tourism of Vojvodina (Serbia)

Bojana Kalenjuk Pivarski[1,2]*, Dragana Tekić[3], Stefan Šmugović[1], Aleksandra Novaković[4], Velibor Ivanović[1], Marica Petrović[3], Maja Banjac[1], Bojan Đerčan[1], Dragan Tešanović[1], Miloš Ćirić[1,5], Ivana Čabarkapa[6], Ivana Ćirić[1,7], Veljko Šarac[3] and Nikola Maravić[6]

[1]Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia, [2]Faculty of Economics, University of East Sarajevo, Pale, Bosnia and Herzegovina, [3]Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia, [4]Faculty of Education, University of East Sarajevo, Bijeljina, Bosnia and Herzegovina, [5]College of Hotel Management, Academy of Applied Studies Belgrade, Belgrade, Serbia, [6]Institute of Food Technology, University of Novi Sad, Novi Sad, Serbia, [7]Vocational School of Hotel and Tourism Management, Belgrade, Serbia

The research dealt with traditional food products (TFP) observed on the local hospitality-touristic market, from the point of view of 300 restaurant workers employed in managerial positions, as important subjects in preservation of tradition in hospitality and touristic industry of Vojvodina (Republic of Serbia). The research examined the management's views on TFP, as well as whether there are differences based on the features of the respondents as well as the restaurant facility. In order to obtain data that would provide additional guidelines for acting on the hospitality and tourism market, the procurement and consumption of TFP was also examined. In order to determine set differences the non-parametric Kruskal-Wallis test was applied. In order to establish statistically significant differences between the observed groups, the Dunn's *post hoc* test was applied. In the second part of the research, a binary logistic regression model was applied in order to determine which of the observed variables has a significant impact on the respondents' decision to acquire TFP from their field. The research showed that the level of education and the field of management education significantly influence the attitudes about the offer of TFP in the hospitality and tourism market, as well as the type of restaurant offer and the development of the field of business.

KEYWORDS

traditional food, consumption, opinion, gastronomy, restaurant, local market, tourism, hospitality

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1. Introduction

Traditional food products (TFPs) are gradually becoming the main topic of research in terms of sustainability of gastronomic hertitage as a part of cultural identity and market placement in hospitality and tourism (Guerrero et al., 2009; Vanhonacker et al., 2010; Cantarero et al., 2013; Almerico, 2014; Barska and Wojciechowska-Solis, 2018; Zocchi and Fontefrancesco, 2020; Kalenjuk Pivarski et al., 2022). These products are a reflection of the culture and life of the people of a particular area that has managed to be preserved throughout history (Trichopoulou et al., 2007). They are special due to their production methods which are associated with certain ingredients, combined with specific production processes that are being preserved through generations (Kocman, 2018; Petrescu-Mag et al., 2020). The principal advantage of these products is the contrast they pose to food products from mass production (Moscatelli et al., 2017). As such, these products represent an important cultural phenomenon that is being given special attention by leading national and international bodies (Cantarero et al., 2013; Almerico, 2014; Brulotte and Di Giovine, 2016).

Globalization has significantly encouraged traditional tastes and production, highlighting their value (Pieniak et al., 2009) and importance of preservation (Rocillo-Aquino et al., 2021). An increase in consumers' demand, especially touristic consumption, influenced the revival of these products (Wang et al., 2015; Roselli et al., 2018; Török et al., 2022) which was recognized by different commercial facilities (Vanhonacker et al., 2010). Traditionality of these products is associated with production methods and labels that mark their special quality (Barska and Wojciechowska-Solis, 2018; Caputo et al., 2018), synonymous to traditional cuisine and traditionally prepared meals (Petrescu-Mag et al., 2020) on hospitality and touristic market.

The subject of this study TFP on the local catering-tourism market perceived in terms of restaurant workers on the territory of AP Vojvodina (northern region of the Republic of Serbia), as important subjects in deciding the implementation of exactly such goods in restaurant facilities' offer.

This research aims is to examine the attitudes of the restaurant facilities management staff towards the offer of TFPs that are available on the hospitality touristic market, as well as if socio-demographic characteristics of the respondents and characteristics of restaurant facilities have different attitudes towards TFPs. In order to get more valuable data which would provide additional guidelines for activities on the hospitality and touristic market the procurement of TFPs was examined, focusing on local market products (i.e., administrative areas of the facility) and regional disparities.

The objectives of the research are the following (Scheme 1).

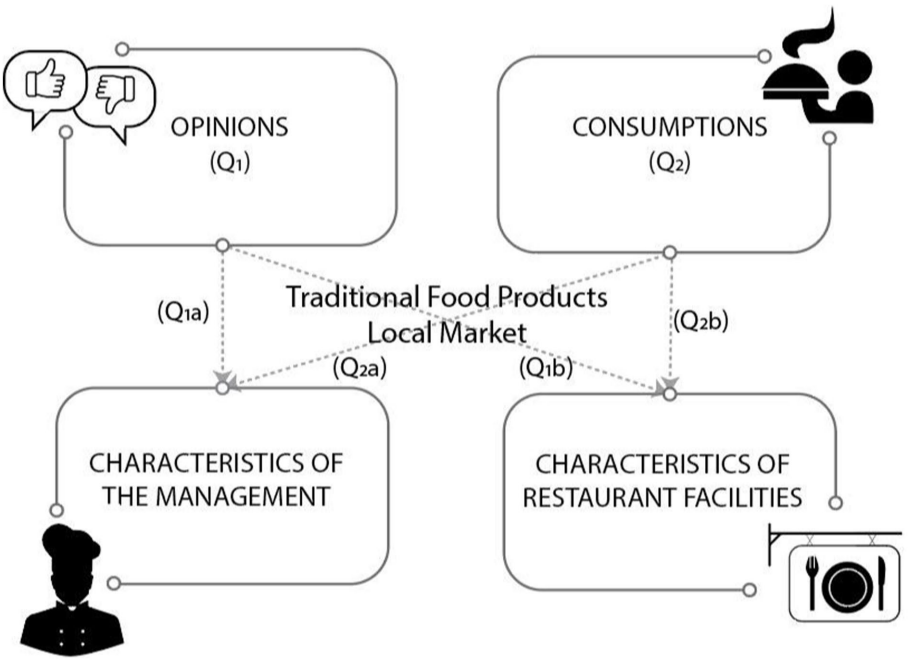
- to determine the existence of differences in the opinion of restaurant management about TFP in the hospitality and tourism market depending on the socio-demographic characteristics and characteristics of the restaurant facilities and
- to determine the consumption of local TFP depending on the socio-demographic characteristics and characteristics of restaurant facilities in the region.

The key questions that our research will seek to answer are:

Q_1: What is the opinion of the restaurant's management staff about TFP in the hospitality and tourism market?

Q_{1a}: Are there any differences in opinions depending on the socio-demographic characteristics of the management staff?

Q_{1b}: Are there any differences in opinions depending on the characteristics of a restaurant facility?



SCHEME 1
The research objectives (Authors: Đerčan and Kalenjuk Pivarski, 2023).

Q_2: Do restaurant establishments obtain TFPs from the local market?

Q_{2a}: Are there any differences in consumption depending on the socio-demographic characteristics of the management's staff?

Q_{2b}: Are there any differences in consumption depending on the type of a restaurant facility?

2. Literature review

2.1. Traditional food in researches

TFPs are a subject of many researches in recent decades (Dogan et al., 2017; Barska and Wojciechowska-Solis, 2018; Kocman, 2018; Silvestri et al., 2020; García-Barrón et al., 2021). However, the research approaches are different (quality, perception, consumption, distribution, impacts, innovations and other) (Guerrero et al., 2010; Mohamed Shaffril et al., 2015; Nguyen et al., 2018; Kovács et al., 2022). The focus is mainly on producers and consumers, including tourists, and the least focus is on the caterers (Grubor et al., 2022; Kalenjuk Pivarski et al., 2023b) as the main consumers and officers on the touristic market. Researches mainly deal with the general attitudes of caterers, but insufficient number of studies included the socio-demographic characteristics of caterers as important in the analysis of the current situation (Kocman, 2018).

The researchers showed that TFPs significantly influences the satisfaction of consumers, through loyalty and this is one of the reasons they return to certain destination (Mohamed Shaffril et al., 2015). Consumers' decision-making about TFP consumption is influenced by familiarity of the product, source, detected worth, consumer's life duration and purchasing power (Cacciolatti et al., 2015). Equally important characteristics are added to these decisions, namely retail price, quality certification, retail channel, specific taste, quality, appearance, nutritional value, healthiness and safety (Almli et al., 2011; Balogh et al., 2016).

The researches have shown that the characteristics differentiating TFP from customary food are associated mainly to tradition, as well as to the receptive and health features they have. There being also: natural taste perception, quality of a product, sales in the source region and labeling, but also determinants of choice of these products, such as: traditional recipe, sensory quality of food - taste and uniqueness of these types of products (Bryła, 2015).

2.2. Traditional food - influencing selection and consumption

The development of TFPs is important for the local community and local producers and companies, because they encourage the diversification of agriculture and the sustainable (Barska and Wojciechowska-Solis, 2018). TFPs on the hospitality and tourism market influence the preservation and nurturing of traditional manufacture, society, personality and inheritance, which are the focus of tourists' interest as significant factors in the improvement of local agriculture and craftsmanship, which indirectly influence the development and conservation of gastronomic culture and tradition (Bessiere and Tibere, 2013; Ivanović et al., 2022). TFPs in tourism represent the part of local activities, which affect the sustainability of gastronomy and economy (Niedbała et al., 2020).

Researches have proven that the use of TFP affects the increase in demand for traditional restaurants, which has a positive economic effect (Lopes et al., 2022) with a significant impact on the economic development of rural areas (Śmiechowska, 2014), agriculture and craft production, with significant reduction of regional economic gaps and significant growth of the local economy (Guerrero et al., 2010; Todericiu, 2012; Duda-Seifert et al., 2016).

As already mentioned, there is a shortage of studies on the effects of sociodemographic characteristics on the attitudes of caterers towards local food (Ćirić et al., 2021; Liu et al., 2021). Studies of this type are significant because based on them, a base of local community behavior is created, on the basis of which it is easier to establish a development plan (Liu et al., 2021).

The researches have shown that approaches to TFP preferences between the sexes are of equal interest for men and women observed on the European market (Vanhonacker et al., 2010; Serrano-Cruz et al., 2018). However, there is no in-depth information on the subject.

2.3. Traditional food in Vojvodini

TFPs represent one of the key attractions in tourism industry (Mohamed Shaffril et al., 2015), whose potentials tend to be used in the area of AP Vojvodina as well (Northern region of Serbia). Vojvodina is a multicultural region with a large number of ethnic groups that have created a specific mix of gastronomic influences and authenticity. Large movements of the population in these areas throughout history have brought different mixes of tastes and products that have become indigenous and today form an integral part of traditional production and gastronomy. Traditional gastronomy is characterized by a lot of meat, different meat products such as salted and smoked meat, a lot of cheese and milk products, various types of dough and different fruit and vegetable products (Kalenjuk Pivarski et al., 2023a).

In the context of TFP in Vojvodina, certified products with the TASQ label, i.e., Traditional and Standard Quality (htTFPs://tasq.rs/sr/; TASQ, 2023), attract the most attention. 156 products from 40 small producers have this label. Their label guarantees that these are products of precisely defined sensory or nutritional quality, combined with additional quality indicators. They have a label that confirms these are products of organic origin, with geographical label, whether they are made of domestic or non-domestic sorts, kinds or species (depending on the type of products), whether are traditionally produced and if they possess HACCP production certificate (Ikonić et al., 2021; Ivanović et al., 2022; Stošić et al., 2022). One of the most important items of production process, that highlights their authenticity and traditionality, is that they are produced exclusively in family households (Ikonić et al., 2021; Kalenjuk Pivarski et al., 2022, 2023b). These products influence the creation of general perception of the touristic destination that is aimed at further development (Florek and Gazda, 2021).

3. Methodology of the study

3.1. Research site

The research was conducted on the territory of Autonomne Provance Vojvodina, which is the northern region of the Republic of Serbia, located in the southeastern part of Europe. The research covers

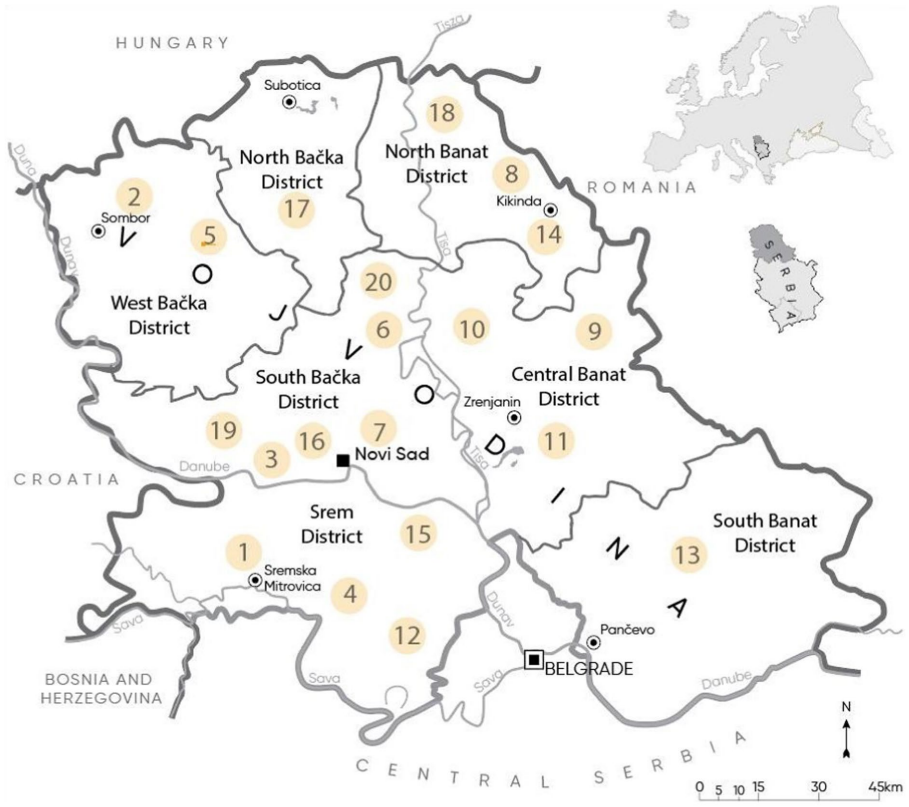


FIGURE 1
Traditional products in Vojvodina: 1. Spicy Slovak sausage from Srem - Sremski kulen; 2. Spicy Slovak sausage from Svetozar Miletić - Lemesh kulen; 3. Spicy Slovak sausage from Bački Petrovac - Petrovac kulen; 4. Homemade sausage from Srem; 5. Homemade bacon; 6. Smoked meat; 7. Meat product made from pork ears, tongues, legs, skins, and pieces of meat from the pork's head - Shvargla; 8. Rolled cheese; 9. Homemade cheese; 10. Sliced cheese in brine; 11. Swabian (cottage) cheese; 12. Linden honey from Fruška Gora Mountain; 13. Flower honey from Deliblatska sandstone; 14. Cold pressed pumpkin oil; 15. Apricot and plum jam; 16. Fresh and pickled cabbage from Futog; 17. Product made from roasted peppers - Homemade ajvar; 18. Ground paprika - sweet and hot; 19. Homemade raspberry, apple and cherry juices; 20. Elderberry, mint and lemon balm homemade syrup (Author: Đerčan, 2023).

seven administrative areas: Southern Backa, Western Bačka, Southern Banat, Northern Banat, Central Banat, Northern Bačka, and Srem, which are shown in Figure 1. The areas are differently economically developed and territorially populated (Kalenjuk, 2017).

3.2. Creating a survey questionnaire

The presented sample of respondents, in this study, was part of a large research of TFPs. The survey questionnaire consisted of seven parts, which were specially processed and created according to the model of similar research (Nguyen et al., 2018; Grubor et al., 2022; Kalenjuk Pivarski et al., 2023a,b), with certain modifications for the purpose of quality. This study presents the results of set issues, i.e., only three parts of the created survey questionnaire:

- The first part are data related to issues about respondents' social and demographic features and the features of the facilities where the respondents are employed.
- The following part of the survey is associated with examination of general opinions about TFPs on the market (8 claims whose opinions are measured in Likert scale of 1 to 5).
- The third part is about obtaining data about TFPs procurement from area they work in, and which are characteristic for that part of the market. The survey questionnaire included a list of 20 TFP products that have the TASQ label.[1] Their selection was made by special expertise with a focus on products that, as such, were among the first to appear on the market with this label. The regional distribution of covered TFP is different and is not conditioned by regional development, nor proportional distribution. Many products can be found throughout Vojvodina, but they do not have a quality guarantee. For these products, in the case of procurement, respondents declared themselves in terms of frequency of consumption on a Likert scale from 1 to 5. For the purposes of this research, answers about the use of the mentioned TFPs were generated with yes/no. The production location of the included TFPs is shown in Figure 1.

1 https://task.rs/sr/

3.3. Data collecting

The research was carried out from February to June 2022 and included collecting of 300 survey questionnaires from different restaurant facilities, with compliance with all ethical principles for this type of quantitative research. The selection of restaurant establishments was carried out by free sampling, focusing on forming a sample that is relative to the number of people employed in the catering industry in administrative areas of Vojvodina that are in agreement with the records of the Republic Institute of Statistics - Registered Employment (2022).[2] The proportional number of respondents by administrative area is shown in sample description. The focus was on questioning the management staff as the key factors in TFPs procurement in the hospitality and tourism market.

3.4. Statistical data processing

The data obtained are processed using the R version 4.1.2 software. Descriptive statistical analysis was applied first. In order to determine if there are variations between the socio-demographic features of the respondents and the features of the facilities where the respondents are employed in terms of general attitudes about TFP on the market, a non-parametric Kruskal-Wallis test was applied. Kruskal and Wallis (1952) is a non-parametric statistical test that assesses differences among three or more independently sampled groups at a single, non-normally distributed continuous variable. The Kruskal-Wallis test is an alternative to ANOVA, with the exception that, unlike analysis of variance, it does not assume the normality of the distribution of the observed data. The initial hypothesis of the Kruskal-Wallis test implies that the medians of the observed groups are equal, while the alternative hypothesis assumes that there is a statistically significant difference at least between the two medians of the observed groups (Ostertagová et al., 2014). In the case of establishing statistically significant varieties between the determined groups, the Dunn post-hoc test was used for determining between which groups there is a statistically significant difference.

In the second part of the research, a binary logistic regression model was applied in order to determine which of the observed variables have a significant impact on the respondents' decision to procure TFP from their area. Binary logistic regression is a type of regression analysis where the dependent variable is dichotomous, and the independent variables are continuous, categorical, or both (Midi et al., 2010). In the case when the dependent variable Y is dichotomous then $0 \leq E(Y|x) \leq 1$ applies, the dependent variable takes the value 1 or 0 depending on the outcome of the experiment. In logistic regression, the probability π is modeled as:

$$\pi = P(Y = 1 | X_1 = x_{1\ldots}, X_k = x_k).$$

If π represents the probability that something will not happen, then the odds ratio is $\pi/(1-\pi)$. That is:

$$\pi/(1-\pi) = e\text{^}(\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_k x_k).$$

If both sides of the above equation are logarithmized, the following expression is obtained:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_k x_k.$$

The obtained function is called logit and it is linear with parameters ßi,i = 1…k. π belongs to the interval [0,1], while the value of the logit ranges from $(-\infty,+\infty)$, so it can be said that the logit function is the best choice for displaying this function (Samprit and Ali, 2006).

3.5. Sample description

The analysis of the results of the survey began with a descriptive statistical analysis of the observed socio-demographic characteristics of restaurant workers employed in managerial positions, the following parameters were included: gender, age, then the education degree, work experience in hospitality, as well as the characteristics of the facilities where the respondents were employed (type of hospitality facility, type of offer, ownership and area within the region) (Table 1).

The largest percentage of the respondents is employed as deputy chefs (35%), followed by owners of facilities who work in managerial positions (29%), chefs (21%), while the smallest number belongs to those who work as food and drinks managers (15%).

Based on the observed characteristics of the facilities where the respondents are employed, it can be seen that as many as 50% of the respondents work in a la cart restaurants, while the smallest percentage of respondents (2.7%) are employed in mass restaurant restaurants, namely workers, hospital, school and other canteens.

Observing the structure of the food offer, it is important to note that more than half of the responder are employees of restaurants with a joint food offering - home-made, local, international (51%), followed by restaurants with an international offer (21.7%), home-made food restaurants(17.7%) and restaurants with national food offerings (9.7%). Respondents were also asked about the type of ownership of the restaurant in which they are employed, and the majority of respondents (90.3%) work in restaurants that are private ownership, while only 9.7% of respondents work in restaurants that are franchised or corporately owned. The gender structure in facilities ownership is interesting, considering that there are 70% male owned facilities. Moreover, male dominance in terms of power and decision making is also reflected in men being chefs (65%), while women are mainly employed as deputy chefs (54%).

Observing the areas of AP Vojvodina in which the respondents work, the largest percentage of respondents work in Southern Bačka region (42.3%), which is also the most developed area of AP Vojvodina with the capital of this area, but as already stated in the methodology of the work, the number of respondents is proportionate to the number of employees in processed regions of Vojvodina.

2 https://www.stat.gov.rs/oblasti/trziste-rada/registrovana-zaposlenost/

TABLE 1 The characteristics of the respondents and facilities.

Variables	Categories	*n*	Percentage
Socio-demographic characteristics of the respondents			
Gender	Male	180	60.0
	Female	120	40.0
Age	Up to 30 years old	96	32.0
	31–40 years old	94	31.3
	41 and higher	110	36.7
Level of education	Tertiary associate degree	210	70.0
	Bachelor university degree	47	15.7
	Academic study program	41	13.7
	Master/PhD	2	0.7
Area of education	Hospitality, industry, tourism	152	50.7
	Economy, low, management	65	21.7
	Food technology, agriculture, chemistry	25	8.3
	Other areas	58	19.3
Work experience	0–5 years	81	27.0
	6–10 years	78	26.0
	11–15 years	53	17.7
	16 and more	88	29.3
Characteristics of restaurant facilities			
Type of a facility	Mass catering restaurant	8	2.7
	A la cart restaurant	150	50.0
	Fast food restaurant	74	24.7
	Other types of restaurants	68	22.7
Type of offer	International food offer	65	21.7
	National food offer	29	9.7
	Domestic food offer	53	17.7
	Combined food offer	153	51.0
Type of ownership	Franchise/corporate ownership	29	9.7
	Individual ownership	271	90.3
Area where a catering facility is located in Vojvodina	Area of Southern Bačka	127	42.3
	Area of Western Bačka	25	8.3
	Area of Southern Banat	38	12.7
	Area of Northern Banat	15	5.0
	Area of Central Banat	17	5.7
	Area of Northern Bačka	36	12.0
	Area of Srem	42	14.0

Source: Author's interpretation.

4. Study results

4.1. Analysis general opinions on TFP on the market

Considering the results of the general opinions about TFPs on the market (Table 2), it can be seen that the respondents mostly agreed with the statement that the TFPs offer affects the gastronomic offer in a restaurant facility (mean = 4.07), as well as with the statement that greater diversity is needed in the offer of TFPs (mean = 4.05). Respondents showed the minimal agreement with statements related to contentment with the ease of purchasing TFP (mean = 3.45) and the statement that the price of TFP is justified by their overall quality (mean = 3.46). The highest level of variability was observed in the

TABLE 2 Descriptive statistical analysis of general opinion on TFPs on the market.

Statement		Mean	Standard deviation
S1	I am satisfied with the TFP offer on local market	3.91	1.069
S2	I am satisfied with overall quality of TFPs	3.86	1.023
S3	I think greater diversity of TFP offer is needed	4.05	1.040
S4	I think that the price of TFP is justified by their overall quality	3.46	1.104
S5	The offer of TFPs influences the gastronomic offer of a restaurant facility	4.07	0.96
S6	Guests ask for meals prepared from TFPs	3.96	1.077
S7	Certain legal regulations complicate the procurement of TFPs	3.70	1.175
S8	I am satisfied with the ease of procurement of TFPs	3.45	1.105

Source: Author's calculation.

TABLE 3 The Kruskal-Wallis test of differences in levels of education of the respondents and general opinions about TFPs on the market.

Statement	Mean				*p*-value
	Secondary	Tertiary	High	Master's/PhD degree	
S1	4.02	3.72	3.54	4.00	0.031
S3	3.94	4.00	4.46	4.00	0.039
S7	3.75	3.81	3.24	5.00	0.006

Source: Author's calculation.

claim related to legal norms that make it difficult to procure TFP (SD = 1.175), i.e., it can be seen that the respondents had different opinions about this claim.

4.2. Analysis of the respondents' level of education influence on general opinions about TFP on the market

Using the Kruskal–Wallis test, an analysis was performed with the task of establishing whether there are differences between the respondents' education degree in terms of their general opinions about TFP in the market (Table 3).

Using the test, it was determined that a statistically significant variety in the education degree of the respondents and their contentment with the TFP offer on the domestic market (S1) exists, and the outcome of the post-hoc test showed a statistically significant variety between respondents with a secondary school diploma and respondents with higher education ($p = 0.034$). Based on the arithmetic mean of the responses, it can be deduced that the respondents who finished high school expressed the highest level of satisfaction with the TFP offer on the market, and the respondents who are highly educated showed the lowest level of satisfaction.

A statistically important difference between respondents of different levels of education was also observed in the opinions about the need for greater diversity in the TFP offer (S3). Even in the case of this claim, the post-hoc test established that statistically important differences between respondents with secondary education and highly educated respondents ($p = 0.043$) exist. Respondents with higher education believed that it is more necessary to improve the diversity of the TFP offer, compared to respondents of other levels of education.

Based on the outcomes, a statistically important difference can be seen in the level of education of the respondents and their opinion that certain legal norms make it difficult to acquire TFP (S7). The outcomes of the post-hoc test presented a statistically important variety between respondents with master's or doctorate degree ($p = 0.021$), as well as between those with higher education and respondents with master's and doctorate degree ($p = 0.018$) in terms of their opinions about legal norms complicating the procurement of TFP.

4.3. Analysis of differences in respondents' fields of education on general opinions about TFP on the market

Using the Kruskal-Wallis test it was conducted an analysis on differences between field of education of the respondent in terms of their general opinions on TFPs on the market (Table 4). The outcomes of the test affirmed that a statistically important difference in the field of education of the respondents and their attitude that the price of TFP is justified with their overall quality (S4) exists. Based on the arithmetic mean of the responses, it can be observed that respondents whose field of education is hospitality or tourism showed more agreement with the statement that TFP prices are justified by their overall quality, while respondents whose field of education is food technology, agriculture and chemistry and respondents from other fields of education showed the least agreement with this statement. The post- hoc test affirmed that there are statistically important differences between these groups of respondents ($p = 0.040$; $p = 0.015$).

A statistically important variety between respondents of various fields of education was also observed in the statement related to

satisfaction with the ease of acquiring TFP (S8). The outcomes of post-hoc test confirmed that there is a statistically important difference only between respondents whose field of education is hospitality or tourism and those whose field of education is food technology, agriculture or chemistry ($p = 0.045$), whereby respondents who are from the field of hospitality or tourism show a higher degree of satisfaction.

4.4. Analysis of differences between the type of restaurant offer of the restaurant where the respondent is employed and general opinions about TFP on the market

In the following, using the Kruskal–Wallis test, an analysis of the difference between the type of restaurant offer of the restaurant where the respondent is employed was performed in terms of their general opinions about TFPs on the market (Table 5). Based on the results of the Kruskal-Wallis test it can be seen there is a statistically significant difference between the respondents who work in a restaurants of different gastronimic offer and their opinions about the claim that guests ask for meals made of TFPs (S6). From the presented results, it can be seen that respondents employed in restaurants offering domestic food and national food show the highest level of agreement with S6, while respondents who are employed in restaurants with domestic food offer show the highest level of agreement with the statement related to legal norms (S7). The outcomes of the post-hoc test presented that there is a statistically important difference between respondents who work in international food restaurants and those who work in national food restaurants, national food restaurants and combined food offer ($p = 0.000$; $p = 0.002$; $p = 0.037$), as well as between the respondents employed in restaurants with domestic food offer and combined food offer ($p = 0.024$).

A statistically important difference was observed between respondents employed in establishments with a mixed gastronomic offer and the claim that certain legal norms make it difficult to obtain TFP (S7). Based on the average values of the respondents' answers, it can be seen that respondents working in restaurants offering domestic food agree the most with the previously mentioned statement, and respondents working in restaurants offering international food the least. A post-hoc test revealed a statistically significant difference between these two groups of respondents ($p = 0.015$). The S6 claim referred to guests' demand for meals made of TFPs and it was noticed that the highest demand for such dishes is precisely in restaurants with local food offer.

4.5. Analysis of differences in the restaurant region the respondent is employed in on general opinions about TFP on the market

In the following, also by applying the Kruskal–Wallis test, an analysis of the existence of differences between the geographical areas of the restaurant business where the respondent is employed in terms of their general attitudes about TFP on the market was performed (Table 6). The test found that a statistically important difference between the field of respondents 'work and their opinions on the claim that certain legal norms make it difficult to procure TFP (S7) exists. A post-hoc analysis

TABLE 4 The Kruskal-Wallis test of differences between the field of education of the respondents and their general opinions on TFPs on the market.

Statement	Mean				*p*-value
	Hospitality, Tourism	Economy, law, management	Food technology, agriculture, chemistry	Other	
S4	3.66	3.40	3.04	3.05	0.002
S8	3.59	3.40	3.12	3.23	0.039

Source: Author's calculation.

TABLE 5 The Kruskal-Wallis test of differences between the type of gastronomic offer and general opinions on TFPs on the market.

Statement	Mean				*p*-value
	International food offer	National food offer	Domestic food offer	Combined food offer	
S6	3.46	4.34	4.40	3.95	0.000
S7	3.42	3.90	4.06	3.66	0.020

Source: Author's calculation.

TABLE 6 The Kruskal-Wallis test of differences between the restaurant region and general opinions about TFPs on the market.

Statement	Mean							*p*-value
	Southern Bačka	Western Bačka	Southern Banat	Northern Banat	Central Banat	Northern Bačka	Srem	
S7	3.36	3.13	4.37	3.53	4.53	4.25	3.71	0.000
S8	3.34	3.54	3.39	3.27	3.47	4.26	3.19	0.000

Source: Author's calculations.

revealed the existence of a statistically important difference between the respondents from the Western Bačka region and the respondents from the South Banat region, the Central Banat region, and the North Banat region ($p = 0.000$; $p = 0.000$; $p = 0.002$), as well as between the respondents from the Southern Bačka region and the respondents from the Southern Banat region, Central Banat and North Bačka regions ($p = 0.000$; $p = 0.002$; $p = 0.003$). The lowest level of satisfaction with the S7 statement was shown by employees in West Bačka and South Bačka regions, and the highest level of satisfaction was shown by employees in the Central Banat region. A statistically important difference between the working areas of the respondents was also observed in the statement related to the degree of satisfaction with the ease of procurement of TFP (S8). Respondents employed in North Bačka agree most with the S8 statement, and the respondents employed in Srem least agree. The outcomes of the post-hoc test presented a statistically important difference in respondents' level of contentment with the ease of procurement of TFPs between respondents employed in Northern Bačka and the respondents employed in Srem, Northern Banat, Southern Bačka and Southern Banat ($p = 0.040$; $p = 0.000$; $p = 0.017$).

4.6. Logistic regression to determine the impact of different variables on the decision to purchase TFP from one's region

In order to determine the influence of the observed variables on this decision of the respondent, a logistic regression model was applied, where the dependent variable was dichotomous (0- does not acquire TFP characteristic of the area in which it operates, 1- acquires TFP characteristic of the area in which it operates). Analyzing respondents' answers, it was observed that 118 respondents do not purchase TFP from their area, and 182 respondents purchase TFP from their area (distribution of researched products by area, Figure 1). The results of the Omnibus test of coefficients showed that the model was well adapted to the data [$\chi^2(17) = 102.162$, $p = 0.000$]. This result was also confirmed by the results of the Hosmer Lemeshow test [$\chi^2(8) = 9.446$, $p = 0.306$] (Table 7).

Considering the results of the logistic regression that is presented in Table 7, it can be deduced that the socio-demographic features of the respondents are important variables ($p < 0.05$) influencing the decision whether to acquire TFP from their field are age and working experience in the hospitality industry. Based on the calculated probabilities from the table below, it can be deduced that the chance that respondents up to 30 years of age acquire TFP from their area is 23.95%, and for respondents from 31 to 41 years old it is 22.72%. Observing the working experience of the respondents, the lowest probability of acquiring TFP in their field occurs among respondents with an experience of 11–15 years (60.72%).

The type of restaurant and the area where the restaurant is located stood out as significant among restaurant's characteristics ($p < 0.05$). Looking at the type of restaurant facility, the lowest probability (39.06%) for the procurement of TFP in the area in which they work occurs at fast food restaurants. And statistically, the highest probability of purchasing TFP is at a la carte restaurants (86.20%). Observing the results of the probability for the area in which the restaurants work (Figure 2), it can be seen that there is the highest probability of acquiring TFP from their area for restaurants from North Bačka with 81.44% and South Bačka region with 75%. The research of TFP produced in households in the North Bačka region includes domestic ajvar. Ajvar is one of the most represented and representative traditional products of Serbia (Popović et al., 2014). Traditional products from the South Bačka district were included in the research and were among the first to receive the TASQ label. Some can be found in other areas throughout the region. The research included: Kulen sausage from Bački Petrovac, smoked meat, shvargla, fresh and pickled cabbage, homemade raspberry, apple, and cherry juices, and elderberry, mint, and lemon balm homemade syrup. While the lowest probability is (1.77%) that respondents from Western Bačka region will procure TFP.

4.7. Analysis of regional disparities

The previous results within the region conditioned the implementation of further analysis, which attempted to see the possible connection of the obtained data on the consumption of TFPs by region with the structure of the examined management and the characteristics of restaurant facilities. Using descriptive analysis does not realize significant differences in management structure as the primary influence on the results. The characteristics of the researched restaurant facilities also showed no differences, which could affect the obtained results on consumption by region.

From the obtained data shown in Table 8, it is impossible to determine the significant impact of the management structure and the characteristics of restaurant establishments on the consumption of TFPs from the local market.

5. Discussion

5.1. Opinions of the management of restaurant facilities about TFP on the catering-tourism market

The first study question was aimed at obtaining data (Q_1) about the opinion of the management of restaurant facilities about TFPs on the catering-tourism market. It resulted in two subsidiary research questions to which answers were obtained by applying appropriate analyses. The first subsidiary question (Q_{1a}) referred to analysis of differences in management staff's opinions depending on their socio-demographic characteristics. The research showed that education significantly affects the level of satisfaction of TFP supply on the market. Employees in management positions with a high school diploma have higher level of satisfaction compared to respondents with higher education. This may be related to the perception of the offer itself, where the highly educated could be characterized as much more demanding in terms of the offer composition of these products.

This part is followed by the results that show that precisely the highly educated respondents are of the opinion that there is a need for greater diversity in the TFP offer. Reason for this could be that there is a larger number of highly educated managers in South Bačka's restaurant facilities, which, due to its nature of business and the large fluctuation of different visitor profiles, require a much wider and more diverse offer, so this response is to a certain extent expected (Brunori et al., 2016).

The same group of respondents stands out in terms of their opinions on legal norms that affect the procurement of TFP. These

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TABLE 7 Logit model results.

Variables (%)	B	S.E.	Wald	df	Sig.	Exp(B)	Probability
Age			7.456	2	0.024		
Up to 30	−1.156	0.566	4.163	1	0.041	0.315	23,954
31–40 years old	−1.223	0.451	7.336	1	0.007	0.294	22,720
Level of education			1.505	3	0.681		
Secondary	−22.125	25440.536	0.000	1	0.999	0.000	0,000
Tertiary	−21.865	25440.536	0.000	1	0.999	0.000	0,000
High	−22.590	25440.536	0.000	1	0.999	0.000	0,000
Field of education			2.506	3	0.474		
Hospitality, tourism	−0.472	0.495	0.909	1	0.340	0.624	38,424
Economy, law, management	−0.254	0.551	0.213	1	0.644	0.775	43,019
Food technology, agriculture, chemistry	0.440	0.705	0.390	1	0.532	1.553	60,830
Working experience in hospitality industry			5.151	3	0.002		
0–5 years	1.093	0.588	3.457	1	0.063	2.983	74,893
6–10 years	1.071	0.494	4.703	1	0.030	2.920	74,489
11–15 years	0.436	0.501	0.758	1	0.384	1.546	60,723
Current employment			1.561	3	0.668		
Chef	−0.213	0.480	0.196	1	0.658	0.808	44,690
Deputy chef	−0.378	0.417	0.822	1	0.365	0.685	40,653
Food and drinks manager	0.179	0.558	0.103	1	0.749	1.196	54,463
Type of a restaurant facility			12.729	3	0.005		
Mass food restaurants	0.776	0.389	3.988	1	0.046	2.173	68,484
A la cart restaurants	1.832	1.108	2.734	1	0.098	6.247	86,201
Fast food restaurants	−0.444	0.430	1.066	1	0.302	0.641	39,062
Type of gastronomic offer			3.909	3	0.271		
International food offer	−0.660	0.388	2.891	1	0.089	0.517	34,080
National food offer	−0.630	0.540	1.362	1	0.243	0.532	34,726
Domestic food offer	0.016	0.467	0.001	1	0.973	1.016	50,397
Type of ownership	−0.784	0.511	2.357	1	0.125	0.457	31,366
Area			38.296	6	0.000		
Southern Bačka	1.099	0.468	5.521	1	0.019	3.000	75,000
Western Bačka	−3.994	1.141	12.251	1	0.000	0.018	1,768
Southern Banat	−0.445	0.515	0.747	1	0.388	0.641	39,062
Northern Banat	1.008	0.843	1.430	1	0.232	2.741	73,269
Central Banat	−1.811	0.773	5.493	1	0.019	0.163	14,015
Northern Bačka	1.479	0.595	6.168	1	0.013	4.388	81,444
Constant	22.858	25440.536	0.000	1	0.999	8454980067.114	

Source: Author's calculation.

respondents emphasize that the legal norms greatly complicate the procurement of TFPs. These results are unsurprising, considering that highly educated respondents have a better perception of regulations that TFPs have to pass before they get on the market. The government policies present a crucial role in placement of local products on the catering-touristic market. In Vojvodina, the situation is not like that at the moment, even though it is planned to improvement the hospitality industry as one of the goals of the tourism development strategy currently in force in the Republic of Serbia (Government of Republic of Serbia, 2016, 2023). In practice, the government's actions towards establishing decentralization of the region proved to be good, which could also be applied to the given example (Rinaldi et al., 2021).

Respondents whose field of education is catering or tourism are more in an agreement with the argument that TFP prices are justified by their overall quality, while respondents whose field of education is food technology, agriculture and chemistry and respondents of other fields of education agreed in a smaller percentage. Such results are a consequence of the fact that people

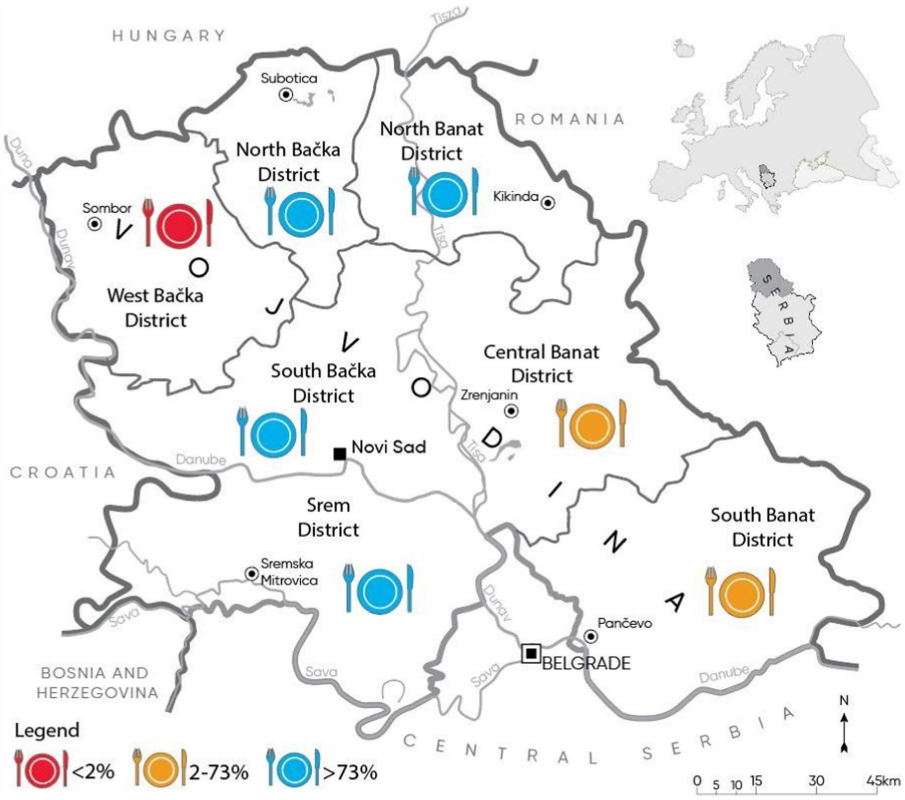

FIGURE 2
Acquisition and consumption of TFP from the local market (Author: Đerčan, 2023).

with an education degree in hospitality and tourism have had more contact with TFP, and are familiar with the quality of those products and that it has an acceptable correlation with their price (Vecchio and Annunziata, 2021). However, the respondents from education filed such as food technology, agriculture and chemistry perceive the quality of TFPs differently, starting from basic raw materials and production processes.

Respondents educated in the field of tourism are will pay more money for TFP because they see the importance of including them in their gastronomic offer from the perspective of business improvement. The offer of authentic, traditional gastronomic products is attractive to foreign tourists who want to try authentic national food and are ready to spend more money for it (Braghieri et al., 2014; Tran et al., 2022). Such claims are also confirmed by the research conducted in the countries of the Western Balkans, which includes, among other things, Serbia (Vukasovič, 2014). Respondents who are more familiar with the methods of preparing TFP and the fact that they are made respecting authentic recipes but preparation methods, in a way that is different from production in the food industry, are aware that such products, due to their quality, usually cost more than commercial products (Hidayat et al., 2023). Similar results in his research were pointed out by Kocman (2018), who researched the mutual difference in the opinions of employees towards TFP prices in catering facilities in certain European countries such as Italy and the Czech Republic and in all countries obtained approximately the same, high results. The same group of respondents showed a greater level of satisfaction with ease of procurement of TFPs, for which no real causal link could be found, compared to other managers educated in other fields. The market of TFPs is equally available to everyone, only the perception of procurement is different depending on the type and characteristics of the product.

The second subsidiary research question (Q_{1b}) referred to the differences in management's opinions on TFPs on the catering-tourism market. The management of domestic and national food restaurants significantly agrees that the guests demand meals made of TFPs. Looking at the demand of guests for meals prepared from TFP, it was observed that the highest demand for such meals is in restaurants with a domestic food offer whose basic offer is formed from local and TFP, and it is also expected that respondents employed in these restaurants consider legal norms as a limiting factor for the procurement of TFP to a significantly greater extent compared to respondents from restaurants with an international offer who have very little need for such products that can be very easily satisfied with the current offer on the market (Millán Vázquez de la Torre et al., 2016).

Significant varieties were detected between the administrative area in which the restaurant facility is located and their opinions that legal norms make it difficult to procure TFP. The lowest level of satisfaction was shown by the employees in Western Bačka and Southern Bačka, and the highest level of satisfaction was expressed by the ones in Central Banat. The difference between the areas of business in which restaurant facilities operate was also observed in the statement related to the degree of satisfaction with the ease of

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TABLE 8 Regional disparities of samplings.

		Southern Bačka	Western Bačka	Southern Banat	Northern Banat	Central Banat	Northern Bačka	Srem
Acquisition and consumption of TFP from the local market		>73%	<2%	2–73%	>73%	2–73%	>73%	>73%
Socio-demographic characteristics of the respondents (%)								
Gender	Male	65.6	45.8	42.1	66.7	82.4	61.1	54.8
	Female	34.4	54.2	57.9	33.3	17.6	38.9	45.2
Age	Up to 30 years old	38.3	25.0	34.2	26.7	17.6	30.6	23.8
	31–40 years old	34.4	20.8	15.8	60.0	35.3	30.6	31.0
	41 and higher	27.3	54.2	50.0	13.3	47.1	38.9	45.2
Level of education	Tertiary associate degree	65.6	70.8	84.2	40.0	70.6	83.3	69.0
	Bachelor university degree	13.3	12.5	10.5	26.7	23.5	8.3	28.6
	Academic study program	21.1	16.7	5.3	26.7	0.0	8.3	2.4
	Master/PhD	0.0	0.0	0.0	6.7	5.9	0.0	0.0
Area of education	Hospitality, industry, tourism	55.6	37.5	47.4	26.7	76.5	55.6	57.1
	Economy, low, management	16.7	29.2	23.7	60.0	23.5	33.3	26.2
	Food technology, agriculture, chemistry	7.9	25.0	10.5	0.0	0.0	2.8	11.9
	Other areas	19.8	8.3	18.4	13.3	0.0	8.3	4.8
Work experience	0–5 years	25.8	33.3	34.2	40.0	11.8	36.1	14.3
	6–10 years	31.3	12.5	31.6	20.0	11.8	22.2	23.8
	11–15 years	19.5	12.5	5.3	33.3	23.5	19.4	16.7
	16 and more	23.4	41.7	28.9	6.7	52.9	22.2	45.2
Characteristics of restaurant facilities (%)								
Type of a facility	Mass catering restaurant	2.3	4.2	2.6	6.7	0.0	2.8	2.4
	A la cart restaurant	50.0	41.7	60.5	73.3	58.8	44.4	38.2
	Fast food restaurant	28.9	29.2	13.2	6.7	29.4	27.8	21.4
	Other types of restaurants	18.8	25.0	23.7	13.3	11.8	25.0	38.0
Type of offer	International food offer	25.0	33.3	23.7	6.7	17.6	22.2	9.5
	National food offer	12.5	8.3	15.8	20.0	0.0	0.0	4.8
	Domestic food offer	23.4	8.3	13.2	26.7	23.5	5.6	14.3
	Combined food offer	39.1	50.0	47.4	46.7	58.8	72.2	71.4
Type of ownership	Franchise/corporate ownership	12.5	0.0	5.3	6.7	23.5	13.9	2.4
	Individual ownership	87.5	100	94.7	93.3	76.5	86.1	97.6

Source: Author's calculation.

procurement of TFP, respondents employed in the Northern Bačka region agreed the most, and respondents employed in the Srem region the least. Differences in responses between administrative areas are mainly related to the offer and number of dishes for which TFPs are used as well as the availability of those products on the local market, which has been confirmed by other research (Đurić and Prodanović, 2017).

5.2. Procurement TFPs from the business market of restaurant facilities

This part researched (Q_2) whether the restaurant facilities obtain TFPs from their own areas, regions, i.e., local market. The research showed that only 61% of restaurant facilities obtains TFPs from their own region-area. For this part of the research, two subsidiary research questions were created, to which answers were obtained by applying appropriate analyses. The first auxiliary question (Q_{2a}) had the task of investigating varieties in intake depending on the features of the respondents. The research showed that age and working experience in the hospitality industry are the most important factors in the decision to acquire TFP from one's area. Respondents up to 30 years of age and from 31 to 41 years of age were singled out here. Observing the working experience of the respondents, the lowest probability of obtaining TFP is among respondents with an experience of 11–15 years (with as much as 60.72%). Younger respondents, with less working experience, perceive TFP as more attractive for business, while older and more experienced respondents stick to well-tested,

lighter and more reliable products, with which they have fewer difficulties in procurement and distribution (Grunert and Aachmann, 2016).

The following supportive question (Q_{2b}) was aimed to investigate the differences in consumption relying on the sort of a restaurant facility. Here, the type of restaurant facility and the region where the restaurant is located were distinguished. Looking at the sort of restaurant facility, the lowest probability of acquiring TFP in the area in which they operate occurs at fast food restaurants, which is expected, given that this type of restaurant uses industrial products that are cheaper and more accessible (Souki et al., 2020). On the other hand, the highest probability for TFPs procurement occurs at a la cart restaurants (86.20%). These results can be explained with probable ease of procurement of these products, i.e., there is a good relation between restaurants and domestic producers who enable easier, faster and safer procurement of TFPs.

Observing the results of the probabilities for the regions-districts in which the restaurants operate, it was concluded that the highest probability for procurement of TFP from their region is with restaurant facilities from Northern Bačka and Southern Bačka, while the lowest probability is in Western Bačka. The study carried out by Stošić et al. (2022), shows that employees in the Northern Bačka highly value all the features of TFP and understand how important their characteristics are, and it is to some extent expected that in that region there will be a high probability of purchasing TFP from their locality. It is important to mention the significant demand of TFP South Bačka as the main administrative area of Vojvodina (Ivanović et al., 2022). This area is economically, economically, and touristically the most developed and has many protected products that can be found on the local market. The following products stand out here: Kulen sausage from Bački Petrovac, smoked meat, shvarga, fresh and pickled cabbage, homemade raspberry, apple, and cherry juices, and elderberry, mint, and lemon balm homemade syrup. These products are significant representatives of traditional cuisine, and as such, they are important in the hospitality and tourism market. The research did not show the influence of the management and the facilities' characteristics on the obtained data on the consumption of TFH from the local market.

6. Conclusion

Based on the set and conducted research on the subject of TFP in the local catering and touristic market realized in the territory of AP Vojvodina, significant conclusions were reached that are related to the influence of social and demographic features of administration staff and features of restaurant facilities as consumers of this type of food, as well as regional disparities. The results showed there is a fluctuation in education level in terms of satisfaction with the TFP offer on the market and that persons employed in managerial positions with only a high school diploma are much more satisfied with the offer compared to other respondents with higher education. Highly educated respondents have diverse opinions about the need for greater diversity in the TFP offer. While the respondents with a completed master's or doctorate degree stood out in terms of attitudes that legal norms make it difficult for them to purchase these products, which is also significantly reflected in the offer in restaurant establishments.

Management whose field of education is catering or tourism pointed out that the prices of TFP are justified by their overall quality, and they are more willing to pay a higher price for these products, but also more satisfied with the ease of purchasing TFP. Employees in local food and national food restaurants have confirmed that guests are looking for dishes prepared from TFP. Employees in restaurants with domestic food offer emphasize that legal norms make it difficult for them to procure and directly offer such products, precisely these restaurants have the highest demand for dishes prepared from these foods. Employees in restaurant facilities in the North Bačka region are most satisfied with the ease of procuring these products, which is conditioned by the development of the area.

The research confirmed that the decision to purchase TFP from their region-area is influenced the most by age and working experience in the hospitality industry, i.e., younger respondents recognize these products as adequate and purchase them. Respondents with longer working experience in the hospitality industry show the least interest in acquiring TFP. Fast food restaurants are the least likely to acquire TFP in the area in which they operate. And the highest probability of purchasing TFP from a la cart restaurants, which is reasonable considering the type of consumers they are intended for. By looking at the structure of the examined management and the characteristics of restaurant facilities in terms of consumption of TFH, no significant regional disparities were noted, except that it is seen that the economic development of the region conditions the number of important protected TFH and their consumption from the local market.

6.1. Practical implications and indication of future research

The obtained data can help in defining gastronomic resources that can be used as a very important touristic resource and contribute to the rural development of the area. By better placement of TFP, responsible planning of the gastronomic offer based on the authentic and traditional offer can be carried out, which can significantly improve the local economy.

The obtained data provides a better insight into the structure and thinking of the holder of the gastronomic offer in a certain locality. Everything mentioned presents a good basis for setting different strategies for the development of the gastronomic and overall touristic offer. The collected data can be used as a resource in the positioning of TFP on the market and the achievement of goals aimed at economic, social, cultural and ecological advantages while improving the principles of sustainability at the local level (Almli et al., 2011; Vanhonacker et al., 2013).

This research will improve the enlargement of opportunities of studies that already exist. Further research should be focused on concrete examples of TFP consumption, as well as on research that is focused on consumers, that is, useful services (residents and tourists), as well as producers on which the placement of TFP on the hospitality and tourism market depends. Associating the three main subjects, TFP producers, restaurants that include them in their offer and guests that consume them, represents the main goal of many projects, and finding a way to implement it could be the subject of some subsequent research, which is supported by various national and international bodies.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

BKP: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review and editing. DTek: Methodology, Resources, Software, Writing – original draft, Writing – review and editing. SŠ: Conceptualization, Data curation, Investigation, Writing – original draft. AN: Conceptualization, Investigation, Writing – original draft. VI: Investigation, Writing – original draft. MP: Formal Analysis, Investigation, Writing – original draft. MB: Investigation, Methodology, Writing – original draft. BĐ: Investigation, Visualization, Writing – original draft. DTeš: Investigation, Writing – original draft. MĆ: Investigation, Writing – original draft. IČa: Investigation, Writing – original draft. IĆir: Investigation, Validation, Writing – original draft. VŠ: Formal Analysis, Investigation, Writing – original draft. NM: Investigation, Writing – original draft.

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Conflict of interest

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

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EDITED BY
Michele Filippo Fontefrancesco,
University of Gastronomic Sciences, Italy

REVIEWED BY
Chris Duvall,
University of New Mexico, United States
Paul Frederick Robbins,
University of Wisconsin-Madison, United States
Dauro Mattia Zocchi,
University of Gastronomic Sciences, Italy

*CORRESPONDENCE
Jennifer Grenz
✉ Jennifer.grenz@ubc.ca

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Pop-up restoration in colonial contexts: applying an indigenous food systems lens to ecological restoration

Jennifer Grenz[1]* and Chelsey Geralda Armstrong[2]

[1]Indigenous Ecology Laboratory, Department of Forest Resources Management, University of British Columbia, Vancouver, BC, Canada, [2]Historical-Ecological Research Laboratory, Indigenous Studies, Simon Fraser University, Burnaby, BC, Canada

As environmental injustices and their disproportionate harms to Indigenous communities are increasingly acknowledged, restoration strategies are being deployed widely by environmental NGOs, resource extraction industries, and government agencies. The inclusion of Indigenous communities and their knowledges in restoration efforts are often considered progress in the pursuit of ecological reconciliation. However, in some cases we have observed a lack of meaningful progress as settler colonial prescriptions for land-healing can eschew efforts to decolonize ecological restoration — what we have labeled "pop-up restoration." We consider two restoration efforts underway in St'at'imc and Quw'utsun territories (Canada) and contrast them with what we are learning alongside the communities' own values and efforts to reclaim and revitalize food systems throughout forest, wetland, and grassland systems. Utilizing culturally appropriate pathways, we then evaluate how applying an Indigenous Food Systems lens to ecological restoration may provide a framework to remedy pop-up restoration, confronting settler colonial aspirations to transform Indigenous homelands while asserting justice in ecological restoration contexts.

KEYWORDS

indigenous food systems, ecological restoration, indigenous knowledge, traditional food systems, indigenous food sovereignty, traditional resource and environmental management, traditional land stewardship

1. Introduction

Over the last half century there has been an increase in efforts to right the multitude of environmental harms inflicted upon ecosystems by both human land-use practices and/or impacts from increasing disturbances caused by climate change. These efforts have largely been underpinned by the field of restoration ecology, a scientific field that focuses on the practice of restoring ecosystems that have been degraded, destroyed, or damaged by applying ecological principles and practices to facilitate the recovery of biodiversity, ecosystem functioning, and ecosystem services (Bell et al., 1997; Perring et al., 2015; Higgs et al., 2018). Restoration involves intervening in natural ecological cycles and can include reclamation efforts (after industrial land-use changes from mining, oil and gas development, etc.), invasive species mitigation (species eradication, planting native species in their place), and other habitat rehabilitation efforts (e.g., wildfire recovery). According to the International Principles and Standards of the Society of Ecological Restoration, when restoration is implemented effectively and sustainably

it, "contributes to protecting biodiversity; improving human health and wellbeing; increasing food and water security; delivering goods, services, and economic prosperity; and supporting climate change mitigation, resilience, and adaptation" (Gann et al., 2019).

In North America, restoration initiatives vary considerably in scale and scope but are often led by non-Indigenous stewardship societies, industry proponents and contractors, NGOs, and government agencies. Restoration initiatives in these contexts are largely based on Western scientific principles, values, and objectives, and are implemented across various scales and with varying degrees of success (Suding, 2011; Boström-Einarsson et al., 2020; Mansuy et al., 2020). While restoration falls within the practice of "applied sciences" it is also a special domain of ecology defined largely by context (Palmer et al., 2006) and in Canada is regulated through a combination of federal and provincial laws, policies, and regulations. In these contexts, restoration is driven by scientific inquiry and discovery, legal and regulatory requirements (i.e., mandated under provincial and federal legislation), but also a sense of morality based on very personal, cultural, philosophical, and social norms, all of which tend to posit that restoring damaged or degraded habitats is a noble endeavor. A notion that can make it difficult to objectively evaluate its efficacy and intended outcomes.

Restoration ecology, both in research and applied contexts, has been heavily scrutinized. This is unsurprising given the lofty goals of restoring ecosystems and the potential for practitioners to fall short of their long-term ecological objectives. Burbidge et al. (2011) outlined various challenges to ecological restoration, including inappropriate funding and political timelines and the apparent disconnection between research and practice (but see Wyborn et al., 2012). Another critique is the end goal of restoration itself, to "fake nature" or to construct and manage landscapes toward a state that mimics a natural system before the onset of a given disturbance, an objective that garners significant debate about "naturalness" and the problem of imposing subjective historical and/or shifting baselines (Higgs et al., 2014; Almassi, 2017).

While researchers have defined strands of restoration ecology that focus largely on things like the conservation of endangered species or communities, ecosystem services, and ecological functions (Ehrenfeld, 2000; Higgs et al., 2014; Krievens et al., 2018), the purview of restoration ecology has grown to include a more meaningful consideration of *people*. Debates in the field have long questioned the role of people in restoring and re-designing nature (Katz, 1991), and question which or whose ecological baselines to restore ecosystems to (Foster et al., 2003; Whipple et al., 2011). For example, Moreira et al. (2006) identified a landscape-oriented approach to restoration ecology that centered, among other things, traditional land management techniques and cultural heritage. Similarly, Weinstein (2007) highlighted how urban estuary restoration efforts were more successful when ecosystem functioning objectives were coupled with peoples' sustainable use of the estuary (i.e., for social and economic purposes).

Small and gradual changes in the field of restoration ecology like the increasing inclusion of people, provides some hope for more equitable and just relationships to land-healing decision-making. However, despite the intimate connections and understandings that Indigenous communities have to their ancestral lands, Indigenous knowledges, values, and traditional stewardship practices are rarely considered in land-use decision-making or restoration (Wilkinson et al., 2022). For example, we have observed only a slow and reluctant inclusion or superficial assimilation of Indigenous Peoples' knowledges into dominant restoration ideologies and practices in settler nations like Canada (Grenz, 2020). We argue that restoration objectives have, to date, largely included reformist and incremental attempts to include Indigenous Peoples in restoration efforts, abating the influence or application of Indigenous worldviews to efforts that could provide novel approaches to improving long-term ecological outcomes (Nelson, 2008).

Here, we introduce the term "pop-up restoration" to describe restoration initiatives in British Columbia (BC), Canada that not only fall short of their restoration goals, but in presiding over how land is used and "restored," continue to discriminate and impose inequities on unceded and stolen lands. Our goal is not to undercut all restoration efforts, but to highlight how some efforts are causing more harm than good. These efforts are commonly led by industry proponents, government, and NGOs, are consistently limited in scope (fragmented efforts), and are disconnected from the wider spatial, temporal, and cultural contexts of a given landscape or region. Three key characteristics underly our definition and critique of pop-up restoration. First, such restoration efforts literally pop-up then leave; they lack long-term and continued engagement, funding, or monitoring after initial restoration activities (e.g., removal of invasive species). Second, restoration efforts that are conducted under the logic of fortress conservation, that deny access to and use of areas by people whose traditional territories have been used for *millennia*, characterizes a pop-up restoration mentality (Hunn et al., 2003; Dowie, 2011).

Finally, the third characteristic we define in pop-up restoration efforts concerns the practical issue of restoration baselines—restoration for who, and restoring to when? Although not a new critique, in settler nations like Canada we continue to grapple with the issue of pre-colonial or pre-industrial baselines, which not only privilege one historical moment over another (Almassi, 2017), but often do so without sufficient or critical use of historical-ecological data (Lane, 2019; Clavero et al., 2022). For example, in places like British Columbia, narratives about Indigenous land-use and their effects on floral and faunal communities, populations, and entire landscapes continues to be downplayed or ignored (Anderson, 2005; Deur and Turner, 2005; Turner, 2020). Few ecologists are aware of or accept the fact that Indigenous Peoples actively managed forests, wetlands, grasslands, and intertidal ecosystems through repeated and intensive fertilizing, burning, coppicing, pruning, transplanting, weeding, or landform engineering (Trusler and Johnson, 2008; Deur et al., 2015; Armstrong et al., 2023). Overtime these practices resulted in highly diverse, heterogenous, and ever-changing landscapes that do not fit the restricted space–time limits proscribed in pop-up restoration efforts. Pop-up restoration appears self-serving and hypocritical: working in acknowledgment of an increasingly changing climate, but effectively pausing the essential ebbs and dynamisms of a living and breathing system. Pop-up restoration might overlook climate resiliency and food systems, countering deeply entangled and rooted Indigenous histories, labor, and relationality.

Indigenous worldviews, which posit a deep and interconnected relationship between people, lands, and the biota within them, are guided by a complex axiology of relational accountability, respect, and reciprocity (Wilson, 2008; Kimmerer, 2013; Smith, 2021). Unlike pop-up restoration, these fundamental tenants, and philosophies of

being conceptualize land as, for example, food and medicine—the things that nourish and sustain us and that are responsible for the health and well-being of all relations. While Indigenous food systems differ globally (regionally and culturally), the Indigenous Food Systems Network (2023) frames such systems in ecological terms, as the interdependent relationships between all species, air, water, and soil, the health of which is inseparable from Indigenous Peoples foods which are actively cultivated and cared for with respect and through reciprocating acts (Paulowska-Mainville, 2020). An Indigenous food systems lens provides a holistic approach to food production, distribution, and consumption, that centers humans' coexistence with other living beings and prioritizes a cultural-ecological equilibrium over exploitation or fixed restoration goals (Kuhnlein, 2020). Indigenous food systems are increasingly recognized for their potential contributions to community health and well-being, biodiversity conservation, and sustainable forest use (Settee and Shukla, 2020), but have yet to be fully considered in the context of restoration ecology. Here we consider the ways in which an Indigenous food systems approach to restoration ecology offers an opportunity to confront colonial assumptions about land and Indigenous land-use—particularly around restoration dualities which continues to divide people from "nature" and inherently erases longstanding and purposeful land management and stewardship efforts (Grenz, 2020; Wilkinson et al., 2022).

We assess how the application of an Indigenous-food systems lens to restoration may provide a paradigm shift to counter and remedy pop-up restoration and the issues raised here by sharing research experiences working on two distinct but overlapping restoration efforts in so-called British Columbia. We assess restoration efforts after a large-scale (450 km^2) wildfire in St'at'imc territory and a previously managed Garry oak ecosystem (6.5 ha) impacted by farming and urban expansion in Quw'utsun (Cowichan) territory. The unique cultural and historical contexts, combined with their distinctive restoration needs and ecological settings provide two unique perspectives on restoration efforts currently underway in the province. These study areas were chosen based on the cultural and ecological contexts we are most familiar with (especially Grenz) and given our roles as interlocutors in both restoration efforts to date. Furthermore, longstanding colonial impositions (land-use conflicts) and colonial infrastructures (regulatory requirements) persist in each region, making these valuable case studies in which we can assess the successes and failures of Western-dominant environmental and regulatory practices. First, we briefly assess historical-ecological data for each region and then consider the efficacy of current ecological restoration efforts therein. We then consider how Indigenous-led restoration efforts, which centers food systems reclamation and revitalization, are currently underway in each community. These efforts center the perceptions, values, and needs of both St'at'imc and Quw'utsun, leading to a critical integration of Indigenous food systems approaches in ongoing and future restoration efforts.

2. Methods

We assessed disturbance-restoration cycles in two unique study regions (Figure 1) with each assessed at a relatively broad landscape-scale, focusing on: (1) historical-ecological evidence of Indigenous and settler colonial land-use practices over broad (centennial and millennial) timescales (2) recent, current, and ongoing restoration efforts, and (3) future-focused and Indigenous-led visions for land restoration and revitalization.

One author (Grenz) has worked for 7 years on restoration efforts in Quw'utsun territory and 2 years in St'at'imc territory. These added interlocutor experiences form part of the conceptual methodologies used to consider disturbance-restoration cycles and alternative strategies presented herein. As an Indigenous scholar (Grenz) works alongside Indigenous communities in a praxis grounded within Indigenous research methodologies based on respect, reciprocity, and relationality, using land-based learning and open-ended knowledge sharing opportunities, such as "sitting on land" in observation and discussion with community (Wilson, 2008; Kovach, 2021).

2.1. St'at'imc territory, McKay Creek wildfire area

St'at'imc (pronounced *Stat-liem*, previously known as Lillooet) is a large polity of independent Indigenous Nations in the southern Coast Mountain and Middle Fraser Canyon regions of British Columbia. The focus of our study is the McKay Creek Wildfire Area, a roughly 450 km^2 area encompassing major Fraser River drainages of Bridge River and Seton Lake (Figure 1). A unique feature of this landscape is its impressive combination of Biogeoclimatic Zones—the area is encompasses Interior Douglas-fir, Ponderosa Pine, and Bunchgrass zones at lower elevations and Interior Mountain-heather Alpine, Montane Spruce, Engelmann Spruce–Subalpine fir at higher elevations (Meidinger and Pojar, 1991). The heterogeneity of the landscape is matched by its long-term and diverse use and occupation by St'at'imc people spanning millennia (Prentiss and Kuijt, 2012) and illustrates a vibrant intersection of biological and cultural diversity (see Maffi, 2007).

We analyzed historical and written texts documenting Indigenous and setter colonial land-use in the McKay Creek Fire Area, but also included broader St'at'imc references if they were deemed relevant. While not an exhaustive historical-ecological study, this short review allowed us to consider aspects of land-use not typically considered in restoration contexts. Special attention was given to extractive industry gray literature, ethnographic accounts, and government surveys and reports (e.g., grazing tenures, agricultural land reserves, etc.). On June 29, 2021, after a heat dome spurred record-breaking temperatures causing extreme fire conditions over much of the Pacific Northwest of North America (Still et al., 2023), the human-ignited McKay Creek Wildfire, began approximately 11 km north of the town of Lillooet, BC. In response to the devastating fire, restoration planning activities led by the BC government gave rise to the assembly of the McKay Creek Technical Committee which offered an opportunity for affected St'at'imc communities to express their concerns and priorities regarding wildfire recovery. Non-Indigenous governments, NGOs, academic researchers, and restoration contractors were invited to join the technical committee. The technical committee was mandated to facilitate and act as a communication channel between the member communities, government and, when necessary, industry.

One of us (Grenz) is a member of the technical committee and evaluated invasive plant records (prior to the wildfire), assessed fire records amassed by the provincial government's Wildfire Service, and conducted a post-fire plant assessment in the area. We conducted

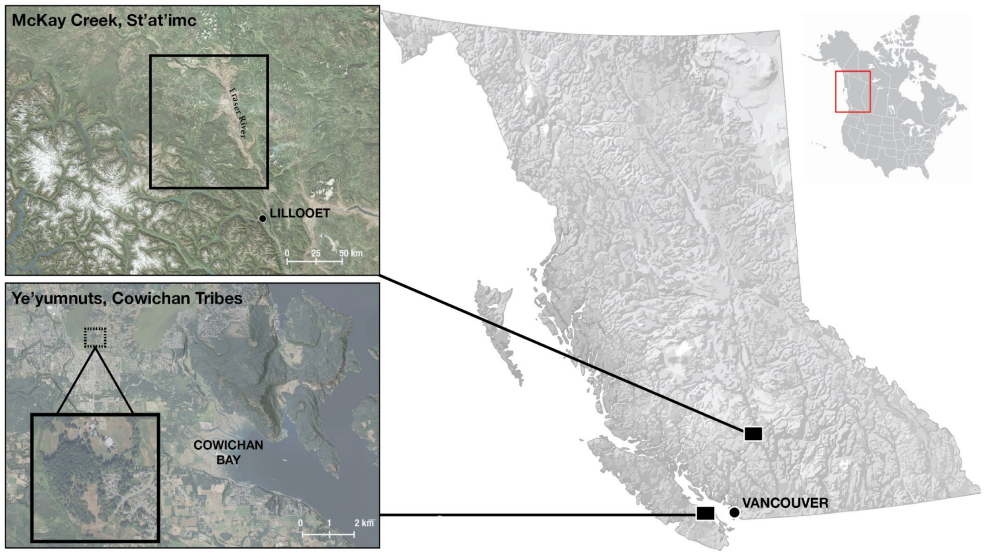

FIGURE 1
Study site locations.

multiple field visits across the entire fire zone to ground truth fire severity mapping (this work began in September of 2022 and is ongoing). Based on community knowledge of plant harvesting locations (locations withheld to protect data sovereignty) we used targeted meandering surveys to map culturally important plants. We coupled these surveys with invasive plant species data from pre-fire inventories in the Invasive Alien Plant Program Database for the Province of British Columbia. Plots for a more in-depth study of vegetation, and to project growth trajectories, were established in June 2023 using a combination of preferential and stratified random sampling methods (Michalcová et al., 2011). Hundred and twelve plots were coded by (i) burn severity rating (low, medium, and high), (ii) grazing pressure (grazed, un-grazed), and (iii) invasive species presence prior to the wildfire (prior presence, no prior presence). Using ArcGIS, plot locations were randomly selected within each of these strata combinations, yielding 12 unique plots for vegetation monitoring. All work was, and continues to be, directed by St'at'imc leadership as members of the wildfire recovery technical committee and we continue to be guided by lessons and input provided by knowledge sharing opportunities (workshops, interviews) and monthly participation in technical committee meetings.

2.2. Quw'utsun camas meadows (Garry oak ecosystems) and Ye'yumnuts ancient village site

Ye'yumnuts is an important biocultural landscape in the densely occupied city of Duncan on Vancouver Island. The eastern flank of the site is bounded by the Somenos River (meaning "resting place") which drains southeast for roughly 3 km into the Cowichan River and ultimately to the Cowichan Bay Estuary which hosts a diverse mix of tidal mudflats, salt marshes, and seagrass beds (Figure 1). The region is heavily developed but comprises the dry maritime subzone of the Cedar Western Hemlock Biogeoclimatic Zone and is characterized by a mix of forested ecosystems dominated by western hemlock (*Tsuga heteropylla*), Western redcedar (*Thuja plicata*), and Douglas fir (*Pseudotsuga menziesii*), and more sparsely vegetated ecosystems of arbutus (*Arbutus menziesii*) and hairy manzanita (*Arctostaphylos hispidula*), wetland ecosystems of peat-moss bog and Sitka willow (*Salix sitchensis*), and finally, the dominant ecosystem type at Ye'yumnuts: Garry oak ecosystems. Garry oak ecosystems are some of the most biologically diverse ecosystems in Canada and are fundamentally cultural spaces that have been shaped and used by people for millennia (McCune et al., 2013; Pellatt and Gedalof, 2014). Recently, restoration of Garry Oak ecosystems across Vancouver Island has been more inclusive and acknowledging of Indigenous Peoples' long-term stewardship of these places (Beckwith, 2004). However, the story of Garry oak restoration at Ye'yumunts is still unfolding and was critically analyzed here.

To investigate 150+ years of Quw'utsun and settler colonial land-use history at Ye'yumnuts, historical and archeological data were collated and analyzed (e.g., archeological reports, historical texts provided by Cowichan Tribes, Cowichan Valley Naturalists, and Somenos Marsh Wildlife Society). Working in close step with Dianne Hinkley, Director of Cowichan Tribes Lands and Research Department and Ye'yumnuts community authority, we conducted semi-structured interviews with Quw'utsun Elders and knowledge holders (Luschiim, Mena and Peter Williams, Harold Joe), and archeologists about the historical and ecological legacies of the site.

To assess current and ongoing restoration efforts, we compiled a mix of ecological and semi-structured ethnographic data. Plant inventories were conducted between April–September 2018. A complete inventory of all vascular plant species (herbaceous plants, shrubs, and trees) was conducted over the entire site (including mapping and recording of relative abundance/density). Land-based knowledge-sharing workshops and field site tours with Cowichan Tribes staff, Elders, and ethnobotanists familiar with the site were conducted April 2018–July 2022. The purpose of these workshops and visits was to share oral histories, stories, and traditional ecological

knowledges, to take part in archeological work completed on site, and to discuss restoration planning and visioning. Some of this data is based on Grenz (2020) doctoral dissertation work, who took part in and reviewed the consultation process and restoration planning at Ye'yumnuts between Cowichan Tribes and Provincial government/contractors in 2017–2020. This process is ongoing.

Finally, we assessed Indigenous-led visions for restoration at both sites. We scoped and assessed how these visions align with, challenge, disrupt, or enrich current and ongoing land restoration efforts led by non-Indigenous organizations and governments. This work coincided with the workshops, field visits, interviews, and technical committee meetings at each study site.

3. Results

3.1. St'at'imc territory, McKay Creek wildfire area

There was a relatively rich body of archeological and ethnographic data to piece together aspects of St'at'imc land-use histories. Archeological surveys and excavations spanning decades have highlighted the extensive use and occupation of the McKay Creek region by people for millennia (Prentiss and Kuijt, 2012; Prentiss et al., 2014, 2020). Archeological data provided glimpses into pre-colonial seasonal rounds and broad usage of fish, plant, animals. Prentiss et al. (2014) inferred how kin-groups moved three to four times a year to access foods growing at different locations and at various altitudes. People used the entirety of the landscape, harvesting ungulates like deer (*Odocoileus hemionus*) in the alpine and harvesting root foods like spring beauty (*Claytonia lanceolata*) and balsamroot (*Balsamorhiza sagittata*) in the sub-alpine. Plant foods that could be harvested in large quantities, like mountain blueberries (*Vaccinium cespitosum*) and saskatoon berry (*Amelanchier alnifolia*) formed a critical part peoples' diets and, veering down slope into the river valleys, salmon harvesting along the Fraser River and its productive tributaries formed an integral component of the round.

Early twentieth-century anthropologist James Teit's publications (Teit and Boas, 1900; Teit, 1906, 1930) and unpublished field notes and manuscripts collected and analyzed by historians like Wickwire (1991, 1998, 2019) and Wickwire and Tiet (1993) provided broad perspectives for St'at'imc (and Nlaka'pamux) resource management and governance. For example, Teit noted how nearby Nlaka'pamux organized in a de-centralized fashion, appointing different chiefs for tasks like war, hunting, and cultivation. Wickwire notes, "He wrote that … female plant specialists and cultivators appointed a respected member of the group to serve as the chief of their berry-picking or root-digging expeditions" (Wickwire, 2019, p. 168). James Teit recorded direct accounts of a rich and complex range of land-use protocols relating to the production of food, where everyone "'understood that it was against the law to interfere with the service berry [saskatoon berry] patches until a designated man or woman declared that the berries were ready for picking. At that point, all the girls and women arrived at the designated picking grounds at the same time and held a ceremony to offer thanks 'to the crop of berries' and to ask for abundance the next year. They did this for huckleberries, tobacco, and certain roots that 'were all products of the earth and related to a kind of earth deity.' The community approached its fishing sites, hunting grounds, soapstone outcroppings, and paint deposits in a similar way" (Teit, Wickwire, 2019, p. 181).

St'at'imc People were not mere hunter-gatherers, but active, coordinated, and knowledgeable landscape managers. The minimum extent of St'at'imc cultivation and management is exemplified by the genetic manipulation and isolation of plant species like saskatoon berries that resulted in distinct crop varieties. Turner (1972) recognized five varieties of saskatoons among Fraser River St'at'imc: (1) The main variety: stsaqwəm-ʔúl (real/original saskatoons); (2) the lowland variety: (s)páqpəq (white); (3) the red-berried variety: (s)wałkwaʔúʔsaʔ ("red-berries"); (4) the sweet variety: (s)tl'əxl'ús (sweet-eye/face/berry) and; (5) the bitter variety: təxl'ús (bitter).

Settler colonial history in the St'at'imc region began with the Fraser River Gold Rush which, after spotty and incidental contact between fur traders beginning in the 1810s, overnight propelled thousands of miners into the region. The colonial discovery of gold in 1857 spread quickly and boomtowns sprang up along the Fraser River at Yale, Lytton, and Lillooet. The rush quickly declined as the more accessible deposits were depleted—mining continued in some pockets, while other speculators settled the area permanently, ushering in an age of intensive cattle ranching. The impacts of Fraser cattle farming on the forests and grasslands in St'at'imc country cannot be underscored enough. The clearing of land for cattle, ensuing compaction, introduction of invasive species through fodder, wildfire suppression, and pre-emption policies that removed Sts'at'imc managers and stewardship authorities from their lands have resulted in significant changes and in some cases negative impacts to landscapes and ecosystem functions in the region (Turner, 2008; Grenz and Clements, 2023). Our experience in the restoration and land-use space have found that many of the land-use conflicts and issues brought on by the sudden influx of miners and ranchers have not been dealt with and the legacies of their impacts persist.

Results focusing on the impacts of the McKay Creek wildfire and current restoration and management efforts show that most of the wildfire area was classified as severe, owing to the >70% mortality of tree biomass after the fire (Hagmann et al., 2021), leaving behind virtual moonscapes mostly devoid of plant life (Figure 2A). Such a high severity wildfire has not been previously or historically observed in this region (Grenz and Clements, 2023). Post-impact assessments of the McKay Creek wildfire found multiple overlapping causal factors including a century of fire suppression, resulting in a dominance of fire-intolerant species and increased fuel loads accumulated at surface, ladder, and canopy levels (Hagmann et al., 2021). The area's grasslands have become dominated by a hyperabundance of sagebrush (*Artemisia tridentata*) (see Figure 2B) that was previously managed by St'at'imc through repeated low intensity burnings (Grenz and Clements, 2023). Forested areas have become more homogenous in structure, spatial patterns, and composition, dominated by Douglas fir (*Pseudotsuga menziesii*) with poor light conditions for herbaceous and other understory species.

Preliminary vegetation surveys across the wildfire area were conducted in the fall of 2022, 1 year after the fire. During plot placement for a long-term vegetation trajectory study, meander searches revealed little to no vegetation in recovery in the high severity burn areas. Soil organic matter appeared to be burned entirely with only deep ash deposits (~30 cm) remaining on the surface. Significant soil erosion and soil movement was observed throughout the high severity burn areas. Sparsely present plants included native species

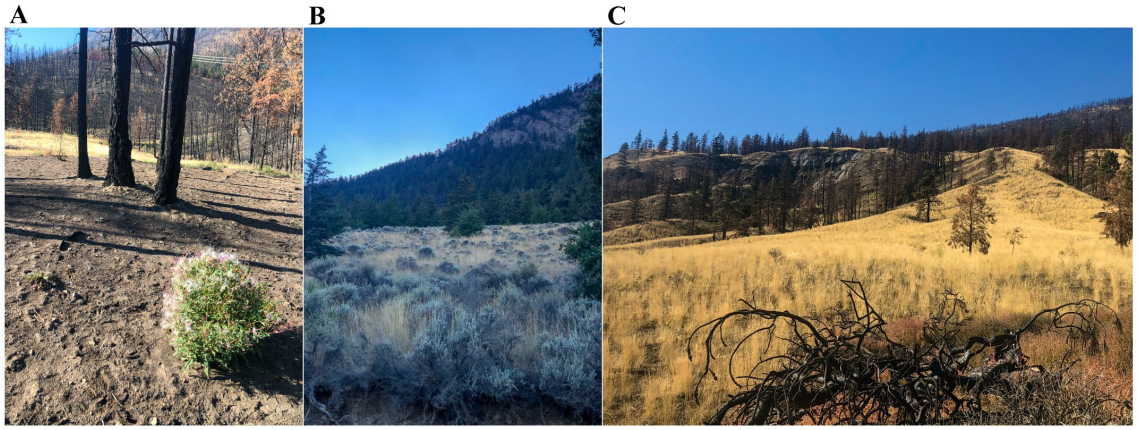

FIGURE 2
McKay Creek wildfire area 1 year post-fire **(A)** high severity burn site, **(B)** unburned grasslands with encroachment by conifers and high-density sagebrush just outside the fire zone, in comparison to **(C)** low severity burn grasslands with conifers and sagebrush burned.

such as snowberry (*Symphoricarpos albus*), fireweed (*Chamaenerion angustifolium*), kinnikinnick (*Arctostaphylos uva-ursi*), Sandberg's bluegrass (*Poa secunda*) and non-native and/or invasive species such as lamb's quarters (*Chenopodium album*), common mullein (*Verbascum thapsus*), and Russian thistle (*Salsola kali*). Riparian areas, streams, and wetted areas where springs occur appeared to serve as plant nurseries regardless of burn severity, with some ethnobotanically salient medicinal and food plants (*Symphoricarpos albus*, *Chamaenerion angustifolium*, *Balsamorhiza sagittata*, *Achillea millefolium*). Medium severity burn sites appeared to have similar plant species to the nursery sites with slightly higher distribution and density. Low severity burn sites in grasslands appeared to respond as Indigenous fire stewards predicted from their own experiences using prescribed burning (see Figure 2C). Previously encroaching Ponderosa pines (*Pinus ponderosa*) were burned back along with large sagebrush, leaving behind dense native grass species and an abundance of native plant species such as nodding onion (*Allium cernuum*), umber pussytoes (*Antennaria umbrinella*), and chocolate lily (*Fritillaria affinis*).

Throughout the intergovernmental wildfire recovery process and participation on the Indigenous-led McKay Creek technical committee, it became evident that concurrent government-led wildfire recovery in the region was largely driven by the values, goals, and priorities of only a few interest groups. Non-Indigenous hunter and rancher interests seemed to be given priority over St'at'imc values, goals, and priorities, especially when those interests were at odds (e.g., a few values certainly overlapped but most did not). For example, rancher desires to re-seed much of the landscape with agronomic species not only undermined the complexity of the landscape (and would introduce non-native plants) but ignored short-and long-term vegetation requirements of resident mammals, birds, and other wildlife relied on by St'at'imc community members. Over the millennial time scale with which the region has been stewarded, this opportunistic solution to a deep-rooted problem exemplified the pop-up restoration ethos. Another example included the provincial government's proposal to reintroduce cattle grazing tenures within the wildfire zone despite expressed concerns of St'at'imc community about insufficient vegetation recovery to support both the cattle and ungulate species relied upon by the Nation for food, such as mule deer (*Odocoileus hemionus*). In assessing the government-led restoration process, we observed a general lack of understanding of the complexity and historical dynamics of St'at'imc environmental management knowledge and values—values that have been applied, tested, and adapted over millennia. We observed how government policy and decision-making overlooked, and in some cases outright dismissed, St'at'imc voices, knowledge, and expertise at the table.

3.2. Quw'utsun camas meadows and Garry oak ecosystems, Ye'yumnuts ancient village site

Archeological excavations at Ye'yumnuts beginning in the 1990s revealed extensive Quw'utsun use and occupation in the area over millennia (2800–800 BP) (McLay et al., 2009, 2013). Remains from a large cooking feature dated to 2,800 BP included plant remains from thimbleberry (*Rubus parviflorus*), blackcap raspberry (*Rubus occidentalis*), red goosefoot (*Oxybasis rubra*), and sedges (*Carex* spp.). Other remains present at the site included fish such as herring (*Clupea pallasii*), salmon (*Oncorhynchus* spp.), skate (multiple species), flounder (*Platichthys stellatus* and *Atheresthes stomias*), anchovy (*Engraulis mordax*), dogfish (*Squalus suckleyi*), sculpin (*Aleutian sculpin*), and greenling (*Hexagrammos decagrammus*) (McLay et al., 2009, 2013). Recent and longer-term fire management at the site was evident from the occurrence of fire-scarred trees and charcoal flecking and lenses identified in organic soil layers. Garry oak ecosystems were managed for, among other reasons, camas production. Archeological evidence spanning the early-mid Holocene highlights camas (and hazelnut, *Corylus cornuta*) as principal plant food resources across the Pacific Northwest (Aikens, 1993; Armstrong et al., 2018; Carney et al., 2021). Historical and ethnographic evidence indicated that camas was one of the most important food staples for Quw'utsun, and that it formed an essential commodity of Quw'utsun economies and trade relationships with other Coast Salish groups on the mainland and up the Fraser River (Lyons and Ritchie, 2017). Well-maintained camas meadows could produce approximately 10,000 bulbs or ~ 225 kg per

family, per year (Deur and Turner, 2005). Ye'yumnuts was likely one such productive meadow that was managed through repeated burning, weeding, and selective harvesting, especially by women, over millennia.

Based on archival and other historical sources, Ye'yumnuts colonial history began in 1876 when a 100-acre parcel was pre-empted and farmed for the next century with much of the Garry oak meadow serving as pasture for livestock and other portions of the site cleared to grow grain (Thom, n.d.). One of Canada's most threatened habitats, only 1–5% of original Garry oak ecosystems persist in British Columbia (Lea, 2006). Substantial changes to ecosystem composition, structure, and function occurred after European settlement in the region, who often favored Garry oak meadows for farming. With the suppression of fire and ongoing expansion of peri-urban subdivisions, Ye'yumnuts is one of the few remaining but severely fragmented Garry oak ecosystems on Vancouver Island and coastal islands (McCune et al., 2013).

Current conditions at Ye'yumnuts exhibit heavily degraded and compacted soils, the contracting of Garry oak trees (*Quercus garryana*) and associated plant species, and the hyperabundance of invasive plant species such as Scotch broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), Canada thistle (*Cirsium arvense*), and reed canarygrass (*Phalaris arundinacea*). More recent soil formation processes indicate the proclivity of nutrient rich anthrosols (Howard, 2017) that are result of historical agriculture on the site (likely from the application of manure fertilizers). This is distinct from the anthrosols associated with typical Garry Oak ecosystems which are often shallower, have excessive drainage (Roemer, 1972, 1993), and are nitrogen poor (Klinka et al., 1989).

We assessed various restoration attempts of Ye'yumnuts Garry oak meadows over the course of a decade, beginning with stewardship groups and government agencies who planted Garry oak seedlings at the site (with 50% success rate) and planted camas bulbs at various ages and sizes in the southern portion of the site (0% success rate). Efforts to eradicate invasive species have been relatively unsuccessful. Non-chemical management trials on reed canarygrass (*Phalaris arundinacea*) (solarization and covering) were applied, and Scotch broom was cut (when in bloom)—both attempts were unsuccessful. Without follow-up or further studies, planting and eradication efforts could be considered "pop-up." The Garry oak ecosystem continues to contract and longer-term approaches are clearly needed.

Douglas fir continues to encroach on the site (see Figure 3A), outcompeting Garry oak seedlings and in some cases resulting in a net turnover of Garry oak meadow species like nitrogen-fixing forbs and ethnobotanically significant species (Erickson, 1996). Alternatives to longstanding Quw'utsun fire stewardship techniques were proposed to stop the encroachment of Douglas fir. These alternatives (e.g., felling encroaching conifers) were not supported by the surrounding settler community who did not want any trees cut down. A compromise was reached, and restoration technicians topped encroaching conifers, but it was shown to be ineffective as light conditions remained insufficient for Garry oak and associated species to grow and adjacent canopy closure continued so the treatment was stopped (Singleton, personal communication, 2018; see Figure 3A).

Other restoration issues included the overwhelming presence of the native plant species snowberry (*Symphoricarpos albus*) which grows evenly across the meadow understory, reaching a height of 1.6 m (see Figure 3B). We observed that their presence likely inhibited the germination and growth of Garry oak seedlings causing seedling mortality. The current stand of Garry oaks in the area is, as one Elder described, "grandparents without their children or grandchildren," referring to the proclivity of snowberry which halts multigenerational succession (Luschiim, personal communication, 2018). Approximately one decade ago, mowing experiments were used and were relatively successful in keeping species like snowberry at bay, but this required repeated care and the project ran out of long-term funding (Singleton, personal communication, 2018). Mowing was also observed to accidentally kill off Garry oak seedlings that were growing among the dense snowberry as they were difficult to see (Hinkley, personal communication, May 2023). There continues to be challenges in managing snowberry as its categorization as a "native" species does not lend itself to management resources allocated by the provincial invasive plant management program.

We observed that, over time, camas numbers appeared to be declining in areas it was re-introduced to through local stewardship groups in the upper Somenos Garry Oak Preservation Area of Ye'yumnuts. Not only did this observed decline manifest in the reduced number of individuals, but also reduced bulb size, and/or plants exhibiting signs of stress such as decreased growth and drought intolerance. We observed that camas bulbs were overcrowding for lack of harvesting and, despite signage, recreators were walking and biking over top of them.

3.3. Indigenous-led restoration

In both study areas, St'at'imc and Cowichan Tribes governments participated in the restoration processes. In both cases, despite the limitations of working within settler government-led programs, they continued to find ways to increase their influence within restoration spaces. As a result, both communities were actively developing rationales and plans for restoring and revitalizing the McKay Creek Wildfire Area and Ye'yumnuts.

In evaluating the beginning stages of Indigenous-led visioning and restoration, we observed several commonalities between both efforts. First, both placed considerable value upon archeological and historical-ecological data and oral histories and testimonies for providing an informed and long view context prior to making management decisions on the ground. Second, both communities applied a food systems lens which emphasized four discrete but overlapping components which we have distilled here (Figure 4).

The St'at'imc and Quw'utsun food system approach to restoration and reclamation required: (1) a holistic perspective accounting for the entire landscape as a food system, including all of the processes, actors, and actions involved in the production, distribution, re-distribution, and consumption of food; (2) an interdisciplinary and cross-epistemological approach which valued, evenly, multiple knowledge systems (e.g., Indigenous and Western scientific praxes) and had to be justly combined to assess baseline ecosystem conditions before creating any restoration plans; (3) a community health focus was emphasized in revitalization planning and required deep community consultation to gain clarity on the health values, concerns, and needs of people. Both communities expressed the desire to reconnect with and incorporate traditional foods as a greater part of their current diets to improve community health (spiritual, emotional, physical). Supply chain issues arising from the

FIGURE 3
Garry oak ecosystem encroachment at Ye'yumnuts by **(A)** coastal douglas fir (*Pseudotsuga menziesii*) and **(B)** snowberry (*Symphoricarpos albus*).

FIGURE 4
Indigenous-led land healing routinely points to: food; valuing all knowledge systems; health and well-being; and justice.

COVID-19 pandemic were underscored as an ongoing issue, galvanizing more emphasis on how traditional food systems, through land restoration and revitalization, can play a greater role in the daily lives of community members and help to combat food insecurity. Finally, (4) equity and long-term visioning was, across the board, heavily centered on youth involvement and justice through reconciliation —increased access to lands and traditional foodways. In all aspects of restoration planning, land healing efforts were touted as both the process and outcome to strengthen individual and community skills, leadership, and culture.

In assessing both community's restoration visions, there was some divergence when it came to the specificity of place. As predicted, the composition of, and emphasis on, certain species in each food system differed slightly, as well as peoples' relationships and stories of plants and soils, land usages, stewardship techniques, seasonality, colonial histories and impacts to land, and community interests, needs, and capacity. This confirms our expectation, that Indigenous food systems are not a monolith and should reflect the diversity of peoples' practices through space and time.

One concern consistently raised about restoring food systems was about the "types" of species being introduced—that some varieties or subspecies may not be suitable for all systems. Even when there are similar taxonomic species across Indigenous food systems, there was emphasis on ensuring the genetic integrity of local varieties, even if they were not recognized by the standards of western taxonomies. This underscores the importance of long-term and deep consultation and engagement—an anathema to the funding cycles and timelines of pop-up restoration. For example, in St'at'imc contexts, Elders and knowledge keepers recognized the local specificity of the same species growing at different elevations, those that tolerate heat, those that grow along a particular stream, and those species that produce fruit that look, taste, and preserves differently. In some cases, this was reflected within the languages where there were multiple words for what we would consider to be one species differentiated them in different ways (e.g., restoration of saskatoons would call for more nuanced and critical approach that considers the multiple St'at'imc varieties and their ecological needs).

4. Discussion

Results suggest that applying an Indigenous food systems lens to ecological restoration may provide a tangible framework for resolving some of the issues faced in top–down colonial policies common in pop-up restoration contexts. Our findings underscore that the good intentions which compel restoration ecologists and their works are largely driven by settler-ingrained stewardship expectations and paradigms which, despite numerous calls by restoration ecologists, continue to rely on a fixed separation of people and place, further dispossessing Indigenous Peoples from their lands (Gordon et al., 2023). Consciously or not, Western frameworks that exclude Indigenous title-holders as active managers and decision-makers, continue to influence how restoration goals are defined, funded, and implemented, not just in our case studies, but across British Columbia. The result has been a fragmented and privileged restoration *modus operandi*, where not only are Indigenous Peoples excluded from restoration projects, but they also often feel the negative impacts of their faulty implementation the most. As Robinson et al. (2021) have argued, "restoration projects exclusive of Indigenous needs are more akin to degradation than restoration."

While restoration practitioners continue to confront influences and biases in their work—biases that stem from conservative environmentalism, outdated scientific paradigms, and deep unknowing of historical and ongoing land-severing policies—two themes in our assessment of pop-up restoration emerged. First, true self-reflexivity, which acknowledges colonial wrongdoing, injustices, and ongoing legacies appears to be rare in restoration contexts (see also Beller et al., 2019; Liboiron, 2021) and globally, the characteristics of pop-up restoration embedded in many restoration plans and policies continue to disconnect Indigenous Peoples from their territories and livelihoods (Moola and Roth, 2019; see also Scheidel et al., 2023). For example, we found that restoration practitioners in St'at'imc and Quw'utsun contexts either disregarded or were simply unaware of basic principles of environmental justice, where acts of distributive, recognition, and restorative justice (e.g., Figueroa and Waitt, 2010; McGregor et al., 2020) should be the norm, but were mostly unknown or uncharted territory. In our review of the literature, we found this to be true in other Canadian contexts, where restoration practices in protected areas or mitigation of land-use changes from industry continue without consent or regard to Indigenous inherent and legal rights (Binnema and Niemi, 2006; Sutherland-Wilson et al., 2019). This unknowing is an obstacle, but also an opportunity for practitioners to dedicate themselves to active growth and life-long learning (see also Igance et al., 2023). Historical ecologists have remarked that "the landscape is a liberating scale at which we can work to prevent harm and recognize/restore who and what has agency" (Wolverton et al., 2023, p. 65). In this sense, restoration is a privilege. Learning to be mindful and attentive to non-human agents, places, and descendant communities is a privilege. And so, researchers and practitioners have an opportunity to exert this privilege toward more transformative and lasting outcomes—not only is this more just, but we have found it is more ecologically viable as well.

The second theme that emerged from the results is that while biases in pop-up restoration are beginning to be confronted and challenged, there is a simultaneous expectation that Indigenous knowledge and practices must instantaneously inform all that Western science has been ill equipped to handle on its own. The integration of Indigenous knowledge in restoration ecology requires ethical engagement with community and a sincere and critical integration of source knowledges and worldviews (Grenz, 2020; Robinson et al., 2021). However, such epistemologies and values are specific to place (Wickham et al., 2022) and are not easily duplicated and scaled-up—an anathema to large restoration enterprises and management agencies where formulaic or cookie-cutter solutions are the goal (Tsing, 2005; see also Armstrong et al., 2023). The idiosyncrasies of space and complexity of time mean that Indigenous knowledges risks being misused or misrepresented, appropriated, co-opted, and in some cases even discredited (Nadasdy, 1999; Johnson and Hunn, 2010).

We are at a critical juncture in applied environmental sciences, where Indigenous knowledge (traditional ecological knowledge or TEK, etc.) is finally, thanks to Indigenous leaders, Elders, and knowledge holders, being recognized. However, this recognition comes with important warnings regarding the superficial applications of that knowledge, misappropriations of the knowledge and unreal expectations (Wildcat, 2010; Campion et al., 2023). The reality of "academic gaslighting" where Indigenous knowledges have been coercively and actively suppressed for over a century but are now being summoned by the same institutions that tried to erase them, causes measurable harm (Geniusz, 2022). While broader scholarly discussions have more recently considered the importance of bridging Western scientific and Indigenous knowledges, referred to as braiding (Kimmerer, 2013), weaving, or two-eyed seeing (Reid et al., 2021), there is still significant learning and growth that individual practitioners and institutions must undertake to accomplish something that resembles a symmetrical, lateral, and equal bridging (Campion et al., 2023).

Done critically and justly, Indigenous-led restoration can lead to all kinds of cultural, social, and ecological benefits (Folke et al., 2010; Hofstra et al., 2020). Applying an Indigenous food systems lens to restoration and reclamation may be one avenue for centering the health of the land and the health of the people (e.g., Parlee et al., 2005). An Indigenous food systems approach attempts to critically dismantle settler colonial conceptions of *terra nullius* and wilderness and unsettles and rejects anthropological heuristics like the "hunter-gatherers." Our call to relational food-centered thinking pushes restoration practitioners beyond land acknowledgements and low-level consultation meetings and urges practitioners to process the deep and highly cultural, spiritual, and social histories of the lands they are attempting to shape. From the stewardship actions and governance principles that have been enacted since time immemorial, to the relational experiences and powers brought to the fore by medicines, foods, and technology, to the colonial harms, physical and systemic, that continue today.

Bringing the People back to the land and rekindling People-land-food relationships was a primary focus across our research sites, as it has been in other Indigenous-led food restoration projects (e.g., Settee and Shukla, 2020; Joseph and Turner, 2020; Tea Creek Farm Impact Report, 2022). As such, Indigenous-led restoration efforts should also dovetail with other overlapping pursuits (e.g., ethnobotanical studies, land-based cultural camps and initiatives, etc.). This is a priority in many communities—to ensure accountability and reciprocity that the lands need and have been missing —so they can be productive. As my (Grenz) Nlaka'pamux Elders have shared, "If we do not use the plants,

they will disappear." This wisdom is supported by widespread regional evidence in both Nlaka'pamux and St'at'imc territories where it has been observed that traditional root harvesting enhances their overall productivity (Turner and Kuhnlein, 1983).

The lessons we have learnt when applying an Indigenous food systems lens to restoration efforts include: (1) honoring the specificity of people and place and making space for each community's unique (and often unscalable) values, goals, knowledges, stories, plants, and animals; (2) acknowledging the diversity of experiences and impacts under past and ongoing waves of colonialism; (3) being genuinely open and flexible to evolving needs, cumulative impacts, current and changing conditions, including acknowledging failures and wrongdoings, and; (4) understanding and having compassion for the varying levels of interest, knowledge, resources, and skills for supporting land healing initiatives. This framework provides yet another path toward food sovereign futures for Indigenous communities (see also Coté, 2016), while providing a tangible way for ecological restorationists to pursue ecological justice without co-opting Indigenous knowledges. It broadens the collective construct of sustainable food systems and allows us to go beyond measuring success by counting individual shrubs and trees planted, to more meaningful and just and ongoing measures of accountability that ensure all are fed and healthy.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by UBC Behavioural Research Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JG and CGA contributed to conception and design of the study, preformed the analysis of the data. JG conducted the research at the study sites and wrote the first draft of the manuscript. CGA gathered and analyzed the historical data for each study site. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

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

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EDITED BY
Massimiliano Agovino,
University of Naples Parthenope, Italy

REVIEWED BY
Cristian Timmermann,
University of Augsburg, Germany
Massimiliano Cerciello,
University of Naples Parthenope, Italy
Aamir Javed,
Università degli Studi G. d'Annunzio Chieti e Pescara, Italy

*CORRESPONDENCE
Abrania Marrero
✉ amarrerohernandez@fas.harvard.edu

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Food laborers as stewards of island biocultural diversity: reclaiming local knowledge, food sovereignty, and decolonization

Abrania Marrero[1]*, Christie Nicoson[2] and Josiemer Mattei[1]

[1]Department of Nutrition, Harvard TH Chan School of Public Health, Boston, MA, United States, [2]Department of Political Science, Faculty of Social Sciences, Lund University, Lund, Sweden

Creating nutritious and ecologically regenerative food cultures depends on the local knowledge of food system laborers. Food producers in small island developing states center socioecological interdependence in their livelihoods and, as such, conserve biocultural diversity. Amid burgeoning health, economic, and climate crises brought on by colonialism, reclaiming food sovereignty requires a critical and embodied scientific approach, one that considers *what* traditional ecological knowledge is and *who* creates and sustains it. This study positions laborers as the primary sources of knowledge in island food systems; discusses declines in nutrition and agrobiodiversity as consequences of food labor loss; and proposes laborers' stewardship as essential to regenerating self-determination. Using critical quasi-ethnographic methods, this report synthesized primary data from narrative interviews in Guam (Guåhan, $n = 13$) and Puerto Rico (Borikén, $n = 30$), two former colonies of Spain and current territories of the United States, as specific examples of place-based knowledge production, interwoven into critical discussion of broader literature in this space. Our findings show that local food laborers combine intergenerational, ecosystem-specific knowledge with robust human value systems, negotiating across competing economic, cultural, and ecological needs to sustain livelihoods and regenerate biodiversity. As well-connected nodes in family and community networks, laborers serve as the scaffolding on which compassionate and relational care can thrive. Trade policies and the market dominance of transnational food corporations have severely reduced local food production in favor of food import dependence in islands, aggravating labor shortages and augmenting food insecurity. Through waves of out-migration and cash remittance, social care relationships have become monetized, reinforcing mass-produced food consumption and dietary diversity loss as islanders, both at home and in the diaspora, transition to an industrialized diet. The loss of local labor similarly poses threats to agrobiodiversity, with export-oriented agribusiness simplifying landscapes to streamline extraction. This study demonstrates that to reclaim food systems in Guam, Puerto Rico, and similar island settings, laborers must be valued as stewards of cultural and agrobiodiversity and can be integral to efforts that preserve cultures, agroecosystems, and health.

KEYWORDS

labor, local knowledge, food culture, biodiversity, nutrition, colonialism, small island developing states, food systems

1. Introduction

The means to create and sustain a diverse set of nutritious, culturally desired, and ecologically regenerative foods is dependent on the traditional ecological knowledge of laborers. For the peoples of small island developing states—living in longstanding hotspots of geologic and meteorological volatility (Thomas et al., 2020)—the work entailed in producing food reflects cultural wealth and safeguards biological diversity. International development agendas have often emphasized small islands' fragility, pointing to burgeoning health, economic, and climate crises in rhetoric that reifies cataclysm, exotifies traditional lifeways, and promotes foreign aid dependence (Baldacchino, 2017). Little attention is paid to the colonial and neo-colonial activities decidedly producing such crises (Plahe et al., 2013; Marrero and Mattei, 2022) and even less so to island peoples themselves, working in and adapting to their new social, economic, and natural environments. To truly conserve biocultural diversity in small island food systems, a critical and embodied scientific approach is needed—one that asks not only *what* traditional ecological knowledge is but also *who* holds it, with what power, and with what desire to continue holding it amid existential threat.

Laborers—including local and Indigenous peasants (campesinos), smallholder farmers, fisherfolk, artisans, landless farmworkers, and caregivers—are the primary producers of island food cultures (e.g., Kelly and Wallman, 2014), relying on highly-specialized livelihood practices in diverse and often challenging environs. The traditional ecological knowledge held by laborers is intergenerational and ecosystem-specific and, as such, has been touted for its capacity to promote nutrition, agrobiodiversity, and climate resilience (Shaffril et al., 2020; Vogliano et al., 2021). The worth of island food cultures, however, extends past its utility. As stewards of human-nature relationships, island food producers create robust value systems that center socioecological interdependence, cohesion, and conservation (Kueffer and Kinney, 2017). Their toil is wealth inherently, valuable beyond wage (Ferguson et al., 2022) and the toolkits of top-down, technocratic environmentalism (Kelman and West, 2009). Yet, in post-industrial and increasingly out-migrating island landscapes, this wealth cannot survive without economic revival.

Hegemonic epistemologies largely frame islanders as victims of crisis, utilizing longstanding deficit models of knowledge production (Campbell, 2009) and overlooking nascent efforts to reclaim food sovereignty (Connell et al., 2020). Some food systems research calls for uplifting traditional knowledge but often falls into the trap of co-opting "the local", with resulting policies reinforcing inequalities and harm (Lemke and Delormier, 2017). Addressing this gap necessitates decolonizing and reclaiming knowledge production in small islands. In the midst of change, laborers are not powerless; they understand and respond to disaster and disease acutely, intergenerationally, and cyclically—not as unexpected shocks but as the very reason iteration in socioecological systems exists in the first place (Beyerl et al., 2018; Talubo et al., 2022). Thus, in exploring island biocultural diversity, labor in islands can be interrogated not as "in crisis" but *in flux*, cultivating new forms of wisdom dynamically. With the objective of decolonizing and reclaiming knowledge production in small island developing states, this research aimed to (1) conceptualize food laborers as the primary safeguards of traditional ecological knowledge in food systems, (2) identify losses to dietary and agrobiodiversity resulting from losses in labor, and (3) propose stewardship as the means of regenerating livelihoods and self-determination.

2. Methods

In this contribution, we focused on two cases studies on labor as it relates to biocultural diversity: Guam (Guåhan) and Puerto Rico (Borikén). Considered small island developing states, these territories provided key insights into food system dynamics in the context of ongoing coloniality. Guam and Puerto Rico have been territories of the United States (US) since 1898, both ceded by Spain, who colonized the islands for more than 300 years. More recently, food systems in both cases have largely been shaped by US-American economic and political interests. This offered a strategic and critical entry point for this research: health and environmental change phenomena are created by long histories of imperialism, and contemporary experiences of these phenomena are shaped by legacies and continuations of colonial structures (O'Lear, 2016; Hickel, 2020; Sultana, 2022). For example, in 2020, 20% of the ~154,000 people residing in Guam lived in poverty, and an estimated 22% of households were receiving food assistance from the federal government (US Census Bureau, 2022). In Puerto Rico, having just under 3.2 million residents, 41% of individuals lived in poverty and 44% of households reported use of food assistance (US Census Bureau, 2020). In both locales, these contrasted the far lower levels (10 and 11%, respectively) found in the mainland US and speak to ongoing structural disparities.

Synthesizing a robust literature base with primary data from qualitative research in Guam and Puerto Rico, this study offers both an overview and specific, place-based examples of the central role laborers play in small island food systems, traditionally and in modernizing contexts, highlighting mechanisms by which dietary and agrobiodiversity are lost, and considering pathways to safeguard local and Indigenous knowledge. We drew on territorial, place-based examples to nuance dynamics of local knowledges and practices with persisting colonial structures, highlighting resulting tensions and implications for biocultural systems. Findings were structured as a critical quasi-ethnographic report, interweaving current scientific theory, novel contributions from narrative interviews carried out in Guam and Puerto Rico, and our own analytical interpretation. Critical ethnographic methods were chosen because they challenge normative colonial-capitalist modes of knowledge production and, by doing so, investigate cultural dynamics as acts of resistance and collective agency (Foley, 2002). Although fieldwork was carried out in a relatively short timeframe (2–3 months), data collection was immersive, in-depth, and relational, facilitating more immediate application of findings through community partnerships (Murtagh, 2007).

Published evidence was amassed from both peer-reviewed and gray literature (e.g., dissertations, books, and reports) via Google Scholar to ensure completeness in these under-researched settings. As an interdisciplinary endeavor, articles throughout the natural and social sciences (e.g., nutrition, conservation, anthropology, political ecology, and global development) were screened by title and abstract for relevance before inclusion as full-text reports.

Search terms included small island(s), small island developing states, labor(er)(s), local knowledge, traditional ecological knowledge, subsistence, smallholder farmer(s), farmworker(s), fisheries, ecosystem(s), food sovereignty, food system(s), culture, local, dietary diversity, nutrition, biodiversity, agrobiodiversity, colonialism, markets(s), wage economy, care (giving), cooking skills, social network(s), and stewardship.

Primary data from Guam was generated and collected during fieldwork conducted in 2016. Case study design was employed and included quasi-ethnographic methods, collecting empirical material through both qualitative interviews and informal sources (Ritchie et al., 2013). Opportunistic and convenience sampling was used to recruit research participants among actors in local food initiatives, identified based on expressed interest or active involvement in production, processing, selling, or consumption of food grown in Guam. To amplify representation across the food sector, various types of individuals and organizations (e.g., cooperatives, non-profit organizations, for-profit farms, educators, and vendors) were identified to form a network of contact. Chain referral across the network was then used, which allowed sampling, research aims, and level of community involvement to be largely participant-driven, evolving according to local contexts and needs (Brounéus, 2011; Ritchie et al., 2013). An explicit focus on localizing food and prominence in the community (based on word-of-mouth and reach) were identified as important considerations for participation by community partners, given the project's emphasis on immediate and actionable community-based research translation. From an initial screening of 32 individuals, 13 participated in the study, including farmers, educators, restaurateurs, and food cooperative members.

Participants were scheduled for 1-h semi-structured narrative interviews, held in English with one primary researcher. An interview guide was developed based on findings from previous work on local food systems as well as input from local actors. The guide focused questions on consumer food access and producer capacities within the local food sector including resource distribution, structural factors (e.g., climate change and US military operations), and future visions or goals. The semi-structured nature of the interview encouraged spontaneous participant reflection and storytelling (Brounéus, 2011). All interviews included discussion about goals and challenges each actor faced, with participants able to share personal and family histories, or point to sociopolitical events, as illustrative of current food conditions in Guam. Interviews were recorded and transcribed *verbatim*. In addition to the transcripts, empirical material also consisted of reports and existing datasets (e.g., from food production and public health international organizations, local non-governmental groups, and government agencies), news articles (online and in print), and informal observations and conversations (e.g., at academic conferences, educational events on agriculture or culture, and tours of different facilities) (Ritchie et al., 2013).

Detailed descriptions of study design and interview processes for data obtained in Puerto Rico are published elsewhere (Marrero et al., 2022). Briefly, a concurrent mixed methods research design was employed in a non-probabilistic, purposive sample of 30 agricultural workers in 2019, 2 years after the occurrence of Hurricane María. Two-hour interviews were conducted with participants and included a quantitative questionnaire (collecting sociodemographic data, farm characteristics, food product inventories, and hurricane-related risks) and narrative interview, moderated by a trained English- and Spanish-speaking researcher. This analysis used data from the narrative interviews, composed of open-ended questions on resource access, social support, and agricultural sector development, offered in an unstructured format to encourage participant storytelling.

Data from both Guam and Puerto Rico were anonymized, and inductive interpretive thematic analysis was carried out separately until saturation was reached. Interpretive analysis was carried out abductively, relying iteratively on theory, empirics, and an analytical framework as well as discussion with key research participants to code data and organize them into thematic results. This analytical approach allowed for participants' latent interpretive frameworks to surface, including common experiences and underlying meaning-making processes. Raw data and derived themes from both sites were then queried for subject matter on labor shortages, traditional food production practices, and personal experiences in modernized economies. Selected quotes were balanced across and summarized key findings common to both sites; highlighted important, place-specific ecological and cultural features; or exemplified similar concepts in broader small islands literature. Research findings were shared with participants and others in a stakeholder or community report. Work conducted in Puerto Rico was approved by the Institutional Review Board of Harvard TH Chan School of Public Health and Ponce Health Sciences University (Protocols IRB19-0034 and 1903007592). This ethnographic analysis, including data from Guam, was designated as exempt (IRB22-1368). All participants provided written or oral informed consent.

3. Findings: results and critical discussion

3.1. Wisdom and diversity in food systems labor

Local and Indigenous knowledge combines grounded skills in "visible" natural resource use with "invisible" values and belief systems, including interdependence, gratitude, and self-determination (Huambachano, 2019). Wisdom refers to the ability to negotiate across these potentially competing biocultural relationships to meet various economic, cultural, and ecological needs (Jacques and Jacques, 2012). In studying wisdom, we conceptualize "food laborers" as knowledge bearers and creators of both autonomous livelihoods (for self) and compassionate care (for kin, community, and nation), serving as catalytic actors at the center of socioecological systems. Thus, labor in traditional food production extends both to those *creating* and *sharing* food and, thus, involves smallholders, fisherfolk, landless farmworkers, homemakers, and caregivers. Although these roles are often interconnected or performed jointly (and fluctuate between paid and unpaid spheres), we make these distinctions to emphasize radical inclusivity of what it means to work and care for others, especially where hegemonic gender, race, and class divisions prevail. Together, interrelations in socioecological

systems sustain social cohesion and nature conservation. As well-connected nodes in familial and community networks, laborers serve as the scaffolding on which compassionate, relational social environments thrive, fostering food-giving, shared meals, and reasserted cultural and national identity (Paponnet-Cantat, 2003; Pollock, 2009).

Smallholder farmers, formal landowners of small plots (typically 5–20 acres or less) (Lowder et al., 2016), are critical contributors to localized food systems. In Puerto Rico, most farms (84%) are owned by individuals and families and 49% are considered small (USDA NASS, 2020a). In Guam, about three-quarters (71%) of farms continue to be owned by Indigenous CHamoru peoples and 89% are small (USDA NASS, 2020b). Labor in food systems also extends to temporary and informal waged workers, men and women who, often as immigrants and with their families, work on lands and with tools not their own. An estimated 100,000–300,000 undocumented Dominican migrants work throughout the Puerto Rican food system as farmhands, domestic workers, and street vendors (Ferguson, 2003). Among the 8,230 registered farmers on the island, 22% operate land that is rented or worked on for others (USDA NASS, 2020a). A similar prevalence (33% of a total 264 registered farms) is observed in Guam (USDA NASS, 2020b). Smallholders often move in and out of these "landowning" and "landless" roles, diversifying incomes by maintaining their own farms while also serving as farmworkers on larger landholdings.

Absent in these censuses are fisheries and the appreciable number of gardens, backyard plots, foraged forests, and other household food sources outside the formal economy (Gould et al., 2017). Contributions of the domestic sphere are immense yet seldom recognized as paramount to food availability, access, and quality. Homemakers and caregivers, often women who care for children, aging parents, and others in the family and community, labor and contribute to food security in their own right (Trees and Dean, 2018). From grocery stores, public lands, gardens, and farm stands and into kitchens, caregivers transform raw agricultural products into desired cultural foods, demonstrating love and cultivating wisdom and sustenance in food preparation. Together, these dimensions of labor highlight the critical and often neglected roles that marginalized groups (e.g., women, farmworkers, Indigenous peoples, and migrants) play in food production (Patel, 2009).

3.1.1. Labor as knowledge in forests, on coasts, and at sea

Labor in subsistence agriculture and fisheries is most easily distinguished by its plurality and epistemology—work that learns from manifold weather patterns and terrains. In the challenge of adapting to diversity, landscapes become part of social worlds "through the everyday ritual of movement and labor", creating familiarity, order, and meaning (Daynes and Williams, 2018, p. 90). As described by a mid-sized farmer in Puerto Rico,

> "On the coast, they regularly work vegetables, plantains, and fruits. [Here], in the countryside, we work plantains, *yautía*—everything that has to do with roots, which are hardier products, stronger for the climate [and] bacteria." (P2)

Because island landscapes (mountainous, volcanic, and otherwise) are diverse and often ill-suited for large-scale agriculture, multiple sets of small-scale, context-specific food traditions arise. Localized food harvesting and sharing practices in islands, as a result, are a reservoir of biocultural diversity, with geographically-bound food cultures transforming across time (e.g., intergenerationally) and space (e.g., via inter-island voyaging) to meet societal needs. In the process, wisdom and its values develop and are passed down, strengthening human-nature interdependencies as sources of physical and spiritual nourishment. In Puerto Rico, smallholder farmers time harvests of crops to supply traditional foods (e.g., *pasteles*) needed for holidays and festivals (Avilés-Vázquez, 2014), with rituals of meaning-making grafted onto material necessity. Farmers, as a result, diversify crop production beyond those cultivated for market to varieties for community consumption, distributing risk as consumer demands fluctuate (or, similarly, as likelihood of disaster rises and falls) (McMillen et al., 2017; McGuigan et al., 2022).

Central to these traditional modes of smallholder agriculture is equitable land access and collective mutual aid. In the Pacific, communal land ownership remains high (45–98% of total land mass), protecting land access even for relatively impoverished households (Mitchell et al., 2014). Through well-integrated kin networks, smallholder farmers mobilize social capital and pool together equipment, cash, and other material resources. Relational mutual dependence, in turn, facilitates labor-intensive agroecological practices (e.g., composting, intercropping, terracing, and contour plowing) (Avilés-Vázquez, 2014; Suzuki and Tachihara, 2014). As an act of reciprocity, food sharing is paramount, with farmers often giving unsold produce to workers, family, neighbors, and friends. As one farmer reflected,

> "Guam's other name is Guåhan, which means 'we have,' and if you look around this island, there is a lot of food here. There are a lot of resources in the jungle. [...] The concept of selling things was not in [us]. We would just rather give it." (G1)

Among Indigenous CHamoru societies, food and recipe sharing remains an important practice in social gatherings like *fiestas*, with long histories of oral tradition and hospitality toward friends and strangers (San Nicolas, 2021).

Deeply rooted in tradition, farmers and fisherfolk operate in increasingly modernizing economies and, as such, "engage in multiple livelihoods, occupying intermediate/ambiguous positions between a traditional subsistence depending on local ecosystems and a 'modern', proletarian subsistence, engaged with larger labor markets" (García-Quijano, 2009, p. 4). The wisdom held by workers, then, has also adapted and expanded to reflect what has been called a mixed subsistence-market economy; beyond social and ecological worlds, laborers' knowledge must now also be responsive to wage, built environments, and market demands (Busilacchi et al., 2013). Despite alternative sources of wage, many fisherfolk desire to maintain a lifestyle at least somewhat dependent on fishing, highlighting the satisfaction that comes from serving as providers for their families and communities (García-Quijano, 2009). In the Puerto Rican context, "even fishers who

migrate to work in the mainland US keep the possibility of fishing alive, monitoring changes in fisheries at home [...] and keeping their memories of and attachment to home ecosystems" (García-Quijano, 2009, p. 7). This affective knowledge, which creates familiarity and attachment to place, also sustains diversity in nature. On coasts and at sea, marine ecosystems near islands remain some of the most diverse and bio-productive in the world, seafood that is mostly consumed locally (Zeller et al., 2006).

3.1.2. Knowledge as dexterity and desire in the domestic

Informal and less labor-intensive food production lies closer to the home, carried out in gardens and "covered" greenhouses. In Puerto Rico, home gardening originated in the Taíno (the predominant pre-colonial Indigenous tribe in the archipelago) use of *conucos*, gardens that were both supplementary food sources and grounds for experimentation to determine local robustness in various crop varieties (Avilés-Vázquez, 2014). Home gardens remain a source of readily accessible and affordable foods throughout the Caribbean and Pacific (Guell et al., 2021). These compact and less strenuous modes of production also bridge important gaps in labor access. A young mother and greenhouse farmer in Puerto Rico discussed how her work facilitated gendered roles as both caregiver and income generator:

> "Everyone gets surprised that I like the earth or that I like to plant. And then they see that I have the greenhouse and that it is very big and looks very pretty like that, all planted. [...] And [since I am] a woman, they tell me, 'Really, you do all that?' [But] this is what I want to do, and it is easy for me. I have the girls, [my daughters,] that can be there [in the greenhouse], or they can stay here in the house." (P5)

Wisdom that interrelates food production with caregiving, in turn, ties people to place, precipitating in communities a nostalgic devotion to the ecologies that sustain them.

Once caught, foraged, or harvested, foods in traditional production systems are brought into the domestic (if not already produced in home gardens or backyard plots) by homemakers and caregivers, who take diverse raw materials and, through inherited knowledge and dexterity in cooking, increase that diversity as a wide array of traditional meals. Traditional cooking practices are attentive to what foods are seasonally available from the field, sea, social networks, and marketplace—and align skills to effect utilization, processing, and storage. As one CHamoru farmer shares,

> "We plant the[se heirloom seeds] because, traditionally, this type of corn is used to make different traditional dishes, tortillas and *titiyas*, which is influenced by Spanish but has sustained our people for a couple of hundred years before those imports came over. [...] So, we take them, we dry them out, we store some of the seeds, [and] we pass them out to visitors." (G4)

Titiya (CHamoru tortilla-like flatbreads) preparation involves extended families coming together to husk corn, often telling stories and passing down traditional food processing knowledge (Flores, 2021); collective preparation of traditional food similarly occurs across Puerto Rican households. Mutual dependence, as knowledge in gathering food resources outside the monetized market economy, is also needed. The Chuukese, a fast-growing Micronesian migrant group in Guam, rely on networks of care among family and community members to obtain adequate food and overcome high food prices, a form of informal aid particularly relevant to food security in Guam's increasingly cash-reliant foodscapes (Jugo, 2020). Once foodstuffs are gathered, creating and sharing meals in a colonized food system is motivated just as much by taking tender care of a child, neighbor, or aging parent as it is by a defiant desire to prevail. As a Puerto Rican farmer described,

> "People help each other [by] making communal kitchens. [With] everybody distributing [food], there is an atmosphere of overcoming." (P27)

Traditional cooking skills are inextricably linked to women and the domestic sphere and are a product of desire (Mookerjee, 2019), an experience—alongside taste, food preferences, and culinary traditions—typically deemed superfluous in hegemonic nutrition and public health discourse (El-Tom and Cassidy, 2021). In colonial ontologies, human appetite (palatability and pleasure-seeking) is characterized as a dysregulated, dysfunctional impulse—a "craving" that must be resisted or else blamed for disease (Veit, 2013). In a feminist and culturally-imbedded epistemology, however, desire is paramount to food production (Mookerjee, 2019), encapsulating a longing beyond what *is* for what *could be* and what must be, therefore, brought forth. In this way, appetite presupposes labor. Crafting a meal requires skill and dexterity in transforming foodstuffs into food cultures, hinging upon a desire for more than the raw materials of the natural world. Thus, instead of a lack of control, human appetite demonstrates the capacity to live in control—receiving (what is), adapting (what could be), and transforming (what we bring forth) our natural ecologies to cook and feed others. Relational experiences like joy, meaning, creativity, and caregiving through food, as anti-colonial exercises, similarly reclaim desire as an act of utopian world-building, resisting tropes of irretrievable cultural loss (Sultana, 2022).

3.2. Loss of labor and land, loss of self

Foreign corporate and governmental involvement has introduced drastic political-economic change in small islands, largely shifting labor away from subsistence in favor of export-oriented agribusiness, industrialization, and tourism (Mitchell et al., 2014). Declines in local agricultural productivity in islands can be traced back to periods of agricultural intensification; currently, arable yet uncultivated lands previously sustained large-scale plantations of copra, sugarcane, and other non-nutritive cash crops, first introduced by Europeans colonizers and bolstered by slavery for benefit in global trade (Marrero and Mattei, 2022). Local and Indigenous smallholding communities—largely dispossessed of their lands (or else enslaved to work on them), unable to produce food, and ultimately accustomed to consume imported products—learned to seek out new livelihoods in the form of wage, remittance, and foreign aid. In militarized islands like Guam, work

in the government sector, and congruent shifts in land use toward military bases and business districts, dominated this transition (Marutani et al., 1997).

After the collapse of plantation economies in the early twentieth century, localized traditional agriculture and fisheries were not necessarily revitalized. Today, laborers in islands largely participate in the colonially-introduced wage economy, both at home and in the diaspora; as described by a small-scale polyculture and hydroponic producer in Puerto Rico,

> "There are no personnel available because everybody is working—that, or they left for the US. So, there is a shortage, and for the few [farmworkers] we can find, we are grateful." (P14)

In Guam, agriculture has been associated with "pulling weeds under the hot sun" among youth (Marutani et al., 1997), a generational disenchantment with the profession. An educator in the local food sector observed,

> "We have this mentality [of], 'I do not want to do that, it is hot!' [...] If we could increase our agricultural workforce, we could increase our production by far. [...] But being Westernized really changed our thoughts on what is a good job and what is a respectable job." (G6)

With farm work disintegrated from cultures and ecosystems, labor (like land and food sources) has become a commodity, easily replaced by alternative income sources.

Today, farm labor shortages, indeed, are a direct result of relatively low compensation, with day laborers looking to other sectors for less exploitative working conditions and more stable income (Li, 2011). The introduction of food aid and other government assistance programs has also "raised the local price of agricultural labor by giving people an alternative means of subsistence" (Rudel et al., 2000, p. 391). To compensate, modernized agricultural systems capitalize on intra-island and often undocumented migration to obtain "cheap" labor—able to do so by privileging standardized, technoscientific models of production reliant on agrochemicals and mechanization instead of local knowledge. Along with unfair compensation and wage theft, undocumented migrant laborers are particularly vulnerable to discrimination, hazardous living conditions, and poor social service access (Ferguson, 2003; Ball et al., 2011); they also disrupt families and social networks (Castles and Ozkul, 2014) and reinforce gendered inequities in unpaid work (Chattier, 2019). Without robust labor protections, low-paying farm work and its enablers (e.g., foreign labor and land dispossession) reify planter colonialism and perpetuate cycles of poverty, racism, and injury. In the few islands where agriculture remains economically-viable, high-value production of fruits, vegetables, livestock, and seafood is typically controlled by multinational corporations for export, doing little to support local livelihoods, food security, or self-determination (Murray, 2001).

Laborers in small islands, as a newly-formed proletariat, have had little control over these and other food system transformations—yet they experience their economic, health, and environmental consequences acutely. In Puerto Rico, industrial power and pharmaceutical plants (dependent on tax incentives and erected on former sugarcane plantations) have created an unstable coastal job market prone to downsizing and layoffs, with many workers falling back to fishing during "off-hours" for food and supplemental income (García-Quijano, 2009). Among coffee plantation farmers in the rural mountains of the interior, periodic food insecurity is increasing (Iverson et al., 2019), a "hungry farmer paradox" which worsens after extreme weather events and propagates rural abandonment (Rodríguez-Cruz et al., 2022), elaborated on by a local farmer in reference to Hurricane María:

> "The hurricane destroyed the coffee zone. [...] Those people in the center are dying of hunger, putting it tragically. [And if] they are not dying of hunger, they are leaving of hunger from this, our central mountain range." (P27)

In Guam and other Pacific islands, militarization and foreign resource extraction (in the form of mining, logging, and commercial fishing) have polluted local ecologies and, as a result, eradicated traditional food and water sources (Spencer et al., 2020). Along with limiting local food production, land dispossession has disrupted a variety of traditional lifeways, a pattern of biocultural loss that continues today. A Guam farmer described plans for the development of a military firing range on a CHamoru cultural site, "a place where we have a lot of Latte Stones" (ancient cultural artifacts) and a wide variety of native plants, utilized as food and medicine for millennia (G4). Lands are the sites where culture and biodiversity entangle, an interdependence that is threatened when traditional land stewardship is lost. Together, colonialism and environmental change in island food systems diminish local food cultures and economies, spur out-migration, and drive farm labor shortages. Ultimately, without laborers as the central, grassroots organizers of agroecosystems, place-based cultural knowledge deteriorates and, with it, food and agrobiodiversity declines.

3.2.1. Declines in dietary diversity

When agroecosystems are well-balanced, traditional diets are the foundation of optimal diet quality and nutritional status. Although long impacted by colonial political and cultural forces, interacting geographies (rural and urban), cultures (traditional and modernized), and trade dynamics (local and imported) form a multidimensional space of food habits, in which dietary traditions can in fact survive. Amassing evidence at this convergence, traditional, locally-sourced diets in small islands have been reclaimed and are largely composed of minimally processed roots, fruits, vegetables, and other foods of plant origin (Marrero and Mattei, 2022). They are high in fiber and essential micronutrients (Shintani and Hughes, 1994; Colombet et al., 2021) and are often supplemented by seafood, seeds, and poultry, thus containing adequate levels of high-quality protein and unsaturated fats (Kawarazuka, 2010; Charlton et al., 2016). Importantly, most foods in a traditional diet are derived from local polycultures, foraging, artisanal fishing, and other small-scale labor. Among the 30 smallholders sampled in Puerto Rico, a total of 38 unique agricultural products were reported as cultivated largely for home consumption, including a variety of citrus fruits, beans, peppers, pumpkins, herbs, and root vegetables (Marrero et al., 2022).

Dietary diversity, characterized by daily consumption of a target number of food groups (Verger et al., 2019), is benefitted by diversified local food production and is a key predictor of micronutrient adequacy and low chronic disease disk in island settings. High dietary diversity is a result of high farm diversity in Fiji, for example, where many households co-produce traditional starchy roots (e.g., taro and cassava), leafy greens, and other vegetables (O'Meara et al., 2019); when used for home consumption instead of income, these foods mitigate risk of micronutrient deficiencies, even among impoverished and multigenerational homes. Agrobiodiversity is similarly associated with high dietary quality, a human-ecosystem symbiosis that is lost in agriculturally poor, import-dependent food supplies (Burlingame et al., 2019; Marrero et al., 2021; Vogliano et al., 2021).

Food market access in island settings, in contrast, has been associated with lower dietary diversity, with highly processed, energy-dense food imports in grocery stores and fast-food restaurants supplanting the greater variety of whole fruits, vegetables, seeds, and lean animal protein available locally (Haynes et al., 2020). With an estimated 80 and 95% of food imported in Puerto Rico and Guam, respectively, a structural dependence on food imports decreases dietary quality and has been implicated in the islands' high rates of chronic disease (Hosey et al., 2009; Marrero et al., 2021). One farmer described the poor quality of food typically available in supermarkets, saying,

> "The imported eggs come, like all produce, [from] miles and miles away. By the time it gets here, it is picked early, [and] it is not the full nutritious product." (G4)

Dishes in social activities have decreased in nutritional quality (Paulino et al., 2008), with the "Americanization" of diets visible as nonperishable, highly-processed and energy-dense table spreads (Hammond and Perez, 2021). In Puerto Rico, losses in cooking skills and knowledge have similarly diminished local food purchasing in favor of food imports (Avilés-Vázquez, 2014). Transnational food corporations exploit island populations by dumping these cheap, hyperpalatable food products, blind to local environments, cultures, and health (Hughes and Lawrence, 2005).

Losses in local agricultural productivity and resulting food import dependence aggravates farm labor shortages—knowing they will be unable to compete with low-priced imports, many farm owners are unwilling to offer fair wages to workers (Gould et al., 2015), who consequently seek out employment in industry and other sectors. As described by a smallholder farmer in Puerto Rico,

> "Now construction here is paying—they raised the minimum to 15 dollars—so to recover all of those people that previously worked in agriculture will be complicated." (P29)

Losses in farm labor reduce the capacity for both wild and farm-produced foods to be harvested in a timely and efficient manner, instead propagating as much as 25–30% of post-harvest food loss and reducing local fresh fruit and vegetable availability (Kumar and Underhill, 2019). Waves of out-migration also result in fractured mutual exchange relationships (Smith, 2016) and, through remittance, recreate them to rely on transnational cash flows (Dalsgaard, 2013). Ultimately, the monetization of social capital reinforces mass-produced, commercialized food consumption and dietary diversity loss, a nutrition transition toward a global, industrialized diet among islanders both at home and in the diaspora (Hughes and Lawrence, 2005).

3.2.2. Losses to agrobiodiversity

Losing the traditional ecological knowledge of laborers also threatens agrobiodiversity. Species evenness is higher in small-scale farms cultivating traditional crop varieties, who are more likely to employ crop diversification and rotation than their industrial counterparts (Sander and Vandebroek, 2016; Sardos et al., 2016). As a collective, farming communities, composed of many small polycultures with high crop divergence, similarly improve species richness (Jarvis et al., 2008). Even when cash cropping intensifies, biodiversity can be preserved, with farmers likely to spare endemic tree species, for example, that provide ecosystem goods (e.g., foods and medicines) and services (e.g., shade, nitrogen fixation, and erosion control) (Ticktin et al., 2018). Importantly, the biodiversity benefits of smallholder agriculture do not end at the farm gate; through carbon sequestration, soil stabilization, and watershed protection, small-scale farmers contribute to the conservation of habitats throughout adjacent non-farmland areas (Idol et al., 2011; Iverson et al., 2019). A farmer in Guam with four decades of experience shared that they had turned to traditional no-till practices, recognizing the superiority of CHamoru methods in regenerating healthy agroecosystems:

> "Like any good commercial farmer back in the day, we had a tractor and a plow and, you know, plowed up the ground; and it looked great, worked great. But then over the years, [...] you have consumed a lot of time and a lot of fuel to do nothing, and you have degraded your soil. Every time you do that, you kill everything in the soil; the biological activity stops or slows down." (G3)

As evidenced, industrialized agriculture *simplifies* landscapes to streamline extraction, converting complexities in nature into atomized resources for state and corporate interests (Jacques and Jacques, 2012). The globalized production of ultra-processed foods is a key driver of agrobiodiversity loss (Leite et al., 2022). In this agro-industrial complex, laborers are "removed from intimacy with the soil, their labor, their traditional cultures, languages, values, technologies, and lifeways" (Jacques and Jacques, 2012, p. 2983). The skills and knowledge base laborers use to enrich biodiversity are similarly lost, replaced by production that instead responds to market interests. As a farmer in Guam explained, fast-growth crops are preferred and,

> "It is only going to be the same crops that are already being grown because they have the higher margin that can pay for that. Other, less profitable crops, you just rule that out." (G3)

In modernized and aid-dependent agricultural systems, small farmers increasingly respond to pro-industry government incentives (helping overcome otherwise prohibitive start-up investments) (Department of Economic Development

and Commerce, 2019), turning to novel technologies like hydroponics to boost economic productivity and reduce labor costs (Cassidy et al., 2020). Controlled-environment technologies may alter the very fabric of labor dynamics in the agricultural sector, potentially reducing labor shortages in the first place (Azzaretti and Schimelpfenig, 2022). Crucially, however, there are island-context-specific drawbacks, including extensive energy requirements (problematic in areas with fragile non-renewable energy infrastructures) and the need for highly-specialized technical expertise. Relying on artificial inputs and a built, largely sterilized environment, the production scheme also stands in stark contrast to more eco-integrated agroforestry, agroecology, and other agrobiodiverse modes of food production (Joy, 2021). These latter issues, at their core, highlight how technocratic, top-down agricultural solutions can fail to leverage culture- and place-based knowledge and ecosystem services, repeating one-size-fits-all approaches of the industrial monoculture era. They also persist in devaluing labor—the central organizing tenant of extractive-capitalist-colonial agricultural schemes (Jacques and Jacques, 2012).

As the initial entry points and ongoing strategic geopolitical holds of colonial expansion, small island nations are, arguably, at the most advanced stages of agrobiodiversity and biocultural loss, offering a glimpse of futures fully devoid of subsistent human-nature relationships. In this post-industrial era, for example, where laborers in islands primarily work in tourism and other urban service sectors, a spontaneous re-naturing of abandoned lands has occurred. In the last half century, Puerto Rico has experienced an unparalleled rate of reforestation, unaided by human intervention and largely occurring on steep, previously tobacco- and coffee-producing lands (Rudel et al., 2000). Although auto-regenerative ecosystems on islands may sound appealing, passive conservation will likely not restore endemic biodiversity after centuries of intensive human environmental change (e.g., invasive species) (Woinarski, 2010). It also does not ensure that lands will not again be colonized, perpetuating injustice through, for example, conservation efforts that strictly limit land access (Grove, 1996) or foreign-owned real estate development (Hinojosa and Meléndez, 2018). Instead of total abandonment, restoring symbiotic human-ecology relationships through stewardship—in which subsistence farming communities leverage local knowledge to re-diversify food-giving landscapes—can simultaneously bolster livelihoods, enhance food security, and conserve biological diversity.

4. Implications: stewardship as the way forward

Recognizing the *who* behind the what, how, and why of food systems, it is apparent that reclaiming food cultures demands personifying traditional ecological knowledge because, ultimately, knowledge actualizes power—a power held by and for people (Borda, 1988; Haverkamp, 2021). In the pursuit of self-determination and under colonial and climate duress, bolstering food sovereignty interrogates and reconstructs lattices of power, a notion otherwise absent in common conceptualizations of food security (Patel, 2009; Ferguson et al., 2022), and centers laborers as the rightful and most fundamental protectors of food and biocultural diversity (Claeys, 2015). Labor has historically preserved the wisdom of how to produce healthful, ecologically-viable food because laborers have been most deeply and enduringly rooted in their social and ecological contexts—and remain engaged when climates and economies fall apart. Especially in island landscapes, fundamentally altered by colonial-capitalist extraction, food laborers persist at the intersection of cultural and biological diversity, creating and sharing food through care work in fields and homes and safeguarding knowledge for livelihoods and self-determination.

Considering the enduring centrality of laborers in relational, agroecological food systems, we position stewardship as the active process through which biocultural diversity can be preserved. Stewardship is a caretaking of the earth; as a central tenet of subsistence, stewardship preserves and restores the gifts of natural landscapes as they are used for sustenance by humans, which "remain local, do not need economies of scale to be of service", and are diverse, with "a family or village [able to] hedge their bets against changes or failures" (Jacques and Jacques, 2012, p. 2984). Heterogeneous income generation is likely a prerequisite of this vision, especially in islands, where out-migration to the mainland for economic opportunity is now commonplace. Without more equitable integration into the marketplace, including acceptance of diversified income streams by government regulation (Avilés-Vázquez, 2014), laborers and their craft will not return from the diaspora. But livelihoods and living wages are not enough. Economies exist within and are products of cultures, which themselves exist within and are products of natural environments. Based on our findings, we conceptualize laborers in island food systems as creating and stewarding biocultural diversity by maintaining nested, synergistic relationships between nature and communities, leveraging local resources, agroecological practices, traditional ecological knowledge, and cultural values to do so (Figure 1). Through the valuing of interdependence and self-determination, labor as stewardship resists isolating economic productivity in colonized small island food systems and, instead, galvanizes food sovereignty and decolonization (Saiz-Álvarez and Palma-Ruiz, 2019).

Decolonial activism—including demands for the end of land grabbing, food dumping, wage exploitation, tenure insecurity, and disaster capitalism—is a crucial first step of this reorganization; along with challenging powers that be, collective organizing dissolves artificial divides between workers and consumers, rural and urban communities (Minkoff-Zern, 2014; Mitchell et al., 2014), revealing a truer interdependence of *people* across food systems to generate solidarity, resistance, and self-determination. In a food sovereignty sense, the values of autonomy and reciprocity underpin this "neo-traditional" food system, one that harkens to embodied histories but situates them in ever-evolving modernity, both self-generated and imposed. In reclaimed mixed economies, for example, stewarded ecosystems can serve multiple, ethno-economic roles (e.g., subsistence, sector development, and tourism) directed by and for local peoples (Baker et al., 2015); agritourism ventures combine these approaches and, in islands, have been employed to preserve food biodiversity (Berno, 2020). As resistance to colonial import dependencies, islanders have also organized around equitable trade policies, including those that reduce prices

FIGURE 1
Laborers in food systems steward biocultural diversity by maintaining nested relationships between nature and communities, leveraging local resources, agroecological practices, traditional ecological knowledge, and cultural values to do so. Through the valuing of interdependence and self-determination, labor as stewardship galvanizes food sovereignty and decolonization.

and augment healthful food availability (Paddock and Smith, 2018). Increasing local production of fresh fruits, vegetables, seeds, and root crops are central to this goal. In Guam, farmers have already begun shifting from commodities (e.g., rice and field corn) to high-value specialty crops, with local consumers willing to pay for fresh fruits and vegetables that, otherwise, often arrive damaged or spoiled on cargo ships (Marutani et al., 1997); from 2007 to 2018, the proportion of farms selling fruits and nuts rose by 22% on the island, while sectors like livestock rearing stagnated (USDA NASS, 2020b). These transformations, guided by autonomous farmers' decision-making, demonstrate grassroots adaptation at work—a small, but perhaps viable goal.

Stewardship as the guiding principle of food system reclamation centers people and their power, not only to navigate complexity in agroecosystems but also to *care* for that complexity. In this mode of being, stewards safeguard "valuables", things of importance in their natural and social worlds, and do so through embodied *values*, wisdoms, and collective memories. Laborers, as stewards of biocultural diversity, are not reduced to their economically productive capacity; they are, instead, caregivers, responsive and responsible for remembering place-based and intergenerational knowledge. Along with informal organization in smallholding communities, codifying stewardship into institutionalized governance will be diverse and decentralized; instead of seeking out optimal agricultural products or practices, bolstering local food production should instead strengthen the interactions *between* the actors safeguarding those products and practices, enabling networks of diversity and innovation (Saint Ville et al., 2015). Likewise, documenting traditional ecological knowledge in small developing island settings should not itself be a process of extraction, whereby global health interests add to their arsenal of "resource management" tools in the name of sustainable development. Unlike disembodied abstraction toward best practice, protecting socioecological systems means understanding that there is no such thing as an ultimate "best" in diverse and ever-changing environmental contexts. Instead, ways of knowing are as dynamic and relational as the peoples and places in which they are created.

5. Conclusions

Food laborers leverage traditional ecological knowledge, robust value systems, and networks of care to sustain livelihoods,

nutrition, and biodiversity. As integral to domestic and community-based food production, they serve as the scaffolding on which compassionate and relational care can thrive. Trade policies favoring food import dependence and large-scale corporate activity have severely reduced local food production in small island developing states, aggravating labor shortages and augmenting food insecurity. Through waves of out-migration and cash remittance, social care relationships have become monetized, reinforcing mass-produced food consumption, poor diet quality, and food cultural loss. Deficits in food labor similarly pose threats to agrobiodiversity, with export-oriented agriculture and fisheries simplifying landscapes to streamline production. To reclaim food systems in Guam, Puerto Rico, and similar island settings, laborers must be valued as stewards of biocultural diversity. Future research is needed to elucidate actionable steps by which such stewardship can be safeguarded, protecting food laborers and their livelihoods through, public policy, business activities, and civil society action. These interventions must center participatory approaches, so that priority-setting at household and community levels effectively guide governance and accountability.

Embedded in networks of individuals, communities, and organizations seeking to advance food sovereignty, this research sheds light on the lived experiences of food laborers in Guam and Puerto Rico, narratives that exist for their own sake and, simultaneously, critically inform broader discourse around coloniality in food systems research. This non-probability sampling approach may engender self-selection bias and limit the representativeness of our findings. Nonetheless, while limited to two US territories, with distinct globalization experiences from other small island developing states, our findings reflect similar trends in nutrition, sustainability, and cultural loss in island communities across the Pacific and Caribbean. In these settings, the goal of food system reclamation can center local knowledge as the fertile grounds on which the flux of nurture and decay comes alive (Haverkamp, 2021); it stresses that knowledge production and its praxis are most aptly wielded by the people seeking their own means of self-determination.

Data availability statement

The datasets presented in this article are not readily available because of concerns for participant privacy. Requests to access the datasets should be directed to amarrerohernandez@fas.harvard.edu.

Ethics statement

The work conducted in Puerto Rico was approved by the Institutional Review Board of Harvard TH Chan School of Public Health and Ponce Health Sciences University (Protocols IRB19-0034 and 1903007592). The ethnographic analysis, including data from Guam, was designated as exempt (IRB22-1368). All participants provided written or oral informed consent.

Author contributions

AM conceptualized the research question, searched and synthesized the literature, collected, analyzed, and interpreted data obtained in Puerto Rico, and wrote the manuscript. CN took part in conceptualization, collected, analyzed, and interpreted data obtained in Guam, and contributed to the manuscript. JM supervised research and contributed to the manuscript. All authors have read and approved the final manuscript.

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Conflict of interest

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

Publisher's note

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EDITED BY
Andrea Pieroni,
University of Gastronomic Sciences, Italy

REVIEWED BY
Brian Dermody,
Utrecht University, Netherlands
Peter Collings,
University of Florida, United States

*CORRESPONDENCE
Andrea Hanke
✉ andrea.hanke1@ucalgary.ca

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Supporting Inuit food sovereignty through collaborative research of an at-risk caribou herd

Andrea Hanke[1]*, Amanda Niptanatiak Dumond[2], Juliette Di Francesco[1], Cindy Lou Adams[1], Terry Milton[3], Lisa-Marie Leclerc[3], Beverly Maksagak[4], Rosemin Nathoo[5], Amélie Roberto-Charron[3], Gwendolyn Blue[6] and Susan Kutz[1]

[1]Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada, [2]Kugluktuk Angoniatit Association, Kugluktuk, NU, Canada, [3]Department of Environment, Government of Nunavut, Kugluktuk, NU, Canada, [4]Ekaluktutiak Hunters and Trappers Organization, Cambridge Bay, NU, Canada, [5]Wildlife Management Advisory Council (NWT), Inuvik, NWT, Canada, [6]Department of Geography, Faculty of Arts, University of Calgary, Calgary, AB, Canada

Introduction: Climate change is increasing vulnerability to food insecurity and biodiversity loss for many Indigenous Peoples globally. For Inuit, food sovereignty is one expression of Indigenous self-determination, and it includes the right of all Inuit to define their own conservation policies. Caribou conservation is particularly pertinent because of the central role caribou play in Inuit food systems. The "Dolphin and Union" (DU) caribou herd is a critical component of Inuit food systems in the Canadian Arctic and has declined by 89% in 2020 (3,815) from the peak measured by aerial survey in 1997 (34,558).

Methods: Our first objective was to identify insights about this herd from and with Inuit *Qaujimajatuqangit* (knowledge). Using thematic analysis, we created a collective account on the DU caribou herd through a research partnership among Indigenous knowledge keepers, government, and academia. Our second objective was to put our findings into the broader literature on the DU caribou herd and connect isolated data on their abundance and distribution.

Results: We found understanding Inuit knowledge of caribou meant situating harvesters' knowledge within their family history, harvesting methods, conservation ethics, and in relation to other harvesters. Through this framework, we conceptualized Inuit-described metrics of caribou status, resulting in three sub-themes of caribou trends over time – their abundance, distribution, and health, – and ending with conservation concerns and potential actions. The synthesized data indicated that the overall population size increased since ~1990s and then decreased after ~2000s alongside a range contraction. Our results add value to co-management literature by (1) articulating Inuit-described metrics of a population decline that inform continued monitoring and incorporation of these metrics into management planning and (2) synthesizing data from various studies on the DU caribou herd abundance and distribution that assists management to make informed conservation decisions based on Inuit and Western knowledge.

Discussion: Results from this research contribute to understanding the six dimensions of environmental health, i.e., availability, stability, accessibility, health and wellness, Inuit culture, and decision-making power and management relating to caribou. The results contribute information that is used by to support environmental health, i.e., knowledge systems, policy,

and co-management relating to caribou. Thus, this collaborative research study supports the expression of Inuit food sovereignty through caribou conservation.

KEYWORDS

co-management, Indigenous knowledge, species-at-risk, *Rangifer*, Dolphin and Union caribou, Traditional knowledge, thematic analysis, Inuit food security

1 Introduction

Despite global efforts to avoid the worse case climate scenarios, climate change is implicated in numerous cases of increasing vulnerability to biodiversity loss and food insecurity (Nunez et al., 2019; Muluneh, 2021). The destructive ecological impacts of climate change may still be mitigated with swift international cooperation (Whyte, 2020; Intergovernmental Panel on Climate Change, 2022), requiring expertise across disciplines, worldviews, and public service sectors (Gavin et al., 2018). International science-policy organizations, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) or the Convention on Biological Diversity, have emphasized the need to "bridge the divide" between Indigenous and Western knowledges to address biodiversity loss (Löfmarck and Lidskog, 2017; Tengö et al., 2017; Tomasini, 2018; Intergovernmental Panel on Climate Change, 2022). Yet, the effectiveness of these efforts is often impeded by collaboration struggles among conservation actors (Rose et al., 2019). Barriers to collaboration may manifest as misconceptions and biases, language barriers, legacy effects, and limited resources, trust, and experience, among others (Tengö et al., 2017; Ulicsni et al., 2019; Wheeler et al., 2020). Indigenous leaders explain the connection between climate change and colonization, where climate change and colonization are one and the same or that they exist as two issues in the same system, fueling each other (McGregor et al., 2020; Whyte, 2020). These authors contend that addressing climate change requires empowering collective self-determination of Indigenous Peoples.

Indigenous groups around the world have harvested wild species, or country foods, for thousands of years, and this is integral to their culture, identity, and health (Boulanger-Lapointe et al., 2019; Akinola et al., 2020; Ajibola et al., 2023). Inuit food sovereignty, one expression of Inuit self-determination, is the right of all Inuit to define their own conservation policies, determine what is appropriate distribution of food, and maintain means to access country foods (Inuit Circumpolar Council Alaska, 2020). Inuit food sovereignty is required for Inuit food security (Inuit Circumpolar Council Alaska, 2020). Inuit food security is characterized by environmental health, and dependant on six components: (1) availability, (2) stability, (3) accessibility, (4) health and wellness, (5) Inuit culture, and (6) decision-making power and management (Inuit Circumpolar Council Alaska, 2020). Indeed, arctic country foods are nutritionally rich, and although store-bought foods are now common place, country foods remain preferred for their nutritional value, spiritual value, and taste (Inuit Circumpolar Council Alaska, 2020; Inuit Tapiriit Kanatami, 2021). Climate change has generally decreased the accessibility and availability of country foods (Inuit Tapiriit Kanatami, 2021), with Inuit reporting unpredictable and more dangerous harvesting conditions because of thinning sea-ice, thawing permafrost, rising sea levels, stronger and more variable wind conditions, and shifting wildlife ranges (Inuit Circumpolar Council Canada, 2012; Fawcett et al., 2018; Beaulieu et al., 2023). The health of cold-adapted wildlife is challenged under these new climate conditions, like the Arctic char (*Salvelinus alpinus*) who experience reduced cardiorespiratory performance and recoverability in higher water temperatures (Gilbert et al., 2016, 2020).

Wildlife conservation is inherent to Inuit food security and sovereignty (Inuit Circumpolar Council Alaska, 2020). In Canada, species status assessments through the federal Species at Risk Act (i.e., Endangered, Threatened, Special Concern, Least Concern) and subsequent wildlife management decision-making often rely on reports that compile and analyze the best available information on the species of interest (Lyver et al., 2018; COSEWIC, 2021). Various health indicators, such as population demographics, distribution, habitat quality, body condition, or disease status, can guide a species' conservation status (Peacock et al., 2020). Historically, these indicators were informed almost exclusively through quantitative science. However, an inclusive process that incorporates Indigenous knowledge side by side with Western knowledge (inclusive of quantitative and qualitative science) is recommended to improve species assessments (Polfus et al., 2014; Lyver et al., 2018; Peacock et al., 2020; Singer et al., 2023) and is often mandated by local (e.g., Statutes of Nunavut, 2018; Government of Northwest Territories, 2019), national (e.g., COSEWIC, 2017a), and international agencies (e.g., Cross et al., 2017; Löfmarck and Lidskog, 2017). Increasingly, Indigenous knowledge, often documented with methods from qualitative science, is used to enhance understanding of wildlife and environmental status, trends, and health (e.g., Ostertag et al., 2018; Tomaselli et al., 2018; Fox et al., 2020). This approach guides and improves decision-making with the goal that wildlife populations who are around today may be present in the future (Berkes et al., 2000; Kutz and Tomaselli, 2019; Peacock et al., 2020; Singer et al., 2023).

In Nunavut and the Northwest Territories (NWT), Canada, the land claims agreements, wildlife management systems, and their corresponding legislation centre Inuit rights and promote the use of Inuit knowledge in wildlife management decisions (e.g., Statutes of Canada, 1984, 1993; Statutes of the Northwest Territories, 2009; Statutes of Nunavut, 2018). For example, article five of Nunavut Land Claims Agreement Act outlines the approach towards wildlife management within the Nunavut Settlement Area. This article recognizes that "there is a need for an effective role for Inuit in all aspects of wildlife management, including research" (5.1.2 (h)) and implements the Nunavut Wildlife Management Board, whose membership includes Inuit, federal government, and territorial government, as "the main instrument of wildlife management" (5.2.33) (Statutes of Canada, 1993). While the Nunavut Land Claims

Agreement Act does not invoke the term "co-management," these mandates towards collaborative management and research for wildlife that shares power between Inuit and public governments is consistent with co-management definitions (Berkes, 2009). Land claims-based co-management within Canada has advanced Indigenous sovereignty in the settlement areas, albeit with facets that require improvement (see Parlee and Caine, 2018; White, 2020; Swerdfager and Armitage, 2023).

An animal of particular importance in Nunavut and the NWT, and more generally across the circumpolar regions, is the caribou, *Rangifer tarandus* (Freeman, 1976; Anderson and Nuttall, 2004; Borish et al., 2021). Caribou in Canada have experienced widespread declines in abundance, including the three caribou sub-species and designatable units ("discrete and evolutionarily significant units of the taxonomic species") in the central Canadian Arctic (COSEWIC, 2011, p. 14; Festa-Bianchet et al., 2011). These designatable units include Peary (*R. t. pearyi*), Dolphin and Union (*R. t. groenlandicus x pearyi*; DU) and Barren-ground (*R. t. groenlandicus*) caribou which are currently assessed as Threatened (Peary, Barren-ground) or Endangered (Dolphin and Union) (COSEWIC, 2015, 2016, 2017c; Species at Risk Committee, 2022, 2023; Nunavut Wildlife Management Board, 2022b). These three populations are harvested by Kitikmeot Inuit in Nunavut and Inuvialuit in the NWT. The widespread declines of Barren-ground caribou have limited the availability of caribou for country food and increased community dependence on the DU caribou herd, the latest herd to decline (COSEWIC, 2015, 2016, 2017c).

The goal of our study was to document Inuit knowledge on the DU caribou herd to support and strengthen Inuit food sovereignty through equitably informed caribou co-management. Specifically, our first objective was to create a collective account of Kugluktukmiut knowledge around the DU caribou herd and identify Inuit-described metrics of a changing caribou population. Our research question was "What were the past and present trends in the DU caribou herd's population, distribution, health, and threats as described by Kugluktukmiut knowledge keepers in 2018–2020?" Our second objective was to position these findings within the broader literature on the DU caribou herd and, by doing so, connect isolated data and different ways of knowing on this herd's abundance and distribution from previously published peer-reviewed and grey literature. By bringing together these disparate and valuable sources of knowledge, we aim to ensure that co-management partners have the information necessary to uphold their responsibilities outlined in land claims agreements and centre Inuit knowledge in policy recommendations that directly affect Inuit food security.

2 Materials and methods

2.1 Study populations

This work began with a common interest of having the DU caribou herd around for future generations. We started a collaboration among representatives from the University of Calgary, the Kugluktuk Angoniatit Association (a Hunters and Trappers Organization), and the Government of Nunavut to learn more about caribou from Kugluktuk harvesters and their Traditional knowledge. Traditional knowledge, also known as Inuit Qaujimajatuqangit, Inuit knowledge, or Indigenous knowledge, is the term frequently used in Kugluktuk to refer to knowledge that Inuit have gained over many generations and is inclusive of Inuit values, customs, and principles for living (Pedersen et al., 2020). Over the years from 2017 to 2023, our collaboration grew to include the Ekaluktutiak Hunters and Trappers Organization, the Olokhaktomiut Hunters and Trappers Committee, and the Wildlife Management Advisory Council (NWT), covering the main communities that depend on the DU caribou herd. Beyond these caribou, people in Kugluktuk, Ekaluktutiak, and Ulukhaktok share a rich cultural history as Inuinnait. Inuinnait are distinct collective of Inuit who use the coastline of Victoria Island along the Coronation Gulf and around to the neighbouring shore of Banks Island as well as the adjacent mainland (Bennett and Rowley, 2004; Collignon, 2006). Their collective represents at least 16 different groups of Inuit (often identified with the suffix-miut) with loose economic and social ties (Bennett and Rowley, 2004; Collignon, 2006). Today, most Inuinnait have close familial connections and have moved to the main settlements of Kugluktuk, Ekaluktutiak, and Ulukhaktok, with very few people remaining in the outpost camps of Umingmaktok and Kingauk (Bennett and Rowley, 2004).

The interviews in objective one focus on Kugluktukmiut knowledge. Kugluktuk is the westernmost community in Nunavut and was home to 1,382 people in 2021, 89.5% identifying as Inuit (Statistics Canada, 2021) (Figure 1). Caribou are essential for subsistence and were the most frequently discussed wildlife species in previous interviews focusing on climate change and food security (Government of Nunavut, 2018; Panikkar and Lemmond, 2020). Herds commonly harvested by Kugluktukmiut include Barren-ground caribou (Bluenose East, Bathurst) and the DU caribou (Government of Nunavut, 2007). Characteristically, the DU caribou herd summer on Victoria Island and winter on the adjacent mainland, crossing the sea-ice during their fall and spring migrations (Poole et al., 2010) (Figure 1). In 2011, the Government of Canada listed the DU caribou

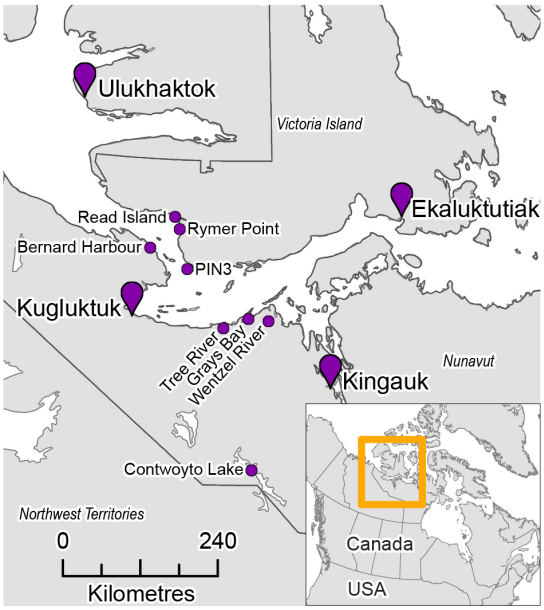

FIGURE 1
Study area, including communities that harvest DU caribou (pins) and important places for Kugluktukmiut (dots as indicated from interviews).

herd as Special Concern in the Species at Risk Act given uncertainty around abundance and harvesting levels (COSEWIC, 2004; Government of Canada, 2011). In COSEWIC (2017c) reassessed the herd as Endangered because of abundance declines and multiple threats such as decreased sea-ice connecting seasonal habitats. The Nunavut Wildlife Management Board supported the federal uplisting of the DU caribou herd to Endangered in 2022 (Nunavut Wildlife Management Board, 2022b), and the Species at Risk Committee in the NWT reassessed the herd as Endangered in 2023 (Species at Risk Committee, 2023).

2.2 Conceptual framework

We used critical realism to conceptualize how harvesters learned and knew about caribou (see Supplementary materials for glossary). Critical realism acknowledges existing external realities (Maxwell and Mittapalli, 2011; Pickens and Braun, 2018). For example, caribou exist and have lives separate from humans. Critical realism also presumes we can never fully understand these realities because of our socially and culturally situated truths of reality (Maxwell and Mittapalli, 2011; Pickens and Braun, 2018). Thus, harvesters can have partial, differing accounts of caribou that can be true simultaneously because they have different lived experiences, influenced by aspects such as age, class, gender, and other individual experiences or characteristics (Maxwell and Mittapalli, 2011). Similarly, harvested and collared caribou are chosen for their particular characteristics, such as body condition, location, age/sex class, or group size. Such characteristics add another lens to understanding data derived from the caribou, which is sometimes called a selection bias. Under critical realism, biases are not aspects to try to reduce or remove. Instead, we have aimed to account for and retain these orientations so that we can make the best connections possible in the data. Critical realism informed our interview facilitation, data documentation, and analytical stages.

2.3 Creating a collective account of Kugluktukmiut knowledge

We held a series of semi-structured interviews from 2018 to 2022, informed by results of previous research (Tomaselli et al., 2018; Hanke et al., 2021) (Figure 2). This approach included initial individual, exploratory interviews, followed by group interviews focused on caribou abundance, distribution, health, and conservation concerns, and then feedback sessions for verification of the researchers' interpretations of the interviews (see Supplementary materials for interview guides). We invited expert caribou harvesters to participate in the study based on recommendations by the Kugluktuk Angoniatit Association (purposive sampling) and suggestions of other harvesters from people already involved in the interviews (snowball sampling) (Green and Thorogood., 2014). We invited harvesters who were already involved in the study, as well as new ones, at each subsequent research stage.

All research stages were audio-recorded, but only the individual and group interview recordings were transcribed. The transcription followed a list of conventions that we created for consistently documenting distinct pauses in conversation, laughter and coughing, and parts of the audio-recordings we were unsure about (Tilley, 2016).

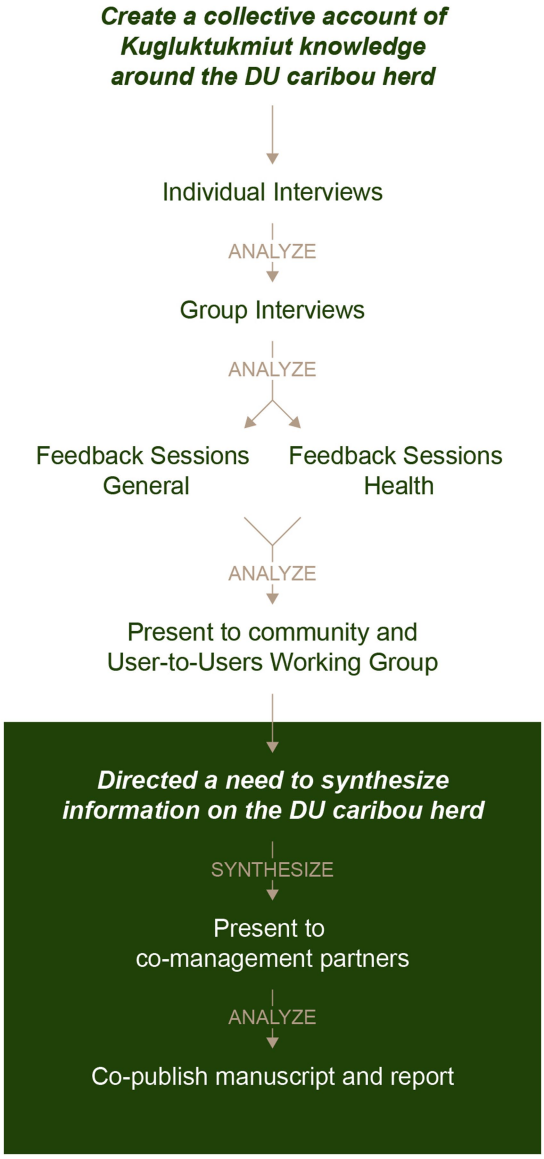

FIGURE 2
Progression of study methods. The top section in white refers to the steps taken to achieve study objective 1, and the bottom section in green refers to the steps taken to achieve study objective 2. Activities are connected by arrows and the moments taken to complete analyses based on the input received during the previous activities. After a set of analysis was completed, the results were returned and discussed with community (study participants or public presentations) or co-management partners. The User-to-Users Working Group is a collective of representatives from each of the Hunters and Trappers authorities within the DU caribou herd range, including the communities of Kugluktuk and Ekaluktutiak in Nunavut and Ulukhaktok and Paulatuk in the NWT.

Interviews were conducted in English. Harvesters who were fluent in English and Inuinnaqtun translated during group interviews when needed to support conservations between other harvesters and the interview facilitators; no language support was needed during the individual interviews. All harvesters received honoraria set by local guidelines. The Kugluktuk Angoniatit Association confirmed the age/experience category that interviewees self-identified as (i.e., Elders and non-Elders) and all interviewees were over the age of 18 years old.

We composed the group interviews based on these categories (e.g., Elders grouped with Elders) to help navigate group dynamics. We offered knowledge keepers the opportunity to be named as a contributor to this research, in their quotes, and on their photographs. This type of participant identification is consistent with Indigenous ethics (McGrath, 2019; Wheeler et al., 2020) and was agreed upon among the University of Calgary, the Kugluktuk Angoniatit Association, and the participating harvesters.

2.3.1 Individual interviews: exploratory

Individual interviews were facilitated in September and October 2018 with nine self-identified Elders and six non-Elders at the Kugluktuk Angoniatit Association office. The interviews explored the meaning of the DU caribou herd to the community, observations related to the herd's abundance, distribution, and health, as well as conservation concerns and potential ways to address these concerns. The interview guide, which was informed by expertise from the Kugluktuk Angoniatit Association, was built using previous interviews that were facilitated in 2003 and used participatory mapping to aid the discussions (Hanke et al., 2021). The preliminary analysis of the individual interviews was used to inform the group interviews.

2.3.2 Group interviews: participatory epidemiology

The goal of the group interviews was to further explore themes gleaned from the individual interviews and create semi-quantitative data on caribou distribution, abundance, demographics, and health. We facilitated seven group interviews with two to three knowledge keepers in January 2019, engaging nine self-identified Elders and seven non-Elders. We chose group interviews so harvesters could build their answers together and discuss why their perspectives may differ (Tilley, 2016).

We used participatory mapping (see below) to document knowledge keepers' common travel areas and harvesting ranges for the DU caribou herd. We used proportional piling to document relative abundance of the DU caribou herd and create ratios of changes in abundance over time (Tomaselli et al., 2018). First, we asked harvesters what year(s) in their life experience they saw the most DU caribou; this became the 100% mark and was represented by a two-cup pile of beans. Second, we asked the knowledge keepers to select the portion of the beans from the pile that represents how many DU caribou they saw in 2019 compared to the peak time (100%). Then, we measured that amount of beans with a two-cup measuring cup to create a percent ratio from peak caribou (100%) to the number of caribou observed in 2019 (XX%). If the harvesters had information before peak population (100%), it was determined using the same steps. The facilitator and harvesters then estimated a line that connected the data points on a paper chart. Once drawn, the facilitator calculated the associated percentage for every five years and adjusted the results according to guidance from the knowledge keepers.

We used printed images of common caribou diseases to help guide our discussions around caribou health. When harvesters said they had seen signs of disease in caribou (caught/harvested or observed), we asked harvesters for more details on a temporal line since their first sighting of the abnormality to the time of the interviews (2018–2020). We used proportional piling to track changes in how often they saw this in caribou over time. We used proportional piling and discussion to explore how signs of disease may have varied with caribou demography (sex, age class), seasonality, occurrence, and severity.

2.3.3 Feedback sessions and presentations: verification

Feedback sessions were used to share results, including maps, charts, and themes, and correct any misinterpretation by the researchers. Knowledge keepers had the opportunity to amend all results, including re-piling the abundance data, redrawing the maps, and adding nuance to the disease data. We facilitated four group and five drop-in feedback sessions with knowledge keepers in January and February 2020. Harvesters who could not attend the scheduled group feedback sessions were invited, at their convenience, to come to the Kugluktuk Angoniatit Association office and go through the results. In total, these sessions engaged 16 self-identified Elders and nine non-Elders. A second set of feedback sessions focused on health were completed in May 2022 with a subset of six harvesters (four Elders, two non-Elders) representing five of the original seven interview groups through one-on-one discussions. All participants from one Elder group interview had passed by the time of the health-focused feedback sessions.

2.3.4 Participatory mapping methods

Each interview set employed participatory mapping, using paper maps generated in ArcGIS, to aid discussions about the land (Armitage and Kilburn, 2015). The individual and group interviews used a single map per individual/group and coloured markers to differentiate attributes such as type of observation, year, and season. Each feedback session used 11 different maps to further elucidate spatial and temporal details: one for "What parts of the land do you know really well?", and two sets of five for "Where do people see DU caribou?", and "Where do people catch DU caribou?", respectively during different time-intervals: 1980–1989, 1990–1999, 2000–2009, 2010–2017, and 2018–2020 (i.e., "today"). Each knowledge keeper drew on the maps with a marker unless they asked for the interviewer to do it for them. Interviewer notes were added in pencil to the maps during the interviews. All mapping attributes were confirmed before the end of the interviews.

2.3.5 Analysis

We analyzed the data thematically using inductive thematic analysis to explore shared patterns of meaning in the interviews (Braun and Clarke, 2020a,b). There are six phases to this analytical method: (1) data familiarisation and writing familiarisation notes; (2) systematic data coding; (3) generating initial themes from coded and collated data; (4) developing and reviewing themes; (5) refining, defining and naming themes; and (6) writing the report (Braun and Clarke, 2020b). We familiarized ourselves with the data while facilitating the interviews, transcribing the audio-recordings, digitizing the maps, editing the transcripts and maps, and reviewing the finalized materials while taking notes of analytical interest. Our coding process was systematic through each research phase using two specific coding strategies: holistic coding that allowed room for an analyst-focused exploration of the data, and *in vivo* coding to ground the coding in the data, that is the words of the knowledge keepers. In this, we were able to reflexively review differences in worldviews that may appear in the coding due to differing cultural backgrounds among the knowledge keepers and the analysts. We did all the

interview coding in NVivo 12, a software that assists in organizing qualitative data (QSR International, 2022). We did these steps for each research stage and interview set.

After the individual interviews, our theme development initially focused on categories that described what harvesters were saying about caribou abundance, distribution, health, and other concerns. We presented the main results from this stage of the analysis at the beginning of the group interviews. After the group interviews, we deepened and expanded our analysis to learn how harvesters spoke about the DU caribou herd and identify the relationships among topics discussed in the interviews. We presented results from this analytical stage during the feedback sessions. We then returned to the theme development with the harvesters' guidance to ground more spatial context into the caribou observations. We presented the revised themes to the community at the Kugluktuk Angoniatit Association annual general meeting. We followed this same iterative process with the sub-group of harvesters involved in the health feedback sessions.

Participatory maps were scanned or photographed, georeferenced, and digitized into polygons and polylines within ArcGIS Pro software (Esri, n.d.). We merged all participatory maps across the study to summarize observations across maps (Honeycutt, 2012). We dissolved all the mapping by harvester or group interview, so that only inter-harvester/group overlapping was counted in the spatial analysis. These methods allowed us to count how many times a location was mapped across different interviews, resulting in a hue gradient in the final maps. We used geoprocessing tools (Dissolve, Clip, Calculate Field) to summarize the area (km^2) covered by the polygons, rounding to the nearest hundred to allow a buffer for mapping accuracy (Armitage and Kilburn, 2015; Robertson, 2017).

We created a hue gradient bar, from light to dark, showing caribou relative distance from community based on the oral accounts of changing caribou locations. The darkest hues represent when caribou were closest to community and the lightest hues represent when caribou were furthest from community.

We compiled the proportional piling data on abundance trends with a smoothed quadratic regression model using R software (The R Foundation, n.d.). We tested a linear regression for the affects of polynomial terms and harvester age before determining the model of best fit.

2.4 Synthesis of disparate data sources on the DU caribou herd

The data synthesis was inspired by our interviews and various ongoing research collaborations around the DU caribou herd [e.g., Hanke et al., 2020; Peacock et al., 2020; Hanke et al., 2021; Hanke and WMAC (NWT), 2023] where all partners described in section 2.1 emphasized the importance of using all tools available to learn about these caribou to ensure that the best possible conservation decisions are made. We, thus, pulled together the available peer-reviewed and grey literature on the DU caribou herd to put our results into a broader context and provide a synthesized assessment of this herd's abundance and distribution (Table 1). We identified literature by reviewing the DU caribou herd assessments and management plans, examining their reference lists, and contacting researchers and authorities who may know of other relevant research (COSEWIC, 2004, 2017c; Environment and Climate Change Canada, 2018; Species at Risk Committee, 2023).

TABLE 1 Data sources for the synthesis on abundance and distribution.

Topic	Data sources
Abundance	Campbell et al. (2021); Dumond and Lee (2013); Hanke et al. (2021); Hanke and WMAC (NWT) (2023); Leclerc and Boulanger (2018, 2020); Nishi and Gunn (2004); Tomaselli et al. (2018)
Distribution	Bates (2006); Campbell et al. (2021); Gunn et al. (1997); Hanke et al. (2021); Hanke and WMAC (NWT) (2023); Leclerc and Boulanger (2018, 2020); Thorpe et al. (2001); Tomaselli et al. (2018)

Additionally, we searched Scopus and Web of Science to detect additional studies that contained Traditional knowledge of abundance or distribution. Our database search strategy was:

> ("Traditional knowledge" OR "local knowledge" OR "Traditional ecological knowledge" OR "Inuit Qaujimajatuqangit" OR "Inuit knowledge" OR "local ecological knowledge" OR "citizen science")
>
> AND ("caribou" OR "Dolphin and Union caribou" OR "Tuktu" OR "tuktuit" OR "reindeer" OR "*Rangifer tarandus*" OR "*Rangifer*")
>
> AND ("Kugluktuk" OR "Coppermine" OR "Cambridge Bay" OR "Ikaluktuutiak" OR "Iqaluktuttiaq" OR "Ekaluktutiak" OR "Bay Chimo" OR "Umingmaktok" OR "Bathurst Inlet" OR "Qingaut" OR "Kingauk" OR "Gjoa Haven" OR "Uqsuqtuuq" OR "Victoria Island" OR "Ki'liniq" OR "King William Island" OR "Qikiqtaq" OR "Paulatuk" OR "Paulatuuq" OR "Kitikmeot" OR "Ulukhaktok" OR "Holman")

We reviewed the titles and abstracts, retaining results that included newly documented Traditional knowledge of caribou and removing results that reported secondary data. Next, we reviewed the full reports and retained results that specifically mention the DU caribou herd or behaviour/descriptions that match the DU caribou herd, focusing specifically on abundance and distribution.

2.4.1 Analysis

We digitized and extracted the abundance data from the various literature sources to compile them within one graph. To standardize the y-axis, we retained the relative abundance used in the Traditional knowledge studies and converted the survey results to a percent of 40,000 animals, the peak abundance estimated in the management plan (Environment and Climate Change Canada, 2018). The Ekaluktutiak trend line is a cubic regression model (Tomaselli et al., 2018), and the Kugluktuk trend line is a quadratic regression model (this paper). The survey estimates (Nishi and Gunn, 2004; Dumond and Lee, 2013; Leclerc and Boulanger, 2018, 2020; Campbell et al., 2021) and Ulukhaktok decadal estimates [Hanke and WMAC (NWT), 2023] are connected by straight lines. We retained the smoothed confidence ban and the data points for the Traditional knowledge trend lines and the confidence intervals for the survey results.

Because previous results on the DU caribou herd suggested a close link between the spatial and abundance data (Hanke et al., 2021),

we created similar gradient hue bars used in the Kugluktuk interviews to illustrate the relative distance of caribou from Ekaluktutiak and Ulukhaktok. These gradient hue bars were based on the interview quotes and participatory maps available from the study publications [Tomaselli et al., 2018; Hanke and WMAC (NWT), 2023]. We added additional, numbered notes on DU caribou locations and distribution changes from other available studies (Gunn et al., 1997; Thorpe et al., 2001; Nishi and Gunn, 2004; Leclerc and Boulanger, 2018, 2020; Tomaselli et al., 2018). For additional information on the synthesis methods, see the Supplementary materials.

2.4.2 Review of synthesis

Each part of this synthesis underwent extensive review and revision from the co-management partners. We presented these results from 2018 to 2023 to the User-to-Users Working Group, the Kugluktuk Angoniatit Association, the Ekaluktutiak Hunters and Trappers Organization, the Olokhaktomiut Hunters and Trappers Committee, the Governments of Nunavut and NWT, and Environment and Climate Change Canada. We remained cognizant to any sources of tension in the data, methods, and overall research practices as we pieced together data and considered feedback. This practice was similar to our dual coding in objective 1, where any observed tensions indicated a need to review differences in worldviews and ameliorate potential ontological dominance in the analysis (Kutz and Tomaselli, 2019; Wheeler et al., 2020).

3 Results

3.1 Creating a collective account of Kugluktukmiut knowledge

Our study included 62 points of contact over four years with 33 harvesters (Table 2). We documented spatial use of the landscape, stories about travelling and caribou, and thoughts around caribou health and conservation (for study area, see Figure 1).

From the interviews, we conceptualized Inuit-described metrics of caribou status that fell under three sub-themes: (1) Abundance trends: "Fewer caribou to see… for the past, maybe 15, 20 years," (2) Distribution trends: Caribou are further away and way behind, and (3) Health trends: "We know the healthy caribous." We begin by situating harvesters' knowledge within "Knowing caribou through harvesters," present the "Inuit-described metrics of caribou status," and finish with "Conservation concerns and potential actions."

3.1.1 Knowing caribou through harvesters

Through the interview process, harvesters frequently interjected contextualizing information when speaking about, and mapping, their personal experiences with DU caribou. We considered this context for each harvester's insights to understand caribou over time and space, where observations on abundance, distribution, and health were distinct among harvesters yet interconnected and adaptive to changes. Kugluktukmiut knowledge of caribou often differed alongside three key aspects of individual harvesting: family history, harvesting methods, and conservation ethics. These individualized aspects helped to identify which caribou (e.g., herd, age, sex) and what part of their annual lifecycle was reflected in harvesters' accounts.

Responding to the question "What parts of the land do you know really well?", the harvesters collectively mapped 286,200 km^2 (from approximately 1960 to 2020), including travel routes and general harvesting areas (Figure 3A). They mapped 240,400 km^2 as the DU caribou herd range (Figure 3B, Table 3), 33% of which was outside their best-known areas. They also mapped 138,700 km^2 of land they used to harvest DU caribou (Table 3, Figure 3C), 8% of which was outside their best-known areas. The decadal maps of caribou range and harvesting area are presented in Figures 4, 5.

Each harvesting area was used during prescribed seasons to match the expected migratory behaviour and health status of the caribou.

TABLE 2 Knowledge keepers who participated at each research stage.

Research stage	Number of harvesters	Elder harvesters	Harvesters	Date
Individual interviews	15	Larry Adjun, Bobby Anavilok, Gerry Atatahak, Stanley Carpenter, Joe Allen Evyagotailak, Roger Hitkolok, John Kapakatoak, Allen Niptanatiak, John Panioyak	Anonymous 1, Anonymous 2, Randy Hinanik, Eric Hitkolok, Kevin Klengenberg, Sheldon Klengenberg	September–October 2018
Group interviews	16	Larry Adjun, Bobby Anavilok, Charlie Bolt, Jorgan Bolt, Stanley Carpenter, Joe Allen Evyagotailak, Roger Hitkolok, John Kapakatoak, Tommy Noberg	Anonymous 3, Anonymous 4, OJ Bernhardt, Eric Hitkolok, Kevin Klengenberg, Sheldon Klengenberg, Wendy Klengenberg	January 2019
Feedback sessions	25	Anonymous 5, Anonymous 6, Bobby Anavilok, Gerry Atatahak, Ida Ayalik McWilliam, Charlie Bolt, Stanley Carpenter, Joe Allen Evyagotailak, Mike Hala, George Haniliak, Roger Hitkolok, Ida Kapakatoak, John Kapakatoak, Allen Kudlak, Tommy Noberg, Agnes Panioyak	Anonymous 3, OJ Bernhardt, Randy Hinanik, Dettrick Hokanak, Kevin Klengenberg, Perry Klengenberg, Sheldon Klengenberg, Wendy Klengenberg, Billy McWilliam	January–February 2020
Feedback sessions (health)	6	Bobby Anavilok, Stanley Carpenter, Joe Allen Evyagotailak, Roger Hitkolok	Anonymous 3, Kevin Klengenberg	May 2022
Total Number	33	20	13	

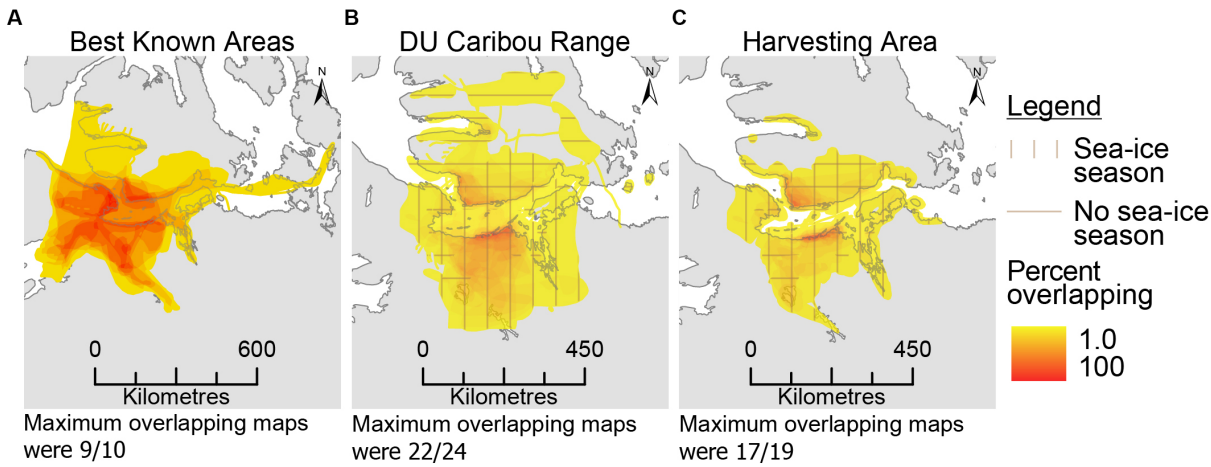

FIGURE 3
Mapping summaries. **(A)** Areas harvesters knew best (roughly 1960–2020), including travel and general harvesting ranges, placenames, and cabins. **(B)** Harvester mapped range of the DU caribou herd from 1980 to 2020 and delineated by sea-ice and no sea-ice seasons. **(C)** Harvesting area for the DU caribou herd from 1980 to 2020 and delineated by sea-ice and no sea-ice seasons. Colour gradient represents the percentage of overlapping maps that identified an area, and straight lines indicate the season the areas were mapped.

TABLE 3 **Caribou range and harvesting area, summarized by decade from 1980 to 2020, mapped by harvesters in 2018–2020.**

Type	Year Interval	Total Area	% of Total	% Change
Caribou range and harvesting area	1980–2020	247,200 km^2	100	n/a
Caribou range	1980–2020	240,400 km^2	100	n/a
	1980–1989	122,800 km^2	51	n/a
	1990–1999	158,300 km^2	66	29%
	2000–2009	133,300 km^2	55	−16%
	2010–2020	156,200 km^2	65	17%
Harvesting area	1980–2020	138,700 km^2	100	n/a
	1980–1989	66,400 km^2	48	n/a
	1990–1999	64,500 km^2	47	−3%
	2000–2009	77,600 km^2	56	20%
	2010–2020	93,700 km^2	68	21%

The values reflect absolute areas and do not consider overlapping areas. % of Total indicates the percent of the related 1980–2020 interval range (maximum) represented in the specific year interval. % Change indicates the percent change in area from the previous year interval.

Knowledge keepers often harvested caribou in locations to which they had family ties:

> *"[DU caribou] mean a lot. That's… that's the most herd I hunt for my family… It means a lot of me because that's where my family originally started, on Victoria Island. So, they've been hunting that herd for as long as I can remember. And I try my hardest to … get there as much as I can, just to keep up the traditional stuff my dad taught me. But my wife is also from Victoria Island and she's lived and hunted off that herd her whole life and she's, she really likes that meat. She doesn't like my caribou that come from the trees. She says it tastes like trees so … yeah, we kind of depend on that herd a lot. It means a lot to my family."—Harvester 1*

As such, there were people who used camps at PIN3, Rymer Point, and Read Island on southwestern Victoria Island (Figure 1), harvesting caribou during late summer before rut (when bull caribou meat is good) and during the fall migration to the coast (when calf-free cows are healthiest). There were knowledge keepers who harvested primarily on the mainland, including groups from Bernard Harbour to Great Bear Lake and westward, groups around Kingauk and Contwoyto Lake areas, and groups east of Kugluktuk to Tree River (Figure 1). The groups harvesting on the mainland often caught DU caribou in the winter before spring migration to Victoria Island, targeting healthy cows or bulls, or following fall migration off the island targeting healthy calf-free cows.

> *"We take our bulls in, August, September. When they're at their prime. You know, and then we leave them alone… and then we take the females in winter. The one that don't have no calves. Females. First year that, never been under stress before! Never had a … carry the, fetus before. Those are the best tasting. And we know those. And you can tell … which ones, under stress and, you know, which ones have calves, no calf, we can tell, you know. And that's where hunter education comes in."—Late harvester Jorgen Bolt*

Harvesters generally used snowmobiles in the snowy seasons and all-terrain vehicles and/or boats in the non-snowy seasons. These transportation types influenced the search intensity, how far harvesters travelled, and how likely harvesters caught animals opportunistically or after careful tracking and observation. Travelling by all-terrain vehicles on Victoria Island restricted travelling distances, while travelling by snowmobile on the mainland allowed far greater travelling distances. When the caribou seemed to move further away from the regular harvesting areas, mainland harvesters travelling by snowmobile were able to follow the change in caribou distribution with few issues compared to Victoria Island harvesters. Victoria Island harvesters travelling by all-terrain vehicles, often based out of

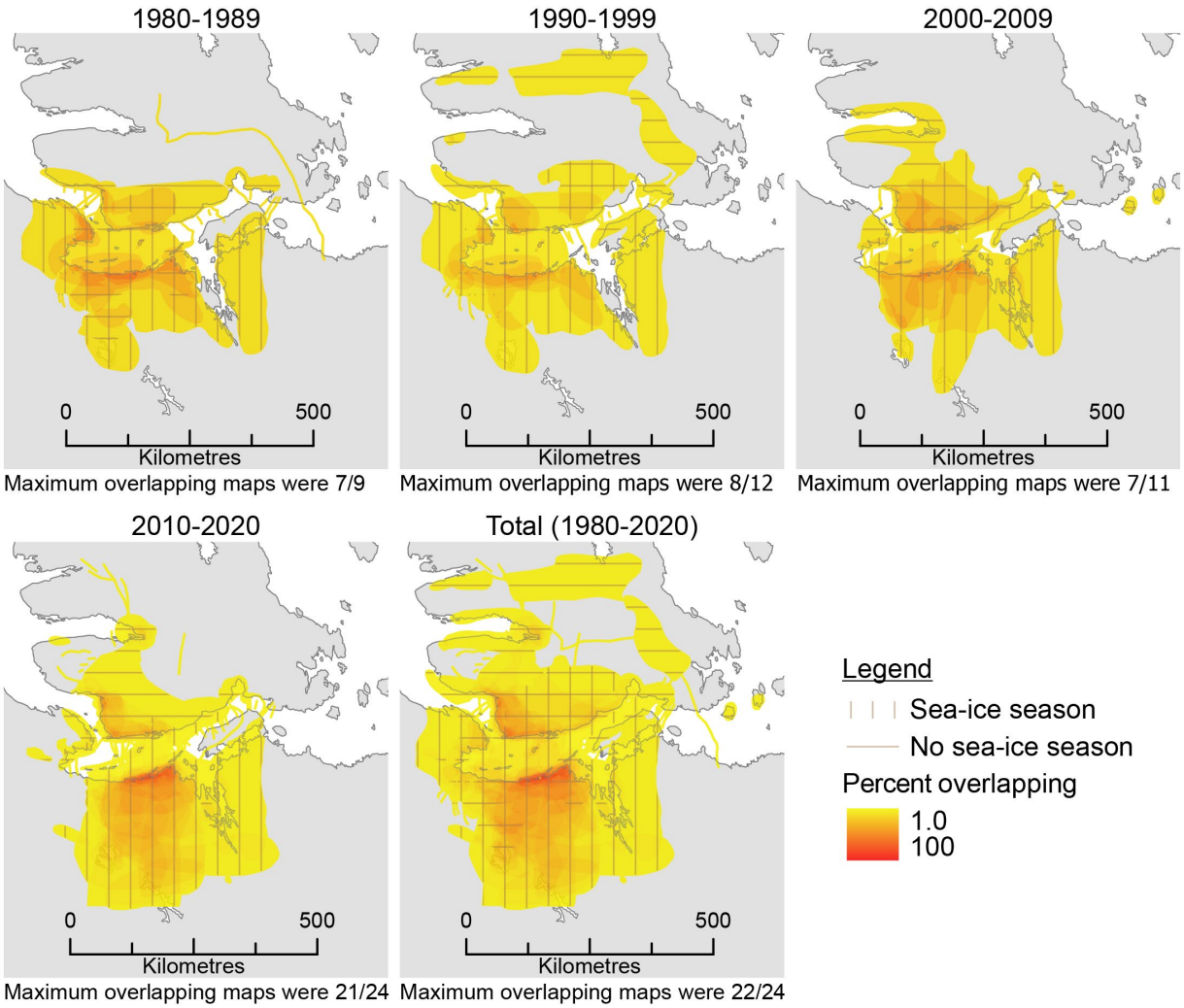

FIGURE 4
Range of the DU caribou herd per decade from 1980 to 2020, as reported by Kugluktukmiut in 2018–2020 and delimited by sea-ice and no sea-ice seasons. Colour gradient represents the percentage of participatory maps identifying an area.

long-used camps, cannot travel as far as snowmobiles during a round-trip. This limitation hampered the harvesters' flexibility to adapt to the changing caribou distribution and restricted the time available to carefully observe caribou before shooting them.

> *"You have to shoot whatever you see now, 'cause back in the haydays when uh … we were Read Island, we'd just, right across the Bay, you'd just glance, "no", "no", "no", "oh, yeah", so … You can't do that anymore. It's get-they're getting few and far in between. And like what [he] said, you have to go travel pretty far nowadays, specially by quad"—Harvester from Group 5*

Annual variations in weather and climate change had impacted the migratory behaviour of caribou and alignment with traditional harvesting locations and seasons. While knowledge keepers expected some deviations in caribou behaviour, there was concern about a sustained shortening of sea-ice seasons, the timing of caribou migrations, and resulting impacts on harvesters' ability to reach caribou.

> *"The temperature, the… everything is a bit confused. [DU caribou], they come down thinking it's time to go across, but by the time they get down here [southwest coast of Victoria Island], there's no ice yet. They go back inland, they come back to the shore, then they go back inland"—Harvester 1*

> *"We used to go mainland in July by dog team. Now in July, we're boating. That's how much change it is now … It's really different now"—Elder Roger Hitkolok*

An internalized conservation ethic also influenced the number of caribou of which harvesters were knowledgeable. For some harvesters, an assessment of herd status influenced the number of caribou they harvested:

> *"When their numbers were higher and they were very healthy, [I'd harvest] anywhere from 15 to 20 [DU caribou], no higher. Last year was the first year I didn't shoot one. Since I've seen the number going down steadily… I haven't harvested over 10 [DU caribou] in*

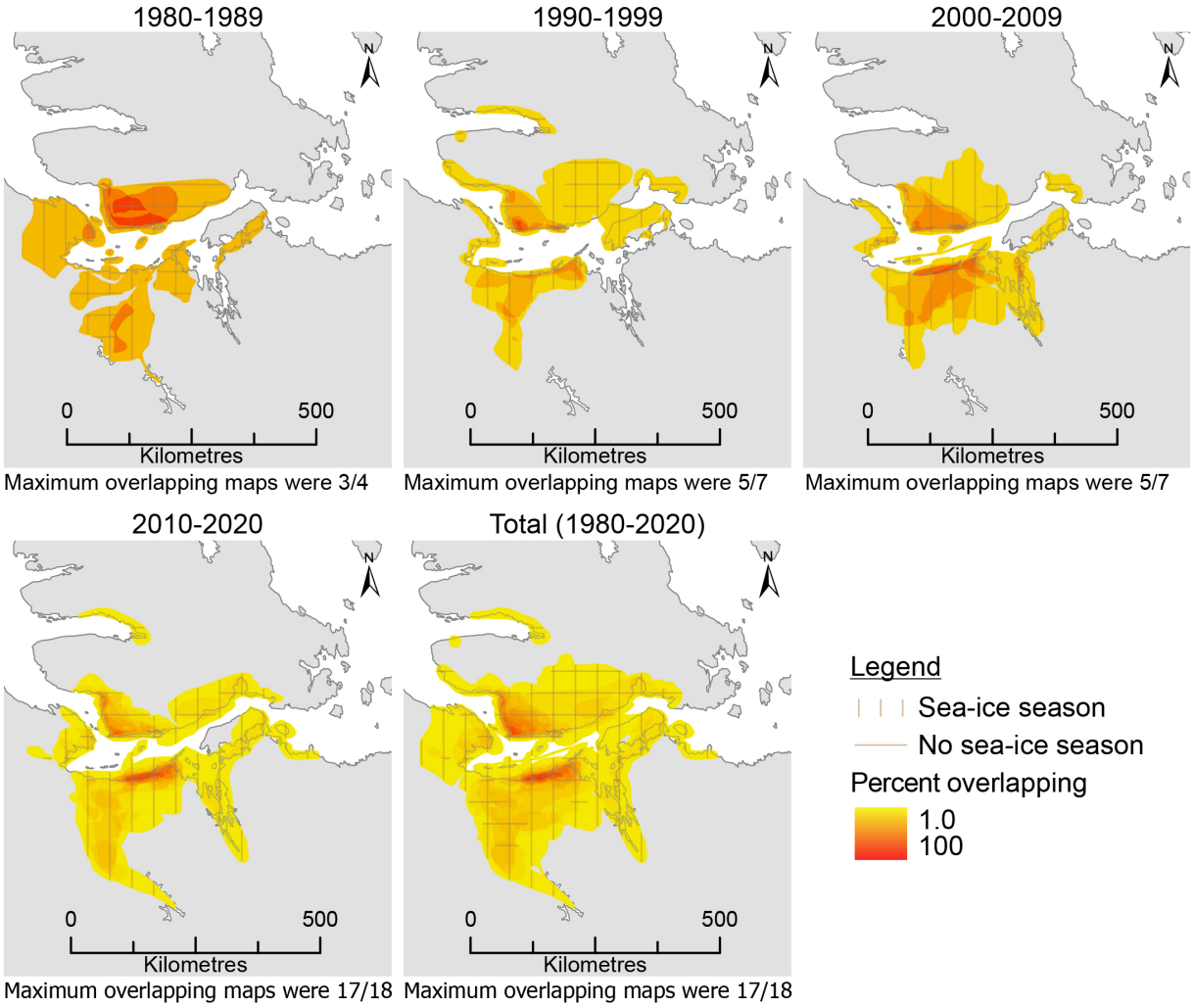

FIGURE 5
Harvesting area for the DU caribou herd per decade from 1980 to 2020, as reported by Kugluktukmiut in 2018–2020 and delimited by sea-ice and no sea-ice seasons. Colour gradient represents the percentage of participatory maps identifying an area.

> *the last 10 years… I've been avoiding hunting DU caribou … I saw them, but I didn't shoot them. Why? I was brought up by my parents and my grandparents to manage and help sustain wildlife. We were told that if you know that they've not in a healthy state, don't harvest them … because they'll come back … so I also heed and listen to those words and just abide by them"—Elder Allen Niptanatiak*

For other harvesters, their conservation ethic included only harvesting cows who did not have calves, choosing adult animals over calves or yearlings when their abundance is low, "mercy killings" for animals who were suffering from injuries or illnesses, or harvesting muskoxen or moose when there are few caribou.

3.1.2 Inuit-described metrics of caribou status

Harvesters detailed interrelated aspects of caribou ecology. They explained that herd abundance was related to distribution, health trends, and the environment: everything exists in cycles. The patterns of caribou abundance, location, and health over time are compiled in Figure 6.

3.1.2.1 Abundance trends: "Fewer caribou to see… for the past, maybe 15, 20 years"—Elder John Kapakatoak

Harvesters spoke about general trends in DU caribou abundance throughout their interviews (top bar in Figure 6). They said that after the population crashed in the early 1900s, caribou were not around until their return in the 1970s. Afterwards, abundance increased from the 1970s into, at least, the 1990s. Harvesters observed different beginnings to the decline in abundance (1995, 2005, or 2015), seemingly influenced by where, when, and how long they had been harvesting.

Proportional piling exercises on abundance had observations beginning in 1965 (n = 1 group), 1970 (n = 1), and the rest beginning between 1980 and 1990 ($n = 4$) (first panel in Figure 6). The group with the youngest harvesters chose not to do this proportional piling exercise. Although there were some differences in the timing of the abundance peak, all who completed the exercise agreed abundance had declined substantially since they began harvesting animals from the DU caribou herd until the time of the interviews. The compiled trend line showed an abundance peak in the mid-to-late 1980s and lowest abundance of approximately 40% of that peak in 2019 (first

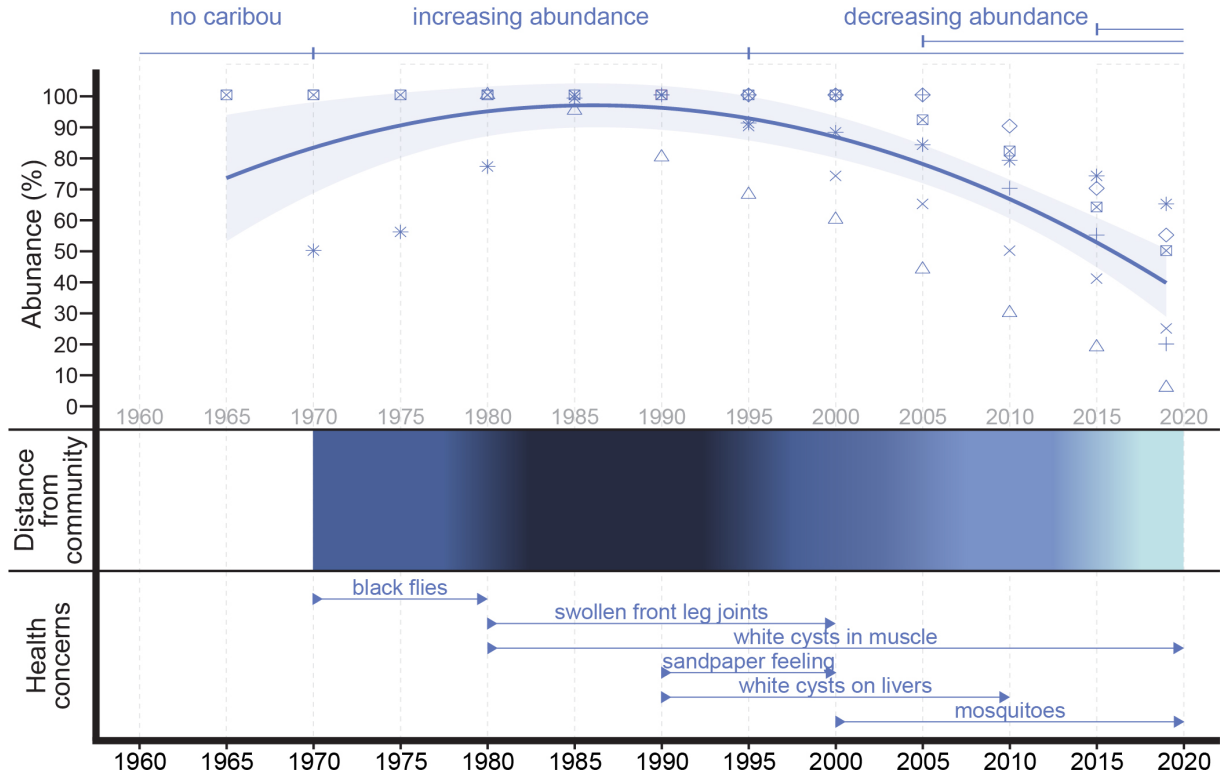

FIGURE 6
Ecological findings from Kugluktukmiut interviews showing changes in abundance, distance from community, and health concerns for the DU caribou herd over time (years). The abundance trends from interview narratives are indicated at the top of the figure. The "decreased abundance" narrative is split into three time periods representing different harvester-indicated starting points. The symbols on the graph represent abundance estimates depicted by each interview group through the proportional piling exercises (six symbols for six groups). The trend line is a smoothed quadratic linear model of the proportional piling data based on the harvester piled abundance estimates. The "distance from community" trend is from interview narratives. Its symbology is based on a hue gradient of close to far away from Kugluktuk, where the darker the colour, the closer they are to the community. The health concerns are placed along the timeline, where their lines indicate the range of time when harvesters first started seeing the disease sign and the up and down arrows indicate changes in observed prevalence.

panel in Figure 6). Interviewee age was not significant in the model. During feedback sessions, harvesters not originally involved in the proportional piling exercises were hesitant to comment on the percentages associated with the trends but agreed with the overall trends. All harvesters who completed the proportional piling described annual variations in abundance, explaining that abundance fluctuates inter-annually even when there is a general increasing or decreasing trend.

3.1.2.2 Distribution trends: caribou are further away and way behind

When caribou were abundant in the past, harvesters recalled them spread over land and not in discrete groups. As the abundance declined, harvesters observed caribou in groups of 15–20 animals approximately 1–5 miles apart from other groups. Then, caribou groups became progressively smaller and further apart. At the time of the interviews, harvesters said caribou groups varied in size, sometimes in the hundreds, but more often fewer than 10 animals.

Harvesters did not expect to see caribou in the same locations every year. However, they described and mapped a gradual, substantial, and directional (eastward) shift in DU caribou locations, and subsequent harvesting ranges, over the past 40 years (Figures 4, 5, second panel in Figure 6). In the 1980s and early 1990s, on the mainland, harvesters found caribou both west and east of Kugluktuk during the winter and summer. During the late 1990s and early 2000s, people only found caribou east of Kugluktuk towards Tree River (Figure 1). During this time on Victoria Island, harvesters found caribou further north and east from their camps (further inland). In the late 2000s and early 2010s, harvesters continued to find caribou further east from Kugluktuk on the mainland, between Tree River and Grays Bay. On Victoria Island, harvesters had to travel even further north and east (further inland) and later in the summer to catch caribou. By the late 2010s, mainland harvesters said caribou were at Grays Bay, Wenzel River, and Bathurst Inlet, and Victoria Island harvesters were having less success during their summer harvesting trips.

> *"We used to just … go 40 miles in the '80s, '90s and get some. Now we gotta go … 120 plus miles [to Grays Bay and Wenzel River in winter] … One way, yep. That's where everybody goes, anyway. And that's quite a ways… Yeah. We used to just go … 40 miles over there, east. Not anymore… There's to-we'd never even reach Tree River to get caribou … now we gotta go way past it. We would get a few west of here. Uh … Island caribou, yeah. *pause* Used to be… quite a few too that, west but … no more. Nobody goes over there anymore. Everybody's always… east."—Elder Stanley Carpenter*

Harvesters described caribou migrating further south and north at the time of the interviews (2018–2020) than in the past. They also thought changes in the formation of sea-ice had resulted in the DU caribou herd shifting their range further east because eastern passages froze earlier than western ones. Harvesters said that sea-ice was thawing before all caribou migrated north to Victoria Island in the spring, leaving some caribou on the mainland for the summer. Several people explained it was normal for some caribou to stay on the mainland, and it had happened occasionally in the past. Others said this change in summer location seemed to happen more frequently today because caribou are migrating further south, taking them longer to return to the mainland shore in the spring.

> *"Year 2011, I was working for MMG, doing environment uh ungulate survey? We're surveying all the animals that's in that route that they're making. And up here too. And … June, when the ice breaks up? You could see a lot of caribou along the shore along here, between Tree River and Grays Bay. That never made it. So, they're staying here all summer. […] The ones that never made it. After, after ice break up? Sometimes they can't make it across because of the open water all, that's already formed? So, they're sitting here, along the coast"—Harvester 4*

3.1.2.3 Health trends: "We know the healthy caribous"—Elder Joe Allen Evyagotailak

Harvesters noted their limitations in observing signs of disease, foremost because they actively looked for healthy animals and not diseased animals. When selecting individual animals to harvest, they would look for animals in groups and said it is odd to find caribou who are alone. People would watch the caribou for external signs of sickness, i.e., poor hair condition, abnormal gait, or visible injuries. After catching a caribou, harvesters would look closer at the body for lumps and at the hooves. They would gut and skin the animal and check that everything inside is slick and *"not stuck together" (Elder Bobby Anavilok)*. Finally, they would assess fat, colour of the meat, and bone marrow condition to see if anything seemed abnormal. Some Elders said antler size is important to evaluate for choosing older, dry cows who do not breed anymore (very large antlers) and to reduce the risk of harvesting sick animals (small antlers for body size or otherwise abnormal antlers).

Harvesters learned what is normal to find in caribou from their parents and Elders. They emphasized that if they see anything abnormal in the caribou, they are very cautious to protect their family's health:

> *"Yeah, there's always that concern [for my safety when butchering], for sure… I never want to catch any sick animal and get the sickness myself, particularly… or more importantly, I never want my kids or any of my family to get sick from animals that I go out and catch myself."—Harvester 2*

Harvesters would ask a respected Elder or the wildlife officers from the Government of Nunavut for advice when they detected unfamiliar abnormalities. People described some ways of dealing with common abnormalities: remove white cysts in muscle, but if there are more than a few in each cut of meat, the harvester may leave the carcass on the land; cut off legs with swollen joints and leave them on the land, butcher the remaining carcass, package it separately from other catches, and mark "cook well."

> *"Some caribous would have uh, puss on their joints or in between their skins… And uh, meat. And those are the ones we have to be careful with … we don't even know what that causes it and we don't wanna try 'n fin-find out through eating them. We-we would leave them because our Elders always say, 'If you think that caribou is sick, don't bother eating it … because it may take your life… or your family'"—Elder Joe Allen Evyagotailak*

Some Elders thought less experienced harvesters do not understand some of the normal things to see in caribou, like the common nose bot and *Taenia* cysts, or yellowing and bubbles. They said the less experienced harvesters may unnecessarily discard a caribou carcass with these types of appearances.

> *"The other day, they get the caribou and says, he said 'it's a bad caribou'. I said 'let me take a look … this is not a bad caribou at all'. He looked at me and said 'look at it, it's yellow.' Yeah when they run around they get kind of bubbly some-some places. You know, it's like where the muscles are… they get starts-they start to get bubbly a little bit. He said 'kind of yellow a little bit'. I said 'that's nothing. Look at the fat. It's really fat, it's healthy.' He said 'oh, okay.'"—Elder Roger Hitkolok*

Despite these limitations, knowledge keepers detailed various abnormalities and health concerns for the DU caribou herd and how these may have changed over the time of their harvesting experience (Tables 4–6, fourth panel in Figure 6). Observations included caribou with swollen front leg joints, white cysts in the muscle, a sandpaper feeling when skinning, white cysts on the liver,

TABLE 4 Harvester reports on observed health concerns in the Dolphin and Union caribou herd when the health concern was first noticed and the possible etiology.

Health concern	First noticed	Possible etiology
Parasites		
Mosquitoes (kitturiat)	Always	*Culicidae* spp.
Warble larvae (kumak)	Always	*Hypoderma* spp.
Nose bot larvae (tagiuq)	Always	*Cephenemyia* spp.
White muscle cysts	Always; started late 1980s, 1990s, 2000, or 2010s	*Taenia cf. krabbei.*
White, surface liver cysts	Started 1980s; or late 1990s–2000s	*Taenia hydatigena*
Syndromes		
Hair loss on nose	Always	*Besnoitia tarandi*
Hair loss on neck	Always	*Solenopotes tarandi*
Sandpaper-like feeling	Always; started 1990	*Besnoitia tarandi*
Swollen leg joints	Started 1980s–2000	*Brucella* spp.; *Erysipelothrix rhusiopathiae; Chlamydia* spp.; *Mycoplasma* spp.; Injuries
Overgrown hooves	Always	Injuries; trace mineral imbalances

Observations often differed within groups because individuals harvested in different seasons and in different locations.

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TABLE 5 Harvester reports on prevalence and trends of observed health concerns in the Dolphin and Union caribou herd.

Health concern	Proportion affected and trends	Trends in severity
Parasites		
Mosquitoes (kitturiat)	Constant 100%.	Intensity increased 50–80% since 2000s. Higher intensity on mainland versus Victoria Island. Increase attributed to higher temperatures, increased rain, and longer summers. One Elder said there are fewer mosquitoes when it is too hot.
Warble larvae (kumak)	Constant 85–100%.	Some said 2–5% or 50% increase since the past, varies over time, or has not changed. One group said that five to six warble larvae is considered a very light infection.
Nose bot larvae (tagiuq)	Once in a while, few, 5–20, 20, 50% or 100%.	Some said it varies over time, has not changed, less over time, or did not know.
White muscle cysts	Piled at 5–20% in general, and younger group indicated 80% on the mainland and 5% at Victoria Island.	Some said they saw a few white spots per animal to a few white spots in each cut of muscle.
White, surface liver cysts	Once in a while. Variable reporting: more or less common today. Some groups said this is more commonly found in Bluenose East caribou.	If seen, there are only a couple or a few (around 7) spots on the livers.
Syndromes		
Hair loss on nose	Consistently rare. Some groups had only seen this in Bluenose East caribou.	One group also saw hair loss around the eyes.
Hair loss on neck	Rare to 25%. Only reported by Elders.	Varying intensity.
Sandpaper-like feeling	Older groups saw this once in a while, but younger groups piled infection frequency at 90–100% on the mainland. Increased since 2014; has not changed from the past; or has decreased from the past; or did not know.	Found on the skin of the legs, abdomen, and sometimes the hindquarters. Not seen in DU caribou eyes.
Swollen leg joints	Once in a while, 1–20%. Peaked in the 2000s and fewer instances today.	One group said the swelling seems larger today than in the past (but other groups disagreed).
Overgrown hooves	Once in a while. Variable reporting on changes: has not changed or has increased since 2015.	No comment.

Observations often differed within groups because individuals harvested in different seasons and in different locations. The proportion affected and trends were variably measured with proportional piling or indicated through conversation, but harvester preference was through conversation.

and a concerning increase in mosquito abundance. There were variations in when harvesters first started seeing/noting something as abnormal or a health concern. While these variations seemed related to harvesters' family history, harvesting methods, and conservation ethics, there was not enough information captured in the interviews to determine location-based health trends as done with the abundance trends. Elder Allen Niptanatiak spoke about a connection between caribou health and their population cycles, where *"caribou were healthier before there were more."* He explained that disease spreads as the herd approaches their peak abundance, and it contributes to the stressors causing abundance to decrease. Elder Allen Niptanatiak's observation corresponds with panel 3 in Figure 6, where some harvesters reported seeing signs of disease before observing declines in abundance.

3.1.3 Conservation concerns and potential actions: "Wolves and grizzly bears anywhere you go."

Harvesters' spoke of various conservation concerns for the DU caribou herd, often including their reason for concern and some suggestions to address the concern. The impact of predators was among the top concerns by the knowledge keepers. Harvesters explained that, normally, wolves, grizzly bears, and wolverines eliminate sick and slow caribou from the population and that wolf quantity depended on caribou quantity. However, they said that there were fewer people harvesting predators today than in the past because it requires extensive time, resources (e.g., gas, food, equipment, repairs), and expert knowledge (e.g., safety, technical) and the resulting compensation (e.g., sale of fur, sample submission) rarely justified the financial and resource investment required. Related to the competing wage income, one harvester said:

> *"When my dad and his buddies were trapping, that was all they did… it was hard-core… you know, they'd come home, 10, 15 wolves… it meant piles of fur… and they would shoot bears… [they] kept it quite under control. In the last 20 years, nobody traps like that anymore. Nobody hunts wolves like that anymore. You have to work. Everybody's gotta work now."—Harvester 1*

Knowledge keepers were concerned that declines in predator harvesting (hunting and trapping) could negatively affect the natural caribou population cycle by creating an imbalanced predator pressure on caribou (Table 7). Harvesters also noted that grizzly bears and wolverines have expanded their range northward to include Victoria Island. They were worried that this predator range expansion has also contributed to higher relative abundance of grizzly bears and

TABLE 6 Epidemiological observations by harvesters on the appearance, seasonality, ecology, and impacts of parasites and disease syndromes in the Dolphin and Union caribou herd.

Health concern	Harvester comments
Parasites	
Mosquitoes (kitturiat)	Previously observed from June to September, now seen from April/late May to late September/October.
Warble larvae (kumak)	Observed in the spring (March–June). One person said you can see these in December–January, but they are tiny. Some said younger animal are infected worse than older animals, or bulls are infected worse than cows, or there are no differences between bulls and cows. The larvae were a source of food in the old days.
Nose bot larvae (tagiuq)	Observed in the spring (April) or summer (June–August). The larvae were a source of food in the old days.
White muscle cysts	Associated this with discoloured meat. Some people said the meat looks lighter in colour or is dark yellow/green. However, some people thought colour change is related to an injury.
White, surface liver cysts	Found typically in younger or older animals that are otherwise healthy. If young animals are infected, they will get more cysts as adults. Not all groups had seen this.
Syndromes	
Hair loss on nose	Observed during spring–summer months, particular ones that are hotter and have more insects/mosquitoes than normal. Thought to be caused by insects or caribou rubbing their skin against something (like sharp ice). Not all groups had seen this.
Hair loss on neck	Observed in spring (March–April). Some said it was worse in younger bulls than older animals or worse in middle-aged animals. Thought to be caused by insects or caribou rubbing their skin on something (like sharp ice). Not all groups had seen this.
Sandpaper-like feeling	Observed mostly during the spring (April) harvest on the mainland and in skinny animals, mostly bulls. Also observed in the fall. Some groups said they saw this in animals with pale livers. One Elder group said that when this progresses, it will cause the animal to lose hair.
Swollen leg joints	Observed in skinny bulls. Associated with abnormal antlers and limping animals with abnormal/overgrown hooves. Not all groups had seen this.
Overgrown hooves	Observed in bulls and cows. Seen to hinder movement. Some harvesters connected this to injuries, swollen leg joints, or diet. Not all groups had seen this.

Observations often differed within groups because individuals harvested in different seasons and in different locations.

TABLE 7 Harvesters' conservation concerns for the Dolphin and Union caribou herd, including the reason and their suggestions to address the concern.

Harvester concerns		Reason for harvester concern
1.	Harvesting	Barriers between youth and Elders that impede learning, including conflict between harvesting and employment as well as language differences.
1.1.	Predators	Increased numbers of grizzly bears, wolves, and wolverines over time on the mainland and Victoria Island. This was linked to predator harvesting not being as common nor practiced the same today versus the past.
1.2.	DU caribou subsistence	Poor meat management, poor sharing practices, and inexperienced harvesters having a negative impact on caribou numbers.
1.3.	DU caribou outfitted hunts	Undue pressures on important breeding male caribou. Variable concern because outfitted hunts are seen as a good job and uncertainty about the impact this has at a herd-level.
2.	Climate changes	Changes in rain, wind, temperature, moisture, vegetation, sun, and timing of seasonal changes.
2.1.	Rain-on-snow	Forms a layer of ice over the vegetation, making it difficult for the DU caribou herd to access high-quality food.
2.2.	Thin sea-ice	Observations of DU caribou drowning and their migration path changing, linked to seasonal freezing and melting of sea-ice.
2.3.	Insects	Increased levels of insect harassment that prevent caribou from eating and resting.
3.	Exploration and development	Including municipal disturbance, natural resource exploration, and anthropogenic development
3.1.	Noise pollution	Increased over time: more helicopters, planes, and snowmobiles.
3.2.	Habitat loss	Potential mining, roads, and port developments that would use important habitat for the DU caribou herd.
3.3.	Grays Bay road project	Variable concerns against and for the project that were out of the scope of this research.

Categories are ordered by relative importance as indicated by the harvesters.

wolverines within the DU caribou herd distribution today compared to the past.

Additionally, knowledge keepers were concerned that less experienced harvesters were missing the knowledge needed to follow proper conservation practices, and this influenced the form and depth of their interactions with caribou (Table 7). The missing knowledge manifested in poorer meat management (e.g., spoiling meat, feeding caribou meat to dogs, not knowing what meat is safe to consume), harvesting practices (e.g., harvesting the wrong animal for the season, approaching animals directly and not at an angle), and how they shared their catches (e.g., selling rather than gifting). For example, some less experienced people may discard meat when common and harmless parasites, such as the common nose bot, *Cephenemyia* spp., is present:

> *"Some youngster cooks like uh, housewives… they cook heads… they try to cook heads, but cut it up, they see this kind [nose bots] in them, in their mouth, they throw 'em in the garbage *chuckles* They throw them out … throw the whole head out! *chuckles* They just don't like to see those kind, I guess…"—Late Elder Tommy Noberg*

As a potential solution, harvesters suggested it would be useful to have education programs on caribou harvesting that would connect harvesters who want to learn with experienced harvesters who want to teach. Topics should include selecting appropriate animals (type and species) related to season and population statuses, safe butchering and carcass handling practices, recognizing what is safe to eat, etiquette around sharing, harvest quantity, as well as general camping skills (e.g., collecting safe drinking water and travelling safely on land, water, and ice). Harvesters said these programs should include support and/or coordination by/between the Kugluktuk Angoniatit Association and Government of Nunavut. Further, they emphasized the importance of including hands-on learning activities (e.g., on-the-land camps).

> *"I mean … if a young hunter doesn't know about, normal antlers? In the wintertime? If you can't tell the difference between a, a, a bull and a … a cow? With no more antlers in it, you know, he might shoot the bull that been the breeder for, how long or whatever, you know? And he had good strong genes… you know, so they might shoot the, shoot the one that, you know … handing out his strong genes. That that hunter couldn't tell the difference between a bull and a … and a female or whatever, you know? 'Cause, I mean, I can tell you who I think they are, you know?"—Late harvester Jorgen Bolt*

3.2 Synthesis of disparate data sources on the DU caribou herd

In the data synthesis, it became apparent that the different sources of knowledge were connected to specific areas of observation and methods. Thus, each study was connected to a particular seasonal and spatial context that aligned with a particular aspect of caribou ecology. Kugluktuk knowledge was connected to their caribou harvesting by boat and all-terrain vehicle during the late summer on Victoria Island (before rut) and on the mainland by snowmobile in the spring (before migration) and fall (after migration) (Dumond, 2007; Hanke et al., 2021). Ekaluktutiak knowledge matched with their caribou harvesting by snowmobile on Victoria Island and mainland in the spring (after migration), by snowmobile on Victoria Island in the fall (before migration), and sometimes by quad on Victoria Island in the summer (Bates, 2006; Environment and Climate Change Canada, 2018; Hanke et al., 2021). Population surveys were completed by plane along the southern coast of Victoria Island while the caribou aggregate during their fall rut (Nishi and Gunn, 2004; Dumond and Lee, 2013; Leclerc and Boulanger, 2018, 2020; Campbell et al., 2021). The context for each knowledge source functions similar to results from the interviews, that harvesters know caribou through their experience and personal background, and was needed to interpret the data and make connections for the synthesis.

The synthesized abundance data display a general abundance increase until around the 1990s and decrease after around the 2000s (Figure 7). The Traditional knowledge trends showed different peaks for Kugluktuk (approximately mid-to-late 1980s), Ekaluktutiak (approximately 1990 to mid-2000s), and Ulukhaktok (approximately 1990s), and all communities observed the most caribou when caribou were closest [this paper; Tomaselli et al., 2018; Hanke et al., 2021; Hanke and WMAC (NWT), 2023]. The synthesis of abundance and spatial data indicates that Kugluktuk (this paper; Hanke et al., 2021) and Ulukhaktok [Hanke and WMAC (NWT), 2023] saw an eastern shift in caribou distribution while Ekaluktutiak (Tomaselli et al., 2018; Hanke et al., 2021) and population censuses (Nishi and Gunn, 2004; Leclerc and Boulanger, 2018, 2020) described a western shift in the eastern edge of the caribou distribution (Figure 8). The numbered notes with spatial observations from other studies support these same shifts in distribution (Gunn et al., 1997; Thorpe et al., 2001; Nishi and Gunn, 2004; Leclerc and Boulanger, 2018, 2020; Tomaselli et al., 2018). The concurrent distribution shifts suggest that the caribou distribution contracted alongside the abundance decline after approximately the 2000s.

4 Discussion

In 1976, the Government of Canada ratified the International Covenant on Economic, Social, and Cultural Rights (United Nations General Assembly, 1999). This treaty affirms the right to adequate food as a fundamental human right, including "sufficient quantity and quality to satisfy dietary needs, free from adverse substances, and acceptable within a given culture" (United Nations Economic and Social Council, 1999). In 2015, the Inuit Circumpolar Council Alaska (2015) developed a conceptual model of Inuit food sovereignty that defines food security as environmental health determined through availability, stability, accessibility, health and wellness, Inuit culture, and decision-making power and management. These aspects of environmental health are supported by policy, knowledge sources, and co-management, held together by *Sila* (i.e., the spirit of everything), and uplifted by food sovereignty (Inuit Circumpolar Council Alaska, 2015). Within this context of Inuit food sovereignty, we discuss how our results contribute to each dimension of environmental health and the tools available to support their stability.

4.1 Dimensions of environmental health

Availability, stability, and accessibility are reflected in the main ecological findings of this study. The knowledge keepers' reports on caribou abundance and if the caribou are around for harvesting comments on caribou availability (e.g., a biodiverse ecosystem). Seasonality is a big component of availability – for caribou, this may relate to their migratory, rut, and calving cycles. Caribou stability (e.g., the ability to adjust to shifts within the ecosystem) is then shown through their changing abundance, distribution, diseases, and predation. For Inuit, availability may relate to their seasonal harvesting, e.g., Kugluktukmiut harvest char in early summer (Falardeau et al., 2022), DU caribou in late summer/early fall on Victoria Island, DU caribou in late fall on the mainland (this paper), muskoxen in the winter (Di Francesco et al., 2021), and so on. Inuit

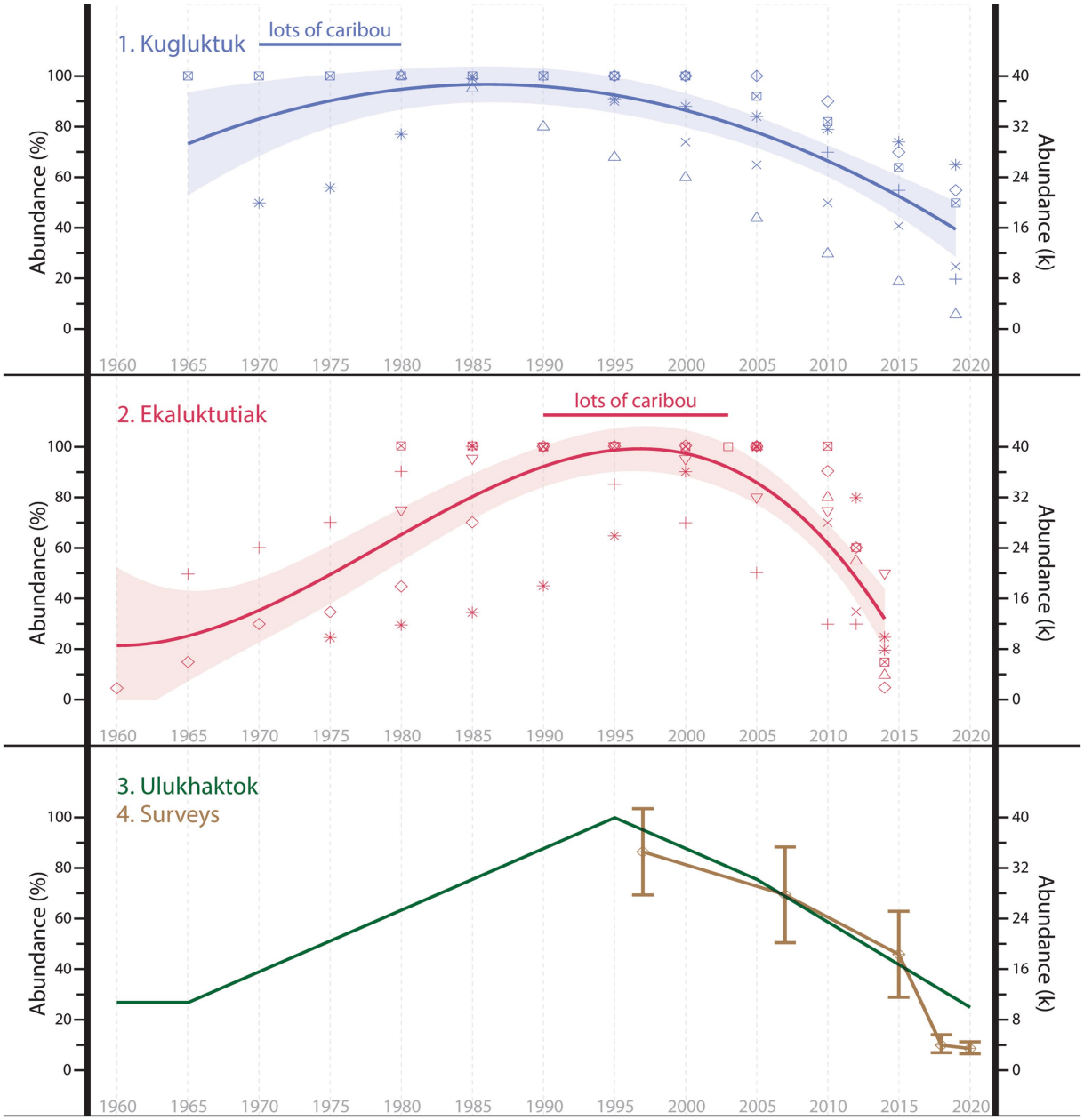

FIGURE 7
Digitized and extracted abundance data on the DU caribou herd. The top panel are relative data from Kugluktuk, including the proportional piled data and trend line from this paper and a report of a lot of DU caribou from Hanke et al. (2021). The middle panel are relative data from Ekaluktutiak, including the proportional piled data and trend line from Tomaselli et al. (2018) and a report of a lot of DU caribou from Hanke et al. (2021). The bottom panel are relative data from Ulukhaktok [Hanke and WMAC (NWT), 2023] and the survey abundance estimates from 1997 (Nishi and Gunn, 2004), 2007 (Dumond and Lee, 2013), 2015 (Leclerc and Boulanger, 2018), 2018 (Leclerc and Boulanger, 2020), and 2020 (Campbell et al., 2021).

adapt to these seasonal changes in availability by adjusting their harvesting locations, timing, and species, thus connecting Inuit availability to stability. The resulting ability of people to access caribou is an aspect of harvesters' accessibility (e.g., the ability to live off the land), compounded by migratory caribou behaviour, shifting caribou range, climate change (e.g., reduced sea-ice season), and harvester resources (e.g., transportation, seasonal camps). In conjunction, the declining DU caribou abundance, reduced range, increased disease, and looming predation are all related to the caribou's availability and accessibility. Availability, stability, and accessibility aspects of environmental health are particularly hard to discuss in isolation. Gagnon et al. (2023) had a similar conclusion, finding that Inuit ability to meet their needs in caribou was influenced by complex relationships among environmental conditions, trends in caribou demography, and cultural traditions: e.g. they found that caribou being close to community did not impact caribou availability if there wasn't snow suitable for travel. Additionally, our results showed that economic conditions can and do limit harvester accessibility to caribou: e.g. competing harvest versus wage jobs or needing gas money for travel. Managing the DU caribou herd under the Inuit food sovereignty

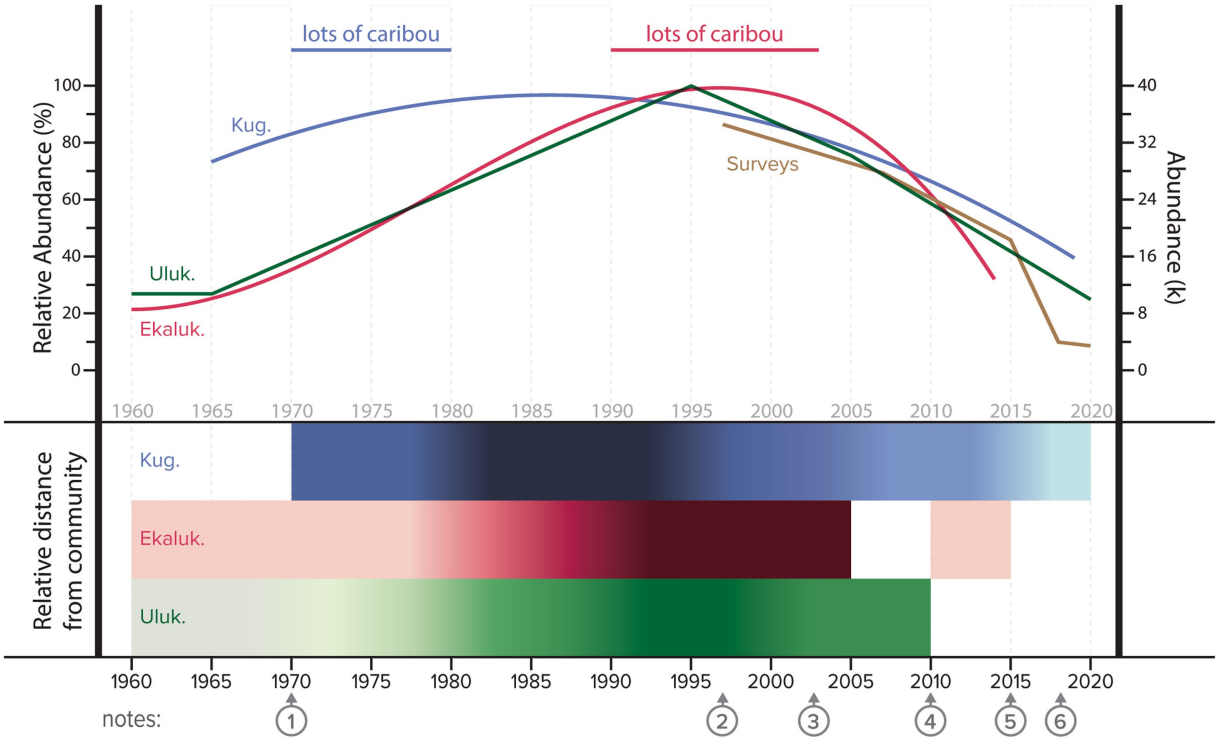

FIGURE 8
Synthesized abundance data and gradient bars showing relative DU caribou distance from community. Notes: ① Sighting on mainland near Umingmaktok (Gunn et al., 1997), ② highest density east of Ekaluktutiak (survey) (Nishi and Gunn, 2004), ③ decline in numbers near Kugluktuk (interviews) (Hanke et al., 2021), ④ decline in numbers near Ekaluktutiak (interviews) (Tomaselli et al., 2018), ⑤ lower density in eastern range (survey) (Leclerc and Boulanger, 2018), ⑥ lower density in northern and eastern range (collar data and survey) (Leclerc and Boulanger, 2020).

framework means that availability, stability, and accessibility of caribou must be understood through harvester accessibility.

Health and wellness components of environmental health are reflected in the harvesters' reports on caribou diseases. These reports are followed by the consequential impacts on human health if the diseases can be passed to people (zoonoses) and the mental strain of discarding carcasses or worrying about their family's safety. Knowledge keepers described several disease syndromes and concerns about diseases with respect to impacts on food safety (transmission of disease from country foods to people), mental strain (conflicts in harvesting and meat handling practices) and food availability (impacts on caribou population dynamics).

Harvesters from Kugluktuk (this paper; Hanke et al., 2021) reported observations of swollen front leg joints starting in 1980s, a description consistent with *Brucella suis* biovar 4. Similar observations in the DU caribou herd were reported by Ekaluktutiak harvesters (Tomaselli et al., 2018; Hanke et al., 2021). *Brucella* is a zoonotic bacterium (Aguilar et al., 2022), thus its apparent increase in the DU caribou herd represents a risk to food safety. On the other hand, the presence of harmless nose bot larvae or non-zoonotic *Taenia* (tapeworm) cysts in caribou carcasses can give the meat a displeasing appearance, and, in some cases, would lead harvesters to discard the meat. While harvesters are taught to never take risks when it comes to food safety, these larvae do not pose a risk to human health and discarding of meat in this case raised concern among Elders with respect to the knowledge base of less experienced hunters. Calls from knowledge keepers to improve/increase hands-on learning opportunities for harvesters are not unique to this work (e.g., Inuit Circumpolar Council Alaska, 2015, 2020; Mearns, 2017; McGrath, 2019), but, indeed, educational programs could help less experienced harvesters avoid unnecessary discard and ease the mental strain on more experienced harvesters who are faced with this conflict. Increasing opportunities to train harvesters connects the health and wellness dimension to the Inuit culture dimension of environmental health by contributing to the education system and the passage of knowledge, thus could support the stability of both dimensions (Inuit Circumpolar Council Alaska, 2015).

Harvesters also recognized the potential impact of diseases on caribou populations, and thus food availability. Two diseases that knowledge keepers identified as increasing near the population peak and decline, brucellosis and besnoitiosis, can have detrimental effects in caribou. *Brucella suis* biovar 4 can cause reproductive impairment, reduced mobility, and reduced survival, and has been documented during some caribou herd declines (Ferguson, 1997; Carlsson et al., 2018; Aguilar et al., 2022). A subset of 82 DU caribou tested in 1991 were negative for this bacterium, but more serological surveys (16.3% from 2015 to 2021) and observations by harvesters in Kugluktuk and Ekaluktutiak indicate that it is now present in the herd at a relatively high prevalence (this paper; Gunn et al., 1991; Tomaselli, 2018; Hanke et al., 2021; Fernandez Aguilar et al., 2023). Similarly, *Besnoitia tarandi,* a protozoan parasite, is present and increasing in the DU caribou herd, as evidenced by results from sample analyzes (7% of DU caribou sampled in 1987–1990; 41.0% of caribou sampled between 2016–2019) and harvester reports of a sandpaper-like feeling in

Kugluktuk (starting in 1990s) and Ekaluktutiak (starting in 1980s–1990s with a stable or increasing rate between 1990 and 2000) (this paper; Gunn et al., 1991; Tomaselli et al., 2018; Hanke et al., 2021; Fernandez Aguilar et al., 2023). This parasite was implicated in reduced mobility, reduced survival, and reproductive impairment when it emerged in the Leaf River migratory woodland caribou herd (*R. t. caribou*) of Quebec, Canada (Ducrocq et al., 2013; Taillon et al., 2016). Prevalence increased from 30% of caribou sampled in 2007 to more than 80% of caribou sampled in 2011, and the herd subsequently declined from 600,000 caribou in 2001 to 199,000 in 2016 (Ducrocq et al., 2013; Taillon et al., 2016; COSEWIC, 2017b). While the roles of *Besnoitia* and *Brucella* in caribou population dynamics are not fully understood, the clear impacts on individuals and the association between their emergence and population declines warrant further consideration.

The cultural component of food sovereignty was reflected in harvesters' detailed explanations of place-based context and understanding the world within their personal experience and background (e.g., harvesting to learn to be within and part of their environments). Their astute reflections of caribou emplaced within their own areas of observation and experience demonstrates how their Traditional knowledge is located within their understanding of themselves as apart and within their ecosystems. Country foods, and the harvesting, gathering, and preparation of, is a pedagogy – that is how Inuit learn cultural values, skills, spirituality, and to be apart and within their ecosystems (Collignon, 2006; Inuit Circumpolar Council Alaska, 2015; McGrath, 2019). Similar to the harvester variability within Kugluktuk, the data synthesis showed how communities, researchers, and biologists interact with (i.e., access) caribou at different times of the year and different parts of their range resulted in apparently contrasting information. Closer analysis found that all communities observed the most DU caribou when the DU caribou herd was closest. This finding broadens the support of an interconnection of knowledge and location as the knowledge is created and passed down within and as a part of the ecosystems (consistent with findings from Martinez-Levasseur et al., 2017; Gagnon et al., 2023). As a result, we saw variability in the reports around caribou availability, caribou accessibility, and harvester accessibility. The articulation of these nuances can help non-Inuit understand their Traditional knowledge and, additionally, help centre Traditional knowledge in decision-making.

Finally, this paper's Inuit-described metrics of caribou status and synthesis of different information sources creates avenues and examples of how Indigenous knowledge can be centred in decision-making power and management (e.g., using Indigenous knowledge in collaboration with other knowledge systems). Monitoring wildlife is an important conservation strategy used to detect changes in the environmental health and the resulting availability, stability, and accessibility of wildlife (Inuit Circumpolar Council Alaska, 2015; Ostertag et al., 2018; Peacock et al., 2020). Changes may be assessed by indicator (e.g., abundance, distribution) and evaluated according to their metrics (e.g., aerial survey estimates, Indigenous knowledge relative abundance counts) (Peacock et al., 2020). Recent Inuit-led strategies emphasize the importance of relying on Inuit-described indicators for solution-and Inuit-driven actions (Inuit Tapiriit Kanatami, 2018; Inuit Circumpolar Council Alaska, 2020; Qanuippitaa, 2021). Researchers have responded to these calls; e.g., beluga health indicators, such as body condition, illness, and disease were developed and informed by Indigenous and Western knowledge (Fisheries Joint Management Committee, 2013; Ostertag et al., 2018). Similarly, Fox et al. (2020) co-produced environmental indicators by synthesizing information from weather stations, interviews, and discussions (Fox et al., 2020).

The Inuit-described metrics of this paper provide measures for the indicators of abundance, distribution, and health. Triangulating these sources of knowledge with others can strengthen our confidence with respect to the status of the indicator: e.g. the aerial population censuses and Traditional knowledge relative abundance data both indicated a decline in abundance since around the 2000s (Figure 7); the Traditional knowledge on signs of brucellosis and besnoitiosis suggested emergence of these two pathogens in the population, observations that were further supported by lab analyses of tissues from caribou harvested through a community-based caribou health surveillance program (Fernandez Aguilar et al., 2023). These Inuit-described metrics provide a framework that can be used to guide data collection and Traditional knowledge documentation. Alone, or combined with other information, these Inuit-described metrics provide wildlife managers with insights into caribou population status and trends. These metrics also provide specific examples to management and public health partners of how Indigenous knowledge can guide continued wildlife monitoring, and, thus, management decisions to support the longevity of wildlife populations (food security) (Zimmermann et al., 2023).

4.2 Tools to support environmental health

Policy, co-management, and knowledge sources are three tools used to support environmental health, and thus food security (Inuit Circumpolar Council Alaska, 2015). The results of our synthesis can be incorporated into existing wildlife management frameworks, like those defined in the management plan for the DU caribou herd. This policy guides the conservation of the DU caribou herd and outlines sets of management strategies for different population levels (Environment and Climate Change Canada, 2018). The population levels are spilt into low population (< 8,000 or 20% of peak abundance), increasing or decreasing population (8,000–24,000 or 20%–60%), and high population (> 24,000 or 60%) based on the report's assumption that the peak caribou abundance was 40,000 (a.k.a. 100% of abundance) (Environment and Climate Change Canada, 2018). The synthesized abundance data presented in this study, which includes both quantitative (population censuses) and qualitative (% of maximum) data, can be superimposed over the management categories to help guide evidence-informed decisions regarding management strategies.

Knowledge keepers also described a geographic range for the DU caribou herd that is greater than that represented on the official range map (Figure 9) (Environment and Climate Change Canada, 2018); this new knowledge source can, and should, be used to update the range maps for this herd. Caribou herds with restricted distributions are of higher conservation risk (Lucas et al., 2019) and at risk of higher cortisol levels (Ewacha et al., 2017), restricted genetic flow (Thompson et al., 2019), reduced resilience to predation (Lesmerises et al., 2019), and higher susceptibility to rain-on-snow events (Macias-Fauria and Post, 2018). A range map that reflects the deep historic knowledge shared by knowledge keepers in this study is important to ensure that

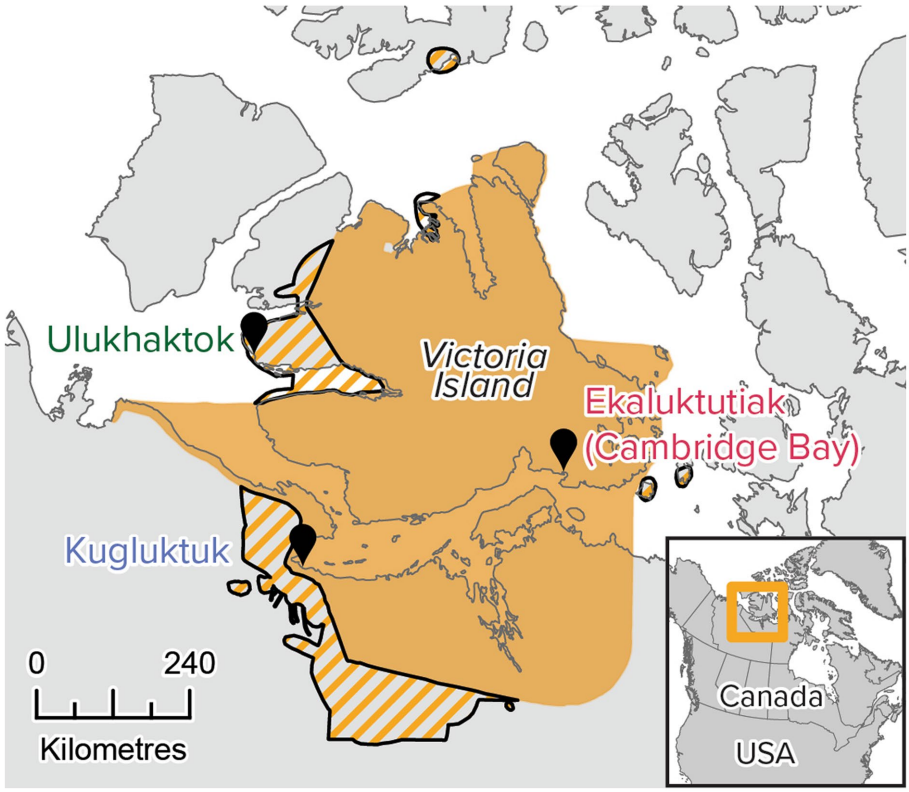

FIGURE 9
The DU caribou herd range (Environment and Climate Change Canada, 2018) with added hatched areas used by the DU caribou herd based on interviews in Kugluktuk (this paper; Hanke et al., 2021) and Ulukhaktok [Hanke and WMAC (NWT), 2023].

habitat protection extends across the entire land and water needed by the DU caribou herd throughout their annual and decadal population cycles. Encouragingly, the Species at Risk Committee (NWT) (2023) recently expanded their range map to reflect Traditional knowledge from Ulukhaktok (from Kuptana, 2022 as cited in Species at Risk Committee, 2023) and Kugluktuk (this paper).

In relation to wildlife co-management, information must be accessible to decision-makers in order for them to incorporate it into their decisions (Inuit Circumpolar Council Alaska, 2020). We shared these observations of changing caribou behaviour and distribution throughout our numerous presentations with the co-management partners. These results, alongside many important member contributions, led to the Government of Nunavut modifying the most recent survey to include a larger area so they could see whether the survey area is representative of the herd (Campbell et al., 2021). The results between the 2018 and 2020 surveys did not differ significantly, but they found caribou in locations where results were previously only extrapolated (Victoria Island) or not included (Kent Peninsula) (Campbell et al., 2021). The collaborative process of redesigning the survey seemed to have improved relationships among co-management partners and increased community's confidence in the survey results (Campbell et al., 2021). Additionally, Canadian Coast Guard's (2020) Notice to Mariners adjusted their recommended shipping practices and reporting requirements to protect the sea-ice needed for travel by the DU caribou herd and harvesters (this paper; Hanke et al., 2021). This decision adopted Traditional knowledge to regulations used at the federal level to protect the migration paths of caribou and the livelihood of harvesters. These results were considered in the Nunavut Wildlife Management Board's decision to support a Total Allowable Harvest (Nunavut Wildlife Management Board, 2020, 2022a) and the federal uplisting to Endangered (Nunavut Wildlife Management Board, 2022b) as well as the NWT Species at Risk Committee's (2023) reassessment of the DU caribou herd as Endangered. These trio of decisions were based on the best available information generated from both Traditional and Western knowledges – connecting the tools of co-management and knowledge sources.

Going further into knowledge systems, the Species at Risk Committee in NWT recently restructured their process for assessing species-at-risk to allow for the "meaningful consideration of both Indigenous and scientific knowledge" (Singer et al., 2023, p. 2). The restructure introduced dual assessments, one component for Indigenous knowledge and one for scientific knowledge, and the final assessment recommendation is consensus-based and supported by evidence from either or both of the dual assessments (Singer et al., 2023). Importantly, this new process offers a way to validate each knowledge claim within their respective knowledge system, promotes cross-cultural communication and learning, and gives confidence to each member that their expert knowledge is included within the assessment and validated in a meaningful way (Singer et al., 2023). Our research approach perhaps complicates the division line used to separate the dual assessments. We have used quantitative, semi-quantitative, and qualitative data in this paper to learn about the DU caribou herd from Inuit and Western knowledge systems. Inuit were instrumental in sample design and collection for health analyses

included in the discussion and their knowledge was central to designing the abundance survey (Nishi and Gunn, 2004; Fernandez Aguilar and Kutz, 2020; Campbell et al., 2021). Traditional knowledge was documented through interviews and analysed with different qualitative methods (e.g., this paper; Tomaselli et al., 2018). It would take a much longer discussion than there is space for in this paper to piece together the cultural differences, similarities, and merges within the data sources available for the DU caribou herd. However, these different ways of triangulating metrics can increase understanding for social-ecological system resilience (Salomon et al., 2019; Gagnon et al., 2023), provides examples of how to access multiple ways of thinking, and, ultimately, bolsters opportunities for Inuit food sovereignty through species management and recovery.

5 Conclusion

Sila, translated as "the spirit of everything," holds together food security and environmental health, its dimensions, and the tools used to support its stability (Inuit Circumpolar Council Alaska, 2015, p. 19, 2020). *Sila* is a complicated term to define in English, but it could be understood as "the life-giving element, which enfolds all the world and invests all living organisms, and without which there can be no life" (Williamson, 2013, p. 22). Included in *Sila* is an understanding that the ecosystems exist without divisions, and impacts in one place ripple throughout – e.g. an impact to caribou availability may be felt through Inuit mental health (Cunsolo et al., 2020; Borish et al., 2021) or wolf availability (Klaczek et al., 2016). Inuit food sovereignty uplifts this entire food security system, yet there are barriers that prevent its full expression (Inuit Circumpolar Council Alaska, 2020). The Inuit Circumpolar Council Alaska (2020) used Inuit perspectives to examine the legal framework of co-management in Alaska and the Inuvialuit Settlement Region. They defined various calls-to-action including to place Inuit knowledge and Inuit rules, laws, and practices foremost in decision-making for the sake of Inuit food sovereignty (Inuit Circumpolar Council Alaska, 2020).

The results from our research respond to this call-to-action and address its various identified needs or spaces for improvement (Inuit Circumpolar Council Alaska, 2020). We wrote the Traditional knowledge down and systematically analyzed it with methodologies and methods consistent with Inuit values of respect, collaboration, and sharing. Written documentation is one strategy to make Indigenous knowledge available to more people involved in decision-making and to combat the tendency of Indigenous knowledge being considered anecdotal (Inuit Circumpolar Council Alaska, 2020; Wheeler et al., 2020). By understanding abundance through life histories of harvesters and caribou, we directly addressed a well-known methodological conflict between survey abundance counts and Indigenous knowledge understood phenomena that caribou numbers are supposed to vary annually, through sometimes unstable cycles, and as a function of migration (Martinez-Levasseur et al., 2017; Inuit Circumpolar Council Alaska, 2020). Our collaborative partnerships and guidance from knowledge keepers through the staggered interviews with multiple rounds of feedback resulted in research that was community driven. This research provides an example about equitable inclusion of Indigenous knowledge and equitable partnerships in community-based monitoring or co-management. These methods also created many opportunities for sharing, cooperation, and ensuring that the results were meaningful and accessible to communities for making decisions and to support food sovereignty. Collaborative research and assessment strategies have supported the expression of Inuit food sovereignty (this paper; Tengö et al., 2017; Gagnon et al., 2023; Singer et al., 2023). Continued collaborative, respectful, and reciprocal actions genuinely have the potential to move conservation towards a more equitable future of Indigenous self-determination.

Power relations and colonialism continue to weigh heavily on the discussion and actions towards equitable environmental governance and Inuit food sovereignty (Nadasdy, 2005; Snook et al., 2020; Zimmermann et al., 2023). These issues are well documented, including the dominance of Western cognitive processes (Collings et al., 2018; Ljubicic et al., 2018), failure to implement land claims agreements (Berger, 2005), lack of administrative independence for co-management boards (White, 2018), and the scientization of decision-making (Tester and Irniq, 2008; Hessami et al., 2021), among others. The focus of this paper on documenting what Inuit knew about DU caribou abundance, distribution, and health was its own negotiation among the research partners and contributors to the study. Ultimately, we emphasized qualities such as written knowledge (versus oral) and ecological facts (versus broader Inuit knowledge) that our team thought could be helpful to the current co-management system looking after these animals. We attempted to balance this skew towards characteristics of Western knowledge with our methodology and methods, such as having multiple sessions with the harvesters, heeding guidance offered by the harvesters and the Kugluktuk Angoniatit Association, and highlighting the interconnections among the results and to the land. While our research may act as an example of transdisciplinary research among academia, government, and Inuit, we look forward to the continuing conversations around, and improvements to, collaborative wildlife conservation.

The larger problematic power relations at play in environmental governance (i.e., Wheeler et al., 2020; Robertson et al., 2023) are set up by the formal and informal legal systems (Coates, 2020; Colombi Ciacchi and von der Pfordten, 2023). Promisingly, legal systems are psychological in nature and are constantly changing alongside society (Ogloff and Schuller, 2001; Coates, 2020). There are many calls to transform governance approaches, from Indigenous to state to international governance, introducing terms such as multispecies justice (Celermajer et al., 2021), planetary health (Redvers et al., 2022), Indigenous environmental justice (McGregor, 2018; McGregor et al., 2020), Indigenous climate justice (Whyte, 2018, 2020), ethnogeographies (Reibold, 2022), inherent dignity (Youngblood Henderson, 2019), and ecosystem-based management (Fisher et al., 2022; Wienrich et al., 2022). Commonalities among these suggestions return environmental governance to include interconnected networks of beings with no division between culture and nature. This approach is called biocultural conservation in Wheeler and Root-Bernstein (2020) and is perhaps consistent with Inuit knowledge and legal systems (Aupilaarjuk et al., 2017; Laugrand and Oosten, 2018). Continuing to attune research and the down-the-stream decision-making to politics/power relationships and emphasizing social learning may lead to unique, topic/geographic specific governance models (Bohensky and Maru, 2011; Fisher et al., 2022).

Data availability statement

The datasets presented in this article are not readily available because of the nature of this research and its focus on Indigenous knowledge. The participants of this study did not consent for their data to be shared publicly beyond what is included in the paper. Supporting data are not available. Requests to access the datasets should be directed to SK, https://vet.ucalgary.ca/contact-us/susan-kutz.

Ethics statement

The studies involving humans were approved by Conjoint Faculties Research Ethics Board at the University of Calgary (REB17-2427) and licensed by the Nunavut Research Institute (04 013 23R-M). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Ethical approval was not required for the study involving animals in accordance with the local legislation and institutional requirements because the primary data in this paper was obtained from humans. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

AH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. AND: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft. JDF: Data curation, Investigation, Methodology, Project administration, Resources, Validation, Writing – original draft, Writing – review & editing. CA: Conceptualization, Formal analysis, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. TM: Conceptualization, Data curation, Investigation, Methodology, Project administration, Validation, Writing – original draft. L-ML: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. BM: Conceptualization, Methodology, Project administration, Supervision, Validation, Writing – original draft. RN: Conceptualization, Methodology, Project administration, Visualization, Writing – original draft. AR-C: Conceptualization, Methodology, Writing – original draft. GB: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. SK: Conceptualization, Data curation, Funding acquisition, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1306521/full#supplementary-material

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EDITED BY
Michele Filippo Fontefrancesco,
University of Gastronomic Sciences, Italy

REVIEWED BY
Russell Hedberg,
Shippensburg University, United States
Rita Calvário,
University of Coimbra, Portugal

*CORRESPONDENCE
Juliana Merçon
✉ jmercon@uv.mx

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Embroidering care and reciprocity: contributions to food sovereignty by feminist peasant women from the mountains of Veracruz, Mexico

Thelma Mendes Pontes[1], Juliana Merçon[2]*, Citlalli López Binnqüist[1], Carlos Roberto Cerdán[3], Gisela Illescas Palma[4], Denisse García Moreno[5], Mónica Severiano Hernández[5] and Helda Morales[6]

[1]Centro de Investigaciones Tropicales, Universidad Veracruzana, Xalapa, Mexico, [2]Instituto de Investigaciones en Educación, Universidad Veracruzana, Alianza de Mujeres en Agroecología, Xalapa, Mexico, [3]Facultad de Ciencias Agrícolas, Universidad Veracruzana, Xalapa, Mexico, [4]Vinculación y Desarrollo Agroecológico en Café, Gerente de Femcafé, Movimiento Agroecológico Latinoamericano y del Caribe, Ixhuatlán del Café, Ixhuatlán, Mexico, [5]Vinculación y Desarrollo Agroecológico en Café, Ixhuatlán, Mexico, [6]Colegio de la Frontera Sur, Alianza de Mujeres en Agroecología, San Cristóbal de Las Casas, Chiapas, Mexico

Different authors from academia and social movements point to agroecology as a path to food sovereignty and as a way out of multiple social-ecological crises. Peasant feminism (*feminismo campesino*) informs the daily practice of women, and has contributed to broaden the meanings of food sovereignty as a political framework. Vinculación y Desarrollo Agroecológico en Café (VIDA) is a Mexican coffee growers' organization that is centrally guided by principles of agroecology, food sovereignty, and peasant feminism. A transdisciplinary study held with VIDA members shows how food sovereignty is based on more dimensions than the official ones. In this paper, we use the Mexican art of embroidery as an integrating metaphor to analyze how female coffee growers' practices around integral health, food gathering, and bartering contribute to food sovereignty. Our intention is also to analyze how these activities expand from the family unit to the territory, as well as from human to more than human beings. Based on their agroecological knowledge and practice, VIDA's feminist peasant women invite us to consider agroecology and food sovereignty as key dimensions of Earth stewardship.

KEYWORDS

food sovereignty, peasant and popular feminism, food gathering, bartering, integral health

1 Introduction

Climate change, the dominant agricultural model and its drive for hyperproductivity, the energy crisis and the precariousness of labor are serious problems of the current food system (Giraldo, 2022). Against this backdrop, various scholars support the peasant, black, feminist and indigenous movements (Vivas, 2012; Nyeléni, 2014; LVC, 2015, 2021; Shiva, 2016;

Montoto, 2017; Montano Morales, 2021)[1] that point to agroecology as a path toward food sovereignty as a way out of the current food system problems and other social-ecological crises.

Food sovereignty is a political framework proposed by the international peasant organization La Via Campesina (LVC). It emerged in 1996 as a response to the concept of food security (LVC, 2015) put forward by the Food and Agriculture Organization of the United Nations (FAO). Based on notions of poverty and scarcity, food security is denounced by Colombian indigenous movements as an exercise of welfarism and power over biocultural territories (Montano Morales, 2021). In contrast, food sovereignty offers a new paradigm with the strategic objective of creating alternatives to neoliberal policies based on local cultural, political, and economical systems (Nyeléni, 2014).

The food sovereignty framework recognizes an agriculture linked to the territory, oriented to local and national markets, and that takes life as a central concern. It promotes autonomy by valuing peasant and indigenous' ways of production and management of the territory, common goods, knowledge, and organizational forms (LVC, 2016). Agroecology and food sovereignty advocate for political equality, which implies an end to the various forms of physical and structural violence to which women are subjected (Nyeléni, 2014; LVC, 2015). Thus, women's and children's rights are key issues for the current debate on food sovereignty (Nyeléni, 2017).

Since 1996, organized women have promoted a strong gender perspective in the initiatives and decision making within LVC, so that their rights are recognized as central to the food sovereignty of the household and the community (LVC, 2021). Regarding contributions to the concept, it was women who raised the banner of food sovereignty as a right (Montoto, 2017), pointed to the dimension of human health (Vivas, 2012), and argued that peasants and indigenous peoples have the right to produce their own food in their territory, recognizing their role as guardians of seeds (LVC, 2021). Through the construction of peasant and popular feminism, they integrated gender issues, the full demand for human rights, actions to combat violence in rural areas and gender equity within peasant organizations (LVC, 2021).

The United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas (UNDROP) was published in 2020. It is a legal document that recognizes the identity linked to the ways of producing, being and relating with people and nature (LVC, 2021). This document focuses on all rights anchored in food sovereignty and proposes feminist agrarian reform. In the construction of this declaration, peasant women uncompromisingly defended collective and organizational rights, seeds, land and territory, the right to ancestral knowledge and wisdom, the defense of biodiversity and the participation of women and youth in related issues (LVC, 2021).

Despite the mentioned contributions to feminist struggles, the final text of the UNDROP does not directly address several key gender equality issues. As Claeys and Edelman (2020) point out, the document does not discuss the right of women to inherit land; equality in family relations; sexual and reproductive health and rights; the disproportionate burden of reproductive and productive work; and gender identity and discrimination. Furthermore, it does not directly mention patriarchy as a source of structural oppression, which debilitates its political nature. These limitations are mainly due to the "counter-mobilization" by conservative government alliances and supportive non-governmental actors to oppose the development of feminist human rights policies (Claeys and Edelman, 2020).

Considering that the concept of food sovereignty is still under construction, it can benefit from numerous experiences that integrate it, and critically reflect on it to generate contributions that strengthen it. This has been the case of the contributions made by the Andean indigenous peoples who, based on the paradigm of abundance and liberation of Mother Earth, join the proposal of food sovereignty by conceptualizing food autonomy (Montano Morales, 2021).

The perspectives of peasant and popular feminism that have contributed to broaden the meanings of food sovereignty as a political framework also constitute the daily life of peasant women in several localities around the word. In Mexico, female coffee growers of the organization *Vinculación y Desarrollo Agroecológico en Café* (VIDA), with whom we collaborated in this study, also show us that food sovereignty is made up of dimensions that are less discussed in official documents, such as spirituality and the emotions around food and territory. Their ways of life based on agroecology, the ethic of care and alternative economies are expressed through diverse practices and daily art such as embroidery. In this article, we take embroidered napkins as an integrating metaphor. During our meetings, embroidered napkins were present in all the kitchens and territories visited. The napkins are a symbol of knowledge and experiences shared by women and among women, they accompany the family when they gather to share food, at the table and in the field, they keep the corn tortillas warm. Through the strength of the material and symbolic presence of the napkins, in this article, the colorful threads of the Mexican ancestral art of embroidery help us to show how the knowledge and practices of the peasant women of VIDA are interwoven with food sovereignty.

The purpose of this paper is to expand previous reflections on how integral health, food gathering, and bartering expand the concept of food sovereignty (Pontes et al., 2021, 2023a,b). We are especially interested in how feminist peasant movements from the Global South contribute to this discussion, as it can directly impact the lives of those people involved in such reflexive and practical process. In sum, this article demonstrates how integral health, food gathering and bartering contribute significantly to food sovereignty as a political framework. These contributions emerge from the experiences and knowledge of peasant women of the organization VIDA, who have embroidered napkins of food sovereignty and shared their words with dignity, love, and transformative strength (Figure 1).

2 Stages of our transdisciplinary research

The study on which this paper is based was carried out in Ixhuatlán del Café and Cosautlán de Carvajal, in the center of the state of Veracruz, Mexico (Figure 2). These localities were selected for the larger number of participants and their higher level of participation in

1 In this article we, feminist authors, chose to highlight female academic authors by citing their first name when they appear for the first time in the text as well as VIDA collaborators by citing their name and age.

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FIGURE 1
The colored threads that make up the food sovereignty napkin. Art by Florencia Rothschild and Thelma Pontes composed of napkins embroidered by Clara Palma (green thread: woman enjoying the territory), Irma Moreno (pink thread: the flower of life), Gisela Illescas (purple thread: strength of a woman), and Briseida Venegas (brown thread: barter), all peasant feminist coffee-growing women.

the processes organized by VIDA. The edible coffee plantations[2] maintained by women of VIDA are located in areas of mountain cloud forest, which offer favorable conditions for the production of shade coffee, with diverse flora and fauna species (Figure 3). Reciprocally, agroecological coffee farming contributes to the recovery and conservation of the benefits provided by this ecosystem (Severiano Hernández, 2021).

Vinculación y Desarrollo Agroecológico en Café is a 30-year-old organization that has women coffee growers in charge of various processes. VIDA[3] is made up of 800 families and has a large participation of women in its cooperative called *Campesinos en la Lucha Agraria* (Farmers in Agrarian Struggle). The women were the driving force behind the transition to

2 According to VIDA AC (2016, p. 10) the coffee grove system is a food forest or agroecosystem [...] where economic viability is not only given by the income generated by coffee but also by the economic and cultural benefits offered by the tree layers, since diverse species can be used as food, medicine, as a product of economic value [...] or as material for construction and firewood. Thus, due to their high diversity, the families organized in VIDA recognize their coffee plantations as edible agroforestry systems. These also represent "life, accessible, nutritious, and varied food, family, health, care and conservation of ecosystems, connection with ancestors, identity, harmony, connection with the Earth, sharing, diversification of income, savings, barter, self-consumption and emotions such as tranquility, peace, happiness and relaxation" (Severiano Hernández, 2021, p. 49).

3 VIDA website: https://vidaycafe.org and social networks: @VIDAVinculacionyDesarolloAgroecologicoencafe.

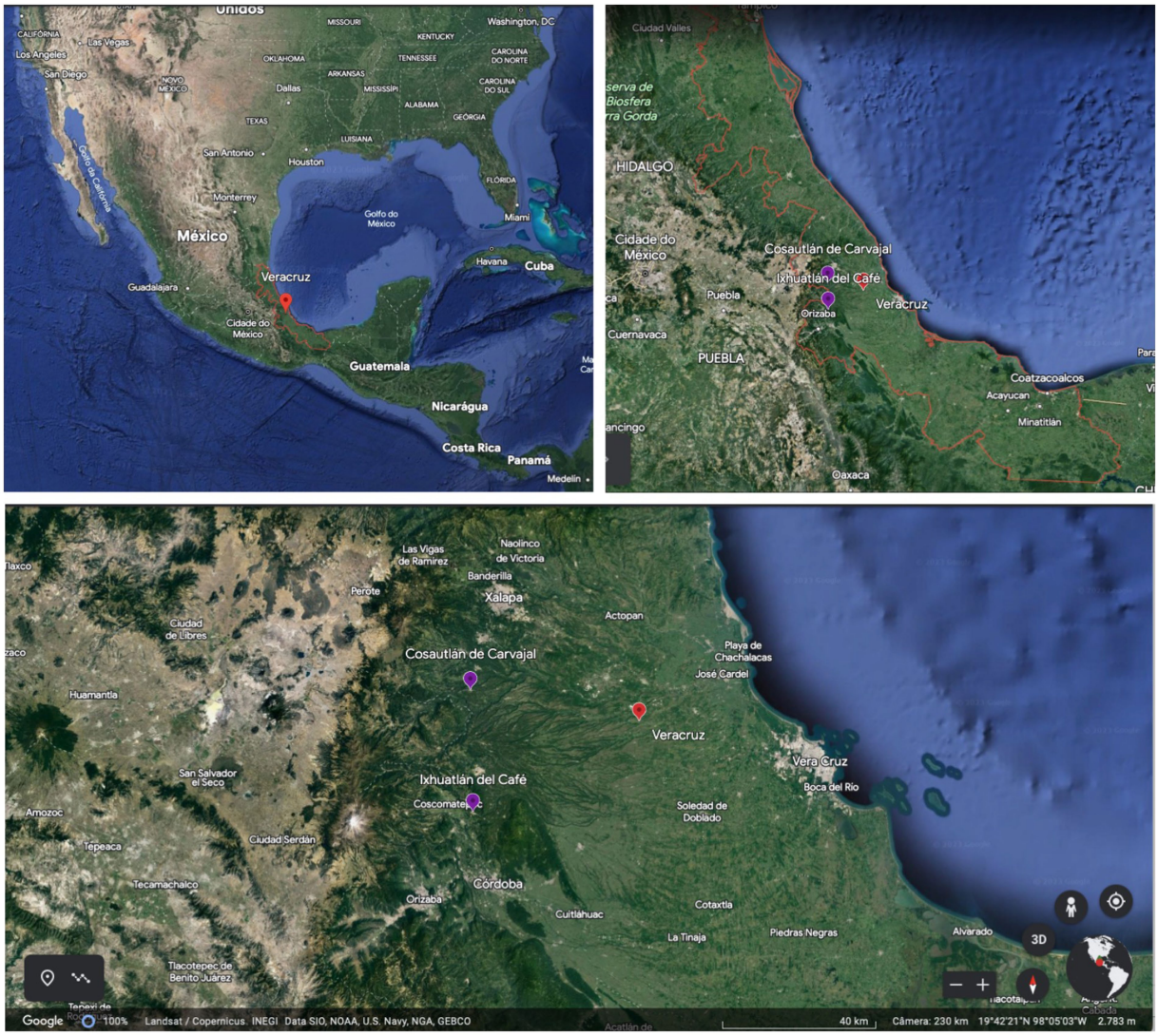

FIGURE 2
Geographic location of the municipalities of Ixhuatlán del Café and Cosautlán de Carvajal, Veracruz, Mexico. Own elaboration using Google Earth images.

FIGURE 3
Edible coffee plantations in the communities of Gusmantla and Ixcatla, Ixhuatlán del Café, Veracruz, Mexico.

agroecology in 1999. Five years later they obtained organic production certification and began exporting high quality coffee.

The transdisciplinary research (Cuéllar-Padilla and Calle-Collado, 2011; Chilisa, 2017; Merçon, 2021, 2022) we conducted puts the voice

FIGURE 4
Meetings with women coffee growers' peasant feminists organized in VIDA, in Ixhuatlán del Café and Cosautlán de Carvajal, Veracruz, Mexico, in 2021.

of coffee women at the center of epistemological production. The research was conducted between 2020 and 2023. Due to the COVID-19 pandemic, virtual meetings were initiated to establish the research team and the co-design of the different stages of the process. In 2020, the concept and practice of food sovereignty was discussed in more depth by VIDA and the first article was collaboratively generated (Pontes et al., 2021). The first face-to-face meetings were held in 2021 (Figure 4), in compliance with security protocols and with a small number of people.

The collaboration took place in four stages (Figure 5). In the first stage we reached agreements around the research team, forms of exchange, and the elaboration of the collaborative texts that would emanate from this research. In the second stage, we conducted two participatory workshops based on the dynamics of World Cafe (Dawkins and Solomon, 2017; O'Connor and Cotrel-Gibbons, 2017). In the workshop, the themes of each table were identified: integral health, food gathering and bartering. Subsequently, three questions were formulated to guide the dialogues on each topic: (1) What is it? How is it practiced? Who does it? Where and when is it done?; (2) Is it linked to food sovereignty? How?; (3) What helps and what hinders this practice? In the third stage, 16 in-depth interviews were conducted around the same themes of integral health, food gathering and bartering to learn about: how these practices are learned and transmitted; the effects of the pandemic; the importance of these practices and their relationship with the coffee plantation, gender and rural–urban links; and the identification of plants.

The narratives derived from the workshops and interviews were systematized for the creation of critical explanations (Holliday, 2006) and discourse analysis (Santander, 2011). This type of analysis conceives communication events and verbal interactions, such as the women narratives, as a social practice linked to their cultural and historical conditions of life.

Eleven women between the ages of 27 and 64 years participated in the collaboration, all of them members of the peasant feminist civil organization VIDA.[4] In addition to growing and commercializing coffee, they make handicrafts and flower arrangements, produce anthurium flowers in greenhouses and in 2022 inaugurated the first Femcafé coffee shop in Ixhuatlán del Café. They cultivate their edible coffee plantations, their milpas, medicinal gardens for herbal medicine, and generate by-products from native bees and maintain five collective brands: *Femcafé*[5] (agroecological and specialty coffee), *Mujer que Sana* (herbal medicine and traditional medicine), *Mujeres de la Niebla* (traditional cuisine), *Familias de la Niebla* (peasant tourism), and *Bordadoras de Vida* (embroidery). In this paper, we included the real names and ages of VIDA women as we present their ideas. This was done with their prior and informed consent.

3 Embroidering food sovereignty

In the following sections, we invite readers to embroider, with the women coffee growers, a napkin for food sovereignty *tortillas*. With the pink thread we will embroider ideas around integral health care, with the green thread the gathering of food and medicinal plants, with the brown thread the barter basket and in the last section of the discussion, with the purple thread, we present a definition of peasant and popular feminism as lived and practiced by the women coffee growers of VIDA (Figure 4). Before exploring the threads of our food sovereignty napkin, we briefly present a reflection on food sovereignty: at the beginning of each workshop, we cocreated a "mystique"[6] and answered *what food sovereignty is for me* to value and recognize the multiple ways in which knowledge is expressed (Figure 6) (Pimbert, 2017).

4 The history of the organization can be found in the article (Pontes et al., 2021).

5 Femcafé website: https://femcafe.mx and its social networks: @mujerquesana, @cafe_femcafé y @cafeteriafemcafe.

6 For the Landless Rural Workers Movement (MST) of Brazil, the "mystique" is a collective ritual that takes place at the start of important gatherings and combines various manifestations (artistic, spiritual and political) through the use of symbols. It has an educational and political connotation, with art being used for political and creative expression through song, dance, rituals, etc. (Lara Junior, 2010).

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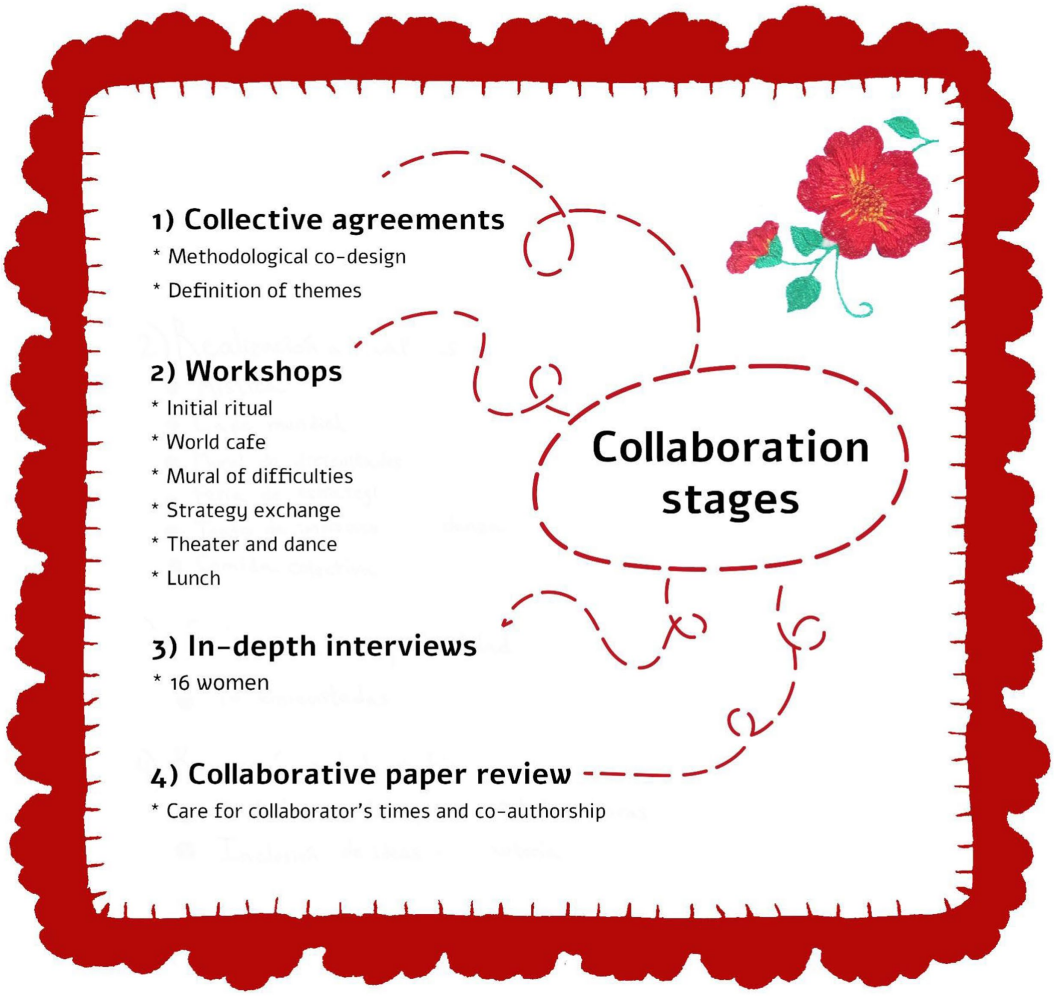

FIGURE 5
Stages of transdisciplinary research and co-production of this study. Own elaboration with art by Florencia Rothschild from a napkin embroidered by Floriberta Jiménez Cruz, herbalist and coffee grower of VIDA, from the community of Guzmantla in Ixhuatlán del Café, Veracruz, Mexico.

3.1 Embroidering hands: women's expressions about food sovereignty

For me food sovereignty is to sow a seed of life and hope, a seed that can be reborn in our hearts, to feed our people, to feed our hope, a seed that gives us vitality, that gives us life, but also a seed that will produce more seeds of conscience to continue sowing our food and harvesting and cooking it, eating and above all sustaining us in the field (Clara Palma, 64 years old).

For many peasant communities, the foundation of their worldviews "resides in the necessary balance between nature, the cosmos, and human beings" (LVC, 2015, p. 16), recognizing that humans are part of nature and the cosmos. As an expression of their spiritual connection with their land and the web of life, the peasant women of VIDA began each meeting with an offering in which each participant placed what she considered to be of greatest social-spiritual value in the center of a circle. The things they presented as an offering ranged from food, medicinal plants, representations of the four elements, as well as objects used for food gathering, production, and cooking. They offered food, seeds, especially coffee beans which are "part of our identity, what makes us be, what makes us feel" (Gisela Illescas, 43 years old), a "molcajete," a "guaje," a "machete,"[7] a flower syrup and many medicinal plants.

As they offered the symbolic elements at the center of the circle, the women expressed their feelings about food sovereignty (Table 1). Emotions generated in the mystique promote the expression of convictions and values held and reinforce group cohesion (Lara Junior, 2010). In addition, the atmosphere generated at this moment allows for the encounter between the sacred and social causes, connecting two fundamental elements: the culture itself and the community environment, attributing new meanings and senses to the things that come from nature and with which

7 Molcajete is a circular mortar made of basalt, used to process food and medicines and to make chili sauces or guacamole. The bule or guaje is made from *Lagenaria siceraria*, a dried gourd from which its contents are extracted and used to contain liquids like a canteen. Machete is a cutting tool, like a long knife.

FIGURE 6
The colored threads representing the knowledge of women coffee growers on integral health, food gathering and bartering as contributions to food sovereignty. Photo-embroidery by Thelma Pontes.

women live and work every day (Lara Junior, 2010). A sense of belonging and collective identity is also reinforced through the mystique (Lara Junior, 2010). For coffee grower women, the mystique also has the following meanings:

The mystique is a way through which spirituality manifests itself. It is also a way of connecting with oneself and womanhood. For us, peasant women, there is a very close relationship between being a woman, food, and food sovereignty. Mother Earth is a woman, at the same time she is the womb that feeds us and she is also part of us. All the elements that are put in the mystique have to do with, from our worldview, with the four elements: water, air, fire, and earth. The fruits symbolize our work with our hands on the earth, the food, and there is also the part of health and other elements of art, such as embroidery. That is to say that it is not something rigid, that is why the altars are so different. Each alter is different, because of what we can offer, we have harvested or we have brought and it is also to share (Gisela Illescas, 43 years old).

Broadening political and epistemological horizons, in the sections that follow, we will seek to contribute to the discussions that expand the concept of food sovereignty. To broaden the concept of food sovereignty and produce a transformation in the field of rights, Micarelli (2018) argues that it is necessary to unlearn hegemonic conceptions of sovereignty and theorize beyond the notion of nation-state. Historically, the concept of sovereignty was born in the Middle Ages in the context of absolute monarchies, in which sovereignty was exercised by the King. In its etymology, the word sovereignty comes from the Latin word *superanus*, which refers to someone who has authority above all others.[8] For Foucault (1996) sovereign power implies obedience to the king, who exercises the power to dispose of the lives of individuals. It is a form of power over lives, both to make die or let live, through control over bodies and space, organizing fixed ties and obligations that bind people to a particular place. In face of these and other historic meanings associated with the notion of sovereignty, Micarelli (2018) proposes that we disconnect the concept of sovereignty from its Eurocentric roots and question the assumptions of an idea of power modeled in terms of the monarch or the state to give rise to plural ways of understanding, feeling and relating to the world. In contrast, she argues that sovereignty is a social creation, aimed at a social, political and cultural order. For example, according to indigenous peoples of the Colombian Amazon, the notion of sovereignty is interpreted as care, protection and responsibility, rather than authority, control and ownership. In these logics, neither land, food, nor common goods belong to human beings; on the contrary, people belong to them, in relations of reciprocity that unite communities and territories. In this living tissue of relationships, nature is recognized as a subject of rights, natural goods are valued by criteria far beyond the economic, and collective work is what makes common life possible (Micarelli, 2018).

In a conversation about the notion of sovereignty, Gisela Illescas, a feminist peasant woman and co-author of this article, argued that this notion has for her a deep meaning of connection, recognition, freedom and unity. "Connection with our own body-territory; recognition of our place in the body-territory; being free from oppressions and neocolonialism (including academic) and unity with ourselves and with everything, including non-human energies." By re-signifying the notion of sovereignty, Gisela Illescas reaffirms the meanings proposed by LVC (2015) around the autonomy of peoples and the necessary union between humans and nature: "Sovereignty obviously comes from a colonial concept, but when it is embraced to talk about food sovereignty it is aimed precisely at freedom, autonomy, connection, and the recognition of the common. When I speak of unity, I am referring to the community and to the connection with Mother Earth" (Gisela Illescas, 43 years old).

8 https://etimologias.dechile.net/?soberani.a

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TABLE 1 Relationships based on the gift in the coffee communities of Ixhuatlán del Café and Cosautlán de Carvajal, Mexico.

Relationship	Meaning	Level	Quotes or Examples
Barter (*Tracaleo* or Change)	Exchange between objects, food, or services that have approximate values[1]	Intrafamily, between families and between communities	"In tracala, sometimes, it may be that mine is worth more than yours, so you have to give me a difference (the edging) (…) for me it was always like that part of saying well, you do not always have to change all for money, there are other ways" (Denisse García, 37 years old).
Cambalache	Exchange between objects or food of the same value	Intrafamily and between families	"Changing one thing for another and that it is worth the same, the same as mine costs, yours costs" (Denisse García, 37 years old).
Faena	Contribute some work that is of benefit to the entire community	Between families	"It is something voluntary that is like an obligation (…), it is like a contribution of work to the community, for the improvement of the community," (Irma). "It is our turn once a year, my husband is never there, so if I have to contribute one hundred pesos so that someone else can represent my husband" (Adriana Quiroz, 35 years old).
Mano Vuelta or *días vueltos*	Support with some seasonal activity	Between families	"For example, I go with a neighbor who maybe has a cornfield or a farm, I help him one day and between the two of us and then we come to my farm, that is the hand turned, and money does not necessarily intervene there" (Irma).
Invite/Share/Give	Gift of objects, services, or food	Intrafamily and between families	"My mother, who would go with my aunt or with close relatives and well, they would do just those food changes" (Denisse García, 37 years old). "Then my aunt would say that you do not have to stay owing anything, it is as if they bring you, you have to pay, but it is a civic duty, and it is like your feelings, like the need to pay for work or the help they give you" (Adriana Quiroz, 35 years old).
Share tasks and activities	Distribution of tasks or activities	Intrafamily	For example, in the kitchen, for a better distribution of work where, while some prepare the dish, others wash the dishes.
The *traje* or *traje* party	Distribution of dishes and food to live together	Intrafamily, between families or between communities.	For example, when they are going to have a party, they agree on what each person or family is going to bring to live together.
Food cooperation	Distribution of food prepared to live together	Between communities	"In Ixcatla, for the festival of San José, the community itself helps to live together, because many people from the communities come, so they give them food, they help each other" (Irais Venegas, 27 years old).
Solidarity support	Material or service support to individuals or families	Between families	For example, some people get together to support a person or family that needs help, be it material or service, especially if there are sick people.

[1]The value is established according to the reasonable prices of the same products in the market.

Considering the current political dispute around the notions of food sovereignty and food security, it is important to strengthen the struggle of peasant peoples for the meanings and uses of the concept of food sovereignty that they have been building for almost 40 years. It is not the purpose of this article to deepen this discussion, but we believe that it may be of interest to peasant and other social movements to rethink the use of the term sovereignty in their worthy struggles, as it may be appropriate to decolonize the term "food sovereignty," considering that many indigenous peoples and peasant communities teach us that the relationship built around food is one of

interdependence, cooperation, solidarity, reciprocity, collective autonomy and not sovereignty in its dominant political sense.

In counterpoint to the sovereign State power, a recurrent aspect of indigenous struggles in Mexico refers to the defense of local autonomy (Cerda García, 2011). Two key examples of indigenous autonomy in Mexico include: (i) the autonomous governance of the *Caracoles Zapatista*,[9] who do not cease to recognize rights and obligations before the State but redefine this relationship from the capacity and right to govern themselves (Cerda García, 2011); and (ii) the autonomy exercised by the Purepecha people in the municipality of Cherán K'eri,[10] where in 2011, the community decided to stop illegal logging of its forests and reorganize local political institutions, with the expulsion of political parties and the creation of a communal government structure (Ramos, 2018).

We can also think of the food issue in terms of food autonomy, the right and the power of each citizen to decide autonomously about what to grow and eat, respecting the different ways of being. In Colombia and Peru, indigenous peoples and peasants' communities defend food autonomy in relation to sowing and eating, looking inward, retaking ancestral knowledge, reciprocity, and mutual nurturing for the care of life (Montano Morales, 2021). Food autonomy is conceptualized as "legacy of socio-cultural, environmental, economic and spiritual wisdom and practices that have been woven over time and are raised in a cosmogonic relationship according to the biological diversity and culture of a territory" (Montano Morales, 2021, p. 117).

One of the main struggles for food sovereignty and autonomy corresponds to the resistance against the hoarding of the commons. These struggles allow us to understand that what is at stake are not simply resources, but the meanings attributed by indigenous peoples and peasant communities to these (non) common goods (De la Cadena, 2015). Many of these meanings are based on relationships of care and reciprocity with Mother Earth, which makes possible the coexistence in the web of life, identity, good living, and dignity (Cariño Trujillo, 2019).

Various practices that contribute to expand the concept of food sovereignty by women coffee growers were strengthened throughout the pandemic (Pontes et al., 2023b). They refer to the care for physical, emotional, mental, and spiritual health, food gathering, bartering, and peasant feminism sorority as alternatives based on interdependence instead of competition, on reciprocity and gift, autonomy and collective work. They challenge hegemonic visions of development, politics and economy based solely on money and profit. From these practices, women model reality, strengthening and broadening food sovereignty in its concept and practice.

3.2 The pink thread: integral health

Being able to decide about one's body is part of health. However, due to lack of experience or lack of knowledge, sometimes we allow external agents to decide for us (Irma Moreno, 56 years old).

The women coffee growers of VIDA define integral health as a process of balance between: "heart, body–mind, and nature" (Denisse García, 37 years old). Health is "having access to information, it is self-care, it is letting go of what depresses, eliminating fears, it is having harmony, peace, balance of emotions, of thoughts" (Irma Moreno, 56 years old), and it is also feeling "love for ourselves, as you cannot transmit it to others if you do not love your own self" (Gisela Illescas, 43 years old).

Integral health is "being able to decide about your body, about the way you heal yourself" (Irma), it is based on self-care and collective care, through harmonious relationships with the environment. Plants are its strong allies, used for the maintenance of a healthy diet and medicines for physical, spiritual, and emotional benefits. Health care depends on innumerable factors, many of which are connected to the customs and food traditions of each person and place. According to the women coffee growers, being healthy should be our priority as human beings, because if we are healthy, in harmony with everything around us, this is transmitted to the family, to the community, to the territory.

Healthy eating inspires them to take care of the first territory: the body in harmony with nature, providing physical and spiritual satisfaction. According to this approach, the body is one with the territory (body-territory), and is conceived as a physical, mental, emotional, and spiritual entity. When coffee women take care of their integral health through traditional knowledge about plants, emotions, spirituality, and the human body, they affirm counter-hegemonic ways of life in connection with their territories, and the construction of peasant feminism from the grassroots. In the last section of the discussion, we present with the purple thread a definition of peasant and popular feminism as lived and practiced by the women coffee growers of VIDA. These views around the body-territory are also present in the Mayan and Shinka women of Guatemala (Cabnal, 2010; De la Vega, 2019) and the fisherwomen from Oaxaca (Espinal and Azcona, 2020),

In this napkin of food sovereignty, the coffee-growing women embroider integral health with the pink thread of care for the body, mind, and spirituality. Reciprocity, love, and care for Mother Earth are also part of a healthy life. Moreover, VIDA women claim that integral health is a path that is necessarily shared with others, nourishing, and being nourished by the collective.

3.2.1 The core of collective health care

We have to be strong and continue to fight. That is a very serious thing to say. We now see that those people we admire are getting old and sick, you say "hey, what have we fought so hard for?" (Gisela Illescas, 43 yerars old).

The existence, vitality, and perpetuation of peasant women's worldview, practices, and values depend on complex processes of knowledge transmission and construction. One of the most valuable contributions of VIDA peasant women refers to how the network of integral health care is constituted, and how transmission of ancestral knowledge is intertwined with contemporary practices and knowledge, leading to its current cultural expression.

Throughout life, learning about health care is done "as a whole, in several links: my family, my mother, other women I have lived with and my personal experience" (Denisse García, 37 years old). A practice that they consider very important is "listening to one's own body" (Denisse García, 37 years old). Most traditional knowledge related to

9 https://enlacezapatista.ezln.org.mx

10 https://www.cheran.gob.mx

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healing processes is applied out of necessity, mainly when they get sick in a more severe way or when they have small children. Because "if you do not have money, I'm going to give you a cup of tea (…) the economy has a lot to do with it" (Adriana Quiroz, 35 years old). Healing is a process of straight connection with the plants and the knowledge of women. To heal is a practice that women learn from their mothers "who are always attentive to the look on their faces" (Adriana Quiroz, 35 years old), from their grandmothers or mothers-in-law "who investigate and see the faces of the children" (Irma Moreno, 56 years old), and "from their great-grandmothers, with the curative plants of the coffee plantation" (Irais Venegas, 27 years old), from the backyard and the forest (Table 2).

In recent years, they have paid special attention to collective practices of mental and emotional health, focusing on individual and collective self-care based on reciprocity. Just as for the indigenous Mayan women of Quintana Roo (Arrese Alcalá, 2021), the women coffee growers of VIDA know that maintaining these practices is crucial for the sustainability of the organizations and to break with the oppressions of patriarchal and capitalist structures, which are based on false individuality, and the cycle of exploitation of bodies through unpaid work. To set limits to these structures and cultivate collective care involves affection, enjoyment, and pleasure (Arrese Alcalá, 2021).

Being a part of a women's support network has shown to be key for their emotional and mental health, because, according to them, health is a collective matter; being well and looking after others is a type of political action (Arrese Alcalá, 2021). The network gives them support, allow them to listen to each other, and make them feel safe and confident, "if I talk about it with my friends, I feel better. They encourage me and tell me: 'keep going, we are here, and we need you'" (Asunción Hernández, 42 years old), "you feel that someone else loves you and you reinforce that love for yourself" (Adriana Quiroz, 35 years old). Through mutual care, they strengthen immediate ties, frame their position as social actors, and their sense of belonging to the community (Arrese Alcalá, 2021).

Women coffee growers have learned throughout this health care journey that the interconnection between physical, mental, emotional, and spiritual health is crucial (Box 1). Women feel spiritually healthier when they listen to their intuition, seek help from healers whenever they need it, and maintain some protective practices, mainly with their children, when they are babies and when they go to the fields. In the territory, they maintain respect for certain sacred spaces or for places where things that cannot be explained happen. Every year, on the first Friday of March, they perform a flower harvesting ritual and prepare a compound called *Marzo*. This is the first medicine they use for healing, in the face of various ailments, mainly stomach related ones.

Spirituality does not apply only to us, the people in communities. It is that link with the physical body, with the mental body, with the energetic body, and with the spiritual body of all people. So, when we talk about food sovereignty, we refer to how we can reconnect ourselves, in our own body, in our territory and as humanity. And I think this is where all these expressions of how we have been taking care of food fit in, but also how women have been a fundamental part of all of this. So much for the conservation of seeds, of biodiversity, but also for the whole of the food part. The consumption of food that gives life, of food that nourishes, of food that heals, of food that connects (Gisela Illescas, 43 years old).

From a feminist perspective, women's spirituality can be defined as the ability to assert and affirm themselves in other ways to improve

TABLE 2 VIDA women coffee growers' expressions on food sovereignty.

Food sovereignty…
1 Not only corresponds to decisions about what to eat, what to plant, and how to do it, but also includes work and care, struggle and peasant identity.
¨Food sovereignty comes from all the mothers, we, who help each other (…). Feeding ourselves and feeding our children too, so that they can move forward" (Maria del Rosario, 40 years old). ¨Food sovereignty is what people have been accustomed to planting for hundreds of years and how they want to eat it. That makes us resilient, that makes me feel secure in my territory and I don't have to go begging in the big cities ¨ (Clara Palma, 64 years old).
2 It is to remember the knowledge of the ancestors through the practices of traditional medicine, gathering and bartering.
¨We decide what we eat, when we eat it, how we prepare it and (…) this implies the recovery of knowledge of how they did it before" (Denisse García, 37 years old). ¨It is like an inheritance that comes from my family. I have a grandmother who is a healer (…) she taught me how to make different types of tea (…) so for me it is more than anything else, it is a family inheritance" (Lucía Moreno, 29 years old). ¨We barter what we have and we don't need cash to buy food. From bartering we bring everything we don't have, and we barter or sell what we have" (Esperanza Reynoso, 57 years old).
3 It is vitality and energy, it is nourishing body and soul, it is sharing and living together, it is having hope for our children.
¨It is that reminder of the importance of eating to be able to live. So every time we have the opportunity to decide what we want to eat, knowing that food not only feeds our body, as it also feeds our soul (…). To be able to eat with family, with friends (…), to enjoy, to laugh, to live together (…). It makes us think a lot… For those of us who have children or family, what we want for them, (…) all that memory of your grandmothers, your grandfathers, the crops, but also those hopes for the future, where we want to go" (Gisela Illescas, 43 years old).
4 It is what helps them to be emotionally well, to have health, family well-being, to eat healthy food and to live well.
¨It is health and family well-being, so as long as we are all well at home and we have health and healthy food, it is a nice thing, it is the good life¨ (Lucía Méndez, 31 years old).
5 It is to dignify the path and the knowledge of women who are the guardians of agrobiodiversity, those who conserve seeds, which are a source of life and identity. It is to take care of the water and the forest.
¨We women become guardians of the seeds, of the cornfield, of the orchard, of whatever comes. Yes, we women are guardians, we do not allow it to be lost (…) in food sovereignty we dignify the path of other people in this struggle for food¨ (Denisse García, 37 years old). ¨It is to feed and it is food. It is knowledge about food and how to pass it on to other generations (…) you preserve the seeds and this is like a generation, a family, (…) if you keep giving to the family you keep giving the seed, it is conservation, it is life. If you don't have seed, you don't have life¨ (Adriana Quiroz, 35 years old).
6 It is to nourish not only the body, but also dignity, rebellion and the collective.
¨In this time of crisis, food sovereignty encompasses the economy. The diversity of food we grow and have is beautiful. It has allowed us to resist this pandemic (…). We have a lot of food to eat (…), to barter. We have it because we grow it" (Clara Palma, 64 years old). ¨It reflects dignity, this part of rebelling, that is, I don't have to do what capitalism says, but what we decide as peoples (…) Food sovereignty cannot be done individually, you have to be together with other people¨ (Denisse García, 37 years old). ¨It makes me think a lot about the whole production, in the kitchen and in the commercial relations as well, to whom our products go, where they travel (…) I think about them, in their forests (…), sovereignty is like that connection that unites people" (Gisela Illescas, 43 years old).

BOX 1 Gisela Illescas (43 years old) and Irma Moreno's (56 years old) accounts of their personal experiences of self-care with spiritual health and reconnection with spirituality.

Gisela says that her great-grandmothers were midwives, and one of her grandmothers and many uncles are healers. As a child, she talked to the angels, but her very Catholic grandmother kept her away from the visions. Until she became seriously ill and sought for conventional medicine aid, reconnection with spirituality, with meditation practices, yoga and rituals with Ayahuasca.

I am in this process of reconnecting with myself, it has been very beautiful, it has been very painful, it has been the most difficult but at the same time it is very important to make big changes, then, in a meditation I could see what terrified me, what I had hidden from myself all my life (…). The first days of May we did an ayahuasca ceremony, a beautiful message came from "grandma," through a friend, who told me: we have to warm the heart of humanity, the heart of humanity is very cold, and we need to warm it. So I think this is a good point to talk about health, to feel again, to remember why we are here, what we are here for, to build different dreams, to enjoy, not competitiveness, productivity, but to feel, to feel alive, to feel connected, to have hope, to have faith, to believe that everything is going to be fine, and to flow with the process (Gisela Illescas, 43 years old).

Irma relates that her experience comes from her childhood when she helped and observed how an aunt did the cures, she was learning throughout her life and with the work in the organization many things about herbalism. Some years ago, when she was 48 years old, she took a course in traditional Mexican medicine with a witchdoctor, which removed the stigma of witchcraft. ¨When I took this course, I saw that witchcraft is wonderful, because it is for the purpose of healing people, for the family, for the community, for care, for protection. Connecting with spiritual guides that help us to redirect our paths and also to maintain contact with mother earth, which is what gives us power, through plants, nature, through the rain, through the sun, and that all of this is healing" (Irma). In this workshop she learned how to unblock energy points, to balance energy and do cleansing with herbs and the egg. On how to direct her inner divinity with the help of spirit guides for cures. It also made her understand historically and politically how important it is to fight to maintain this knowledge and the traditions of the midwives, healers and bonesetters.

Irma says that all of us have this capacity and that you can develop it. For this you have to have discipline and go into meditation. You have to think positive thoughts, not have addictions, learn to turn to your inner child and maintain a good diet, with food that comes from your agro-ecological farm or harvesting and reduce the consumption of meat, mainly from animals that are raised in violent conditions.

each other's lives (Heath, 2006). The spirituality of women coffee growers is centered on relationships; firstly, with their bodies: looking, feeling, listening to intuition, valuing their personal experiences; secondly, in interpersonal relationships, being in a network with other women, caring and healing collectively; and thirdly, maintaining and strengthening the relationship of reciprocity with nature, with the land.

For the coffee grower women of VIDA in Veracruz, the Mayan women of K-luumil X'koóleloób in Quintana Roo (Arrese Alcalá, 2021) and the Mayan and Xinka women of Guatemala (Cabnal, 2010), the defense of their territory begins with the defense of the physical, mental, and spiritual body. It also involves naming, recognizing, and legitimizing the knowledge, resistance and wisdom of ancestral women, all beings, and the territory (Cabnal, 2010). In sacred spaces, they evoke voices, silences, pain, and joy in a liberating action that energetically connects them with the cosmos. Based on peasant feminism, they create libertarian symbols for a transgressive practice, integrating a new imaginary of spirituality (Cabnal, 2010). Their practices and knowledge of care and self-care are reflected in the quality of the relationship they maintain with the environment and are also political tools to defend life, linking a sense of identity to sustainable and reciprocal agro-ecological practices and food sovereignty. In capitalist societies where rest and non-productive practices are often rejected or not valued, care and self-care are political tools that allow women to have health and strength to remain in the struggle for their rights.

To better interpret socio-cultural realities and how these factors disproportionately influence the health of black, indigenous and rural women, it is important to critically study theoretical frameworks that focus on race, class, and gender (Heath, 2006). From the perspective of VIDA women's relational ontology (Escobar, 2011), whereby humans and extra-humans develop relationships of care and reciprocity, other meanings are given to health and illness. For them, life experiences, human bonds and relationships with the environment are key elements to be considered in situations of illnesses; and explanations based exclusively on organic or psychological factors are insufficient (Remorini et al., 2018). The environment can be both the cause and the solution to a problem. Alongside physical symptoms, emotional issues, energetic and spiritual connections play a central role in the cause and choice of treatment.

3.3 The green thread: food and medicinal plant gathering

Throughout evolution, food gathering has been crucial for humans. The gathering of wild plants (Milton, 1993) has long played an important role, complementing the diet of the agricultural societies of Mesoamerica (McClung de Tapia et al., 2014). In previous work, we presented a list of spaces where women of VIDA practice food gathering, the seasons and the types of collected food, and some care practices (Pontes et al., 2023a). We also highlighted the political, social, economic, emotional, and spiritual importance of this practice, which has reciprocity with the Mother Earth as central.

For agroecology and food sovereignty, food gathering is linked to place-based dietary traditions, from women's decision-making in the household to the preparation and consumption of food (Morgan and Trubek, 2020). These processes are governed by their ways of relating to the territory and the recognition that the right to food goes beyond the human, thus implying extended forms of care and Earth stewardship (Micarelli, 2020).

The above connections are also reflected in the rescue, sowing, and gathering of native seeds, edible resources, and medicinal plants, in conserving native vegetation, eating well and valuing local and healthy food. They also entail spirituality for "food, as the sacred, penetrates our being" (Gisela Illescas, 43 years old) and taking care of spaces and animals, like the "little bees that take care of the common wellbeing" (Irma Moreno, 56 years old). Decisions made by the women about what they are going to sow and gather to feed the family and to cure foster their independence from the pharmaceutical industry and rescues their autonomy in the healing process: "we have within our reach what we need to maintain our health" (Denisse García, 37 years old).

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Gathering provides them with access to diverse foods and medicines, which are healthy not only because of their nutritional properties, but also due to links to their family history, local customs, and traditional knowledge. Moreover, seeds are often conserved through generations, to care for the territory and cultural identity through flavors, textures and smells of the foods gathered and sown: "We drink *purple atole.*[11] It satisfies all the symbolic senses linked to it" (Nelly Sánchez, 32 years old).

Irma tells us about the strong and beautiful connection between health, fruits, medicinal plants, and the seasons of the year. The spring plants, which "are going to hydrate you, to prevent from dehydration when the summer comes." The autumn and winter plants "will help you prevent respiratory diseases and then there are many other fruits, herbs that provide you with warmth. The winter herbs are the same ones that midwives recommend when you are in labor, so that your body recovers all that energy, that warmth that it lost during the birth" (Irma Moreno, 56 years old).

Gathering from an integral health perspective also means going to the spaces of life, coexistence, work, and individual and collective leisure, and among these places, the coffee plantation has a very important place. In the edible coffee plantation, women gather many medicinal plants and wild foods, and reconnect with the knowledge of their ancestors. "Within the coffee plantation there are spaces that we like. When we go to cut coffee, we do not eat just anywhere (…). We have a harmonious connection between us and the coffee plantation" (Clara Palma, 64 years old). Gisela Illescas adds: "The coffee plantation for me represents all that: the history, the food, the abundance, the roots, and also the health, the roots, the connection." It is also where the women meditate and look for the necessary energy to continue, to have self-confidence, "think positive from my privileges and my context, to be grateful and to change my way of thinking" (Denisse García, 37 years old). "So those of us who are in the field are happy, we live in glory and sometimes we do not know it, because we do not value our territory" (Lucia Méndez, 31 years old). "In the coffee plantation near where I live, there are some very big trees. I call one in particular grandmother. That is where I like to go when I want to meditate (…), that type of connection also represents going to the coffee plantation, or when you are a child, it is to go to play, to eat, to have fun, to discover, to feel alive" (Gisela Illescas, 43 years old).

The "March compound" made of citric flowers or "azahares" is a product that symbolizes the reciprocal connection between the women coffee growers, the coffee plantation, the medicinal plants and Mother Earth. This is commonly prepared by the women and is the first medicine they use for the cure of any illness, physical or emotional (Box 2).

In sum, food and medicinal plant gathering is an important component of culturally appropriate food sources, that invites us to think about non-capitalist economies for which money is not pivotal. The act of gathering also entails collective care that unites and strengthens coffee grower women in their feminist peasant struggle for autonomy over their food and health. Finally, gathering also implies a deep act of reciprocity and gratitude for the gifts of Mother Earth.

BOX 2 Lucía Méndez's (31 years old) account of the preparation and medicine of the *azares* compound or march compound.

According to Lucía Méndez, the first Friday of March "which is a mystical day, a day when many doors open, it is a special day, when all the plants, all the beings, all the stars, at that moment are working, it is a day when the plants bring out their greatest power." At dawn they collect the flowers of all the fruit trees (*azahares*) and the medicinal plants that you have in your coffee plantation and in your backyard "on this day, in this season, there are a thousand and one *azares* and all the medicinal plants that you know." All these flowers and plants are put to macerate in aguardiente, in a glass bottle with a lid, for 40 days, in a dark place. After these 40 days, it is ready for consumption. It can be taken in various ways, depending on the body's needs and age, from a small glass, or a spoonful to 20 drops in a glass of water. It has its benefits: depression, stress, pains of all kinds, colic pains, stomach pains, even if you cannot sleep, even if you cannot sleep it helps you, because as the *azares* are relaxing then it helps you a lot, it really cures you of everything."

3.4 The brown thread: the barter basket

This is a movement against capitalism, it is a movement that the poor are making, it is their movement for the resistance of the people, to save their seeds, their ways of life, it is a movement to survive in time, with our culture, with other ways of life, with what we are. We have to strengthen this movement, and it has to be much bigger every day, and to combine it with everyone, with the young people (Clara Palma, 64 years old).

The community experiences of Mesoamerican and South American indigenous peoples demonstrate that the ethic of gift and solidarity is essential for humans (Arai, 2020). All people, at some point in history, benefit from mutual support and reciprocity systems (Pardo et al., 2019). These are always present in interactions between humans and extra-human entities, as Barabas (2010) argues in her study of Mesoamerican cultures. Clara Palma, one of the founders of VIDA, confirms that idea: "In different places, in different cultures, people have subsisted through more than 500 years of conquest. How do they continue in their villages? Through what? Barter may seem to be a small contribution, but behind it there are many, many things, much bigger and much deeper" (Clara Palma, 64 years old).

To expand non- or post-capitalist experiences, it is important to make them visible, research them, and learn about their ethical values, forms of operation, and factors that motivate communities to continue to nourish them (Acosta and Guijarro, 2018). In this section, we attempt to highlight these aspects to analyze the practice of bartering carried out by women coffee growers in their territory and how this practice contributes to food sovereignty.

Within the activities based on the ethics of gift[12] (Barabas, 2010) among coffee-growing families in the mountains of Veracruz, women

11 A drink made of purple nixtamalized maize mass, water, and spices.

12 Ethics of the Gift is defined by Barabas (2010) as the ethics and politics that regulate reciprocal relationships between people in all fields of social life,

highlighted that they practice different activities related to bartering (Table 1). The reciprocity system maintained by VIDA women in their communities in Veracruz includes mutual support for multiple tasks, for community self-organization, and allows the exchange of what is needed, especially in times of great difficulty and crises. Among these practices, *tracala*, exchange or barter, are practiced at all levels: between members of the family unit or between families, at the community level and between communities, in the *tianguis* (popular street market).

Everything is exchanged" (Denisse García, 37 years old): from gathered and grown food and medicines to services. In the practice of barter, women are the ones who exchange food to ensure that the family fulfills its needs. The main exchanged products are fruits and coffee, which are mainly exchanged for seasonal fruits, vegetables, creole beans and maize.

According to the coffee grower women from VIDA, barter is important for food sovereignty for three main reasons: (i) Diet diversification: "It allows a diversified diet with what grows in other regions. We can then have things that do not grow here" (Denisse García, 37 years old); (ii) Social support and care: "Exchanging is sharing" (Esperanza Reynoso, 57 years old). "The most important thing is sharing food as a sacred act, because a lot of what is bartered is from gathering, and it is how you are willing to share life when it comes to bartering." (Gisela Illescas, 43 years old). "Knowing that we all have needs, and that we can all help each other, that is an advantage" (Lucía Méndez, 31 years old), the "feeling of collective care" (Denisse García, 37 years old). "Normally when you bring a lot, you tend to give it away to other much more vulnerable women, so that is also this gesture of generosity that also motivates me a lot, impresses me and I think that the cooperation between people and the love that it shows, that is invaluable" (Gisela Illescas, 43 years old); and (iii) Economic complementation: Barter renders value the women's work and supports the household economy with what they save. According to women from VIDA, they manage to save 600–800 Mexican pesos per week through bartering.

The peasant economy is sustained by alternative practices, including the maintenance of ancestral economic practices. The recognition of women's work supports their position as economic subjects, also in the case of barter. Barter and other alternative economic practices reposition the patriarchal biases of the economy and agricultural production and offer a political contribution for the construction of sustainable food systems and counter-hegemonic economies (LVC, 2010; Escobar, 2011). As women state: Barter "values my effort" (Lucía Méndez, 31 years old) and shows that "(…) money is not essential, but rather, what is essential is to give value and dignify the work of peasant men and women (…) because you put love into it, you put passion in it, you worked it with love" (Denisse García, 37 years old). Through barter one "learns to value, question, and be more aware of what you really need" (Irma). "The most important thing is that I can help here at home, because, well, I also put part of my work into what is food" (Esperanza Reynoso, 57 years old). It is also "to support each other and allow that the children see that everything in this life costs. It helps to make them value what they sow, what they love" (Lucía Méndez, 31 years old).

Margarita Flores (59 years old) teaches us the symbolic importance of barter as an instrument of food sovereignty and peasant feminist struggle. In her dignified rebellion to maintain the practice and knowledge of barter in her family, she sees it as a means to have access to local, diverse, healthy and nutritious food (Box 3). Barter also represents other forms of articulation between productive and reproductive work. Coffee grower women, by collectively participating in this activity, contribute to the cohesion of the social fabric, to individual and collective growth, providing learning, autonomy, and sociability (Nobre, 2015). In the studied communities, both the contemporary reproduction of barter and the practices around integral health appear as important political instruments promoted by organized women, who demonstrate how non-hegemonic social and environmental relationships are enacted and nurtured.

Barter favors the creation of bonds of friendship and the street market or "tianguis" becomes a meeting space, where links are made and created between "people who share this idea of believing that we can change some situations in our country, simple people, with values" (Irma Moreno, 56 years old). In addition to admiration and respect for the older women who keep the practice alive, VIDA women express their hope for those who are learning to barter or "tracalear." Solidarity bonds are created around food between peasant communities, around this form of collective organization, the roots and dignity of being peasants, maintaining the spirit of community and the traditions they inherited from their ancestors.

According to peasant feminist women from VIDA, barter has as main values: (i) Trust in each other's word: People talk honestly, negotiate and "opportunities are only given once" (Adriana Quiroz, 35 years old); (ii) Humility and justice: Both when assessing the quality of the products and setting the barter cost; (iii) Solidarity: between more experienced women who share their knowledge with those who are learning to barter; among women who go together to the *tianguis*; and among those who exchange products. Bartering requires diverse values, knowledge, and skills (Table 3). Women reproduce and reinforce social and economic ties, relationships of trust (the word, clients, quality and agroecological products, and friendship ties), socializing relationships (ability to relate, to negotiate), and promote values such as reciprocity, loyalty, honesty, humility, in opposition to capitalist competitive values (Moctezuma Pérez et al., 2021).

Vinculación y Desarrollo Agroecológico en Café women comment that many people feel ashamed of bartering, mainly young people. However, during the COVID-19 pandemic, young people began to use their virtual contact networks to barter through Facebook groups, showing that peasant youth can contribute to the development of solutions to challenges faced by their communities (Pontes et al., 2023b). This and other actions support and adds to the struggle of rural youth around the world (Nyeléni, 2021).

Bartering also symbolizes the importance of collectively occupying public spaces. The street is claimed as a space for creativity, emancipation, and democracy (Moctezuma Pérez et al., 2021). In this occupation, there have been conflicts of interest between VIDA women themselves and local political authorities, which indicates how this form of bottom-up social activity is a target of constant dispute and negotiation (Moctezuma Pérez et al., 2021).

Furthermore, the practice of barter creates lasting obligations and mutual recognition (Moctezuma Pérez et al., 2021), promotes collective care, cooperation, trust, loyalty, and solidarity between people. The barter market is a historical, political and biocultural

between communities and between humans and extrahumans.

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BOX 3 Story about the barter of Margarita Flores (59 years old), co-founder of VIDA.

"I got married for 49 years, I already missed that here (going to barter with his mother), and because I would see here with my husband and say: My God, here every day eggs, beans, chopped, all the days! (…) With my husband, well, he told him: I want to go to Cosco (Coscomatepec) to change! what are you going to go for? People are going to say that they cannot keep you! (…) I mean, no old man, look, my mom taught me, we bring potatoes, squash, chayotes… my mom even changed meat or pork rinds. (…) You are not going!

One day I already had my little girl, Rosario was little and I was pregnant with another girl, (…), Sunday came, and I start roasting coffee (…), I say: No! Now if I'm not going to obey him, I'm going to go, get ready, I'll tell my mother-in-law: (…) Doña Matilde! Do you take care of me my Charito? Right now I'm going to Cosco and I'll be right back! (…) I take my bag, my *petaca* (basket) and my coffee. I changed, it was around 12 and I was already here, back. When she arrives (…) and she tells me (Madam rest in peace!): Did you bring all that? How soon did you take the money? No! just my ticket and that changed everything!

I started taking out my things, (…), I'm going to make bean chilatole for my husband too, I'll make him mole from fat beans, those tender ones. And he arrives and you say: Where did you get fat beans? I went to Costco! (…) He got angry, he says: I do not want to eat! (…). He did not eat, but the next day (…) I make his beans again, and I put his bean cubes, he already had lunch, it arrived in the afternoon, he already ate! I made him some chips, out of what he brought, he already ate!

Well, about a fortnight later, I'm leaving again, and the more he saw how I brought things and all that. Later he tells me: No, well, yes it's true, you are right, well, I'm going to plant plantains and you are going to change (…), and every 8 days I would go, he would accompany me and we would even bring corn, beans, good of everything that is up there (Citlaltépetl Volcano), and I tell him: And what you earn in the week, well, for a little piece of meat, bread, milk for our children. He already looks! We have corn, beans, we have potatoes, everything. He says: No, yes, you are right!"

TABLE 3 Diverse aptitudes and abilities developed by the women coffee growers of VIDA with the practice of barter.

Required	Knowledge, willingness, develop aptitude and negotiation skills and have self-confidence. So that you can offer and value your products and those that are going to be exchanged, so that you feel good and safe at the time of making the negotiation and so that reciprocity prevails.
Learned	Relate commercially and socially with the clients and with the people who live in the tianguis, to remove the shame and grief. ¨There are fellows that I would not know if it were not through barter, I already know many people from the communities above, they especially go to my post, they even speak to me by name¨ (Esperanza Reynoso, 57 years old). To eat and try different foods, as well as exchange knowledge and recipes.
Strengthened	Bond of trust and loyalty between women. Link between generations when children and young people are involved in barter. Respect for the knowledge of the elderly and the strengthening of leadership and autonomy.

process (Moctezuma Pérez et al., 2021), where cultural continuity and transformations occur in regard to identity, knowledge, values, and the territory. "It is a big movement that we must cultivate and that we must motivate others to do. That's what we have to tell city people, even if at the moment it seems romantic" (Clara Palma, 64 years old). The women coffee growers expand the space of the *tianguis* as a meeting place, for community and intergenerational ties, and for the transmission of knowledge within their territory and beyond.

Participating in barter and other economic processes based on solidarity promotes autonomy (SOF, 2015). From a feminist economic perspective, barter contributes to rethinking unpaid productive work, and the reproduction of care that generates savings in the family and community nucleus. It also contributes to food sovereignty and to economic systems based on the values of solidarity, reciprocity, and justice toward the sustainability of human and extra-human life.

3.5 The connecting purple thread: peasant and popular feminism

We, women, have no time, no land, no water (Irma Moreno, 56 years old).

Peasant and popular feminism, as it has been conceived and practiced by the women of VIDA, is in line with feminist theorizations put forward by the women organized in LVC and by the women of various Latin American peasant movements. In Gisela Illescas' words:

> Peasant and popular feminism recognizes how the peasantry live, in ways that centrally involve the family and the community. It is a political stance in which women occupy decision-making spaces both at the family and community levels, and it recognizes all the inequality gaps. It intersects with different feminisms, for example with decolonial feminism, for the spiritual dimension; with ecofeminism, for the connection with the Earth and it also connects with food sovereignty. It is putting life, collective care, spirituality, community organization, the body-Earth-territory connection and shared knowledge at the center. It is not a simple definition but something that crosses many of these spheres. In VIDA we have put it into practice by designing different tools to facilitate the participation of women, as in the solidarity savings group, the work with herbal medicine, with backyard gardens and food sovereignty, in youth leadership. This feminism is the dignification of peasant life, the recognition of how peasant life is reconstructed, recognizing that we exist, that we have been and that we will continue to be here, in contact with the Earth, despite the colonialist invasion that transformed our lives. Peasant and popular feminism promotes strategies of community care, such as the reciprocity of barter that contributes to a dignified life, and the balance with the environment that also contributes to creating dignified livable lives for the peasant families (Gisela Illescas, 43 years old).

The women coffee growers confirm that in respect to health "in different ways, both (women and men) have been violated, and all

these violations of rights have made us see men and women as enemies, and not as partners, as comrades, as a team" (Irma Moreno, 56 years old). According to them, Mexican peasant women are vulnerable due to cultural and political systems such as patriarchy and capitalism, which are responsible for the sexual division of labor. Sexism made men vulnerable for since they are children, they are judged and punished; they learn not to externalize their emotions, their illnesses or whatever is associated with their fragility.

Women are the ones who wake up earlier and go to bed later (Gisela Illescas, 43 years old). Women repress many feelings and emotions so that they are not judged. They learn how to take care of others, but do not learn self-care practices, nor to respect the right to "do nothing." They socialize less and have fewer leisure opportunities. They are socially conditioned, since they were girls, as the only ones responsible for the care of others and motherhood, a type of work that is romanticized, made invisible, not recognized, or valued. "I think that our gender condition decreases our health, and added to that, all the intersection of gender, race, class, ethnicity, and everything else you want to add, in short" (Gisela Illescas, 43 years old).

Clara Palma, as an adult of 64 years of age, recounts that, throughout life, peasant women are subjected to too much workload inside and outside the home. Since childhood, women learn to give up their own care to care for everyone else: "women are compared to the Virgin Mary, who gives up everything," reaching the point of feeling guilty if they get sick. Added to this, multiple gestations and breast feeding without specific care and accompaniment contribute to the fact that "our health is lessened." All these factors, according to Clara, make it very difficult for rural women to empower themselves and feel like subjects of rights in health care. Therefore, a key challenge is to change perceptions around women and promote self-respect and women's rights. As an organization, they have significantly learned about collective ways to change this oppressive reality (Box 4).

Care work reveals social inequalities, relations of exploitation, and domination (Molinier and Paperman, 2020). The stories and desires of coffee farming women provide numerous elements for academic feminists to think of a care society in which key ethical dimensions guide policies that consider vulnerabilities from the bottom up (Molinier and Paperman, 2020). When you are born economically impoverished, your fundamental concern is to eat. If you do not have food, if you do not have enough to feed your family, the emotional stress you suffer because of that is terrible (Gisela). Mexican rural women have been historically deprived of the right to land property and to decide over land management and common goods (García, 2001; Cuaquentzi Pineda, 2007), which makes them more vulnerable in health care. "That is why food and care are fundamental issues. We must not struggle alone; it is a very heavy burden" (Gisela Illescas, 43 years old).

Within the thought of peasant feminism, coffee-growing women consider it important for health care to recognize the feminine and masculine energy that exists within oneself, seeking to balance it, love it, and not judge it. They argue that it is necessary to continue to change how people think within the families so that everyone is co-responsible for care work. To transform patriarchal cultural impositions, it is key to empower girls so that they do not reproduce roles of vulnerability.

At the community and organizational level, they consider it important to actively participate in collective work such as health brigades, promote care spaces that take emotional health in consideration, share specific self-care practices for each phase of life, including moments of rest and leisure, and valuing the care work done by women. In the box Gisela Illescas (43 years old) explains some of these practices and how care and self-care are at the core of peasant and popular feminism (Box 5). They consider it important to maintain a feminist movement that promotes change in the family nucleus and that, based on the creation and maintenance of a solidarity networks between women and other genders, strengthen health: "between us, we have built a family and it gives us that closeness and that confidence to ask, to talk, to guide you" (Denisse García, 37 years old). For women coffee growers, good care occurs collectively, with autonomy, with equality, in the daily practices of self-care and care for the family, the community, the territory, and Mother Earth.

Another fundamental aspect of peasant feminism is related to collective and community work. In the communities, there is no individual leadership but collective leadership, where women share problems and inequalities, but also build transformations and hope in the collective. Peasant feminism is to think of each woman as part of a community.

The experience of women coffee growers contributes to think about collective strategies for the defense of common goods and life as important tools to politicize care, breaking gender roles and taking as a starting point that everyone can position themselves and taking responsibility in their processes (Molinier and Paperman, 2020). A key goal is to integrate care in our society as a widely shared practice, where the values of all and everyone are balanced to make ethically valid choices (Mol, 2008).

The practice of care and intuitive action also implies collaborations with extra-humans and their inclusion in the construction collective care (Rico, 2022). That places the question of reciprocity at the center of thinking and living carefully in a complex network that sustains life (De La Bellacasa, 2017). The knowledge and practices of women are key to the set of relationships that entail the care of the land, the reproduction of collective life, and the territory (Rico, 2022). Collective care is not limited to the human dimensions, breaking androcentric, capitalist, and patriarchal hierarchies. From an ontology produced from their peasant and feminist perspective, coffee-growing women construct daily care connections between their own body (physical, emotional, mental, and spiritual), their family, community, and territorial landscape. By placing care at the center of their relationships, they invite us to think about agri-food systems and food sovereignty from these other relationships of interdependence and reciprocity.

4 Conclusion

The concept of food sovereignty is plural and reflects the multiplicity of meanings and relationships between communities, food, and their food systems (Micarelli, 2020). This notion is still under construction and for this reason it is important to integrate contributions from diverse social groups, especially those who have been historically marginalized. Peasant women of the South have long been excluded from dominant debates and decision-making processes. This study shows how their understandings and commitments with collective life greatly contribute to broaden conceptions, values, and practices around food sovereignty. The particular contributions from feminist peasant women from VIDA point to integral health care,

BOX 4 Narrative of Margarita Flores (59 years old), Irma Moreno (56 years old) and Clara Palma (64 years old) on how comprehensive health care practices began within VIDA.

Margarita relates that in the early years of the organization none of them worried much about health care, they were young and what they worried about was work at home, in the fields and with productive projects. But that today she feels that if from the beginning they already had the rescue of herbal knowledge and the collective health care that they have today, she feels that she would not have accumulated so many health problems. For this reason, VIDA has organized workshops on caring for reproductive and sexual health, self-esteem, human rights, food, and since the 2000s on herbal medicine and botanical walks, which has contributed to motivate and awaken more women. Youth for the importance of health care.

Irma and Clara tell what this experience of starting health care as an organization was like. They found that women, due to having many children and poor nutrition, had various diseases in the womb and that, in the 90s, with the coffee crisis, men began to emigrate to other cities or countries and when they returned, wives contracted sexually transmitted diseases. Due to machismo, they could not question, nor demand the use of a condom. In addition to the stress to which they were subjected by being left alone for up to 10 years, with their young daughters, in charge of the elderly and the coffee plot, which awaited them various diseases, mainly in the reproductive system. So Clara, Irma and Águeda began to promote work with women to raise awareness, self-care and to look for alternatives and ways to support these women, "so that's how we trained ourselves to be able to follow up and accompany women who had this type of situation, so that they could get ahead together" (Irma Moreno, 56 years old).

They learned from a gynecologist how to do and read the Pap smear, and they sought treatment with medicinal plants and only sent serious cases to the health center. They also investigated the main illnesses of the children and concluded that they got sick more from respiratory problems, because they did not have adequate clothing and footwear for winter or because of the conditions of the houses, so they began to make syrups to cough. They sought to exchange experiences with midwives, healers from the community itself, they were invited to herbalist workshops, health courses and, with a group of women in the Sierra de los Tuxtlas, who were dedicated to the preparation of medicines based on plants, they learned to do the botanical walks and the preparations. They also shared experiences with another women's organization in the State of Morelos, Clara went to Guatemala to the University of San Carlos and they also did exchanges with the University of Chapingo "and this is how we gradually enriched ourselves, all this knowledge of plants, not only with external people, but from the community" (Irma Moreno, 56 years old).

BOX 5 Narrative of Gisela Illescas (43 years old) about care and self-care of coffee grower women's popular and peasant feminism.

Care is made tangible in women's circles. These are women's gatherings for emotional health, spaces for each woman to focus on herself, on her self-care, especially emotional, spiritual and physical health. This also implies the appropriation of common spaces within the communities for women's healing. We had to break many taboos that there were no spaces where women gathered to heal themselves and take those spaces, make use of them for such a beautiful activity as self-care. We have also carried out different strategies for the care of the body, for example, rural yoga, where in addition to having yoga exercises, we also did all the work of reflection within the women, about care, in addition to bringing women together. We also manage the funds that are designated for this, so that there is also a budget for these activities.

Regarding patriarchal inequalities in access to land, we have promoted the recognition in the families, that the women coffee growers are also the owners of the land. We created Femcafé brand, which arose precisely to support the women who were not the owners of the land and to ensure that a percentage of the harvest, which is produced by the women, could be commercialized directly, so that the percentage of the harvest that the family produces is negotiated by each woman. She thus has the right to commercialize it and to receive the price for her product and this ensures that she can make decisions about this income.

Decision-making positions within the cooperative have been led by women, and have also included the participation of young people. For example, those who lead the cafeteria are now young women and the strengthening of the youth network. Economic empowerment with women and children groups in solidarity savings also underpin these processes.

Care and self-care refer to how women occupy spaces in their own life, their family life, community life, organizational life, not only working but also taking care of themselves through resting. For example, in the last women's circle we went to the beach—it was fascinating! (Gisela Illescas, 43 years old).

food and medicinal plant gathering, and bartering as crucial practices through which food sovereignty and political-economic autonomy are reinforced.

Peasant families in the mountains of Veracruz maintain their ways of life based on the principles of food sovereignty from their own ethical and political views, reciprocally weaving the web of care: body-family-community-territory-Mother Earth. In this way, the food sovereignty napkin embroidered by VIDA peasant women provides us with clues for an emancipatory political project, which seeks the protection, creative reproduction, and self-determination of cultural systems based on care and reciprocity. VIDA women's daily struggle also embodies the dream for equitable and fair distribution of land and food, participatory and popular democracy, and decolonization, as proposed by peasant movements in various parts of the world.

By weaving the purple thread of peasant and popular feminism (LVC, 2021), the women of VIDA and the women organized in LVC (Montoto, 2017) continue to defend the relationality of their life worlds (Escobar, 2014), resisting capitalism, patriarchy, and androcentrism, defining the kind of society they want to live in, and building the ontological political project they require to achieve food sovereignty. In their claims, they involve all the exploited people of society, valuing care relationships, and emancipation from all forms of oppression. The common objective of the women coffee growers is to collectively construct a world based on respect, equality, justice, solidarity, peace, freedom, and affection.

By weaving spiritual care and health, the coffee-growing women from VIDA evoke ancestral spirituality as politics. In agroecology, the web of life is reflected in the food web: agriculture is mainly taking

care of the land, therefore growing and sharing food is a spiritual and political act (Shiva, 2016). Recognizing and integrating ancestral forms of spirituality in agroecological practice reinforces agroecology as a decolonial social and environmental activity, and strengthens it as an emancipatory, anti-capitalist (Toledo, 2022), and anti-patriarchal practice. VIDA peasant women's views thus invite us to what Marisol De la Cadena et al. (2018) name as an onto-epistemic opening: a receptive attitude that allows learning from and toward other possible worlds.

In 2013, the IV Women's Assembly adopted the Rural Women's Manifesto, one of the first attempts to define the principles of popular peasant feminism at the international level. Against patriarchy, the Manifesto makes explicit the importance of "fighting for the sovereignty of land, territory and the body and saying no to violence against women in all its forms." The document emphasizes an ecofeminist ontology of land, and defines it as "a space of life, culture, identity, an emotional and spiritual environment," framing the mutually reinforcing relationship between food sovereignty and feminism. Based on the most widely used concept of food sovereignty as elaborated by the IPC,[13] it is noted that despite the discursive progress on food sovereignty, there is still a need for greater inclusion of women's perspectives in the re-elaboration of the concept. Women of VIDA greatly contribute to our understanding of the importance of integrating care and reciprocity as manifested by emotions and spirituality in the ways food sovereignty is expressed and practices. They also contribute to the concept of food sovereignty through the insistence on the right to food and peasant human rights, the option for the agroecological model, and access to land and productive resources.

The coffee grower women also show that the production, gathering, preparation, exchange, and consumption of food are acts that define the quality of relationships cultivated with the environment (Micarelli, 2020). One of the main contributions of barter to food sovereignty and agroecology lies in the joy and satisfaction of managing to maintain a table with a diversity of food: healthy, nutritious, seasonal, and local food—a joyful recognition of the abundance that exists in the countryside. The practice of food gathering and bartering are expressions of resistance and rebellion against capitalism and the hegemonic agri-food system, for, in fact, "the most important and valuable things are the will and solidarity among people" (Clara Palma, 64 years old). The alternative economies promoted by VIDA thus value cultural traditions and non-capitalist social practices. In addition, with the good use of social networks, women managed to involve youth in virtual barter, which further strengthens the struggle in defense of traditional practices and food sovereignty.

This article contributes to conceptualize and promote the life project (Escobar, 2014) of coffee-growing women, based on their knowledge, values and practices related to agroecology, food sovereignty, and peasant feminism. From a political ontology perspective, peasant and indigenous women are protagonists in the sociocultural stewardship of nature (Escobar, 2014). This paper offers a testimony of how Mexican peasant coffee grower women look after the Mother Earth, as they embroider food sovereignty, care, reciprocity, and hope.

13 The definition was elaborated during the parallel NGO forum of the CMA+5 (Forum for Food Sovereignty) and can be found in the Food Sovereignty fact sheet on the IPC website at www.foodsovereignty.org.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Comité de acompañamiento doctoral, Centro de Investigaciones Tropicales, Universidad Veracruzana. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

TP: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. JM: Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. CL: Conceptualization, Investigation, Supervision, Writing – review & editing. CC: Supervision, Writing – review & editing. GI: Investigation, Writing – review & editing. DG: Investigation, Writing – review & editing. MS: Investigation, Writing – review & editing. HM: Supervision, Writing – review & editing.

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Conflict of interest

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

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EDITED BY
Tapan Kumar Nath,
University of Nottingham Malaysia Campus, Malaysia

REVIEWED BY
Erin Betley,
American Museum of Natural History, United States
Nelson Chanza,
University of Johannesburg, South Africa

*CORRESPONDENCE
Zach Conrad
✉ zsconrad@wm.edu

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Improving Indigenous Food Sovereignty through sustainable food production: a narrative review

Sarah Rowe[1], Catherine Brady[1], Rhea Sarang[1], Troy Wiipongwii[2], Matthias Leu[3], Lydia Jennings[4,5], Tomalita Peterson[6], Juan Boston[6], Beth Roach[7], Jessica Phillips[8] and Zach Conrad[2,9]*

[1]College of Arts & Sciences, William & Mary, Williamsburg, VA, United States, [2]Global Research Institute, William & Mary, Williamsburg, VA, United States, [3]Biology Department, William & Mary, Williamsburg, VA, United States, [4]Duke River Center, Duke University, Durham, NC, United States, [5]School of Sustainability, Arizona State University, Tempe, AZ, United States, [6]Baltimore American Indian Center, Baltimore, MD, United States, [7]Nottoway Indian Tribe of Virginia, Capron, VA, United States, [8]Chickahominy Tribe – Eastern Division, Providence Forge, VA, United States, [9]Department of Kinesiology, William & Mary, Williamsburg, VA, United States

Indigenous communities in the United States (US) face substantial challenges including health disparities, food insecurity, and cultural disconnection. The Indigenous Food Sovereignty (IFS) movement seeks to address these hurdles through the restoration of traditional foodways in balance with the natural environment. Initiatives aimed at enhancing IFS have proliferated across the US in recent years and are receiving increasing attention from the federal government. While increasing community food production is an important component of IFS, initiatives centered around this goal have received relatively little attention in the literature. A better understanding of current efforts will elucidate the factors underlying their successes and challenges, supporting the development of effective future initiatives. This review characterizes IFS food production initiatives in the US and identifies topics for further research.

KEYWORDS

Indigenous, food sovereignty, food system, food security, agriculture

1 Introduction

Indigenous communities in the United States (US) face substantial disparities in chronic, diet-related diseases in comparison to white Americans (Office of Minority Health, 2020, 2021a,b,c). Indigenous individuals are up to 2 times more likely to develop conditions such as obesity (Office of Minority Health, 2020), diabetes (Office of Minority Health, 2021b), heart disease (Office of Minority Health, 2021c), and liver cancer (Office of Minority Health, 2021a), and are up to three times more likely to die from these conditions (Indian Health Service, 2019). After adjustment for age, sex, and energy intake, Indigenous individuals are 18% more likely to have poor diet quality (McCullough et al., 2022), which represents the largest modifiable risk factor for cardiometabolic mortality (Micha et al., 2017).

Additionally, rates of food insecurity have worsened during the COVID-19 pandemic (Hake et al., 2021). Nearly one-half of Indigenous households reported food insecurity at some time during the pandemic (Stanger-McLaughlin et al., 2021), compared to a national average of 38% (Kakaei et al., 2022). The pandemic has also disrupted the production of food by Indigenous food producers. A survey of Indigenous food producers across the US found that 84% were negatively impacted by the pandemic, with 54% fully or partially closing their operations (Mucioki et al., 2022). Consequently, nearly 80% of Tribal leaders said that their communities had limited access to food staples during the pandemic and nearly 40% indicated that hunger was exacerbated in their community (Mucioki et al., 2022).

These disparities originate from the history of western expansion and endure today due to structural, extractive, and industrial projects that continue to disproportionally impact Indigenous people (Scheidel et al., 2023). Indigenous communities were forced from their ancestral lands and dislocated from traditional food sources and economic opportunities, leading to rates of food insecurity as high as 90% in some communities (Sowerwine et al., 2019). However, food security may be too simplistic of a metric when applied to Tribal communities and should be replaced by the concept of native foods security, which encompasses not only caloric sufficiency but an entire framework of access to culturally significant foods through traditional means (Jarosz, 2014; Gurney et al., 2015; Sowerwine et al., 2019). This concept aligns with research showing a link between health disparities on Tribal reservations and the loss of traditional food systems (Conti, 2016).

Some federal efforts have tried to address these interconnected issues of food access, food security, and nutrition, but major oversights have plagued these programs. For example, the Commodity Supplemental Food Program provides a monthly food package to low-income seniors, and until 2014, women, children, and infants were also eligible (US Department of Agriculture, 2023a). However, many food items provided by this program are high in sodium and saturated fat, which are associated with diet-related chronic diseases (Chino et al., 2009). Although many people living in the United States benefit from supplemental food assistance provided by the Supplemental Nutrition Assistance Program (SNAP), people living on or near Indian reservations often lack access to participating retailers (USDA Food and Nutrition Service, 2018). In response, the federal government created the Food Distribution Program on Indian Reservations (FDPIR) to distribute food packages to these groups, yet traditional Indigenous food options are typically lacking (USDA Food and Nutrition Service, 2021). There is also an unmet opportunity to source these foods from Indigenous farmers, which would support tribal economies and strengthen local food systems (USDA Food and Nutrition Service, 2021). These shortfalls in federal policy are acknowledged in the White House National Strategy on Hunger, Nutrition, and Health, published by the Biden-Harris administration in 2022, which also presents opportunities to strengthen Indigenous Food Sovereignty (The White House, 2022).

The concept of Indigenous Food Sovereignty emerged in response to a food system that does not adequately serve Indigenous communities (Hipp and Shirl, 2015; Maudrie et al., 2021). The idea of food sovereignty was first articulated at the 1996 World Food Summit by the La Via Campesina movement, which put forth seven principles advocating for food systems that protect natural resources, local agriculture, the right to food, and community empowerment (Claeys, 2015). Food sovereignty protects the autonomy of individuals and communities to produce and access healthy and culturally appropriate food through environmentally sustainable methods. Rather than through corporations or market institutions, the control of food production lies within the communities which it supports (Maudrie et al., 2021). In an Indigenous context, food sovereignty encompasses broader ideas rooted in Indigenous values, including relationships of reciprocity and responsibility to the land (Miltenburg et al., 2022). Unlike food security, food sovereignty goes beyond the right to sufficient nutrients to emphasize the importance of culturally meaningful connections to the food system (Ruelle et al., 2011). Each community has the autonomy to define what is culturally relevant to them. In many cases, these are foods Indigenous to their traditional lands. In other cases, this becomes a bit more complex. For instance, while three sisters' agriculture has been a dominant agricultural system for many Indigenous communities throughout Central and North America for a millennium, corn and several varieties of beans were cultivated in Mexico and found their way into many communities through continental trade. In other cases, communities have been forcibly relocated from their traditional communities into regions with very different ecosystems. Their traditional foodways prior to colonization and forced removal may have difficulty flourishing in their new territories. Still others may have adopted foods during colonization that are deemed culturally important to them. Such is the case for the rapid adoption of the imported apple and Asian Persimmon replacing the Indigenous plants that were in different communities. The Senaca and Nottoway tribes were known to have apple and peach orchards as well at the end of the 17th century.

As this movement has grown, communities and organizations have developed Indigenous Food Sovereignty initiatives that target different parts of the food system from producers to retailers (Segrest, 2014) to consumers (Ruelle et al., 2011), in addition to projects focused on community education, school initiatives, and behavioral interventions (Dwyer, 2010; Sowerwine et al., 2019). However, initiatives that address food production have not been well characterized in the literature. Strengthening community food production is a key component of Indigenous Food Sovereignty, and a greater understanding of these initiatives in the US is crucial for supporting the success of this movement. Additionally, the majority of Indigenous Food Sovereignty research has occurred in the West and Midwest, with relatively few taking place in the east. The absence of Indigenous voices in East coast communities on how they define and engage in Indigenous Food Sovereignty initiatives could impact how we define and understand success. Characterizing food production initiatives being undertaken by a wide range of Indigenous groups will help identify the initiatives' strengths, challenges, and knowledge gaps, which can be leveraged to enhance existing programs and develop new ones.

This narrative review provides an overview of initiatives that aim to promote Indigenous Food Sovereignty in the US through food production as well as identifies further research needs. Because of the complexities of narrowing in on what is considered culturally important, and recognizing that there are 574 federally recognized tribes and hundreds of state and non-recognized communities, we adopt the approach of defining Indigenous Food Sovereignty based on each community's own definition. Additionally, because of the general absence of literature on Indigenous Food Sovereignty of eastern tribes, specifically mid-Atlantic and southeastern tribes, this review

includes food sovereignty projects from Indigenous organizations and tribes of these regions. This review is structured around seven themes: (1) Types of food production initiatives to promote food sovereignty, (2) Goals of food sovereignty initiatives, (3) Organizational structure of food sovereignty initiatives, (4) Evaluating outcomes, (5) Barriers to food sovereignty, (6) Food sovereignty among eastern tribes, and (7) The future of Indigenous Food Sovereignty.

2 Methods

2.1 Author positionality

When this manuscript was drafted, over 50% of the co-authors were enrolled members or documented descendants of a state or federally recognized US tribe. This includes co-authors TW, LJ, TP, JB, BR, and JP. TW, TP, JB, BR, and JP are from state and federally recognized tribes whose traditional and contemporary sovereign lands intersect with the colonial states of Maryland, North Carolina, and Virginia. LJ and TW Indigenous authors are academics at nationally ranked, predominantly white institutions. LJ is an enrolled member of the Pascua Yaqui Tribe, and TW is a documented descendant of the Chickahominy and Chickahominy Indian Tribe -Eastern Division. The other four authors are members of this research project's Indigenous Advisory Council (IAC). IAC member JP is employed by the Chickahominy Indian Tribe-Eastern Division and is directly involved with their tribal nation's food sovereignty initiatives. IAC member BR is a tribal councilperson of the Nottoway Indian Tribe and an Indigenous seed-keeper. The final two IAC members, TP and JB, both Indigenous, are board directors of the Baltimore American Indian Center (BAIC), which collaborates with several organizations to bring Indigenous Food Sovereignty initiatives to the Baltimore urban Indian community. For the five Indigenous authors who represent the eastern tribes in the manuscript, there is a recognized element of the absence of eastern communities, their beliefs, perspectives, and understanding of Indigenous Food Sovereignty in the context of Indigenous Food Sovereignty literature. Even among Indigenous scholars, sometimes the language used to represent Indigenous ideas and perspectives does not adequately represent the voice of eastern communities. For this reason, this paper uses a broad definition of Indigenous Food Sovereignty, allowing each community to define what it means to them.

2.2 Narrative review

This review was inspired by a narrative review of another element of Indigenous Food Sovereignty (Jernigan et al., 2021), and provides an overview of initiatives throughout the US that aim to promote Indigenous Food Sovereignty through food production and includes a comprehensive review of Indigenous Food Sovereignty initiatives across the US. These were the phases of the review: (1) article collection and exclusion; (2) content analysis; (3) inclusion of community projects; (4) face validity.

2.2.1 Phase 1: article collection and exclusion

Articles were identified through English language searches using Scopus, Google Scholar, and the United States Department of Agriculture Research, Education & Economics Information System. Searches were performed for articles that described food production initiatives in Indigenous communities, and additional articles were identified if they cited the original articles. Titles, abstracts, and keywords were reviewed for relevancy to programs initiated in Indigenous communities that were designed to, or had the effect of, supporting food production to improve food security and/or increase food sovereignty. These searches resulted in 140 articles, 65 of which were ultimately included after review of the full text.

2.2.2 Phase 2: content analysis

Two undergraduate research assistants led the article collection with the guidance of three faculty members. Over the period of January 2022 to July 2023, weekly meetings were held with the research team to explore the themes that emerged during the review and begin the writing process. Emerging themes were identified if they were key research objectives or outcomes, or key structural characteristics of food production initiatives, and appeared in multiple articles. Additional themes were identified if they were determined by the authors to represent barriers to achieving food sovereignty and their solutions. These themes were reviewed by an IAC that is associated with this project (described below), and ultimately led to the identification of seven primary themes.

2.2.3 Phase 3: inclusion of community projects

This review is associated with a three-year grant-funded project to build decision-support tools to support Indigenous Food Sovereignty initiatives in communities whose traditional and contemporary boundaries overlap with Maryland, North Caroline, and Virginia. The project includes an IAC comprised of six Indigenous community leaders who provide regular feedback on all parts of the project. Four of these IAC members were appointed by their respective tribal nations and two of these members were appointed by their organization's board. The literature is sparse with information on Indigenous Food Sovereignty initiatives for eastern tribes, especially mid-Atlantic first-contact tribes. During this phase, four of our IAC partners became co-authors and contributed commentary on Indigenous-led projects in their communities.

2.2.4 Phase 4: face validity

The key themes highlighted in the narrative review were reviewed independently by our IAC and co-authors. The co-authors and IAC have expertise in nutrition, epidemiology, biology, technology in sustainable food systems, Indigenous data sovereignty, food systems, Indigenous governance, and lived Indigenous experiences. Six of the authors are Indigenous to the US, and five are non-Indigenous to the US. The section on eastern tribes results from the lived experience of the five Indigenous members of eastern communities who feel excluded from the body of Indigenous research and want to contribute their voices.

3 Types of food production initiatives to promote food sovereignty

Food production initiatives to promote Indigenous Food Sovereignty have been implemented in all regions of the US, with the greatest number identified by this review in the West and Midwest

(Figure 1). While this pattern generally follows the distribution of Indigenous populations across the US, very few initiatives were identified in Alaska, the state where the highest proportion of Indigenous individuals reside (National Congress of American Indians, 2020). A possible explanation is that subsistence hunting and fishing are more important than agriculture in this region. Here we review initiative types in three broad categories: (1) farming, (2) ranching, and (3) fishing and whaling. We define farming as any activity involving growing plants, ranching involving animal husbandry, and fisheries and whaling involving fishing and hunting of aquatic vertebrates, respectively.

3.1 Farming

3.1.1 Gardens

Gardens are among the most common types of food sovereignty-related food production initiative in the US, which can range from backyard plots in single family homes to larger community gardens that are collectively managed. An example of a backyard garden initiative is Growing Resilience, a project that supports Northern Arapaho and Eastern Shoshone families living on the Wind River Reservation in Wyoming in installing and maintaining home gardens (Budowle et al., 2019). In Iowa, the Santee Sioux Reservation takes a multi-pronged approach to encouraging more families to garden, from skill demonstrations to nutrition classes, cooking workshops, and gifts of starter plants (Landholm, 2016). This holistic approach is typical, and many garden initiatives also teach skills to community members, encourage youth participation in the food system, and revitalize traditional growing practices (Carlson, 2015; Ho-Lastimosa et al., 2019; Maunakea-Forth and Maunakea-Forth, 2020).

3.1.2 Farms

Farms are larger in scale than gardens, yet many of these evolve out of smaller gardens as their operation grows. For example, Micmac Farms in Maine began as a garden that sought to help alleviate food insecurity and health issues arising from poverty in the region by growing healthy, low-cost food for local consumption (Caulfield, 2011). Today, the 18-acre farm produces a variety of fruits, vegetables, and Christmas trees while also developing additional facilities such as a trout hatchery and greenhouse. The hatchery has particular significance to Indigenous food culture because trout are a key traditional food of the Micmac people. The growing of traditional foods is also a key objective of Tesuque Pueblo Farm in New Mexico (McKenna, 2013). Although

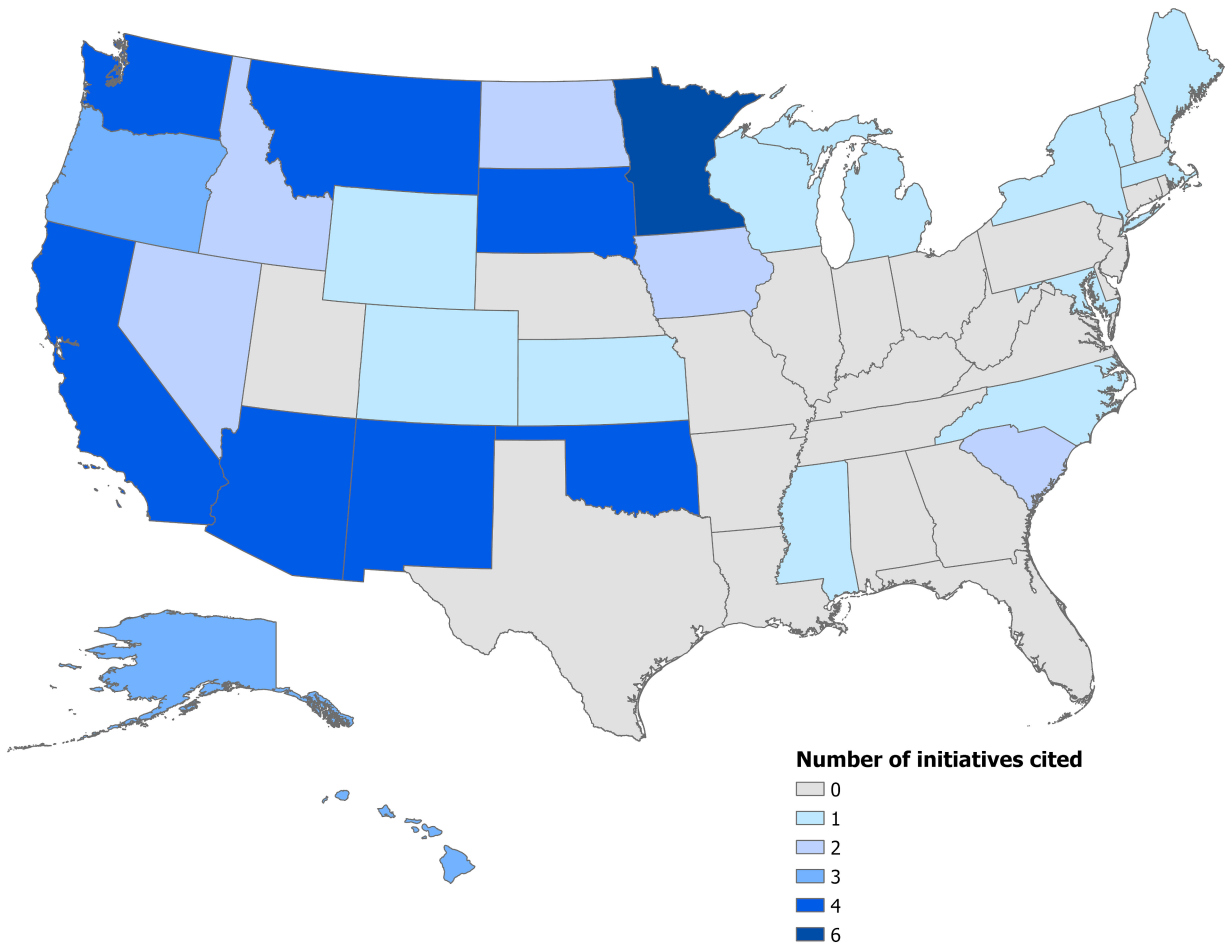

FIGURE 1
Geographic distribution of referenced food production initiatives to promote Indigenous Food Sovereignty in the United States.

the farm initially focused on crops for commercial sale such as alfalfa, it has transformed into a community-focused enterprise that uses sustainable agriculture methods to grow traditional foods and medicinal plants. The farm encourages community involvement through volunteer programs as well as assisting members of the community in preparing fields on the farm to grow their own food. In Hawai'i, MA'O Organic Farms runs a Youth Leadership Training program that teaches young Indigenous Hawaiians traditional agricultural skills in addition to mentoring them for future academic and career success (Maunakea-Forth and Maunakea-Forth, 2020). Those who participated in the program reported being more likely to grow their own food, choose healthy and locally grown food options, and value local and environmentally sustainable agriculture. In 2020, MA'O harvested 71,477 pounds of organic produce and secured over $11 million in funding to continue their operations.

3.1.3 Greenhouses

Greenhouses are often constructed in tandem with farms or gardens, particularly in the West where the arid climate makes it challenging to cultivate certain plants. For example, the Tesuque Pueblo Farm in New Mexico utilizes a greenhouse to shelter vulnerable plants (McKenna, 2013), while the Blackfeet Community College Greenhouse Project uses a greenhouse and a garden for teaching plant-growing skills to the community (Landry, 2014). Particularly in areas with harsh weather, greenhouses are an invaluable tool for protecting immature plants and extending the growing season. These benefits are crucial for restoring control of the food system to local communities, as many localities may be unable to grow sufficient food to feed themselves without the support of greenhouse technology. One particular structure that has been growing in popularity is the hoop house, which consists of arched supports with a plastic covering, allowing for natural temperature regulation within. Their basic design makes them relatively inexpensive and simple to construct, and many food sovereignty programs have found success in expanding the capacity for food production through building hoop houses in community gardens as well as individuals' yards (McKenna, 2013; US Department of Agriculture, 2013; University of Nevada, 2017).

3.1.4 Aquaponics

Aquaponics combines hydroponic growing techniques with aquaculture in contained systems that yield both fish and produce for harvest. This method of food production has been utilized in Indigenous Food Sovereignty programs in Hawai'i because of its resemblance to the traditional food system known as ahupua'a (Beebe et al., 2020). Ahupua'a are tracts that stretch from terrestrial to aquatic ecosystems, whose mutual influence is recognized and cultivated in balance. To improve food security among Indigenous Hawaiians, the organization God's Country Waimanolo in Hawai'i hosts aquaponics workshops that enable families to mirror the principles of ahupua'a in their own backyards (Ho-Lastimosa et al., 2019; Beebe et al., 2020). More than 70 families in the rural town of Waimanolo built backyard aquaponics systems between 2010 and 2016 with the help of these workshops. In interviews about their experience, these participants reported benefits such as improved nutrition, economic savings, stronger familial and community bonds, and a greater sense of cultural connection (Beebe et al., 2020). After witnessing the success of these workshops, God's Country Waimanolo developed a new, 3-month workshop series integrating aquaponics skill-building, nutrition programming, cooking classes, and traditional medicine (Ho-Lastimosa et al., 2019). In the future, the Mini Ahupua'a for Lifestyle and Mea'ai through Aquaponics initiative intends to create an aquaponics certification program and a system to train youth to teach aquaponics to others in turn, expanding the reach of this program (Ho-Lastimosa et al., 2019).

3.1.5 Orchards

Orchards are another key avenue of food production for many Tribes, with the majority located in the Midwest. In Wisconsin, the Bad River Band cultivates apple orchards, while the Shakopee Mdewakanton Sioux Community in Minnesota grows 14 apple varieties in their orchards (Carlson, 2015). As part of their commitment to agriculture in harmony with the land, the Shakopee Mdewakanton Sioux integrate poultry production into their operation to control pests in their orchards. Both of these Tribal initiatives were launched as ways to remedy community health disparities and displacement from historical food traditions. The desire to preserve traditional foods also guides the efforts of the Karuk, Yurok, and Klamath Indian Tribes in California as they collaborate with the University of California at Berkeley (UC Berkeley) to preserve heirloom fruit trees that currently grow in the region but are at risk of dying out ('Securing Our Fruit Trees', 2017).

Maple syrup production has been a popular initiative in the Midwest (Dwyer, 2010; Carlson, 2015; Meskwaki Nation, 2018; Calvert, 2023). Harvesting maple sap to boil into syrup and mold into sweet cakes is a re-emerging Meskwaki tradition being led by tribal youth (Meskwaki Nation, 2018).

3.1.6 Heirloom seeds

Many traditional plants used by Indigenous communities are heirloom varieties, and their seeds may not be readily accessible on the commercial market. To help those wishing to grow traditional foods, many organizations gift or sell seeds. For example, Native Seeds/SEARCH (NS/S) conserves and distributes seed varieties that are native to the Southwest and adapted to the arid climate (Native Seeds SEARCH, 2020). The resounding success of NS/S demonstrates the high demand for seeds as a resource for revitalizing Indigenous cultural foods, with over $1 million in annual gross income from seed sales, donations, and membership subscriptions. NS/S subsequently reinvests this revenue into offering free seed packets to Indigenous farmers as well as conserving over 100 heirloom seed varieties. Another group striving to preserve native seed varieties is Seeds of Renewal in Vermont (Vermont Indigenous Heritage Center, 2023). Initially founded to unearth the history of the Abenaki Tribes in order to gain state recognition, the project has expanded into an effort to restore traditional horticultural practices through gardening classes, agricultural ceremonies, and the creation of a seed bank containing over 50 varieties of traditional crops. In New Mexico, the Tesuque Pueblo Farm specifically dedicates a portion of its land to producing seeds, which it grows on behalf of organizations such as NS/S or for its own seed bank (McKenna, 2013). The farm is especially concerned with protecting Indigenous seeds from cross-fertilization with genetically engineered plants.

3.2 Ranching

Ranching includes food sovereignty initiatives that involve animal husbandry, such as the rearing of livestock. A review of efforts by four Northern Great Plains Tribes to restore historical bison herds revealed a variety of economic and cultural approaches (Shamon et al., 2022). Often Tribes possess both a conservation herd, intended to preserve the bison population in the region, and a commercial herd that can be a source of revenue. Revenue is generated by selling hunting licenses (often at a discount for Tribal members), calves, or mature bison that need to be culled to maintain a sustainable population size. These programs are accompanied by efforts to promote the cultural importance of bison, which may include ceremonies, educational opportunities, and donations of meat to local schools. However, bison restoration also faces major challenges such as fragmented land holdings that makes it challenging to maintain large herds, lack of funding, and lack of meat affordability for Tribal members (Shamon et al., 2022). The Thunder Valley Community Development Corporation in South Dakota helps reduce these barriers by training farmers and ranchers in developing bison herds, while also supporting the community by raising chickens for local consumption (Long, 2023).

3.3 Fishing and whaling

3.3.1 Fishing

Fishing-related food sovereignty initiatives are also taking place, whether in the form of fisheries (U.S. Department of the Interior, 2018), hatcheries (Caulfield, 2011), or campaigns to reclaim fishing rights (Nulhegan Abenaki Tribe, 2020). The Aroostook Band of Micmacs established a successful hatchery to revive the dying brook trout population in Maine, which are culturally and nutritionally significant to their Tribe. The hatchery produces over 50,000 brook trout each year, which are sold to consumers and regional retailers or released into Tribal waters as fishing stock. The wastewater from the hatchery is recycled for agricultural use on the Tribe's farm (Micmac Farms, 2023).

3.3.2 Whaling

Many Alaska Indigenous Tribes have directed their efforts in recent decades towards obtaining subsistence whaling rights, with a major victory at the 2018 meeting of the International Whaling Commission (Ikuta, 2021). However, the Makah Tribe in Washington State is still fighting for their sovereign right to subsistence gray whale hunting, which was guaranteed to them in the 1855 Treaty of Neah Bay (International Whaling Commission, 2023). Whaling is a cornerstone of Makah culture and provides an essential food source in a community where 99% of households depend on subsistence hunting and fishing. In a 2018 survey of those living on the Makah Reservation, 80–88% of respondents reported the desire for regularly available whale oil, meat, or bone, and over 95% expressed support for their community whaling traditions (International Whaling Commission, 2023). Currently, the Makah are forbidden from whaling under the United States Marine Mammal Protection Act. The National Oceanic and Atmospheric Administration is processing the Makah's request for a waiver and expects to make a final decision this year (NOAA Fisheries, 2023).

4 Goals of Indigenous Food Sovereignty initiatives

While food sovereignty initiatives often consist of concrete actions such as constructing a garden, they typically describe the larger purpose that these actions are intended to serve. Based on the initiatives reviewed, the primary goals of many initiatives are cultural preservation, health promotion, and cultural food security. Economic development and environmental stewardship are also prioritized, although less frequently, while disaster preparedness is a newer motivation that is gaining increasing attention.

4.1 Cultural preservation

The preservation of traditional food culture is a primary goal of many initiatives. This can involve educating the community on traditional horticultural techniques, reintroducing traditional foods into the local diet, and organizing cultural ceremonies around important phases of the growing cycle such as harvest time. For example, the agroecology stewardship program of United Tribes Technical College in North Dakota educates the community in techniques for all levels of food production, from beginning a garden to harvesting and preserving produce (Burke, 2015). At each stage, traditional methods and plants of the affiliated Tribes are emphasized. The Technical College's gardens host over 80 heirloom corn varieties, ceremonial plants such as sweetgrass, and plants used in the sacred medicine wheel.

Another important method of preserving cultural practices is the intergenerational transfer of knowledge from elders to youth. This priority was identified in a survey of innovative Tribal food system projects across the US, in which youth engagement stood out as a key theme across initiatives (Hipp and Shirl, 2015). For example, Seneca Nation's Food is Our Medicine project partners with an early childhood learning center to teach young children how to grow traditional plants and hosts children's events at the local farmers market (Robert Wood Johnson Foundation, 2018).

4.2 Health promotion

Concerned by high rates of chronic disease, mental health struggles, and other health issues, many communities have turned to food sovereignty initiatives as a way to restore their health. Because Indigenous communities often understand health in a far broader sense than physical wellness, this goal can encompass a variety of outcomes such as cultural connection, emotional well-being, connection to the land, and reciprocity among people, communities, and their environment (Donatuto et al., 2011, 2016; Lines et al., 2019). For example, the Mini Ahupuaʻa for Lifestyle and Meaʻai through Aquaponics program in Hawaiʻi aims to fight nutrition-related disease through backyard aquaponics systems that produce fish, fruits, and vegetables for Indigenous Hawaiian families. At the same time, this program prioritizes the health benefits that arise naturally from traditional land stewardship practices (Ho-Lastimosa et al., 2019). In Minnesota, the White Earth Land Recovery Project emphasizes intellectual, emotional, spiritual, and physical well-being, the four parts of the medicine

wheel, in their food sovereignty programming ('White Earth Land Recovery Project', 2020).

The Food Is Our Medicine project, a collaboration between the Seneca Nation of Indians and the Seneca Diabetes Foundation in New York, was created to address high rates of metabolic disorders through growing healthy, traditional foods (Pietrorazio, 2021). The Shakopee Mdewakanton Sioux Community in Minnesota has implemented a continuously expanding community garden alongside a health foods store, Tribally Supported Agriculture program, and other projects in order to improve health on the reservation (Carlson, 2015). Another example is MA'O Organic Farms in Hawai'i, which trains youth interns in the principles of traditional horticulture. Program alumni reported greater frequency and variety of vegetable intake than their peers, and after completing the program, both alumni and their families reported they were more likely to choose healthy food options and that they felt more strongly about the community importance of land and water. Many interns and staff also reported feelings of hope, community connection, and healing associated with their time in the program (Maunakea-Forth and Maunakea-Forth, 2020). Additionally, a study is being conducted on a cohort of the interns to compare their physical health before and after participation in the program. Preliminary results show that the percentage of interns who were diabetic or pre-diabetic fell from 62% to 30% over the course of a year in the program (Mauli Ola Study, 2024).

The close relationship between restoring traditional foodways and restoring health was universally expressed in the Traditional Foods Project conducted by the Centers for Disease Control and Prevention (DeBruyn et al., 2020). This project evaluated the food sovereignty initiatives of 17 Tribal partners and identified improving community health as a key motivation, with several initiatives explicitly targeting outcomes such as weight loss, increased exercise, and nutritious diet choices. As that analysis shows, even when health issues are not the primary focus of a project, they are still given consideration. For example, the Osage Nation intentionally selects fruits and nuts with high nutrient density for their community orchard in Oklahoma (Lovell et al., 2021). Initiatives like these seek to increase local production of nutritious foods in the hope that community members will benefit from healthier diets and from reconnecting with traditional practices, although they rarely directly measure the effects on health outcomes.

4.3 Cultural food security

Lack of consistent access to healthy food in Indigenous communities is associated with increased consumption of nutrient-poor food items (Jernigan et al., 2012). This arises from the long history of displacement of Indigenous populations from their ancestral lands, which has interrupted traditional methods of food procurement and exacerbated poverty in Indigenous communities across the US. In an Indigenous context, solutions to hunger must expand beyond addressing insufficient quantities of food, but also address insufficient access to traditional foods, known as cultural food security (Blanchet et al., 2021).

Many initiatives use food sovereignty as a prism through which to address cultural food insecurity. For example, a research collaboration with the Round Valley community in Northern California identified key barriers to food security such as lack of community involvement in local agriculture and poor availability and affordability of traditional foods (Jernigan et al., 2012). To remedy these problems, the project worked to implement policy changes such as creating a Community Supported Agriculture (CSA) program, supplying school cafeterias with local produce, and increasing the amount of fresh produce available at the local grocery store. The Round Valley Indian Health Center also began to distribute additional local produce to 25% of families receiving FDPIR food assistance (Jernigan et al., 2012). In Mississippi, the Choctaw Fresh Produce initiative has implemented a CSA program as well, which is supplemented by a mobile produce market to ensure that remote areas of the reservation have equal access to these foods (Carlson, 2021). A collaboration between several Tribes and UC Berkeley identified food security as the focal point of a broader project to transform the regional food system (Sowerwine et al., 2019). Wide-ranging initiatives were undertaken, from workshops on traditional food preparation to the creation of an herbarium and new grade-school curricula on Indigenous food systems. More than 17,000 people participated in these initiatives, with 65% of those surveyed reporting that the programming made the community more food secure and 81% reporting that it had other positive impacts.

4.4 Environmental stewardship

Although environmental stewardship is a key principle of Indigenous Food Sovereignty, it is rarely the primary goal of food production initiatives. Rather, it is often incorporated into these initiatives as a value that guides their implementation. For example, the FRTEP at the University of Arizona works with the Hopi Tribe to develop regenerative agricultural practices that improve rather than deplete the land (Sekaquaptewa, 2021). One technique is rotational grazing, which is intended to maintain soil health and mitigate climate change by increasing carbon sequestration in the pastures. Similarly, the Salish Kootenai College Extension Programming in Ecological and Human Health Restoration in Montana implemented techniques in its community gardens to increase carbon sequestration and reduce the use of pesticides and water, while also working to eliminate invasive plant species on Tribal lands (Dupuis, 2021). Utilizing these sustainable methods, a 15-week community gardening educational series produced sufficient amounts of fruits and vegetables for all 50 participants in addition to more than 10,000 lbs. of surfeit produce for those in need in the community. Both of these initiatives prioritize environmental stewardship by choosing sustainable agricultural practices.

In a specifically Indigenous context, these practices are often passed down through generations as traditional ecological knowledge (TEK). TEK is the accumulated cultural wisdom of Indigenous communities in regard to living in harmony with the environment (Lovell et al., 2021). In New Mexico, the Cochiti Youth Experience seeks to restore traditional farming practices by facilitating the exchange of TEK between elders and young people (Blauvelt, 2016). Integrating TEK into food sovereignty initiatives ensures that these projects respect the Indigenous values of relationality, responsibility, and reciprocity (Miltenburg et al., 2022). A survey of individuals involved in Indigenous Food Sovereignty initiatives found that these principles are central to their attitudes towards food and the land; rather than viewing nature as an exploitable resource, these individuals

feel a duty to be respectful stewards of the environment (Miltenburg et al., 2022). In return for this stewardship, communities benefit from the sustained abundance of the ecosystem, which supports the longevity of food sovereignty initiatives.

4.5 Economic development

Through selling produce, employing Tribal members, and making local food more affordable, these initiatives can stimulate local economies. For example, Micmac Farms in Maine has expanded from a small garden into a formal business operation with a general store, kitchen, and online interface for streamlining produce delivery and shipping (Caulfield, 2011). Vouchers distributed by the Bureau of Indian Affairs enable members of the Micmac Tribe to purchase the fresh produce that the farm grows. The operation also benefits from USDA funding to support operational infrastructure, including training in marketing and management, as well as electronic systems to facilitate participation in food assistance programs for lower income households (Caulfield, 2011). In Montana, where the Blackfeet Reservation relies on 1.5 million acres of agricultural properties as the basis of its economy, the Federally Recognized Tribes Extension Program (FRTEP) helps youth overcome financial obstacles to becoming farmers and ranchers (Billedeaux, 2023). For example, FRTEP helps young people obtain funds from the Montana Junior Agriculture Loan Program to develop agricultural projects, helping them to build their vocational skills, credit, and equity.

4.6 Disaster preparedness

Disaster preparedness is an emerging theme in Indigenous Food Sovereignty, and often takes the form of improving self-sufficiency to reduce the risk of disruptions to the food supply. Most recently this occurred as a result of the COVID-19 pandemic, which exposed vulnerabilities in the food system that included insecure supply chains and increased reliance on food imports. For example, labor shortages in meat processing facilities left many Indigenous communities with limited access to meat products despite a sufficient supply of livestock (Mucioki et al., 2022). However, while the COVID-19 pandemic exacerbated existing challenges for accessing traditional and store-bought foods, it also revealed the resilience of these communities, which experienced a growth of Indigenous cultural and economic practices, such as food sharing networks and other programming to support access to traditional foods. These efforts during this time of need strengthened the ability of individuals and communities to respond to significant events that might occur in the future (Johnson et al., 2021).

Climate change also poses challenges to the food system. As the frequency of extreme weather events such as hurricanes and wildfires is expected to increase in coming years, communities are increasingly concerned about developing the ability to supply their own food and securing food access in extreme situations (New Entry Sustainable Farming Project, 2019; Mucioki et al., 2021). For example, the Hawaiian Islands rely on imports for 80–90% of their food consumption, leaving the residents vulnerable in the event of natural disasters (McGregor, 2020). Stakeholders including the State of Hawai'i Emergency Management Agency, universities, private schools, and nonprofits are seeking to improve the islands' disaster resilience by strengthening Indigenous Food Sovereignty in the local food system. For example, Kamehameha Schools seeks to restore Indigenous agricultural and land stewardship practices, which were estimated to produce over 1 million metric tons of food per year before colonial European contact in contrast to the islands' current production of approximately 150,000 metric tons of food per year (McGregor, 2020). The use of Indigenous Health Indicators to predict the impact of climate change on community health has been pioneered in Coast Salish communities in Washington and could be a valuable tool for developing priorities for climate change adaptation (Donatuto et al., 2014).

Additionally, to improve Tribes' ability to access food during disasters, the organization Partnership with Native Americans is partnering with the organization Feeding America to facilitate disaster preparedness plans between Tribes and local food banks (Partnership with Native Americans, 2023). Adopting sustainable farming practices may also be a strategy to mitigate the effects of climate change in turn. Likely with these considerations in mind, the Federal Emergency Management Agency is planning to incorporate food security as a priority in its disaster preparedness strategy for Tribes (The White House, 2022).

5 Organizational structure of food sovereignty initiatives

Food sovereignty initiatives are launched at three levels of Tribal organization: Tribal affiliations, reservations, and urban areas, which tend to differ from rural areas in key ways. Additionally, instances of inter-Tribal initiatives are emerging.

5.1 Tribal affiliation

Indigenous Food Sovereignty initiatives are typically developed by a particular Tribe for the purpose of serving its members. For example, Micmac Farms is run by and for the Aroostook Band of Micmacs in Maine (Caulfield, 2011), while the Wozupi project in Minnesota is run by members of the Shakopee Mdewakanton Sioux Community (Carlson, 2015). At the same time, there are instances of inter-Tribal cooperation such as the Growing Resilience project, which supports the creation of home gardens for both Eastern Shoshone and Northern Arapaho families living on the Wind River Reservation in Wyoming (Budowle et al., 2019).

5.2 Reservations

As reservations are more common in the Midwest and West compared to other regions of the US, they are also a more common locus for food sovereignty initiatives in those areas. For example, the Santee Sioux Reservation in Iowa assists residents in starting gardens (Landholm, 2016), while the Shakopee Mdewakanton Sioux Community in Minnesota has introduced a variety of projects including gardens and cooking classes to their reservation (Carlson, 2015). In contrast, initiatives in Alaska and much of the southern and northeastern regions of the US tend to serve Indigenous individuals

that do not live on reservations. The WISEFAMILIES Through Customary and Traditional Living program at the Southeast Alaska Regional Health Care Consortium, for example, is being implemented in several Alaskan towns with significant Indigenous populations (Bingham, 2009). The Seeds of Renewal initiative is based in Burlington, Vermont, and their programming is dedicated towards all members of the Abenaki Tribe throughout the Northeast US and Southeast Canada (Vermont Indigenous Heritage Center, 2023).

5.3 Urban initiatives vs. rural initiatives

Many Indigenous Food Sovereignty initiatives are implemented in rural areas (Caulfield, 2011; McKenna, 2013; Chollett, 2014; Hipp and Shirl, 2015; Landholm, 2016; Hayden et al., 2019; Beebe et al., 2020; Lovell et al., 2021; Pietrorazio, 2021; Calvert, 2023; Sićaŋǧu Co, 2023), while fewer take place in urban areas (Kokua Kalihi Valley Comprehensive Family Services, 2011; Hipp and Shirl, 2015; Women's Environmental Institute, 2015; Miltenburg et al., 2022). Here we define rural areas according to information from the Rural Health Information Hub, which utilizes information about an area from census data, designation by the Federal Office of Rural Health Policy, and the USDA Economic Research Service's Urban Influence Codes (Am I Rural? Tool, 2023). This disparity may be partly attributed to the fact that reservations are a common site for initiatives and tend to be rural. Another possible contributing factor is that rural areas provide more land resources for food production in comparison to more densely populated and developed urban areas. As a result, urban initiatives tend to be more limited in size and scope. While rural initiatives can encompass farms (Caulfield, 2011), animal rearing (Shamon et al., 2022), and orchards (Lovell et al., 2021), these projects are not typically possible in urban areas, where initiatives tend to be limited to household and community gardens (Women's Environmental Institute, 2015; Miltenburg et al., 2022). For example, working within the confines of limited land availability, the Kalihi Valley `Aina to Table Initiative was able to establish a community garden and planter boxes in an urban area in Hawai'i (Kokua Kalihi Valley Comprehensive Family Services, 2011). In contrast, the Rosebud Farm Company in rural South Dakota manages a nearly 2000-acre farm as well as large bison herds (Sićaŋǧu Co, 2023). South Carolina's Building Capacity for Tribal Food Sovereignty Project focuses on revitalizing traditional fishing and hunting practices, establishing farms, and promoting gardening in primarily rural areas of the state (Hayden et al., 2019). Interestingly, although urban initiatives are less common, rates of food insecurity for Indigenous individuals are higher in urban areas (Jernigan et al., 2016), suggesting an unmet need for food production initiatives in these locations.

5.4 Inter-tribal food knowledge exchanges

Recognizing that Indigenous communities are often underserved and underrepresented in scientific research, in addition to being amongst the poorest and most food insecure due to structural inequities, some Indigenous communities are coming together to engage in cross-regional knowledge exchanges. For example, the Indigenous Food Knowledges Network connects Indigenous and non-Indigenous scholars, community members, and leaders from the US Arctic and the US Southwest to co-produce food sovereignty solutions (Jäger et al., 2019). The research coordination network was created in 2017 by the University of Colorado and the University of Arizona and is driven primarily by Indigenous community leaders and scholars, in addition to guidance from an all-Indigenous steering committee. Members of the network exchange knowledge about ways to maintain traditional ways of life, from river restoration, community gardens, housing infrastructure, and farming practices to culture camps in which Indigenous knowledge is shared with younger generations. This work, primarily driven by Indigenous community leaders and scholars, emphasizes community-driven research that addresses Indigenous peoples' interests, foregrounds Indigenous knowledge systems, and both respects and asserts Indigenous sovereignty (Jäger et al., 2019). Outcomes from these gatherings resulted in the Arctic Report Card's first inclusion of Indigenous Knowledges (Johnson et al., 2021) with recognition that Indigenous Food Knowledges can be quite broad, ranging from seed sovereignty and language revitalization to ecosystem protection.

6 Evaluating outcomes

Many Indigenous Food Sovereignty initiatives are grassroots efforts with a diversity of metrics used to measure success. While some initiatives collect quantitative data on program outputs, others emphasize qualitative methods that demonstrate personal and community impacts. In either case, community engagement and consent in data collection processes is of paramount importance in order to prevent exploitation and to embody the collective nature of food sovereignty.

6.1 Quantitative outcomes

Some initiatives measure agricultural output such as the mass quantity or number of fruits and vegetables harvested (Dream of Wild Health, 2019; New Entry Sustainable Farming Project, 2019; Maunakea-Forth and Maunakea-Forth, 2020) or sold (Maunakea-Forth and Maunakea-Forth, 2020; Land to Hand Montana, 2021). Other projects quantify the expansion of their operations. For example, MA'O Organic Farms in Hawai'i reported the addition of 15 fields to rotation, the installation of over 20,000 feet of irrigation, and the acquisition of over 250 acres of land in 2020, in addition to 260,000 pounds of harvested produce (Maunakea-Forth and Maunakea-Forth, 2020). Because community ownership is key to food sovereignty, another common metric is community participation, which can be expressed in terms of number of program participants (Dream of Wild Health, 2019; Maunakea-Forth and Maunakea-Forth, 2020; Thunder Valley Community Development Corporation, 2020) or volunteers assisting in operations such as farmwork (New Entry Sustainable Farming Project, 2019; Native Seeds SEARCH, 2020; Land to Hand Montana, 2021; Mashpee Wampanoag Tribe, 2022). For example, the Mashpee Wampanoag Tribe's Community Food Project reported that 12 volunteers dedicated nearly 1,300 h to food production efforts in one year (Mashpee Wampanoag Tribe, 2022). These volunteers were recruited through postings in the Tribal newsletter, the Tribal website, and the Community Government

Building, although the COVID-19 pandemic made recruitment challenging. Another example is the Land to Hand Montana initiative, where 390 people volunteered in the community garden in 2021 and 1,150 young people participated in gardening and nutrition education programs (Land to Hand Montana, 2021).

A promising method for measuring health outcomes in a specifically Indigenous context has been developed in recent years by the Native Coast Salish communities in Washington State, who piloted the use of Indigenous Health Indicators in health assessments (Donatuto et al., 2016). These indicators assess community-level components of health that are important to many Indigenous individuals but that are rarely included in traditional physical health assessments, such as community connection, natural resources security, cultural use, education, self-determination, and resilience. Future food sovereignty initiatives could utilize these indicators to assess their holistic health benefits.

6.2 Qualitative outcomes

In addition to quantitative measures, food sovereignty also encompasses concepts such as community empowerment and cultural revitalization that are often better captured using qualitative evaluation (Maudrie et al., 2021). Many of these measures ask participants to directly report their experiences with an initiative and the impacts they received. For example, the organization God's Country Waimanolo in Hawai'i worked with faculty and students from the University of Hawai'i at Manoa to conduct interviews with those who took part in an aquaponics program (Beebe et al., 2020). Two researchers collaborated to identify themes in the transcripts and then shared their findings with the participants, God's Country Waimanolo, and the broader community for validation. Themes were categorized as benefits, challenges, and suggestions; benefits included improved diet, sustainability, financial savings, family strengthening, community building, and cultural connection. Challenges included limited support, managing organisms (such as maintaining proper environmental conditions for fish and plant growth), and inclement weather. Suggestions included further opportunities for communal learning, shared community aquaponics systems, and additional training (Beebe et al., 2020). Another Hawai'i initiative, MA'O Organic Farms, conducted a survey of former Youth Leadership Training interns to assess outcomes related to diet, nutrition, and food sovereignty; outcomes included greater reports of growing one's own produce, knowledge of local agriculture, and valuing community resources (Maunakea-Forth and Maunakea-Forth, 2020).

6.3 Participatory research

Indigenous communities have been historically exploited by academic institutions (Budowle et al., 2019). To address issues of power inequities and the exclusion of communities from the benefits of research involving them, Indigenous Food Sovereignty studies often adopt participatory methodologies that empower communities within the research process (Sowerwine et al., 2019). Methodologies that engage the target population at all stages of the process are known as community-based participatory research (CBPR) (DeBruyn et al., 2020). An example of CBPR is the Traditional Foods Project conducted by the Centers for Disease Control and Prevention, which provided funding and support to Tribal partners who were otherwise autonomous in designing and implementing initiatives in their local communities (DeBruyn et al., 2020). These partners worked with community stakeholders such as Tribal councils and local schools to develop goals that were culturally specific, such as the restoration of traditional farming and foraging methods. Local coordinators were responsible for data collection, utilizing methods such as storytelling to understand how participants' perspectives influenced quantitative outcomes such as health-related behavior changes.

Another example is the Growing Resilience project, which sought to decolonize the research process by granting autonomy to the community. Before beginning data collection related to its gardening initiative, the project secured approval for its research from the Eastern Shoshone and Northern Arapaho Tribal Business Councils (Budowle et al., 2019). Participants were able to share their thoughts in talking circles, a method of turn-based discussion rooted in local customs. The talking sticks, which are passed around to indicate whose turn it is to speak, were crafted and blessed by community elders. These talking circles then developed into a broader focus on sovereign storytelling, which provides a voice to research participants in the representation of their experiences. Common ways in which participants chose to tell their stories about their experiences with the initiative included interviews, talking circles, informal conversations, photography, garden journals, garden-related artwork, and videos. Stories were then coded for common themes such as family and togetherness, revealing the personal and community impacts of gardening initiatives.

7 Barriers to food sovereignty

Although the Indigenous Food Sovereignty movement has enjoyed many successes, communities trying to regain autonomy over their food system still face substantial barriers. The historical and ongoing colonization in the US has severely disrupted Indigenous homelands and traditional foodways, often displacing Indigenous peoples far from their traditional lands. Reservations were often established on low-quality, marginal lands where environmental conditions were not compatible with a group's ecological knowledge (Shamon et al., 2022). Other policies such as assimilation intentionally deprived Indigenous individuals of cultural knowledge, including that concerning traditional foods and agricultural practices (Sowerwine et al., 2019). These factors combine to form major obstacles to restoring culturally informed, community-based control of food production. To overcome these challenges, many initiatives are seeking to restore their community's agricultural traditions, which present powerful opportunities to revive cultural practices as well as the quality of depleted soil (Burke, 2015; Budowle et al., 2019; Pietrorazio, 2021).

This history has also contributed to a distrust of the US government and its institutions. Past exploitation of Indigenous communities makes many Indigenous individuals wary of participating in non-Tribal programs or research, including those relating to food sovereignty. These issues took a central focus during a collaborative food security project between UC Berkeley and the

Klamath, Karuk, and Yurok Tribes (Sowerwine et al., 2019). Because of the university's history of appropriating the culture of these Tribes, the initiative began with extensive work to develop policies that would decolonize the research process and protect the Tribes' interests. The Karuk Tribe developed a document to assert their sovereignty and outline protections for all cultural and intellectual property, which included extensive review processes by the Karuk Advisory Board, Review Committee, and Tribal Council (Karuk Tribal Council, 2015). The Karuk Tribe and UC Berkeley also produced another document to provide guiding principles for the research process, including community engagement, benefit to the Tribal community, educational opportunities for Tribal youth, and confidentiality, among others (Karuk-UC Berkeley Collaborative, 2013). Establishing such protections may encourage more Tribal communities to participate in food sovereignty initiatives while simultaneously preventing exploitative practices.

Another obstacle for food production initiatives is acquiring and distributing seeds. Many heirloom plant varieties have been selected over generations to suit local environmental conditions and possess rich cultural significance for Indigenous Tribes (Cherokee Nation, 2023; Native Seeds SEARCH, 2023). However, knowledge of this significance has been lost in some cases, and heirloom seeds can also be challenging to acquire (Vermont Indigenous Heritage Center, 2023). Many efforts have emerged to address these problems, including seed libraries and exchanges. These organizations identify, collect, and sell or distribute seeds to those who wish to grow native plants, ensuring the longevity of heirloom varieties that may not be available from commercial retailers (McKenna, 2013; Cherokee Nation, 2023; Native Seeds SEARCH, 2023). However, the rarity of many varieties can make it challenging to accumulate large stocks of seeds. Supply may be unable to meet demand (Cherokee Nation, 2023), and state restrictions can negatively impact small-scale seedbanks (Women's Environmental Institute, 2015). Despite these challenges, organizations such as Native Seeds/SEARCH in the Southwest and Seeds of Renewal in Vermont are successfully conserving dozens of heirloom seed varieties and integrating them back into Tribal farms and gardens (Native Seeds SEARCH, 2020; Vermont Indigenous Heritage Center, 2023).

Another risk to heirloom plants is cross-fertilization, leading to hybridization that alters the plant's genetics (Cherokee Nation, 2023). While cross-fertilization is always a risk in natural environments, some Tribes are particularly concerned by the rise of genetically engineered plants. Offspring of genetically engineered plants are subject to patents that can lead to costly lawsuits; furthermore, many crops have value that goes beyond sustenance to encompass kinship relationships and spiritual meaning (Raster and Hill, 2016). The modification of these plants through cross-fertilization threatens these relational systems and threatens Indigenous Food Sovereignty. For these reasons, many Tribes have campaigned against the use of genetically engineered seeds and pledged not to plant them (McKenna, 2013; Native Seeds SEARCH, 2023). The Native American Seeds Protection Act of 2019 had the potential to become a major milestone in this effort but did not progress to a floor vote in the US Senate (BillTrack50, 2020). For now, local rights disputes continue, such as the fight of the Ojibwe people in Minnesota to resist commercial appropriation of traditional wild rice (Raster and Hill, 2016).

As the food sovereignty movement grows, finding creative solutions to common obstacles will be essential. Improving soil quality, restoring traditional ecological knowledge, enhancing cooperation among Tribes and funding institutions, and protecting Indigenous plant varieties are some of the major efforts facing Indigenous communities in their work to reclaim traditional foodways.

8 Indigenous Food Sovereignty among eastern tribes

8.1 Challenges facing eastern tribes

The majority of Indigenous Food Sovereignty initiatives that focus on food production have occurred in the West and Midwest, with relatively few taking place in the East. Eastern Tribes have had the longest sustained contact with settler colonialism in the territory now known as the continental US. Through encroachment on sovereign lands, loss of reservation land, treaties predating the creation of the US federal government, and racist policies such as blood quantum, many Tribes were later deprived of the right to be acknowledged by the US federal government as sovereign nations. Many exist as federally non-recognized Tribes, some are recognized by states, and fewer have recently become federally recognized in the past two decades.

For example, the Virginia Tribes that are federally recognized only recently won that battle in the last 5–10 years. In 2015, through the Bureau of Indian Affairs federal acknowledgment process, the Pamunkey Tribe was acknowledged as sovereign. In 2018, through an act of Congress, Chickahominy, Eastern Chickahominy, Monacan, Nansemond, Rappahannock, and Upper Mattaponi were acknowledged as sovereign nations. Like many other Tribal nations, most Tribal members and Tribal descendants live in urban settings and do not have access to large areas of agricultural land. As newly recognized sovereigns with limited access to resources, many first-contact Tribes are trying to catch up with the rest of Indian country in terms of governance structure and institutional capacity. Many Tribes have prioritized establishing healthcare access, land reacquisition, conservation efforts, and to a lesser degree, education initiatives. As a result, scalable food sovereignty initiatives have not been prioritized.

Many Tribes, particularly those in the East, do not have the institutional capacity to manage grants or projects beyond what they are currently doing. Despite there being many highly educated and qualified Tribal descendants, many cannot enroll in their Tribe due to institutional challenges that prevent them from bolstering their Tribe's human capital. For example, some Tribes have restricted their citizenship through blood quantum laws or incomplete base citizenship rolls, and changing those laws may help improve their human capital shortage problem. When other sovereigns such as Canada (Nation-State) or Maryland (US State) face human capital issues to address critical infrastructure, security, health needs, and others, they attract new talent from abroad to help address the human capital shortage, which is not an option for Tribal nations.

For Indigenous people who live outside of Tribal lands and reside in urban areas, their lack of access to healthy, affordable, culturally relevant, and sustainable foods is similar to other disenfranchised communities. Increased membership and access to resources in their traditional communities could benefit many if they are willing to move back to their traditional territories,

which may not be feasible or desirable for many. Tribal nations will also have to invest in supply chain infrastructure to deliver food from rural agricultural areas to densely populated urban areas. However, the eastern Tribes occupy lands that cover a diversity of plant hardiness zones with commensurate diversity in the types of agricultural products that can be produced. Additionally, the proximity to other Tribal nations raises the potential for inter-Tribal food trading and supply chains.

In areas where high quality land, resources, and supply chain coordination are lacking, urban Indigenous communities could benefit from alliances with other disenfranchised communities to establish food networks. Black and Indigenous alliances are emerging throughout the US to address critical issues affecting these communities. Technological innovation will also play an important role as vertical and shipping container farming becomes more efficient, cost-effective, and available.

The following subsections on the food sovereignty initiatives of eastern Tribes were, respectively, contributed by four of this paper's authors who are all enrolled or documented descendants of state and federally recognized tribes from mid-Atlantic and Southeast tribes. They are also personally involved in the efforts described.

8.2 Urban Indigenous Food Sovereignty: Baltimore American Indian Center

The Baltimore American Indian Center (BAIC) is an urban Indian cultural and resource center serving the greater Baltimore area and beyond. The challenges of food sovereignty in urban communities are the consequences of a general lack of economic resources, a lack of availability of food retail establishments near residential areas, and the reality that most major food chains which would offer a wider variety of healthy foods will not open stores in poorer urban districts. Residents also face a lack of accessible areas to grow produce near their homes. Much of the Indigenous urban population only has direct access to small convenience stores that prioritize the sale of low-quality food. Some potential solutions include local government incentives to encourage large food chains to establish stores in poorer neighborhoods, community gardens in areas with healthy and safe soil, government-sponsored farmers' markets in poorer neighborhoods, and healthy eating instruction in public schools.

The BAIC is addressing these urban food sovereignty issues through several initiatives. First, the BAIC partnered with Pearlstone Retreat Center to name a river on their site in honor of the Indigenous people of this area. The river was being blocked which was hindering the rebirth of aquatic life with cultural importance such as sunfish, crawfish, and trout. That river was unblocked in 2022 and now it leads into the Patuxent River. Second, in summer 2023, the BAIC expanded their Baltimore City Public School Indian Education Title VI grant to include elements of food sovereignty education. Students are able to attend a 4-day summer camp at another Maryland nonprofit organization which centers around restorative agriculture, The REED Center, to learn about ecosystem farming. It is an opportunity to get urban Indigenous children reconnected with nature and to understand the impacts of different food systems. The retreat will also highlight Indigenous food as many of these children, like their families, have been disconnected from Indigenous food pathways. Finally, a new Indigenous food program was established in December 2022. This program includes bi-monthly food drives and quarterly Indigenous cooking classes. The Indigenous cooking class operates as a knowledge co-creation and sharing program where urban Indigenous residents can reconnect with Indigenous foods and learn how to cook fresh produce provided during the food drive. Several hundred people have attended at least one of the events to date.

8.3 Eastern Chickahominy and USDA local purchasing program

The Chickahominy Indian Tribe – Eastern Division views food sovereignty as a vital part of cultural preservation and independence as a nation. Food sovereignty involves re-learning the traditional knowledge of ancestors in a way that is sustainable and sharable for future generations. The Indigenous community has a deep connection with the earth and the resources she has given them to steward. The food and water needed for survival and nourishment are seen as gifts to be cared for, shared, and then given back. Incorporating environmental sustainability into food sovereignty initiatives is integral to increasing health and reducing food scarcity in the Indigenous community.

In 2021 the Tribe was awarded a new sustainable materials management grant by the EPA for a community compost and gardening program. The grant's goal was to support efforts to eliminate food insecurity in the Tribal community and raise awareness of traditional and sustainable food management practices. A community garden was planted and cared for by the Tribal community and school, with education, outreach, and fresh produce being offered to Tribal citizens. The grant ended in 2022 and was not renewed by the EPA due to lack of progress by other grant recipients.

In September 2022, the Tribe was awarded the USDA Local Food Purchase Assistance grant. The grant is aimed at strengthening the relationship between the local farm community and the underserved Indigenous community. As a rurally dispersed environmental justice community, there is a lack of education and access regarding locally grown, healthy foods. The USDA grant allows the Tribe to purchase produce and meat from local farms, which is then distributed throughout the Tribal community. Hot meals are prepared and delivered to elders. Fresh produce is utilized in the Tribal school and summer camp program, and there are designated pantry box pick-up days for citizens.

There are future projects that the Tribe hopes to implement to support food sovereignty. A native food forest is in the planning phase, which will incorporate traditional knowledge of food management through cultural classes and Tribal citizen volunteers. There is hope that this could lead to economic development, furthering the Tribe's goal of developing capacity as a sovereign nation. Land acquisition will allow for hunting and gathering, traditional agriculture, and conservation practices. Learning from Tribal elders and other Tribal nations is an important part of reaching these goals, as well as working with organizations, research and educational institutions, and government agencies. As with most goals of underserved communities, lack of capacity, technical assistance, and funding are barriers in reaching many food sovereignty goals.

9 The future of Indigenous Food Sovereignty

As the Indigenous Food Sovereignty movement continues to grow, it will be critical to understand the evolving characteristics of the movement and the approaches that can be most effectively leveraged to generate progress. Trends such as federal support, refined research methods, and harnessing big data could potentially have major impacts on the scale and effectiveness of future food production initiatives.

9.1 Role of the federal government

In addition to motivating grassroots efforts, Indigenous Food Sovereignty is gaining attention on the national stage. The 2022 White House National Strategy on Hunger, Nutrition, and Health outlines explicit strategies to better support the food sovereignty of Tribes with federal programming (The White House, 2022). For example, the USDA has committed to devoting more resources to the FDPIR Self-Determination projects, which grant greater autonomy to Tribes in curating the contents of their government food packages. Through these projects, Tribes are able to advocate for the inclusion of healthier, traditional foods in their packages in place of highly processed commodities (The White House, 2022). The USDA will also provide more traditional food offerings in its Child Nutrition Programs and facilitate the inclusion of traditional foods in school meal programs. In order to create the economic infrastructure to sustain local food systems, another USDA initiative is the creation of Regional Food Business Centers in underserved communities, including Tribal lands. Additionally, the USDA has made recent announcements regarding the nomination period for a Tribal Advisory Committee which will provide greater support and inclusion of Indigenous communities within USDA programs and policy and to include subject matter experts to provide key advice to advance USDA's work within Indian Country and to support Indigenous food security and sovereignty (US Department of Agriculture, 2023b). Much of the work of USDA is funded by the Farm Bill, which is currently under revision. This piece of legislation has the potential to significantly expand federal Indigenous Food Sovereignty programming, as expressed by the Native Farm Bill Coalition, an organization which develops policy priorities in support of Indigenous peoples in the US (Parker and Hotvedt, 2022).

Other government agencies will be instrumental to the federal government's food sovereignty efforts as well. The Bureau of Indian Affairs and the Bureau of Indian Education will seek to increase the availability of healthy and culturally relevant foods at certain schools and detention centers through the creation of Indigenous Food Hubs. The Department of Health and Human Services will also increase its efforts to reduce inequities in Tribal communities by providing greater guidance on the resources related to food security, food sovereignty, and physical activity that are available from the Administration for Children and Families. Finally, the Department of Housing and Urban Development will devote more of its funds to create infrastructure and behavioral programs dedicated to improving food access and health outcomes in Tribal communities. In order to track the outcomes of these diverse projects, the National Strategy on Hunger, Nutrition, and Health also recommends that all levels of government form data sharing agreements with any institutions and stakeholders that collect relevant data. The federal government's interest in promoting Indigenous Food Sovereignty demonstrates the growing strength of this movement in the US. As this trend continues to spread, the identification of effective and sustainable initiatives will be increasingly important.

9.2 Outcome measures

There is limited data on the direct impact of initiatives towards achieving Indigenous Food Sovereignty goals. Many projects rely on indirect measures such as the quantity of produce harvested or the number of skills workshops offered, but individual and community outcomes are rarely measured. For example, initiatives designed to improve community health often report increased availability of fresh produce but do not directly measure outcomes such as rates of chronic disease, making it challenging to assess the initiatives' effectiveness. Future research should collect data on outcome measures related to the goals of food sovereignty initiatives. However, because many of these initiatives are grassroots efforts, they may have limited capacity to expand the breadth of their data collection or to disseminate their findings to a broader audience. Additionally, even when these activities are prioritized, peer reviewed literature is often made inaccessible by paywalls. To ensure that Indigenous Food Sovereignty initiatives can produce impactful data, resources for data collection should be prioritized in the planning and funding stages, and researchers should seek to publish their findings in open access journals, if possible.

When deciding which data to collect, both qualitative and quantitative methods have value. Qualitative methods can shed light on a project's successes and challenges by accounting for intangible factors such as cultural and personal impacts. However, these approaches often lack standardization, making comparisons across initiatives challenging. On the other hand, quantitative measures provide more objective data about an initiative's outputs but may not adequately capture important contextual information. Approaches that synthesize both objective and subjective data could provide a more thorough understanding of an initiative's impacts, supporting the development of more effective and sustainable Indigenous Food Sovereignty initiatives. Additionally, because of the historic exploitation of Indigenous communities by academic institutions, including the misuse of health data, empowering and building trust with these communities must be prioritized throughout the research process (NCAI Policy Research Center and MSU Center for Native Health Partnerships, 2012).

9.3 Data-driven approaches to Indigenous Food Sovereignty

Initiatives to improve Indigenous Food Sovereignty can be complex and must carefully balance many components such as adequate nutrition for community members, cultural norms of food consumption, support for the livelihood of food producers, and stewardship that supports a resilient ecosystem. These diverse objectives can sometimes result in a competition of priorities, such as deciding whether to produce food in ways that favor high yield, enrich

the environment, or provide greater income to farmers. When a community is not able to balance the needs of the community, needs of the producers, and needs of the ecosystem, then it may lack the capacity for food sovereignty. One framework introduced in the Indigenous Food Sovereignty literature highlights seven indicators that address an Indigenous community's capacity for food sovereignty. These indicators include: (1) access to resources, (2) production, (3) trade, (4) food consumption, (5) policy, (6) community involvement, and (7) culture (Jernigan et al., 2021).

According to this framework, access to resources is both a physical and knowledge-based indicator. Communities that are largely fishing communities must have access to their traditional waterways as well as culturally relevant knowledge to sustainably harvest and respect their food source. The production indicator highlights the importance of an equitable distribution of food to the community, which will meet its needs and allow food producers longevity in operation. The trade indicator highlights the importance of balancing affordable food prices for the community with profitability for farmers. The food consumption indicator highlights the importance of healthy and sustainable foods available to the community. The policy indicator highlights the importance of policies that support fair access to resources. The community involvement indicator highlights the importance of community input in food system management, as communities may have the requisite traditional knowledge to ensure the lifecycle of foods is managed in a culturally relevant and sustainable way. Finally, the culture indicator highlights the cultural relevance of the foods consumed.

To use these indicators to measure a community's capacity for Indigenous Food Sovereignty, data is needed to quantify concepts like access to resources, market prices, number of farmers, and ecosystem health. Computing technology could support the collection of these data. Additionally, data science and computing technologies can help measure a community's current capacity for sovereignty and help define pivotal areas to focus efforts for capacity growth.

Many Tribes in the West and Midwest lack access to resources such as productive soil and water for agriculture (Shamon et al., 2022), while many urban Indigenous populations experience a lack of land and limited food availability (Burki, 2021). Innovations in technology can help address these issues. At the agricultural level, data science, artificial intelligence (AI), and blockchain technology has already been used to support soil, crop, disease, and weed management, which can promote increased agricultural productivity and reduced environmental impacts (Eli-Chukwu, 2019). For example, distributed network approaches can be used to better understand the interrelatedness between water scarcity issues across and among agricultural areas, which may lead to better scarcity pattern identification (Lin et al., 2018). Intelligent built-in irrigation systems for precision scheduling may also lead to greater efficiency in water use on Indigenous lands (Nikolaou et al., 2020). The Agriculture Improvement Act of 2018 directed the Federal Communications Commission to improve broadband access on agricultural land with the aim of facilitating precision agriculture in the US. The task force created around this objective has devised specific strategies for implementing the program on Tribal lands, such as collaborating with Tribal colleges to identify unserved and underserved agricultural areas and collaborating with other government agencies to update land use data (Federal Communications Commission, 2021). Additionally, technologies that perform land suitability analyses, such as geographic information systems (GIS), can be a valuable asset to Indigenous farmers (Bandyopadhyay et al., 2009). GIS could also help identify suitable horticultural locations in urban areas (Kazemi and Hosseinpour, 2022) where Indigenous individuals experience high rates of food insecurity (Jernigan et al., 2016).

The production indicator includes disease control, product monitoring, and storage management, which can be implemented and monitored through computing technologies. These processes ensure that food is healthy and resilient from farm to table by (a) operating as an early detection system, safeguarding against potential loss of yield due to disease or other pressures, (b) analyzing crop health and recommending when additional inputs and management are needed, and (c) automating commodity storage systems to preserve food safety and minimize waste. The trade indicator can be supported by AI-assisted forecast crop commodity pricing for farmers (Akkem et al., 2023) which can help determine whether market prices support farmer profitability and community affordability.

The food consumption, policy, community involvement, and culture indicators can be supported by data science and AI technologies that assist with supply chain traceability, sentiment analysis of the community food system, monitoring of the health of food throughout the supply chain (Misra et al., 2022), and promoting healthy food recommendations to consumers (Marvin et al., 2022). Additionally, recommender systems, which are computing systems that explore vast information spaces and make task-specific recommendations relevant to a user's inquiry, can have built-in features that promote sustainable food choices by identifying culturally relevant foods that minimize environmental impacts. Sentiment analysis of online reviews of Indigenous suppliers or forums to discuss community food policy can provide decision-makers with aggregated opinions of the community, thereby creating a feedback loop between the community and decision-makers. Crowd-sourcing as a data acquisition and management strategy can also be useful in transferring traditional knowledge (Papadopoulou and Giaoutzi, 2014). AI can also be used to increase workers' productivity or replace workers where there may be a labor shortage (Ryan et al., 2023).

9.4 Indigenous data sovereignty

Although Indigenous communities have been participating in agriculture practices since precolonial times, Indigenous data has often been viewed through a colonial lens that fails to recognize and value Indigenous approaches and perspectives that may differ from Western norms. In order to better support the involvement of Indigenous peoples in the agricultural sector, greater efforts are needed to engage with these communities to collect accurate data about their farm and ranch operations to identify unmet needs. Fortunately, this process is now underway. In 2002, Montana, North Dakota and South Dakota initiated pilot programs to collect state-level data on agricultural activity on American Indian reservations (US Department of Agriculture, 2007), which was expanded to include all states in the 2007 Census of Agriculture administered by the USDA. If producers did not respond to the mailed report, census employees—many of whom were Tribal members that were

able to bridge language and cultural barriers (United States Department of Agriculture, 2019)—followed up in person to help them complete their forms. These data collection efforts represent a promising first step toward greater inclusion of Indigenous peoples in the US agricultural sector. Importantly, clear agreements on the handling of data collected during research with Indigenous communities are necessary to prevent infringements on Tribal sovereignty and misappropriation of community information (Harding et al., 2011; NCAI Policy Research Center and MSU Center for Native Health Partnerships, 2012).

10 Conclusion

The Indigenous Food Sovereignty movement in the US has emerged in response to the legacy of large-scale displacement, marginalization, and erasure of Indigenous peoples and culture over the centuries since European colonization. The Indigenous Food Sovereignty movement asserts the right of communities to ownership of their own food systems in ways that are culturally meaningful and empowering (Maudrie et al., 2021). Restoring these food systems offers a powerful approach to addressing food insecurity, health inequities, and cultural disconnectedness by dismantling their common roots of unequal access to healthy, traditional foods and a lack of community-controlled food production (Sowerwine et al., 2019).

Recognizing the interconnectedness of these issues, effective Indigenous Food Sovereignty initiatives often take a holistic approach that encompasses several goals and food production methods in addition to programming such as cooking classes (Karuk – UC Berkeley Collaborative, 2012), horticultural demonstrations (Burke, 2015), or youth skills training (Maunakea-Forth and Maunakea-Forth, 2020). By diversifying their efforts, organizations are able to address many prongs of food sovereignty at once, including production, sustainability, and access. However, most literature pertains to gardens and farms rather than less conventional types of initiatives. Future research should seek to characterize lesser-known practices, including those such as hunting and foraging that may occur on an individual scale or through informal channels. These means of food production may be better suited to certain traditional foods and may also provide solutions for unconventional environments. For example, restoring Indigenous fishing rights for a local river could simultaneously amend a historical injustice and provide urban residents with a means of acquiring their own food.

Although the Indigenous Food Sovereignty movement faces challenges such as loss of cultural knowledge, low quality land, and lack of seed access, initiatives continue to make progress towards their goals of cultural preservation, health promotion, cultural food security, economic development, environmental stewardship, and disaster preparedness. Supporting Indigenous Food Sovereignty is an emerging goal of the federal government, which will likely bring greater attention and resources to this movement. To maximize the success of future initiatives, further research should be conducted on the characteristics of current initiatives and the factors influencing their effectiveness. This review contributes to this goal by characterizing food production initiatives that strengthen Indigenous Food Sovereignty and identifying gaps in the literature. This information can advise the development of future food production initiatives and help identify potent research questions, supporting the ongoing and accelerating success of the Indigenous Food Sovereignty movement.

Author contributions

SR: Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing, Writing – original draft. CB: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. RS: Data curation, Investigation, Writing – original draft, Writing – review & editing. TW: Writing – original draft, Writing – review & editing, Funding acquisition. ML: Funding acquisition, Writing – review & editing. LJ: Writing – review & editing. TP: Writing – review & editing, Writing – original draft. JB: Writing – original draft, Writing – review & editing. BR: Writing – review & editing. JP: Writing – review & editing. ZC: Writing – review & editing, Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision.

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Conflict of interest

BR was employed by Nottoway Indian Tribe. JP was employed by Chickahominy Tribe – Eastern Division.

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

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EDITED BY
Ina Vandebroek,
University of the West Indies, Jamaica

REVIEWED BY
Janelle Baker,
Athabasca University, Canada
Ashley McGuigan,
University of Hawaii, United States

*CORRESPONDENCE
Shailesh Shukla
✉ s.shukla@uwinnipeg.ca

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Indigenous values and perspectives for strengthening food security and sovereignty: learning from a community-based case study of *Misko-ziibiing* (Bloodvein River First Nation), Manitoba, Canada

Lisa Young[1,2], Shailesh Shukla[2]* and Taylor Wilson[2]

[1]Bloodvein First Nation, Bloodvein, MB, Canada, [2]Department of Indigenous Studies, University of Winnipeg, Winnipeg, MB, Canada

In recent years, changing environmental, developmental activity, government policies and laws, lifestyle changes and affordability dynamics have continued to threaten the self determination and food sovereignty of Indigenous peoples in the community. Their perspectives, teachings, and voices are rarely present in any scholarly work. Despite food security being a significant challenge among many First Nations communities on Turtle Island, there needs to be more empirical, community-based research that underscores the role of traditional food systems and associated values and teachings in Manitoban communities through an Indigenous lens. This research addresses that gap by building upon Indigenous perspectives and knowledges on the status and future directions of food security and sovereignty in Misko-ziibiing (Bloodvein River First Nation). Guided by Indigenous research protocol and using a qualitative research approach, ten in-depth interviews with Bloodvein River First Nation (BVR) and Winnipeg Elders were conducted. Data was also sourced through discussions with local council members, participant observation, and field visits during 2017. The fundamental values and traditional teachings associated with food sovereignty within the community are aligned with the spirit of sharing, including sharing ethics and protocols, social learning within the community, and intergenerational transmission. Enhanced intergenerational transmission of traditional teachings, education and language revitalization, and local leadership involvement can strengthen these social and cultural values to enhance Indigenous food security and sovereignty in Misko-ziibiing. This research identifies the knowledge and views of Elders, hunters, trappers and fishers, contributing to the current studies associated with traditional food systems and teachings. Strengthening social and cultural traditions and values is vital in working toward Indigenous food governance, sovereignty, and revitalization of their Indigenous food systems.

KEYWORDS

indigenous values, social values, cultural values, food sovereignty, food system governance, indigenous food security, traditional foods, self-determination

1 Introduction

Prior to colonization, Indigenous peoples had a strong relationship to their food systems which was necessary for the ongoing survival of their communities and cultural practices. Colonial systems in Canada have negatively impacted this relationship such as connections to land, food, and knowledge. Despite colonization, there is an ongoing resurgence of Indigenous food systems and connection to traditional territory through processes of engaging in traditional knowledges and spiritual and cultural values (Wendimu et al., 2018). It is important to acknowledge the role that traditional food systems and strengthening cultural values plays in the revitalization of Indigenous food sovereignty (IFS). The Indigenous Food Systems Network identified four principles of food sovereignty: (1) food is sacred; (2) participation in land-based activities is essential; (3) self-determination is critical; (4) and policy reform is a necessary component to achieving food sovereignty (Morrison, 2011). Traditional food systems are building cultural knowledge and practices, satisfying holistic health, and connecting community through active production, consumption, processing, and distribution of foods. These systems and traditional knowledges are passed down through land-based experiential teachings across generations which is central to Indigenous food systems and food sovereignty (Settee and Shukla, 2020). Additionally, traditional food systems "encompass practices which govern the processing and community distribution of harvested animals, as guided by elder oral traditions and cultural values" (Shukla et al., 2019, p. 75). Eating well goes beyond the food itself and every community has distinct food cultures that play important roles in strengthening well-being and connectedness across generations and reinforcing values key to the survival of their cultural heritages (Tamang et al., 2016; Vernon, 2016).

In a study by Haman et al. (2010), it was found that participants in Miskoziibiing (Bloodvein River First Nation) believed that traditional food consumption was a challenge, and declining, due to lack of knowledge of traditional practices for youth, the high costs of harvesting traditional foods, and the growing challenges in accessing traditional foods due to development projects and climate change. These sentiments were shared among Miskoziibiing Elders in this study. There are four factors that have been identified as playing a role in hindering or enhancing Indigenous food systems: (1) the knowledge of traditional food harvesting practices; (2) economics of hunting, trapping, and fishing, (3) the availability and access to traditional foods: and (4) access to traditional territories (Haman et al., 2010). Using these four factors, Miskoziibiing Elders stress that in order to enhance the food system in Miskoziibiing there needs to be active engagement in intergenerational transmission of food teachings and cultural values. When cultural values are cherished and taught, communities – especially youth, acquire resilience and cultural identity. In addition, doing this in ways that use Indigenous languages and ways of learning, we can build upon the foundations of Indigenous values, worldviews, and acknowledgement of the sacredness of food to develop comprehensive and culturally relevant food education (Michnik et al., 2021).

This case study aims to examine the Indigenous food knowledge values and perspectives of Miskoziibiing Elders, hunters, trappers, and fishers in in enhancing food security and Indigenous food sovereignty (self-determined food systems governance). Specific questions addressed in this research were:

1) How are Indigenous food systems (including associated values) understood in Miskoziibiing?
2) What are the challenges for Indigenous food systems in Miskoziibiing?
3) What are the ways in which IFS can be strengthened in Miskoziibiing through engaging in Indigenous food systems?

The processes and knowledges around the interplay between Indigenous food systems and cultural values from Indigenous residents on-reserve is largely understudied. This research identified the knowledges and perspectives of Miskoziibiing participants in a way that will not only contribute to the current studies associated with traditional foods, but it also explores challenges associated with IFS, documenting and preserving Indigenous food knowledge for future generations, and supported Miskoziibiing community members in acknowledging their traditional teachings and knowledge. Indigenous or traditional foods can be defined in many ways, especially when utilizing community perspectives of traditional foods. From a theoretical perspective, traditional foods are a sacred gift that support health and well-being, it links people to their ancestors, each other, and life, and they provide "health, emotional balance, mental clarity, and spiritual health" (Coté, 2016; Jernigan et al., 2021, p. 2). Wilson and Shukla (2020) argue that Indigenous and traditional connect people to their local ecosystems and cultural food practices. What this means, is that traditional foods are and could be foods we typically associate with the land and waters of Indigenous territories, but they can also include introduced foods that have become integral to their health, well-being, and survival such as the introduction of Bannock, a food now synonymous with Indigenous peoples in North America that was introduced by Scottish settlers during the fur trade of the 18th and 19th centuries (Allard, 2023).

Sharing key teachings and values, alongside understanding the barriers and challenges in engaging in IFS, provides an opportunity for Indigenous food system revitalization. The underpinnings of IFS are inherently values-based, holistic, local, and contextual (Martens, 2021). Indigenous foods cannot be separated from cultural values. Kuhnlein (2020) affirms this by sharing that "it is universally recognized that traditional food provides more than the essential physical sustenance; it also provides extensive social and cultural values for communities" (p. vii).

2 Methodology

2.1 Author positionality

The positioning of all authors is an important part of this work, not only to acknowledge the power and privileges we have as being academics and researchers, but to also the tensions we have within our own identities as Indigenous and non-Indigenous authors. Positionality reflects how we view ourselves but also how we are perceived in research spaces, it affects the research process (Holmes, 2020). Kovach (2009) also invites researchers to self-identify within their research to show how relationships are integral to our lives.

The lead author identifies as Anishinaabe from Miskoziibiing and grew up in a large family. It was because of this large family that the importance of food and survival was instilled within her. She grew up listening to the stories that her father shared about the hard times they

had feeding such a large family. Although, her family did not consider these times as hard; to them it was life. Her father started hunting with his father and uncles at the age of 13. The stories he's shared at the dinner table are precious stories; stories that she holds dear to her heart. During her childhood, she understood the seasons based on the food she ate. In the winter, it was trapping and hunting rabbits, moose, and caribou. In the spring, it was hunting geese, ducks, waterfowl, and fishing pickerel, sturgeon, catfish, whitefish, goldeye, jackfish, and suckers. In the summer, it was trips up the river, specifically every Sunday after Catholic Church. In the fall, it was trips to the trapline to hunt for moose, trips up the river for geese and ducks, and commercial fishing on Lake Winnipeg. This was a lifestyle that had been practiced for years, a lifestyle that had been passed on from generation to generation. This way of life instilled love for her family and community within her. My parents, siblings and extended family enjoyed our time together. Today, life is about work, western education, urban areas, and travel. As a mother, her goal is to instill Anishinaabe teachings in her children and to share the experiences that she had in her childhood with them. We share food and tell stories of times with her grandparents, trips to the trapline, hunting, fishing, and harvesting. It was these stories and lifestyles in her past that have influenced this research.

The second author is a first-generation immigrant and original inhabitant from India settled on Treaty 1 Territory. He has always worked with and for Indigenous communities, supporting Indigenous knowledge systems, planetary health, and sustainability in close collaboration with Indigenous communities, academics, governments, and non-government partners from Turtle Island and South Asia. Over the last two decades, he has collaborated with academic and research partners from Canada and Internationally on interdisciplinary research projects on Indigenous knowledge systems and community-based resources management. All of this is to support the ongoing work already being done within Indigenous communities, including this research.

The third author is a Anishinaabe, Cree, and Filipino woman who grew up on the other side of Lake Winnipeg from Miskoziibiing in Fisher River Cree Nation. She grew up medicine picking with her grandmother and listening to stories of what life was like before she was born such as how food was medicine and how connected families and communities were to one another across Manitoba. As she entered Western spaces, she pulled away from traditional practices but reconnected to them through her academic work in food sovereignty. It is not only a pathway to revitalizing Indigenous food systems but reconnecting to ancestral knowledge for a sustainable future.

Our identities have many implications in this work, including our shared responsibilities to support and promote Indigenous livelihood, traditional teachings, resilience, knowledge, and culture.

2.2 Research framework

Miskoziibiing is an Anishinaabeg community, therefore, Anishinaabeg ways of knowing were central to how this research was situated. In *Kaandossiwin: How We Come to Know* by Kathleen Absolon (2011) it is recognized that connection to land is important for Indigenous peoples, and they use a flower image to display a wholistic Indigenous methodology that supports self-determination and liberation. It is important to understand the need to advocate for Indigenous voices within and throughout this type of work, which is core to the principles of IFS. The parts of the flower identify the critical elements in an Indigenous paradigm: (1) the roots represent worldview; (2) the flower center represents the self; (3) the leaves represent the journey; (4) the stem represents critical consciousness and support; (5) the petals represent diversity in methods; (6) the environment represents the academic contexts within which Indigenous research methodologies grow.

The community of Miskoziibiing was selected due to the distinct social and cultural values which provide rich historical teachings based on Indigenous food systems. The Anishinaabeg has occupied this area since time immemorial. The Anishinaabeg of Miskoziibiing self-identify with their territory and know their hunting, fishing, trapping, and harvesting areas. Learning about the territory and waterways, as well as ways to hunt, fish, trap, and harvest, was crucial for the survival of the Anishinaabeg of Miskoziibiing. Figure 1 shows the location of Miskoziibiing and Figure 2 indicates traditional traplines and traditional territories of Miskoziibiing (Bloodvein River First Nation and Whelan Enns Associates Inc, 2007).

A qualitative research design was used to explore connections and reciprocal relationships that the Anishinaabeg have with their traditional hunting, fishing, trapping, and harvesting areas (Creswell, 2009). Using a case-study and focusing on a single community allowed for observation of how the Anishinaabeg from Miskoziibiing locate traditional food: how they hunt, trap, fish, harvest, and prepare traditional foods. The research took place in Miskoziibiing, on the hunting grounds of the Anishinaabeg, as well as closer to the community where an all-weather road was developed. This all-weather road is located right through the hunting grounds of the Anishinaabeg and includes a bridge which runs over the Bloodvein River, and a creek called Long Body Creek. In addition to researching the traditional hunting territory of the Anishinaabeg, the focus was to develop an understanding of the ontology, epistemology, and axiology of the Anishinaabeg in Miskoziibiing.

2.3 Recruitment, data collection, and analysis

In June 2017, a meeting was held between the Miskoziibiing Band Council Leadership and the second author to provide information on

FIGURE 1
Aerial view of Bloodvein River First Nation.

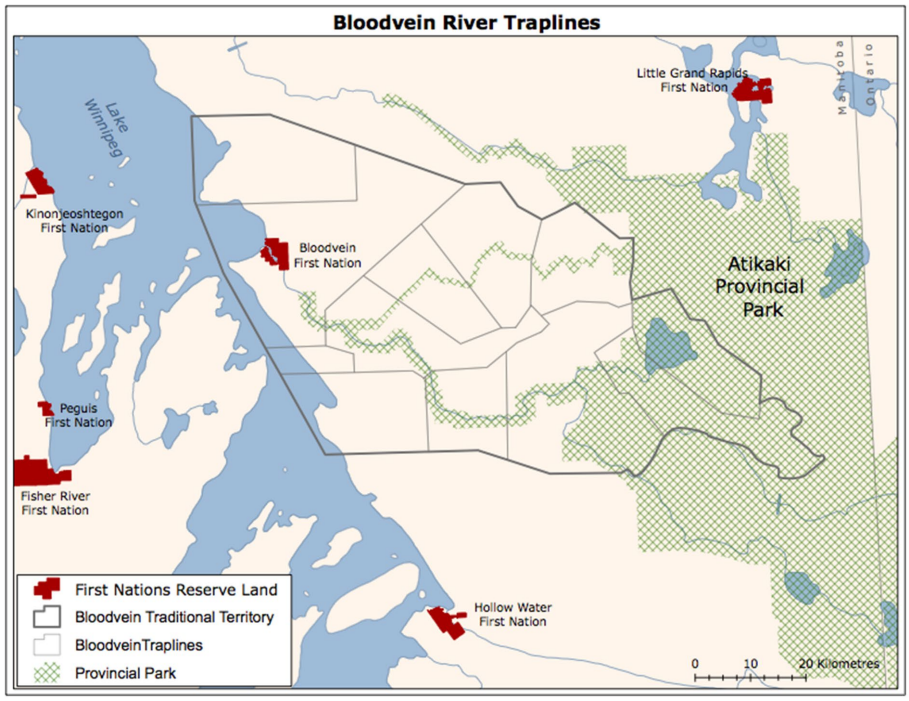

FIGURE 2
Bloodvein River First Nation's traditional territory and traplines.

the potential collaboration between the University of Winnipeg and Miskoziibiing for the benefit of the community. It was here that the Miskoziibiing leadership identified local knowledge keepers and Elders who had in-depth understandings of traditional foods, community culture, and critical values who may be interested in participating. Potential participants resided in both Miskoziibiing and Winnipeg. Potential participants were approached and asked if they would be willing to participate in an interview for this case study. Interviews were chosen as a conversational method which aligns with Indigenous worldviews of orality as a way of transmitting knowledge and upholding relationality (Kovach, 2009). Deloria (1996) interpreted oral tradition as the "non-western, tribal equivalent of science" (as cited in Absolon, 2011, p. 36). That knowledge explains the nature of the people's physical, emotional, mental, and spiritual worlds. Ten Miskoziibiing Elders were interviewed from July to September 2017. Locations of interviews were determined by the Elders and were conducted at their residence, the local Child and Family Services office, and other locations within the community such as during a walk exploring the waterways and fishing, hunting, and harvesting practices occurred.

The research ethics protocol for this project was developed by two of the authors and then shared with the Miskoziibiing Band Council in June 2017 who provided feedback on the process. The Band Council approved the revised ethics protocol in October 2017 which was then reviewed and approved by the University of Winnipeg Huaman Research Ethics Office in May 2018. The protocol was continuously reviewed by the researchers as the Miskoziibiing Band Council and participating Elders made requests to ensure that all community protocols were being followed and participants were being respected throughout the process. The protocol included an interview checklist with an informed consent process where consent forms were reviewed with participants in detail with them before they were signed. An interpreter was also made available for translation of the consent forms and research questions. Two Elders were interviewed using the interpreter. Each participant was given the opportunity to remain anonymous if they chose and after discussions with the Elders it was decided to utilize their initials instead of pseudonyms. In addition to meeting Western academic ethical protocols, the study engaged in Indigenous research ethics protocols such as: (1) Offering of tobacco to Elders as a gift that signified respect and reciprocity (in addition to a cash honorarium through the SSHRC grant of the second author for this research); (2) focusing on the governmental structure within the community of Miskoziibiing and utilizing the concept of reciprocity; (3) participating in ceremonies performed during the research process and holding their cultural knowledges sacred (Kovach, 2009). In addition, there was a continued acknowledgement of participants in the research, there was no competition for ownership of the knowledge shared, it was owned communally as well as by the Elder sharing their stories.

During the research process, the data gathered was analyzed regularly and reviewed by participants. The traditional hunting, trapping, fishing, and harvesting locations were mapped, documented, and photographed throughout the research. They were shown to the research participants to ensure the information was recorded correctly. The collected data was transcribed from an audio format and then coded onto a spreadsheet. The responses were then coded using the open coding procedures, where each response was coded with a theme based on the literature review (Strauss and Corbin, 1998) and compared with the master coding sheet initially developed. The frequencies of codes were derived using the NVivo data analysis software. For the information gathered during the research process to

remain valid, the data was analyzed alongside the participants to ensure everything was remembered and documented correctly.

3 Findings

3.1 Indigenous food teachings from Miskoziibiing: community values ongoing and critical

Anishinaabeg culture and traditions are essential to the community of Miskoziibiing. The interviews highlighted the importance of community sharing and intergenerational teaching in upholding IFS. These fundamental values are upheld within Miskoziibiing and are foundational in providing food security through Indigenous food systems, which was evident in the participants' discussions around the sharing of core values through teachings, community food sharing, the transfer of skills and knowledge, and the importance of social learning.

Regarding IFS, sharing seemed to be of utmost importance to the participants, with one Elder stating, "Sharing was very, very important to the people; they always, always shared what they had" (FY, September 8, 2018). Participants stated several reasons as to why sharing was essential, but two reasons stood out among them. The first was situated in the past, where sharing was about survival, with Elder MF (September 9, 2018) explaining:

> "…because that is the only way people survived long ago by sharing. They shared everything, not only in their territory but the rest of Turtle Island. They shared medicines, food, instruments for ceremonies, they shared everything."

The second reason was situated in contemporary Indigenous contexts concerning the current market-based food governance. Traditional foods were not purchased; rather, they were shared among one's family and community. MM (July 29, 2018) described this when they shared the following:

> "In the summertime, when my dad killed a moose, or some member of the family killed a moose, they shared it to the community. They didn't sell any moose, any of the stuff that was killed, they shared it with the community people. Your neighbor, they would come and get meat from my parents or other members of the community people. They would keep the heart, everything was not wasted, heart, liver, kidneys all that stuff that they saved was eaten by members of the family or they would give to other people. There was a lot of sharing."

The Anishinaabe people of Miskoziibiing live with a distinctive worldview guiding how they interact with the land and food systems. In addition to sharing food, sharing the protocols around food gathering was highly important to the participants. This was mainly discussed in respecting the lives that were given up – both animal and plant life – to support and sustain their health, traditional knowledge, and lifestyles. The teachings surrounding these protocols have been passed down from generation to generation, which was made clear when Elder MF (September 9, 2018) spoke about the history of respect for life:

> "Well, a long time ago, before there was reserves, people said that they were nomads, they followed the food, they followed the animals, and the teachings were to respect all life, to respect those animals because those animals provided food, medicines, clothing, shelter all those things they provided there was teachings to everything that had to do with animals, fish, birds and vegetation."

There were two specific ways in which the values and protocols were practiced amongst participants while hunting and gathering. The first was through offerings to thank both the Creator and the animal or plant itself for the life sacrificed to feed their families and communities. MM (July 29, 2018) described the experience her brothers had while hunting with their father:

> "My brothers I used to hear them, because when my dad went to hunt, they would see my dad putting tobacco out, already that time. Tobacco says if you take something off the land you put tobacco down and thank the creator. Cause the animals give themselves up to the people, to use as food."

The second way these practices were illustrated was through concepts of sustainable hunting practices, wherein overharvesting was understood and monitored carefully to ensure that both the wildlife and the traditional practices and knowledge were passed down to future generations. Elder WY (August 9, 2018) shared about the intergenerational teachings of sustainable hunting practices:

> "…the hunting ethics I guess, the sustainable practices, I guess were passed on down. Not to over kill the animals, that was passed on down to the younger hunters and we're still going to be doing that sometime in the future here."

The passing down of teachings also extended to understandings of the land. Many participants shared their personal experiences and stories they received from their fathers, uncles, and grandparents. Harvesting locations are not on a map but merely in the memory of the hunter, trapper, fisher, or harvester. Additionally, they are in areas that require knowledge of the land and waterways. Without this knowledge, a harvester would be putting themselves at risk. The ability to harvest food from the land requires skills, knowledge and cultural values. If either is lacking, survival may be jeopardized. When travelling up the local river, the hunter must navigate through the river's rapids, avoiding the reefs' rocks and acknowledging the strength of the current. The hunter must always be aware of his surroundings, especially when travelling on the river.

The participants shared how they began learning and engaging in traditional food practices as children and young adults. Each participant discussed practicing these activities – hunting, fishing, trapping, and harvesting with family or community. Intergenerational teachings were passed on to ensure the preservation of the knowledge and sustainability of the environment. Elder ES spoke Anishinaabemowin throughout her interview and spoke of her upbringing with her family (September 10, 2018):

> "They helped each other, they knew by watching, they watched. Whatever, however people lived they just took the kids with them.

> Since they were children, they took them to trap lines and that's how they learned, by just watching and learning."

Working together as a family or community was incredibly important for sustainability and ensuring the whole community's food security. Everyone contributed, and everyone benefited. Elder WY remembered how the food from hunting and fishing was shared with other community members. He also remembered being with extended family on these hunting and fishing trips. The following are recollections from Elder WY (August 29, 2018):

> "…when I was taught growing up with hunting and fishing, it was my dad that taught me and some of the community members were involved as well, my cousins when we were growing up, we would go out hunting and they taught me quite a bit as well."

Throughout the interviews, each Elder reminisced about their childhood and young adulthood. A common thread between each interview was how proud each Elder was of the teachings they received as children. Each participant shared that their teachings had come from their parents or their grandparents and that they shared their knowledge with their children. Elder SD spoke about sharing traditional knowledge with his children (September 9, 2018):

> "I took him twice when he was just a little boy. That's where he was, he was skinning under that moose neck area, he was cutting doing the same thing, he had a lot of moose meat."

Elder SD also shared about learning from his Elders and passing on those learnings to his children (September 9, 2018):

> "That's the way my dad used to tell me, I'd listen to some old people, what they said. They still think of an old man there, I listen to him, I listen to the other people, I listen to Mike Green there. I listened to what's his name; Benson there, Robert Benson. I heard my dad, and sometimes I would hear from umm, my uncle Shell there, but little did, Charlie Weshkup he told me a little bit. But all this was the way to live, the way to hunt. They explained everything to me; I took it and trying to explain that to my own boys now."

3.2 Challenges and barriers to engaging in indigenous food sovereignty

Lifestyle and dietary changes have significantly impacted the Anishinaabeg of Miskoziibiing. These changes have impacted the youth of Miskoziibiing, who are losing their cultural heritage. The lifestyle and dietary practices of the Anishinaabeg of Miskoziibiing have drastically changed over the last 40 to 50 years.

Alongside the change in diet has come a change in lifestyle and activity level. In previous years, physical work was crucial for survival. Simple luxuries such as running water and electricity are new to the Anishinaabeg residents. While clean, running drinking water has enhanced the community's well-being, it has eliminated the daily exercise of carrying water home. Elder ES talked about a lack of hard work that have harmed youth's health (September 10, 2018):

> "Life is different. They had to work for their food. They're not used to the way we used to eat before; they don't even carry water."

Many participants who were hunters, fishers, trappers, and harvesters acknowledged the importance of knowing the environment and the changing landscapes. As previously mentioned, the participants discussed lifelong teachings received from family members. These teachings provided safety and stability while harvesting food but were also impacted negatively by changing weather patterns and new developments in the area. Elder LK recalls having the ability to go berry picking anytime and anywhere. However, today, due to the changed landscapes, there are limited areas to pick berries. Elder LK (July, 2018) shared, "there used to be lots of blueberries, lots of strawberries, cranberries there was lots, raspberries, there was all kinds of berries, lots of them, saskatoons. Now there's none."

Elder MM made the same statement during her interview. The abundance of berries that community members could utilize as a treat have all but disappeared (July 29, 2018):

> "I will say the berries, no more berries. There used to be all kinds of berries in Bloodvein, you could go in the bush or just around the reserve there would be lots of strawberries, blueberries, cranberries, all these things are gone, there's nothing growing anymore."

To add the changes in how participants interacted with the land, many participants echoed challenges regarding policies and laws. In addition to navigating new physical landscapes, they are also navigating new political landscapes. These participants are still actively harvesting and have to abide by provincial regulations. Participants also raised concerns about hunters coming from outside of the community and hunting on Miskoziibiing's traditional territory. Elder WY said (August 9, 2018):

> "And of course there are regulations that are imposed on us and you know we've, with the encroachment of the all-weather road now and there's hunters coming to our area. And they don't hunt safely at all; they're noisy and drunk half of the time too. So those are the challenges and those are the things that the community has to deal with."

Another challenge identified in the interviews was the growing costs of engaging in traditional hunting and harvesting practices. Travel expenses, such as using local airlines for transportation to traplines, are another expense. These modes of transportation and their associated expenses were unavailable in previous years. Elder SD shared, "I had this feeling, boy, it felt like I was going to kill a moose, but I had no way of going because I had no boat" (September 9, 2018). Elder VT also shared about access and affordability (August 31, 2018):

> "Many of the people don't have guns anymore. They don't even have canoes, they don't even have boats, gas, all this. They don't have the proper knives, utilities that they need to go hunting, they don't have the proper tools for skinning the animals even. These things are very expensive. Guns are very expensive."

The affordability challenge came with utilizing a boat and motor or floatplane as a transportation method to their harvesting locations.

The interviews with the participants explained the hard work required to harvest, hunt, fish and trap. This lifestyle required physical and manual labor. Transportation to harvesting, hunting, fishing, and trapping locations required walking, running, paddling, and portaging. In the winter, dogsled and snowshoeing were required. Although these transportation methods may seem challenging, they were simply the way of life for the Anishinaabe. This not only affects their economic stability but their physical health. Elder WY shared (August 9, 2018):

> "We've grown too accustom to the Western foods and all the can stuff, all the processed food and we've forgotten our traditional ways of obtaining our traditional food from our land."

3.3 Opportunities for indigenous food systems revitalization

In addition to the successes and challenges of engaging in traditional food practices, the participants also shared their recommendations for solutions. Indigenous communities across Canada are working to address their problems of food insecurity with the involvement of Elders, local band council leaders, community members, and community advocates. The interviews identified opportunities and strategies to revitalize traditional food systems in Miskoziibiing and promote IFS. Miskoziibiing has been promoting land-based teachings along with other resources, such as Jordan's Principle, Child and Family Services, Miskooseepi School and Chief and Council. Many Miskoziibiing community members have been actively involved in assisting in getting these teachings to Miskoziibiing youth and young adults. The goal is to ensure traditional practices are passed down to the younger generation to ensure these teachings and livelihood is preserved. Any spring, summer, fall, and winter harvests are shared amongst community members. The teachings of the distribution of food are taught and shared with those that can no longer actively get out to harvest food.

The interviewed Elders shared how Indigenous food and land-based teachings were passed on to them through their grandparents and other knowledge keepers from their communities and is their responsibility to continue to teach future generations. Elder MF shared (September 9, 2018):

> "It's important to teach our children because it's our responsibility to teach them. If we don't teach them, it's going to come back to us and it's our fault … if things are not carried on, especially the traditional way of harvesting and eating and all those things. It's our responsibility."

Some interview participants emphasized that starting with teaching simple tasks like where and how to set up traps in different seasons and how to prepare wild meats for winter is essential, and others emphasized transmission of specific practices associated with traditional food hunting and harvesting. Elder MM confirmed this when they stated (July 29, 2018):

> "I believe it will be nice if you had the younger people teach them how to clean these things, fish and all that. Teach them how to preserve them for the winter. They need to be taught, [traditional knowledge] needs to be brought back."

Involvement of local Elders has been strongly practiced in the last five years and the Prevention Program actively involves their input in this development. Miskoziibiing recently developed cultural grounds just outside of the community perimeter called Circle of Voices in *Anishinaabemowin* it is *Ke-wah-way-we-tung* and was named after a Miskoziibiing Elder (Figure 3).

The role of land-based learning by Elders and formal educational institutions such as schools was aptly emphasized by research participants. Elder LK shared that the early introduction of traditional foods was important for children and youth. Elder MF envisaged the community and the local schools having essential roles in intergenerational teachings of traditional food systems through planned interventions (September 9, 2018):

> "They should implement programs in the school and in the community to address these concerns about living a good life. They need to take the children back to the land, back to the water, where they can once again listen to the spirit through the water, the wind, the mother earth, the stars, the sun, the moon, all that. Those were their teachers long time ago."

There is a need for language revitalization in IFS. Elder YY explained the importance of language in traditional food systems (August 29, 2018):

> "Language is critical in terms of how we harvest and how we prepare food, using the language … the younger generation

FIGURE 3
Participants of a sweat at circle of voices cultural grounds (courtesy of Angela Meeches).

> also benefits from preparing the food, while harvesting the food, preparing the food in the language used."

Community support is incredibly important for the success of IFS. For these recommendations to be implemented successfully, the support from the Miskoziibiing leadership is needed. This was stressed by the participants. The Chief and Council have already been involved with their members and partake in activities that happen in the community. Elder FY identified that there are already discussions within the community about organizing spaces for sharing knowledge (September 8, 2018): "Some people that were talking about starting some kind of knowledge learning like that with younger people."

Elder SD mentioned that seeking more support from the Chief and Council would be beneficial to community members (SD, September 9, 2018): "and, the other thing I think about is to ask the Chief and Council when we need something that we could ask them, see if they can help us out."

Elder MF (September 10, 2018) agreed that Chief and Council "should implement programs in the school and in the community to address these concerns so we can live the good life."

4 Discussion

4.1 The Spirit of sharing: core values of Miskoziibiing's indigenous food system

Power (2008) stated that food obtained from traditional food systems is critical to cultural identity, health and are essential factors for the survival of communities and their food systems. Food security requires a healthy environment where land and water are healthy and where animals consume good medicines in the environment (Shukla et al., 2019). Sharing protocols and values is part of the plethora of traditional food knowledge shared amongst the people of Miskoziibiing. The sharing of sustainable hunting and gathering food skills and knowledges are vital to food security. One of the reasons sharing is vital is that not all harvesters are fortunate enough to have a successful hunting, fishing, or trapping experience and harvesters often share their food with their communities. This was reiterated by Pawlowska-Mainville (2020) when she stated that "occasionally, even though everything is done right, nothing gets trapped or netted. If another harvester were fortunate, his catch would be shared with community members to ensure people would not go without" (p. 58). Fieldhouse and Thompson (2012) stated that the ability to harvest, share and consume traditional food is considered particularly important to Indigenous peoples' food security. As reported in other studies from Northern Manitoba, *Asatiwisipe Anishinaabeg* food systems follow the practice of *miigiwewinan*, where meals of locally harvested wild rice or moose are shared within a community (Pawlowska-Mainville, 2020).

Miskoziibiing is one of four communities that comprise the Pimachiowin Aki World Heritage Project (2012). This partnership stresses the importance of sharing traditional teachings and values. Morrison (2011) identified that sharing traditional food practices has shaped, supported, and sustained distinct cultures, economies, and ecosystems. These partnerships display the concept of shared responsibilities, which comes full circle to the discussion of communal responsibility to share food within and throughout the community. Miltenburg et al. (2022) developed a framework on IFS initiatives which situates IFS in place, the connection to land that foundational to Indigenous food systems, this is further centered on core values of relationality, responsibility, and reciprocity. All of which are key for the function of relationships to the lands, waters, and other people. This considers how communities work with each other, are responsible to the land and each other, and give back.

Reciprocity plays a significant role in food sovereignty. It is one of the most basic values for many Indigenous groups (Scott and Feit, 1992). It is required to uphold responsibilities and relationalities, it strengthens relationships. This can happen when out on the land and waters engaging in food harvesting practices wherein a hunter express respect for the provision of healthy foods but also through the mutual relationships built with other community members. Feit (2014) furthers this concept of reciprocity when they discuss the social responsibilities of hunters who do intensive work to harvest food but share it with their kin, friends and family, who do not have the access, skills, or abilities to hunt. This is a form of social responsibility and mutual aid that is core to IFS values.

The literature and study participants also discuss the importance of sharing food for survival due to overpriced store-bought foods. Store bought foods often have higher costs in addition to being higher in sugar, salts, and unhealthy fats, which often results in higher rates of obesity and diabetes that plague Indigenous communities (Wilson and Shukla, 2020). As shared by participants, many community members, and Elders in Miskoziibiing now rely on store-bought goods and acknowledged the importance of sharing with other community members who may not have the means to provide for their families.

4.2 Affordability: evolving challenge

As Indigenous communities moved into the 21st century, the cost of living increased and caused harm. In the past, people hunted, fished, and gathered to provide food for their families. Affordability was not an issue for Anishinaabeg in the past. However, in recent years high costs associated with accessing traditional and healthy food has been a barrier (Wilson and Shukla, 2020). This was present in the findings in two ways, through the high costs of the tools needed to engage in traditional hunting and harvesting practices and increasing costs of store-bought foods.

Skinner et al. (2013) identified that traditional food activities have declined in recent decades, especially for young people. Many of these endeavors are seasonal and are limited by financial constraints for harvesting transportation and equipment. Affordability to maintain this lifestyle has challenged many Indigenous people locally and globally. The cost of transportation, whether by boat, vehicle, plane, or skidoo, and required equipment, such as guns, knives, fishing gear, camping gear, and sleeping gear, can create a barrier to IFS and security. The costs of buying hunting and harvesting tools and the lack of adequate transportation have reduced many young people's time and active participation in traditional food activities (Skinner et al., 2013).

This disconnection from the land was echoed by Pawlowska-Mainville (2020) in her studies in Anishinaabe communities from boreal forest regions of Manitoba. Pawlowska-Mainville (2020) stated, "Whereas most consumers purchasing food from a grocery store rarely consider the aspect of land or what ecosystems their foods came from, Indigenous food systems are founded on the health of the land" (p.70). Utilizing the land, territory, and waterways is essential to the

people of Miskoziibiing and high costs are having an incredible impact on this connection.

Providing for your family and community is crucial for food sovereignty. The cost for travel, such as airfare, to a trapline can cost upwards of $5000.00 CAD for a return trip, this does not include other costs such as purchasing and maintaining equipment or food for the trip, or the loss of income from taking time from jobs to engage in traditional harvesting. Costs continue to put a barrier in with local harvesters to commute to traditional harvesting territories, there is local resource assistance to ensure that local harvesters have the means to get to hunting sites for harvesting and teaching purposes. Despite this, affordability continues to be a barrier to traditional food systems and many community members have utilized local or urban grocery stores to provide for their families. Now, most families rely on store-bought items that have a higher financial cost than food harvested from the land. Both affordability challenges can lead to the destruction and loss of cultural values associated with hunting, harvesting, and food preparation practices in addition to negative impacts on their lifestyles and diets (Glacken, 2008; Wendimu et al., 2018).

4.3 Environmental and landscape changes

The changing climate, development, forestry, and commercialization has negatively affected ecosystems and access to traditional territories. Pawlowska-Mainville (2020) acknowledged that knowing the land and working hard is critical when trapping or hunting food in the boreal forest. Patience, persistence, and confidence in survival techniques are also needed for these activities. Environmental and landscape challenges must be taken seriously. Otherwise, the outcome can be detrimental and life changing. The most experienced harvester must always consider the elements, the landscape, and their experience as a harvester before setting out onto the land as it can pose challenges to any experienced harvester. These challenges can consist of fast-flowing or low water in the river, landscape erosion, or all-weather road erosion. The all-weather road, Provincial Road 34, passes through Miskoziibiing's traditional hunting territories, and some traplines are accessible. This recently constructed all-weather road was completed in 2014. This all-weather road has brought regular traffic travelling through these areas, resulting in less wildlife, other harvesters from surrounding areas hunting in Miskoziibiing's traditional territory, and increased pollution.

4.4 Lifestyle and dietary changes

These changes include fewer harvesting practices and an increase in store-bought goods in local stores and urban areas. The items purchased in local stores or urban areas are often unhealthy, increasing the risk of obesity and diabetes. Harvesting and consuming traditional foods must not only meet nutrition and health needs, but it must also satisfy traditional values (Wendimu et al., 2018). There are considerable economic, social, and cultural barriers to accessing nutritional foods such as "remote living, loss of cultural traditions, lack of economic stability, and am myriad of issues stemming from colonization" (Wilson and Shukla, 2020, p. 203). Food system impacts from colonization includes events like disconnection from traditional territories through the introduction of the reserve system, residential school system causing malnutrition and nutrition related diseases, and the forced dependance on store-bought foods which is directly linked to ongoing dietary diseases (Turner and Turner, 2008; Coté, 2016).

Throughout the interviews, the Elders discussed many foods historically important to their communities that played roles in the transmission of culture and values and contributed to mental, emotional, and physical health and well-being (Table 1; Figure 4). When discussing what was important to survival, Elder ES stated (September 10, 2018):

> "All traditional foods like the beaver, the moose, the fish. So, we have to learn how to harvest the food, any kind of food that they had."

4.5 Government policies, laws

IFS principles must be supported through government laws, policies, and legislation that does not undermine Indigenous food systems practices. This includes regulations and policies that determine who is eligible to possess firearms in Canada. These laws have created challenges for potential harvesters in Miskoziibiing. Many hunters need the means to travel to urban centers to apply for a Firearms Certificate (FAC), and they need the means to purchase supplies required to harvest, hunt, fish, and trap. Laws surrounding firearms have been put in place for protection. However, this has caused underlying challenges for many Indigenous people. Pawlowska-Mainville (2020) stated that present-day provincial resource management laws continue to affect the food sovereignty of another First Nation just 160 km from Miskoziibiing by regulating the harvesting season and firearm permits, changing laws on acceptable traps, and controlling the provincial registered trapline system. These laws can determine whether an individual will qualify to obtain the government regulated FAC (now known as a Possession and Acquisition License). If a person cannot obtain a FAC, they cannot hunt and need to depend on others to share their game. Turner and Turner (2008) further explained that food sovereignty is affected by introduced colonial forces:

> "The exposure of First Peoples to colonial and imperial pressures led, among other things, to a decline in their food sovereignty and security, reflected in the loss of many dietary traditions and resource management practices" (p. 109).

Another challenge is the ongoing encroachment of non-Indigenous hunters in Miskoziibiing and other Indigenous communities traditional hunting territories. All along on the Miskoziibiing all-weather road there are signs that state "Wildlife Refuge" however, the previous Provincial government continues to sell hunting licenses to non-Indigenous hunters (Figure 5). Campsites from non-local and non-Indigenous hunters can be found all along the roads and waterways between urban centers and Miskoziibiing. These hunters partake in illegal hunting practices such as spotlighting, the hunting of nocturnal animals using high powered lights, and the pollution of their campsites when they leave garbage strewn about. This encroachment continues to impact wildlife sustainability and jeopardizes the safety and well-being of local community members.

Miskoziibiing has a land use plan called the Pimitotah Land Use Plan, which the provincial government accepted. The land use plan

TABLE 1 Anishinaabe foods important to Miskoziibiing community members with quotes from Miskoziibiing elders.

Traditional food	Quote	Elder
Geese/Duck	Well, in the spring I get people to kill geese and ducks, and they call me and if I need something and oh, they come and offer me a goose or a duck, sure I said, so I do what I have to do all the time clean them and then get payment with the food, like its exchange.	SD
Wild Rice	Oh boy I was just a little girl, but I remember the wild rice coming in canoes and how they put the, it was either blankets or canvas, and it took four people, they put the wild rice in the canvas, and they would throw it up to take the hulls off, yeah, I remember. I watched that. And I also remember how they cooked it or dried over open fire outside. And it was always stored in bags like cloth bags.	YY
Fish	The fish was all seasons; they caught fish all the time, it did not matter what time of season.	MF
	They harvested, they had winter fishing as well, they used poles, they used nails and they just used a rope, like twine maybe. To make a hook they used nails. Smoked fished, ok, so they even smoked the bone, she says, they made scaffolds to keep their food. How they kept the potatoes when they umm, planted potatoes, in the winter they would keep them where the stove was. They made a hole under there that was, so they did not freeze in the winter.	ES
Moose	Moose, I think the only time they did not harvest moose was in the springtime, I think it was in the springtime or in the summer, when the moose did not have the proper coating and meat on the body. They smoked their foods so they can last longer.	MF
	Mostly hunting moose and whatever is usually from August to the end of October, and I do not know what other people did but the way I did mine, I smoked my meat with dry poplar trees and the moose parts that I used for smoking would be the hind quarter. I use birch, young birch trees.	FY
Gardening	My parents always had a garden. Every spring they used to plant potatoes and other vegetables.	LK

states that the nation must be consulted if there is any activity on the traditional lands. Despite Miskoziibiing's land use plan and the signage along the roadway, hunters still come into our territory in the fall. This makes one question whether the provincial government gave these hunters hunting licenses or were hunting illegally. The Pimitotah Land Use Plan for Miskoziibiing has designated areas that may be used for traditional and commercial activities. In this way, the land should be protected from companies entering the territory to engage in illegal activities. The provincial government is supposed to consult with the First Nation before any new endeavors are undertaken. Miskoziibiing hoped that establishing this land use plan would protect the land.

While many Indigenous peoples in Manitoba have differences, their similarities are related to the encroachment of regulations and policies on their harvesting lands and waterways. These regulations have made it difficult for Indigenous people to achieve food sovereignty. Beaudin-Reimer (2020) found that "harvesters who were 50 years of age or older expressed that legislation of the past had a damaging impact on Métis harvesters, their traditions, and their practices" (p. 244).

5 Community-led solutions based in cultural values

5.1 Intergenerational learning and transmission of food knowledges

Youth are an integral part of hunting and harvesting practices as they are not only helpers to their parents or those teaching them but also receive teachings to maintain and uphold these practices so they can be passed on to future generations. Sources like Gilpin and Hayes (2020) have stated that intergenerational teachings continue the intimate relationship with land and waters and plant the seeds of ancestral knowledge and prepare ways for generations to come. Intergenerational teaching is essential for the sharing and preservation of intergenerational knowledge and ensuring that knowledge stays within communities for generations (Poirier and Neufeld, 2023).

Introducing the younger generation to land-based or culturally based activities provides children and youth with skills such as hunting, fishing, trapping, harvesting, and preparing traditional foods. This ensures our traditional teachings continue to be practiced. Miskoziibiing utilizes and connects with Miskoziibiing knowledge keepers for continued transmission of teachings that have been passed on from generation to generation through The Prevention Program, which has a group of harvesters from the surrounding areas that have actively been harvesting for years connect with youth and knowledge keepers. Along with utilizing our traditional territory as their harvesting grounds, the Prevention Program also utilizes their funding to assist Elders to fly to their traditional traplines for harvesting. This provides the opportunity for young people to gain knowledge, skills and a sense of pride in being able to provide food for their families. Power (2008) identified that Indigenous children have yet to acquire the taste for traditional foods because they were not introduced to them at an early age. Having children and youth involved with harvesting traditional food has empowered them to develop that taste for traditional food. Gilpin and Hayes (2020) explain that community knowledge and traditional teachings become embodied when youth, parents, and grandparents participate in garden projects and hands-on learning experiences.

5.2 Local leadership

Community support is incredibly important for the success of IFS, this happens through supportive funding, legislation, and leading by example through engaging in these activities (Poirier and Neufeld,

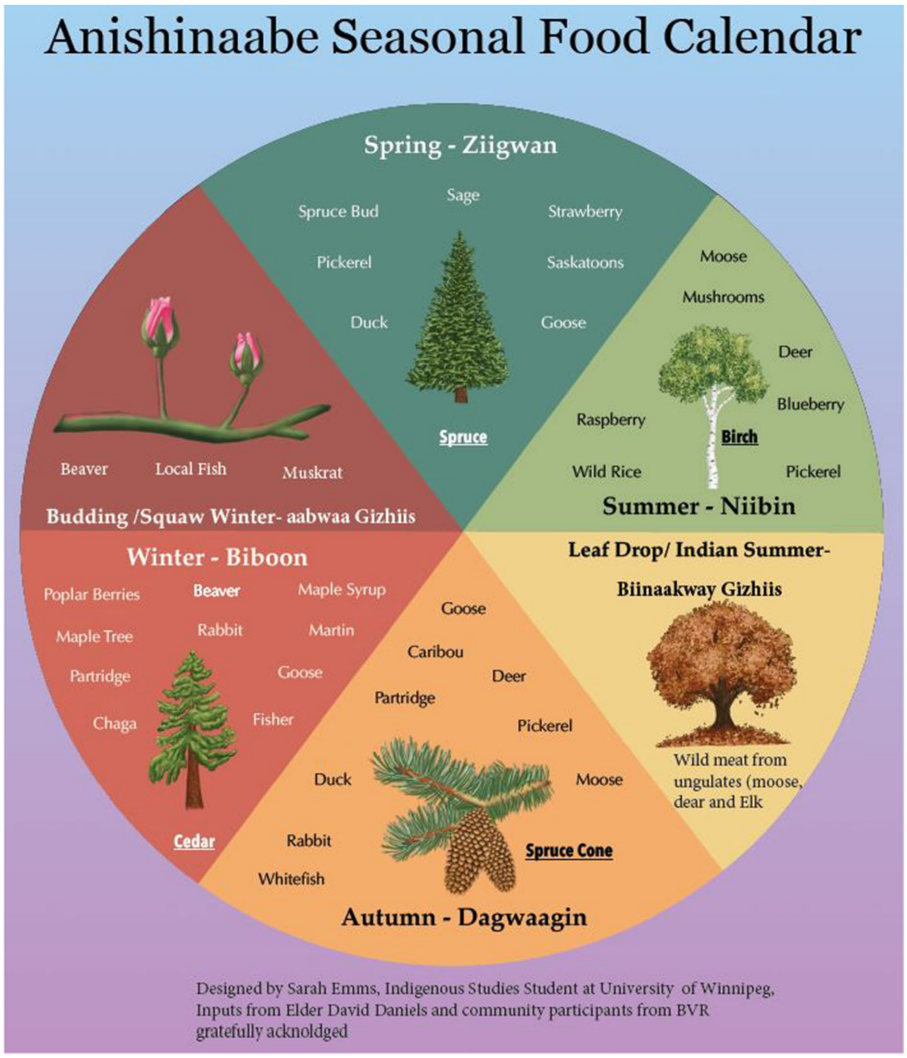

FIGURE 4
Anishinaabe food calendar (designed by Sara Emms, developed from information from Elder David Daniels and Miskoziibiing Elders).

FIGURE 5
Chief George Barker wildlife refuge sign.

2023). The involvement of community members, youth, adults and Elders, along with the Chief and Council, has been encouraging and promising. Encouragement and support from Miskoziibiing's local leadership is crucial in ensuring these practices are not forgotten. The Chief and Council have been actively involved in encouraging local harvesters to become involved with the younger generations. This has been beneficial to many of our young men and women as many have addiction issues. Many resources have been working together to ensure numerous positive, culturally appropriate activities are taking place in the community. Our natural resources have utilized these resources to promote positive lifestyles within the community and the good life – *Mino-bimaadiziwin*.

6 Conclusions and future directions

The research participants shared stories and teachings of growing up with their parents and grandparents around traditional foods, which shaped their perspectives on the meaning of the Indigenous

food systems that nourished them. Sustainability was considered as the most necessary value for the community, and the importance of reciprocity ensured that no one would go without it. This all comes together into a Miskoziibiing-specific version of a food systems governance framework which incorporates social dimensions and knowledge such as community values and intergenerational learning, and stewardship, economics, and governance through building healthy relationships within the community and with the land through food practices, self-governance, and sustainable food practices (Price et al., 2022).

Teachings of hunting, fishing, trapping, and harvesting were shared among community members. There were some similarities in the stories shared by the participants. Their memories and teachings were similar. Each participant acknowledged the communal values of sharing and the importance of sharing teachings with their grandchildren and their community. A continued practice of sharing food with families who have no hunters in the household is also critical and considered an important value to be learned by future hunters in the community. This is key in continuing food practices over generations and building ongoing food knowledges (Joseph and Turner, 2020). Food practices are integral in intergenerational knowledge building because their reciprocal shaping of social institutions, worldviews, customs, and values (Joseph and Turner, 2020).

Participants indicated their challenges in achieving food security and sovereignty for their families and communities. These challenges included dietary changes, environmental and landscape changes, policies, and laws which impact harvesting of Indigenous foods, recent infrastructure developments like the all-weather road, and affordability of food. These challenges only uncovered the tip of the iceberg. Underlying challenges to Indigenous food system-based security and food sovereignty include structural inequalities from the colonial legacy of residential schools and day schools, addictions to drugs and alcohol, lack of intergenerational transmission of knowledge, and a lack of access to affordable and nutritious food due to limited grocery stores. These colonial disruptions undermine self-determination, connections to community, transmission of food way knowledge, and the rights and responsibilities Indigenous peoples have to the land (Ruelle and Kassam, 2013; Ferreira et al., 2022; McKinley and Jernigan, 2023). Community members must travel over 100 km of gravel road and then the highway to get to the nearest town, which has grocery stores with more variety as well as a healthier selection of foods. Only some people in Miskoziibiing have the luxury of owning a vehicle to drive to go shopping and have the money to hire someone from the community to transport them to urban areas. That is why it is so important to community value and spirit of sharing traditional foods that are harvested.

Documenting oral history in Indigenous communities is crucial. The Anishinaabe Food Calendar depicts the rich traditional food heritage and healthy lifestyles that is part of Miskoziibiing's own unique Indigenous food systems. The ability to pass on these valuable teachings to future generations provides a sense of relief as communities lose their Elders. The loss of an Elder is the loss of history and knowledge of the community. Each participant agreed that passing on these teachings would benefit younger generations. The participants identified that they would be willing to work with the youth, band council and the community members to ensure teachings are passed on through land-based programming. The participants shared about how they received teachings from their relatives. They expressed that traditional teachings and a spiritual connection to the land and waterways are crucial for the well-being of future generations.

Strengthening community food security and Indigenous food sovereignty by building upon teachings and Indigenous food knowledges is incredibly valuable for community of Miskoziibiing. This includes enhancing intergenerational transmission of Indigenous food knowledges through the active involvement of Elders and youths, reclaiming and revitalizing learning of traditional food knowledges and languages through education, and proactive involvement of local leadership. Indigenous food systems must include sociocultural meanings, acquisition and processing techniques, and use, consumption, and nutritional consequences of food. Traditional foods are valued from health, cultural, and spiritual perspectives (Shukla et al., 2019). This includes the acquisition and distribution of traditional foods and the practicing and strengthening of associated cultural values (Wendimu et al., 2018). Respecting these values are central to the reasserting the role of Indigenous-led governance for their food security and supports Indigenous food sovereignty.

Indigenous food sovereignty can and will look different in every community. Expanding beyond Miskoziibiing, the concepts discussed in this article can provide guidance and examples of how embracing local and Indigenous food systems values can strengthen Indigenous governance and contribute to the ongoing health, wellness, and sustainability of communities and the lands and territories that surround them. It directly correlates to ongoing struggles globally that Indigenous peoples face when their connections to their land, water, and food systems are threatened by colonization, cultural loss, climate change, land development, and incursion from outsiders who do not respect local land management protocols. Miskoziibiing's work toward revitalizing their local food system through upholding their cultural values and strengths can be replicated in other communities as long as we engage in local and community-based values, protocols, and solutions.

Living off the land and providing for one's family demonstrates food sovereignty. Traditional food ways improve not only physical health but convey and build important sociocultural meanings and values for sustainability of humans and all relatives. For example, reciprocity, discussed throughout this paper which is play an important role in forming relationships, social responsibility, mutual aid, and overall health and wellbeing in community's like Miskoziibiing (Scott and Feit, 1992). They are acts of culture structured in concepts of resistance and resurgence. All of this is crucial for balance, wellbeing, and health (Robin et al., 2021). The values outlined in this paper are foundational to Miskoziibiing, its ongoing resilience, self-determination, and the sustainability for future generations. Promoting our traditional foodways will promote the well-being of the community members of Miskoziibiing. For the people of Miskoziibiing, we as researchers hope and pray to the Creator for *Antawaynchikaywin Mino Pimatisiwin oonji* (hunting and fishing for a good life).

Data availability statement

The datasets presented in this article are not readily available because datasets are co-owned by the lead author and research participants. Requests to access the datasets should be directed to lisacyoung@hotmail.com.

Ethics statement

The studies involving humans were approved by University of Winnipeg Human Research Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual (s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

LY: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. SS: Writing – review & editing, Supervision, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. TW: Writing – review & editing, Validation, Methodology, Formal analysis, Data curation.

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Conflict of interest

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

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EDITED BY
Ina Vandebroek,
University of the West Indies, Mona, Jamaica

REVIEWED BY
Noa Kekuewa Lincoln,
University of Hawaii at Manoa, United States
Colin Charles Dring,
Royal Roads University, Canada

*CORRESPONDENCE
Kristin T. Ruppel
ktruppel@montana.edu

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Blackfeet innovation pathways to food sovereignty: sustainability through indigenous-led research partnerships

Kimberly L. Paul[1], Kristin T. Ruppel[1,2]*, Micaela M. Young[1], Laura Caplins[1], Jill Falcon Ramaker[3], Christopher J. Carter[1], William B. Seeley[1], Christen Falcon[1] and Andrew Berger[1]

[1]Piikani Lodge Health Institute, Browning, MT, United States, [2]Department of Native American Studies, College of Letters and Science, Montana State University, Bozeman, MT, United States, [3]Food Systems, Nutrition and Kinesiology, Health and Human Development, College of Education, Montana State University, Bozeman, MT, United States

The Blackfeet Nation in northwestern Montana, United States, is implementing its Agriculture Resource Management Plan (ARMP), an Indigenous-led, sustainable agriculture plan prioritizing economic development for Indigenous producers, intergenerational health and well-being of Amskapi Piikani Blackfeet people, and ecological and cultural sensitivities within this sovereign nation and its traditional territories. Since the passage of the American Indian Agricultural Resource Management Act of 1993, only three Tribes have drafted and finalized Agricultural Resource Management Plans (ARMPs). The Blackfeet ARMP is now being held up as a national model of Tribal sovereignty. "Blackfeet Innovation Pathways to Food Sovereignty," an Indigenous-led research project, emerged from the Blackfeet Nation's community-based strategic planning process identifying gaps, systemic barriers and impactful solutions for achieving Blackfeet food sovereignty through the implementation of the Blackfeet Nation ARMP, along with research influenced by the ARMP. This paper provides a community case study of the ongoing process and offers a translational model of sustainable agriculture and food sovereignty within Indigenous lands to improve the economic futures of producers and their families, as well as health outcomes for Native communities.

KEYWORDS

indigenous food sovereignty, indigenous-led research, translational, agriculture resource management plan, wholistic research approach

Introduction

After a century of struggle with dispossession of lands, misguided federal agriculture and land policies along with their ecological and social implications, this article demonstrates how the Amskapi Piikani Blackfeet Nation is engaging Piikani (Blackfeet) understandings alongside Western scientific ones as they develop their own pathways to food sovereignty. This is no trivial task as many Indigenous people now suffer from severe health disparities and persistent poverty while climate change marches on, and U.S. colonial era federal policies continue to complicate public and private land use (S. Rept. No. 106–361, 2000; Ruppel, 2008; Justice et al., 2021).

An entire segment of the U.S. population, 574+ federally recognized Tribal Nations, have yet to have their food needs met by U.S. agricultural production even though they participate meaningfully in these systems and produce 6.4 billion in revenue annually from agricultural products (USDA, 2024). Now considered an intractable problem, food-related health disparities represent life and death issues for Native people (Mailer and Hale, 2015; Sarkar et al., 2020; Kuhnlein and Chotiboriboon, 2022). The many decades of minimal access to fresh and nutritious, let alone culturally appropriate foods, compounded by a rise in dependence on federal food distribution programs due to outmoded colonial era federal policies and resulting employment inequity, have contributed to increased incidence of preventable chronic conditions such as diabetes and heart disease for tribes across North America including the Blackfeet Nation. The sovereign food system envisioned here returns control of the food production and distribution apparatus to the Blackfeet Nation and its people (Coté, 2016; Hoover, 2017; Bluebird Jernigan et al., 2021; Maudrie et al., 2021); and contributes to an expanded definition of 'sustainable agriculture' which includes access to and harvest of traditional foods and medicines—culturally significant species that are indigenous to the region—and protocols by which these species may be ethically harvested (Joseph and Turner, 2020; Vasquez-Fernandez and Ahenakew, 2020; Bluebird Jernigan et al., 2021; Domingo et al., 2021).

In 2016, Blackfeet Nation agricultural leaders initiated a stakeholder engaged strategic planning process whereby the Tribe and partners from diverse federal and state agencies, universities, and non-profit organizations—including this article's co-authors—completed 3 years of focused planning on sustainable agriculture, food sovereignty, and natural climate solutions. The outcome of this process by 2019 was the in-house production of the Blackfeet Nation Agricultural Resource Management Plan (Blackfeet Nation ARMP, 2019) as enabled under the 1993 American Indian Agriculture Resource Management Act. At the time, only three Tribal ARMPs existed, and none of these were developed with significant community involvement. Though Tribes were encouraged to develop ARMPs and were provided funding for the planning process (not implementation) through the United States Department of the Interior's Bureau of Indian Affairs, very few Tribes had the internal capacity or political will to push through the months long process of community-based strategic planning, let alone costly implementation. The "Blackfeet Innovation Pathways to Food Sovereignty" project was born out of this period of public engagement by the Blackfeet Nation, and the ensuing recognition that the implementation of any strategic plan would require a community-based commitment to developing a steady stream of public and private funding if any systemic changes were to take place. Founded in 2018, the Blackfeet non-profit Piikani Lodge Health Institute has led this charge, both figuratively and literally, conceived and led by Miisam Sai'piyi Aki, Long Time Charging Woman (Kim Paul MS, PhDc). Piikani Lodge Health Institute is the lead research partner for the Blackfeet Innovation Pathways to Food Sovereignty project. Partnering with the Native Land Project at Montana State University's Department of Native American Studies, the Blackfeet Innovation Pathways project was funded for 5 years (2019–2024) by the Foundation for Food & Agriculture Research (plus a 1 year no-cost extension for COVID-related delays). Since being funded, project team members from Piikani Lodge Health Institute and the Native Land Project have been carrying out applied research projects in three distinct areas where the Blackfeet community identified challenges and possible solutions: land tenure and access; food security/sovereignty networking/coalition building; and the health-diet nexus. After providing geographic and historical context, this paper describes the key programmatic details involved in the project's initial design along with its three areas of inquiry and major deliverables, and discusses the project's implications, lessons learned, conceptual constraints and methodological limitations.

Context

The Amskapi Piikani Blackfeet nation

The Blackfeet—properly known as the Amskapi Piikani (also Piikuni or Southern Piegan)—have long understood the causes for widespread health and economic disparity are rooted in forced assimilation policies responsible for the severed connection to Indigenous lands and traditional lifeways along with protracted poverty and historical trauma.

Land and land tenure

The Blackfeet Nation spans both Glacier and Pondera Counties in Montana. This vast land holding encompasses 1.5 million acres and provides drinking water for millions of people downstream. These lands also comprise more than 48 percent of Montana's biodiversity as the largest intact ecosystem in the lower 48 states (Luna, 2012) (Figure 1). Due to its unique ecological and hydrologic profile, the Blackfoot Confederacy–including the four bands of Blackfoot/Blackfeet 'Niitsitapi' or 'real people' north and south of the U.S.-Canadian border–spans one of the world's most biodiverse regions, with the most ancestral native species living on these lands, many of which are now on the protected species list (Weaver, 2015). Despite their immense natural wealth, the management of these lands by Blackfeet for agriculture and food systems is heavily complicated by U.S. federal Indian land tenure policies.

One of the most vexing regulatory and policy issues among most Indigenous nations in the western United States is the federal treatment of allotted Indian 'trust' lands: lands held in trust by the federal government for Tribes and individual 'Indians' (a legal designation within U.S. federal law). The history here is long and arduous, beginning (for the sake of brevity) with the General Allotment Act of 1887, which turned collectively held Indian lands into significantly minimized, privately owned parcels held in trust for Indian landowners by the federal government. For the Blackfeet, foreign laws made in a foreign language illegitimately reduced their lands from almost the entire landscape of what became known as Montana to the 1.5 million acres pictured above. Over time, fractionation[1] of individual interests in those parcels and the federal mismanagement of Indian trust funds earned from their sale and lease were the basis for one of the largest class-action lawsuits ever brought against an agency of the U.S. federal government (Cobell v. Salazar, 2009), as well as one of the largest

1 System whereby interests in land are inherited, such that "allotted land is not divided physically, meaning heirs receive an undivided interest in the land, the children, spouses, and other relatives of the original and successive landowners inherit increasingly smaller interests in the land" (https://www.doi.gov/buybackprogram/fractionation).

FIGURE 1
Map of the current Blackfeet Nation.

class-action settlements in U.S. history, the $3.4 billion Cobell Settlement of 2009. Because most of 'Individual Indian Money' accounts held in trust by the federal government were destroyed or lost over time, the $3.4 billion settlement reflected a mere fraction of losses endured. Even after Blackfeet banker and rancher Eloise Cobell's landmark case was resolved, the federal system's Department of the Interior, Bureau of Indian Affairs remains underfunded and burdened by bureaucratic complexities, while fractionated ownership grows and individual Indian landowners continue to bear the weight of failed federal policies (Conrad, 2023).

Indian land tenure rules differ from parcel to parcel, depending on whether the land is owned in fee or federally imposed fiduciary trust, whether it is owned by the Tribe or individuals, whether it is held by a single or multiple owners (i.e., fractionated), or any combination of the above. Although numerous scholars have studied the legal, political, and economic effects of fractionated ownership in Indian Country from various perspectives, little scholarship exists on the effects of federal regulations stemming from attempts to consolidate fractionated interests or which types of land tenure yield what results in terms of local understandings of human development and economic well-being as it is defined by Indigenous peoples themselves. Indian land fractionation has ramifying political, cultural, legal/jurisdictional and economic effects. In the Blackfeet context of food sovereignty, land fractionation and federal trusteeship make it hard for people to make decisions about their own land and its uses. Tackling these kinds of issues requires the long-term collaboration of stakeholders in a strategic process that is culturally responsive, participatory, inclusive, values based, and driven by members of each tribal community.

Food and agriculture

Within the Blackfeet Nation, agriculture is the primary industry employing the highest number of people and supplying the most earnings from lands supporting 575,256 acres of crops harvested for grain and forage production, of which 50,082 are irrigated acres. Approximately 1,014,000 acres are designated for grazing land. An estimated 704 farms and ranches are owned and operated by Blackfeet producers and their families. The Blackfeet Nation is a place of natural abundance replete with water, minerals, oil and gas, over 50,000 head of cattle, 1,000 iinnii (bison), and profound cultural and spiritual wealth (USDA, 2017). In terms of achieving food sovereignty through sustainable agriculture, the Blackfeet find themselves in exciting yet challenging times. A 2016 community food security and food sovereignty assessment revealed pervasive food insecurity and related negative health outcomes in Blackfeet Country (McElrone, 2016). The community food security and food sovereignty assessment identified problems within the existing food system such as: minimal access to fresh, local, and nutritious foods, duplication of efforts by the different food delivery programs reservation-wide, and dependency on federal food assistance programs which incentivize nutrition-poor and processed foods (McElrone, 2016).

Trapped in extractive commodity markets for decades, Tribal producers have become accustomed to selling raw product into markets, receiving a fraction of value, mere pennies on the food dollar compared with value added products (NAAF, 2022). This is partially due to lack of investment in regional Tribal operations and food processing infrastructure. There has long been interest in expanding the "Golden Triangle" of Montana to finally be inclusive of Tribal enterprises and operations so they can access the same resources as their non-Native counterparts (Crossroads Resource Center, 2017). Up until this point, this vision has yet to be realized due to lack of federal and private investment. The "Golden Triangle" is an area of significant agricultural productivity in wheat, cattle and calves, and barley in Northwest Montana. The Golden Triangle encompasses a landscape including cities of Great Falls, Havre, and Shelby, contains more than 15 million acres of farmland, and is a major economic engine for the State (Crossroads Resource Center, 2017). In spite of significant challenges, Native producers within the Golden Triangle participate in the agricultural economy and are now re-defining agriculture, and especially sustainable agriculture, a topic of international importance (Institute of Medicine and National Research Council, 2015; National Academies of Sciences, Engineering, and Medicine, 2018).

Key programmatic elements

Blackfeet agricultural resource management plan (ARMP) process and resulting Blackfeet Innovation Pathways project

In 2016, the Blackfeet Nation hired Loren BirdRattler as its new agriculture resource plan manager. Under BirdRattler's leadership, a small team began coordinating monthly meetings among partners to discuss priorities, challenges, and goals of their respective organizations. As per the norm for any large, community-based process, there were also frequent meetings outside of the planning format between the many partners. During the agriculture resource planning meetings, members joined sub-committees focused on water, policy, agriculture, or land. Earlier meetings were spent discussing foundational reports and resource inventories that would inform the process (Blackfeet Environmental Office, 2018; O'komi, 2019). BirdRattler's team members and supporting partners (including this article's co-authors) took notes, and meetings were recorded in audio files that were uploaded to a publicly available google drive for access by community members.

The monthly agriculture resource planning meetings culminated in an intensive two-day strategic planning meeting facilitated by third party Indigenous planning experts Kauffman and Associates. Convened on January 10–11, 2018 by the Blackfeet Nation ARMP team, over 50 participants gathered to identify strategic pillars and objectives for the ARMP through Technology of Participation (ToP©) methods of structured facilitation (Holman and Devane, 1999; Oyler and Harper, 2007; Stirling et al., 2023). Out of this gathering emerged the Blackfeet Nation's ARMP Strategic Plan which details five strategic pillars and their objectives (see Figure 2), each tied to human capacity, resources, and a timeline, as well as the shared mission:

> By 2028, we envision the Blackfeet Nation fully engaged, informed, and actively involved in the development of holistic agriculture resource management for economic, environmental, and health [sic] of the people, land, flora, fauna, and water. Together, we will work to embrace our natural laws, values, and relationships based on respect, trust, and healing. The ARMP will provide a means for establishing reciprocal partnerships among producers, businesses, and landowners to increase international access and availability of quality Blackfeet agriculture products. Our Piikani youth will have mentoring opportunities to learn from elders, producers, and leaders to contribute their voice to a quality Blackfeet way of life (Blackfeet Nation ARMP, 2019).

This vision is for a Blackfeet led holistic approach to the further development of Piikani food systems specifically and intentionally grounded in Piikani values.

Centering Piikani values in the planning process

The Blackfeet ARMP's management practices are guided by a set of Piikani Core Values as identified by Blackfeet community members (Blackfeet Community College, 2000). These values, in turn, drive the manner in which the Blackfeet Innovation Pathways team members—the co-authors of this article— approach the research process and everything that undergirds it. Piikani values are a reminder of how language informs conduct at every level. For example, Tsi-ksi-ka-ta-pi-wa-tsin is translated as the "Blackfeet Way of Knowing: Blackfeet culture/spirituality in philosophy, thought, and action" (Blackfeet Community College, 2000, Vision Statement). Taken as a guiding principle for research, tsi-ksi-ka-ta-pi-wa-tsin is the basis for a holistic—or wholistic (Absolon, 2010)—methodology that builds place-based ways of being, knowing and doing into the project's very research design (see Figure 2).

Case in point: the five "Piikani Strategic Pillars" shown in Figure 2 are an example of Piikani community-based leadership in action, emerging from the ARMP strategic planning sessions described above. Then Agriculture Resource Planning Director Loren BirdRattler had pushed back against a suggestion that the community

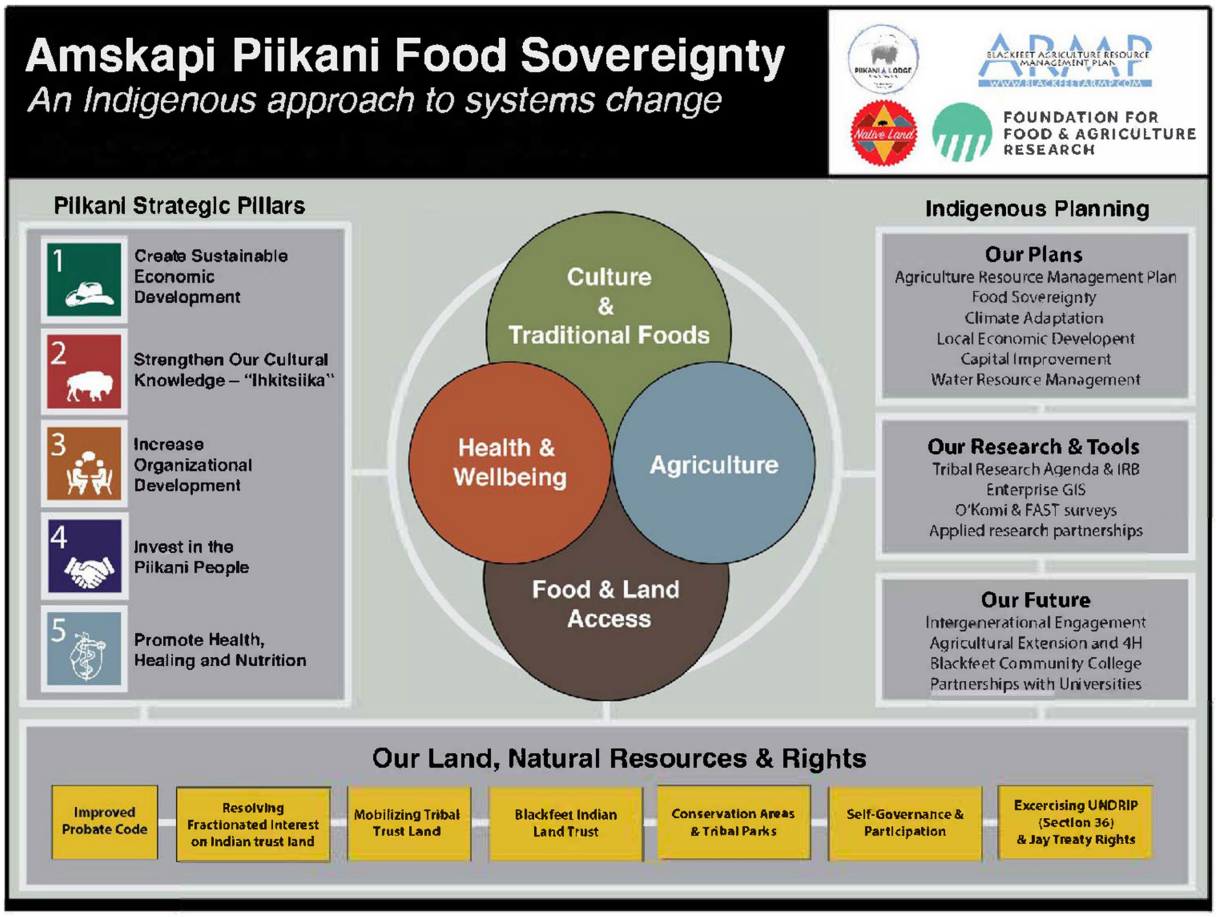

FIGURE 2
Amskapi Piikani Food Sovereignty - an Indigenous Approach to Systems Change.

could adopt the top five Sustainable Development Goals advanced by the United Nations Department of Economic and Social Affairs as part of its 2030 Agenda for Sustainable Development (https://sdgs.un.org/goals), saying he would be "laughed out of the community" if he suggested as much. Instead, community-members actively engaged in the facilitated strategic planning sessions came up with the five Piikani Strategic Pillars shown on the left side of Figure 2. The Blackfeet Innovation Pathways team then used these Pillars–the top priorities expressed by Piikani community members–as the driving force for a systems change theory using a Piikani concept of food sovereignty as its lens. Piikani food sovereignty–the 'whole' represented by the graphic's central circle and its overlapping fields of health and wellbeing, access to food and land, agriculture, and culture and traditional foods–connects priorities of the community to the land itself along with its layers of political and legal obstacles and opportunities (the yellow blocks at the bottom of the graphic), on the one hand, and to a selected list of strategic plans, research tools and tactics as well as a growing network of capacity building institutions, on the other.

Grounded in this approach, by 2019 the Blackfeet Innovation Pathways team—comprising a cross-section of people from the Blackfeet Nation's ARMP team, Piikani Lodge Health Institute, and the MSU Native Land Project team (see Figure 3 for a visual of these research relationships in context)--was able to attract funding from the Foundation for Food and Agriculture Research. Foundation for Food and Agriculture Research is a non-profit organization established by the 2014 U.S. Farm Bill to advance public-private partnerships that can bring innovative research to bear on urgent or intractable challenges within the food and agriculture sectors. Foundation for Food and Agriculture Research does this, in large part, by requiring a 1:1 non-federal match for every dollar it awards. Besides the research partnership between Piikani Lodge Health Institute (a Blackfeet led and founded non-profit within the Blackfeet Nation) and the Native Land Project (a project of the Native American Studies Department at Montana State University), the Blackfeet Innovation Pathways project brought matching funding from a diverse array of partners, including the Blackfeet Nation itself, a number of other non-profits small and large, and a for-profit online retailer specializing in regeneratively grazed bison meat. Foundation for Food and Agriculture Research provided Piikani Lodge Health Institute first relatively large grant, and in so doing created a foundation of much-needed support for growing research capacity within the community.

In turn, the Blackfeet Innovation Pathways project is co-producing knowledge through three Work Areas of inquiry and practice: (1) Land tenure, well-being, and access; (2) Tribal and rural research priorities and collaborations related to food systems; and (3) The influence of traditional Indigenous foods and foodways (where diet and cultural practices intersect) on Native health. Each of these areas has produced an array of deliverables which, at the time of this writing, are in various stages of completion, as discussed below.

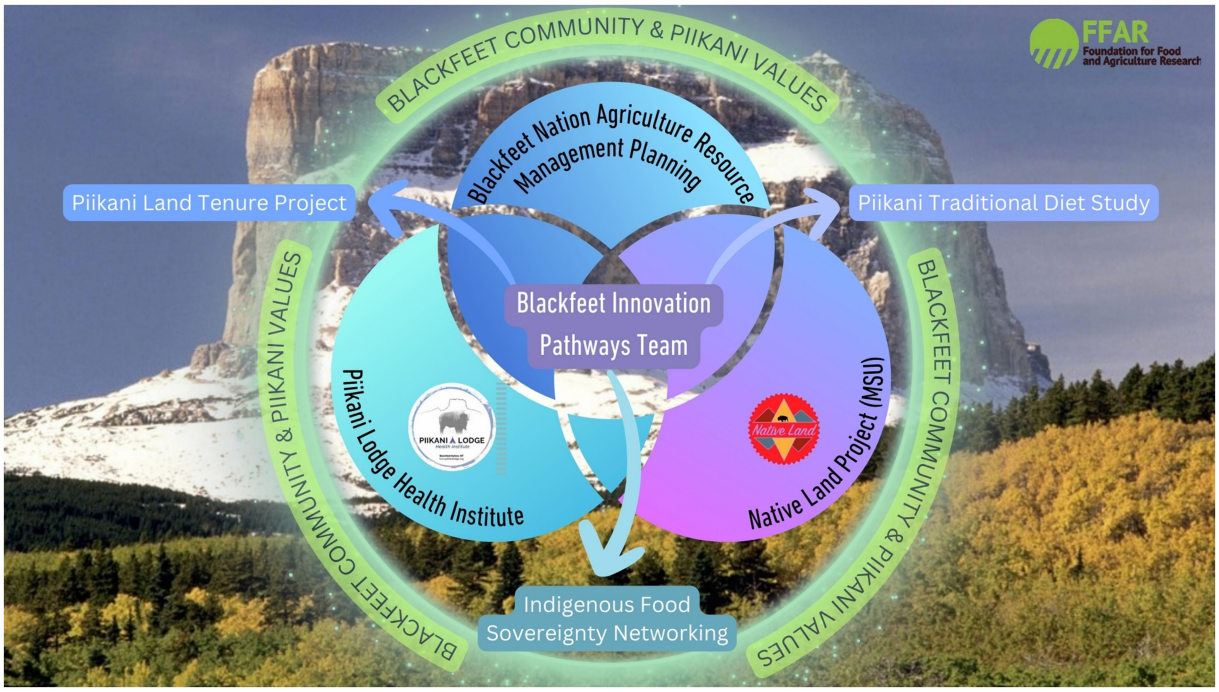

FIGURE 3
Blackfeet Innovation Pathways Research Relationships in Context.

Work area 1: land tenure and access

Landowner roadmaps

An original deliverable for the Blackfeet Innovation Pathways project, the 'Landowner roadmaps' are part of a "Trust Land Owners Guide" that includes a series of visuals developed around individual trust land management processes such as land exchange, rights-of-way, gift deeding, fee-to-trust, and probate (see Figure 4 for one example). This aspect of the Blackfeet Innovation Pathways project provides much needed educational materials for landowners and others engaged in land management within the boundaries of the Blackfeet Nation. This resource: (1) works to identify economic costs and egregious time delays related to the individual (as distinguished from Tribal) landowner's or producer's negotiation of each process, especially as compared to similar processes outside of the Blackfeet Nation; (2) supports the Tribe and Bureau of Indian Affairs in identifying gaps and duplications in processes in order to increase efficiencies through procedural adjustments; and (3) helps the Tribe identify areas where new tribal policies could supplant federal regulations and eventually reduce production costs for landowners by simplifying the processes while also increasing landowner capacity to negotiate bureaucratic processes through education and advocacy.

Piikani well-being index

Per discussion above around land and land tenure, capacity building within the Amskapi Piikani Blackfeet Nation involves designing an Indigenous framework to measure well-being from a Piikani perspective. Called the Piikani Well-being Index, this framework helps to increase internal capacity through the identification of community indicators of well-being based on Piikani values; it helps to answer the question of what it means to be well in Piikani Country, particularly with regard to land ownership, land use, and the elements of food sovereignty that spring from a community's relationship to land and place (see Figure 4). The Piikani Well-being Index also paves the way for data collection efforts that reflect the priorities and concerns of the community by identifying domains and 80 measurable indicators of importance to the Piikani people as opposed to broader measures such as the US Census which are based on western values and informed by western ideologies. The Blackfeet Innovation Pathways team's 2023 article "The Piikani Well-being Project: Indigenous-led metrics and mapping to improve human and agricultural system health within the Amskapi Piikani Blackfeet Nation" describes this aspect of the Blackfeet Innovation Pathways project in detail [see Paul et al. (2023)].

Current work on the Piikani Well-being Index is focused on first developing the agricultural sector of the measure. This includes collecting farm level data on the health and well-being of the producer's family, the economic inputs and resulting income from farm production, and measures of land and biosystem health. These measures go far beyond reductionist perspectives on agricultural economics. Economics alone are not able to take into account for instance, whether there is intergenerational sharing and co-management of the agricultural systems, one of the core stated Piikani values. This complex understanding of well-being is nuanced, and born of the local realities, and will help to deliver a more wholistic understanding of the health of Piikani food systems (Figure 5).

Access options for traditional gatherers

Western models of agriculture, an important aspect of current Blackfeet realities today, only represent part of a sustainable food system. Traditionally, Blackfeet relied heavily on hunting and gathering. The Iinnii and other hoofed animals were hunted and sustained Blackfeet families who used all parts of the animal to

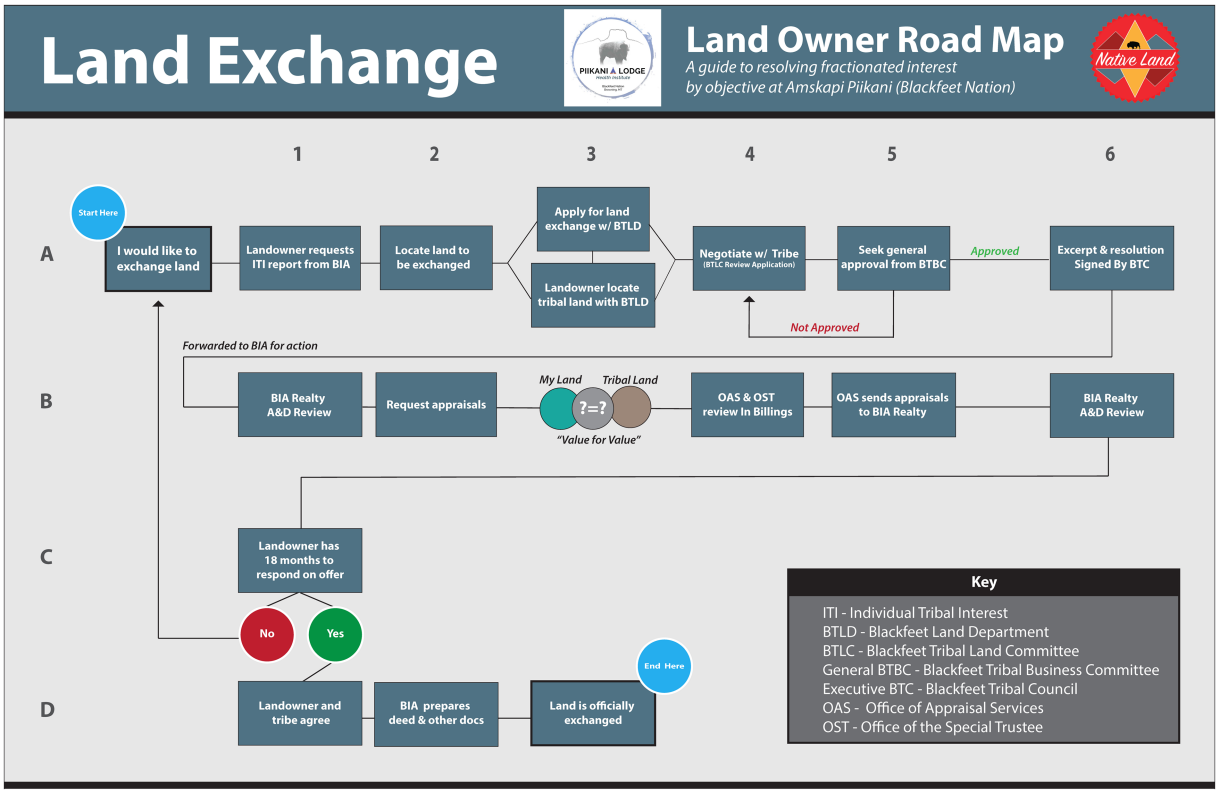

FIGURE 4
Example of a "landowner roadmap" in the Trust Land Owner's Guide.

provide food, shelter, clothing, and other raw materials for daily life. The gathering of plants and medicines was a critical part of Piikani food systems. As noted earlier, current land tenure policies, combined with the catastrophic reduction in traditional Piikani territories, has drastically impacted the ability for Piikani to hunt and gather. The formation of Glacier National Park, Yellowstone National Park and the National Forest system were only possible through the theft of these critical hunting and gathering lands from the Blackfeet. Regaining access to traditional Piikani hunting and gathering territory is critical to a sovereign Piikani food economy.

Increasing access to traditional Native food system resources, including lands outside the current Blackfeet Nation boundaries, helps address the ways that land theft occurred and forced "reservation" placement have profoundly uprooted a land-based way of life and the social, spiritual and cultural well-being that nurtured and maintained good health for the Amskapi Piikani (Tobias and Richmond, 2014). Maintenance of strong connections to the land has been shown to result in increased self-esteem, cultural pride, and overall improved physical health (Tobias and Richmond, 2014). Whereas the traditional Native food system is a community-based and adaptive model of sustenance, which considers the needs of the entire community as extended to the environment, the replacement food system is fragmented by conflicting policies and interests. In addition to the negotiation of cultural easements with public and private landholders to increase access to traditional hunting and harvesting sites within Amskapi Piikani homelands, additional work focuses on the ability for Piikani to access now held federal lands for traditional practices. Current engagement with Glacier National Park, Waterton National Park, Yellowstone National Park, Grand Teton National Park, National Forests and other federal lands aims to uphold current treaty rights, as well as expand these rights. In some cases, there are current rights, but they are logistically difficult to realize, and in other cases new policies and practices need to be put into place.

Work area 2: tribal/rural research priorities and collaborations

Food sovereignty networking

This aspect of the Blackfeet Innovation Pathways project surveyed food related research priorities for Montana tribes and selected rural communities, identifying food sovereignty collaborators at local, regional, national and international levels. Though conducted at the height of COVID restrictions, an advisory council of Indigenous educators and food system practitioners from around the 'Buffalo Nations' region gathered virtually for near-monthly video conference calls to explore research priorities. These facilitated conversations with advisory council members established the need for the development of a seasonal-ecological model of education favoring Indigenous knowledge and land-based education; and, a natural resources-trained workforce. These advisory council dialogs over the course of almost a year and a half resulted in development of the vision for an Indigenous-led research and education initiative in support of Indigenous food systems and proactive, collaborative capacity building for Indigenous food sovereignty. As a result, the Buffalo Nations Food System Initiative was established at Montana State

FIGURE 5
Piikani Well-being Index.

University. An Indigenous vision springing from the Blackfeet Innovation Pathways project, the Buffalo Nations Food System Initiative aligns itself with the Buffalo Treaty (https://www.buffalotreaty.com/treaty), a modern-day treaty signed by Native Nations of the biocultural region who have committed to bringing themselves back to the buffalo. Articles of the Buffalo Treaty specifically note the need for education and research of this sort.

The Buffalo Nations Food System Initiative (see https://www.montana.edu/ehhd/bnfsi/index.html) is being designed to credential Indigenous food systems professionals and develop a robust research agenda in collaboration with the Indigenous nations of the biocultural region of the Northern Plains and Rockies. The Indigenous advisory council developed a guiding document and oversaw the development of an interactive map of the biocultural region that permits users to see the relationship between peoples and place with fresh eyes. In addition, a Buffalo Nations Food Sovereignty networking website (at https://buffalo-nations.net/) was developed to provide support to Native communities and others interested in engaging with local and Indigenous food systems.

Influence of Piikani diet and practices on health

Piikani traditional diet study

This ongoing part of the Blackfeet Innovation Pathways project is intended to build research capacity and understandings about traditional foods as a component of health while incorporating direct community knowledge and experience of Piikani first foods. Research participants are an active part of the knowledge generation process, navigating a 100-day interventional diet approximating what would have been available to Piikani people prior to the imposed high-carbohydrate, beef and grain based Euro-American diet. Community members are at the heart of the implementation of this project as participant researchers discovering firsthand the impacts of reclaiming a traditional diet through quantitative biomarker sampling intermittently throughout diet intervention and qualitative self-reporting on their individual experience. Participants are provided with a suite of informational materials, infographics and a support group to ensure high comprehension and completion among

participants. Post-pilot study, participants will be able to teach traditional diet fundamentals to family and friends. In this way, learning is expanded out to participant spheres of influence, to their families, friends and professional colleagues through peer-to peer learning, a method widely documented to be highly effective in the transmission, mobilization, and translation of new research findings.

Discussion

The Blackfeet Innovation Pathways to Food Sovereignty project was born out of intimate, long-lasting and Indigenous-led research relationships. These relationships bloomed during the Blackfeet Nation's development of its Agriculture Resource Management Plan, a community-based strategic planning process that provided many hours of opportunity to listen closely with Piikani community members as they came, time and again, to values-based consensus over their priorities for systemic change in their communities. Their decision to place a multi-dimensional understanding of food sovereignty–encompassing the people's health and well-being, culture and traditional foods, agriculture, and access to food and land–at the center of their agricultural resource strategic planning is what drove the way this project team thought (and thinks) about the wholistic nature of food sovereignty. A nation's sovereignty over its food system is built on and helps build its political, legal, economic and cultural (including linguistic) sovereignty. A sustainable food system supports and is supported by a nation's economic development, cultural knowledge, organizational development, health and well-being, four out of the five pillars of Piikani strategic planning. The other strategic pillar–investing in Piikani people–is the one that drives Piikani Lodge Health Institute as an Indigenous-led and founded non-profit. The continued work of the ARMP as seen through the Blackfeet Innovation Pathways project was enabled by outside funding, a flexible and ever adaptive work plan, and its core objectives being ones that come from the community itself.

Present and future applications

Just as the food sovereignty networking part of the project sprouted spinoff projects in education, the landowner roadmaps are being used as prompts for in-depth conversations with landowners about their experiences, adding qualitative dimensions to the Piikani Well-being Index which will find expression in story maps and future publications. Additionally, in-field research and collaboration with Blackfeet ranchers has grown substantially over the course of the Blackfeet Innovation Pathways project. This has largely been accomplished through the Piikani Lodge Health Institute Regenerative Grazing Initiative, an effort which was identified as a priority during the ARMP development process. Since the General Allotment Act of 1887 and forced transition to individualized farming and ranching, rangeland biodiversity has decreased regionally and internationally (Augustine et al., 2021). Competitive management practices replaced Piikani stewardship which was for the collective good, inter-reliant on rest-rotation of Iinnii (bison) grazing, supporting habitat for cultural plant and animal relatives, and with an emphasis on mobility and climate adaptation across the seasons. Through collaborative research, the Piikani Lodge Health Institute Regenerative Agriculture program addresses these Piikani values in the context of contemporary tribal agriculture. Future publications will reflect upon these changes.

Acknowledgment of any conceptual or methodological constraints

Because of constraints noted below, in early 2024, the Blackfeet Innovation Pathways to Food Sovereignty project team had to request a no-cost extension from the funder to make good on two of its promised deliverables: following up on its Landowner Roadmaps and their utility to landowners; and conducting its Piikani Traditional Diet Study. These two areas of inquiry are under active investigation as of this writing.

One methodological constraint of the project resulted from early attempts toward research approval and implementation during a global pandemic. Determined to uphold the values, ethics, and sovereignty of the Tribe's/Nation's Institutional Review Board and their imposed moratorium on all research within the Blackfeet Nation during the first years of the pandemic, two out of this project's three work areas were at a standstill for over 2 years. At the time of this writing, the Blackfeet Nation's IRB has been reconstituted post-pandemic and has emerged as a stronger, more effective, and resilient bulwark in assuring that the research conducted within the Nation and its areas of concern are consonant with the Nation's values.

Immersed as PLHI staff and partners—co-authors included—are, in the ongoing work described here and elsewhere (Paul et al., 2023), the overriding and *felt* conceptual and methodological constraint for this project would be the wholistic nature of the research (Absolon, 2010). Concern for the individual as well as the community has put a focus on the creation of jobs, and not just jobs, but meaningful work which also supports the cultural development of the individual as well as the community. In wholistic terms, this requires constant attention to the four-dimensional (spiritual, emotional, mental, physical) context in which the research is being conducted along with the concern for the development (aka "capacity building") of the individual, family, community, nation, and ecosystem. All of this needs to be considered even as the research is being conducted. Piikani Lodge Health Institute itself was being developed as a non-profit (501(c)(3)) organization even as the research for Blackfeet Innovation Pathways was getting underway. While project team members agreed that this was the priority, it meant that PLHI was being built even as it was flying.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Ethics statement

Ethical review and approval were obtained from the Blackfeet Nation Institutional Review Board for the study with human participants in accordance with the local legislation and institutional requirements. Written informed consent from the [patients/

participants OR patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

KP: Conceptualization, Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing, Supervision. KR: Conceptualization, Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing, Investigation. MY: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing. LC: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Writing – review & editing. JR: Conceptualization, Methodology, Writing – review & editing. CC: Conceptualization, Data curation, Formal Analysis, Methodology, Visualization, Writing – review & editing. WS: Investigation, Methodology, Writing – original draft. CF: Investigation, Methodology, Writing – original draft. AB: Writing – review & editing.

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Conflict of interest

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

Publisher's note

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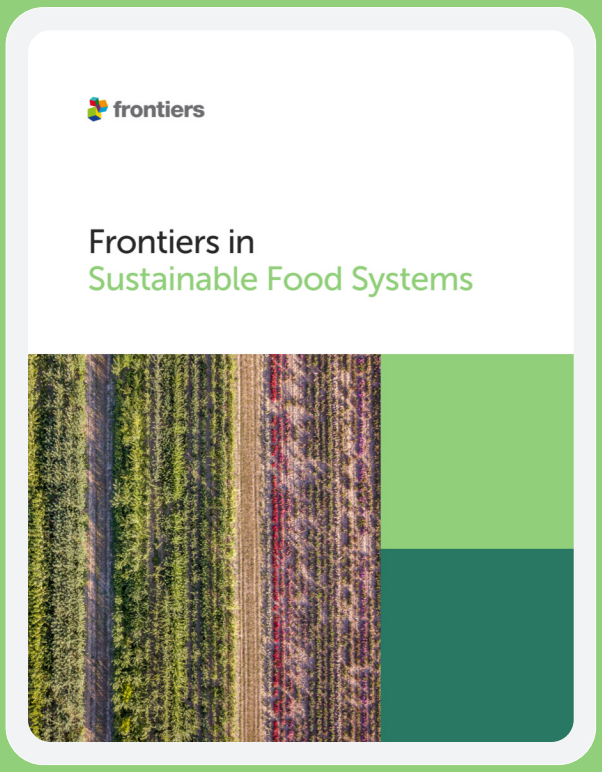

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