Transformative Change in Shellfish Food Systems: Overcoming Barriers to Indigenous Food Sovereignty in Coastal BC

By

Claire Armstrong-Buisseret

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Abstract

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Clams and other shellfish are central to many aspects of coastal First Nations communities including food security, health and nutrition, economy and trade, and culture. However, the current shellfish management systems in BC have created barriers to a flourishing shellfish food system. This research project explores the concept of transformative change towards Indigenous Food Sovereignty (IFS) as a pathway to restore shellfish food systems. The objectives of this research project are to (1) synthesize a framework for IFS in shellfish food systems, (2) identify and describe barriers to harvesting shellfish, and (3) explore levers for change to re-establish a thriving shellfish food system that benefits both people and nature. This research project employs literature review with a mixed-methods qualitative approach using NVivo 12. Inductive coding was used to develop a framework that categorizes barriers based on pillars and indicators of IFS. Deductive coding was used to explore levers that instigate transformative change in shellfish food systems. The main barriers identified were: (1) high levels of shellfish contaminants that pose risks to human health; (2) a lack of monitoring that contributes to long-term closures at shellfish harvest sites; (3) limited access to shellfish harvest sites due to land privatization and coastal development; and (4) loss of Indigenous culture relating to shellfish management practices. The main recommendation is to establish a specific organization with the mandate to support Indigenous shellfish harvesters. This support could include three main components: regional pollution identification and correction programs, regional phytoplankton monitoring and shellfish testing, and eco-cultural restoration programs that provide opportunities for cultural resurgence.

Keywords: shellfish food systems, Indigenous Food Sovereignty, transformative change, British Columbia, sea gardens

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ASP	Amnesic Shellfish Poisoning
BC	British Columbia
CFIA	Canadian Food Inspection Agency
CGN	Clam Garden Network
CSSP	Canadian Shellfish Sanitation Program
DDT	Dichlorodiphenyltrichloroethane
DFO	Fisheries and Oceans Canada
DSP	Diarrhetic Shellfish Poisoning
ECCC	Environment and Climate Change Canada
EPA	United States Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FNHA	First Nations Health Authority (in British Columbia)
FSC	Food, social, ceremonial
HAB	Harmful algal bloom
IFS	Indigenous Food Sovereignty
IK	Indigenous knowledge
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
OSS	On-site sewage system
PIC	Pollution Identification and Correction program
PSP	Paralytic Shellfish Poisoning
SDG	Sustainable Development Goal
SEATOR	Southeast Alaska Tribal Ocean Research
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples

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1. Introduction

In British Columbia (BC), shellfish harvesting contributes a significant amount to the economy. For example, 21.2 thousand tonnes of shellfish were harvested in 2017, contributing a landed value of $173 million to the economy (Canadian Agricultural Partnership, 2019). However, shellfish play a larger role in coastal communities than solely in the economy. Shellfish are key to many aspects of culture, food security, social interactions, and interactions with nature. In this way, shellfish can be viewed as a food system.

1.1 Food Systems

Food systems are complex webs of interactions that encompass all of the actors and activities from the input of resources and production to the trade and consumption of food products (Food and Agriculture Organization of the United Nations [FAO], 2018). In Western food systems, the focus is generally on the food value chain (the overlap with the economic system) including the input of supply and production of agricultural commodities followed by the transportation, processing, retailing, wholesaling, and preparation of foods for consumption and disposal. However, food systems can also place importance on cultural norms around food, nutrition and health, and interactions between the animals or plants providing the food with humans. Therefore, it is evident that food interacts with many other systems (FAO, 2018).

Analysis of food systems requires a broad approach that not only considers food but also all the systems it interacts with. This enables a holistic understanding of a particular issue based on the intricate web of interactions and impacts between systems (FAO, 2018). Underlying food production and the input of resources are ecological systems. Associated with food norms and traditions are cultural systems. Linked to the nutrition of food products are health systems. And, although lacking in Western food systems, education systems are central to learning about all the above: food, the land it comes from, culture, and nutrition. Food systems are therefore deeply linked to ecological, cultural, health, and education systems as well as economic systems.

1.1.1 Shellfish Food System of First Nations in Coastal BC

In this paper, shellfish food systems specifically refer to the Indigenous food system that encompasses all shellfish food and food practices valued by First Nations in coastal BC, with

special emphasis on clams. Ecologically, the shellfish food system involves intertidal ecosystems and the biophysical elements that define it (e.g., pH, salinity, temperature, water quality, biodiversity, ecosystem function). Culturally, the shellfish food system is involved in the values and traditions that come from the interaction between humans and shellfish (e.g., ceremony, rituals, creation stories; Olsen, 2019). The shellfish food system plays a role in health through providing a significant protein source, and it plays a role in education through knowledge sharing of harvesting practices to younger generations (Groesbeck et al., 2014; Olsen, 2019). And of course, economically, the shellfish food system has played a role both in traditional trade systems (e.g., potlatch) and also in current Western markets where First Nations communities participate in the shellfish industry (Olsen, 2019).

Shellfish management systems are a big part of the shellfish food system. One major shellfish management system used by coastal First Nations are sea gardens, also called clam gardens, which is a resource management system used to increase food production, especially the production of clams. Sea garden remains have been found along the coast from Washington to Alaska, with many dating back to more than 3,500 years ago (Smith et al., 2019). Sea gardens are constructed by building a rock wall at the low tide line which alters the drainage patterns of the beach and over time decreases the beach's slope (Groesbeck et al., 2014; Jackley et al., 2016). The decreased slope means there is a larger zone of habitat favourable for clams, hence their previous name in Western science literature: 'clam gardens' (Groesbeck et al., 2014). However, the name 'clam garden' fails to recognize the all-encompassing system, of which clams are only one aspect. The term 'sea garden' reflects the extensive cultural and ecological interactions that the system is a part of, which not only includes clams but other plants, animals, and the land (W̱SÁNEĆ Leadership Council, n.d.).

Sea gardens are central to the ecological elements of the shellfish food systems. Indigenous knowledge (IK) and Western science both show that these ancient sea gardens have ecological benefits to both clam productivity and the biodiversity of the surrounding intertidal zone (Jackley et al., 2016). A study by Groesbeck et al. (2014) found that the productivity of clams in sea gardens is two to four times that of beaches that have not been culturally modified. IK indicates that, not only do sea gardens increase productivity of clams, they also create habitat for other species such as octopus, sea cucumber, whelks, chiton, and red turban snails (The Clam Garden

Network [CGN], n.d.-a). Sea gardens enhance ecosystem function by moderating temperature fluctuations due to increased water retention on the beaches (Salter, 2018). Additionally, sea gardens may limit the impacts of ocean acidification locally as the increased levels of carbonate in sediments functions as a buffer (Salter, 2018). However, the ecological system is not the only aspect that is enhanced with sea garden management practices.

Beyond the ecological system, sea gardens are central to the socio-cultural elements of the shellfish food system (Augustine & Dearden, 2014; Parks Canada, 2015). The management practices for sea gardens and the harvest and preparation activities for consuming clams are directly tied to socio-cultural systems (Hul'qumi'num Treaty Group et al., 2005; W̱SÁNEĆ Leadership Council, n.d.; Parks Canada, 2015). Continuous sea garden management involves activities like tilling sediment and repairing damaged rock walls (Olsen, 2019). These management practices are opportunities for communities to strengthen social networks, share knowledge, and connect to the land (Parks Canada, 2015). Harvest and preparation activities provide opportunities for cultural traditions including ceremony and harvesting rights and responsibilities (Olsen, 2019). Because of this, sea gardens and the ecological and socio-cultural systems they interact with are intricately linked to the shellfish food system of many First Nations in coastal BC (Parks Canada, 2015). This is why clams are featured in most of the discussion about shellfish food systems in this paper. However, due to the impacts of colonialism, barriers have been erected that prevent shellfish food systems from flourishing.

1.2 Challenges Relating to Shellfish Food Systems

Despite the strong links that shellfish food systems display to the ecological and socio-cultural systems that tie humans to nature, shellfish food systems are facing stress due to the past and ongoing impacts of colonialism (Fleming, 2019). Colonialism, and the associated changes in the management of coastal resources, has created barriers to Indigenous self-determination of shellfish food systems (including a lapse in the management of sea gardens; Olsen, 2019; Fleming, 2019; see Truth and Reconciliation Commission of Canada, 2015, p. 190 for a description of Indigenous self-determination). These barriers result in a shellfish food system that does not support the humans or nature that the system is deeply connected to. From a natural systems perspective, there has been a decrease in clam size and abundance in parallel to the threats of climate change, ocean acidification, and marine heat waves (Olsen, 2019; Raymond et

al., 2022). From a socio-cultural systems perspective, reduced harvesting opportunities in communities has led to decreased consumption and the loss of opportunities to strengthen cultural traditions and social connections within communities (Olsen, 2019).

1.3 Opportunities Relating to Shellfish Food Systems

The barriers created over the past 200 years of colonialism have placed stress upon the shellfish food system, negatively impacting the human and natural systems it is deeply linked to. However, there are opportunities to re-establish Indigenous self-determination of shellfish food systems and restore the socio-cultural and ecological systems to the benefit of both humans and nature. One such pathway is rooted in transformative change towards Indigenous Food Sovereignty (IFS) in shellfish food systems. IFS is a concept that "describes, rather than defines, the present-day strategies that enable and support the ability of Indigenous communities to sustain traditional hunting, fishing, gathering, farming and distribution practices, the way [they] have done for thousands of years prior to contact with the first European settlers" (Morrison, 2011, p. 97-98). Transformative change, unlike incremental change, is change that fundamentally shifts current economic, social, institutional, technological, and behavioural structures of our society (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019).

1.4 Research Focus and Objectives

Much has been written and discussed on the separate topics of shellfish management systems, IFS (as well as Indigenous sovereignty and governance in general), and transformative change. This paper brings a novel perspective to the discussion on barriers to a flourishing shellfish food system by describing how IFS applies to shellfish food systems and by focusing on what elements of IFS the barriers impede. This paper also leverages an understanding of transformative change to provide insight into next steps to achieve IFS in shellfish food systems. Therefore, this research project aims to synthesize these separate bodies of literature, draw conclusions upon the barriers and levers to IFS in shellfish food systems, and make recommendations for a pathway forward. The specific objectives are to (1) synthesize a framework for IFS in shellfish food systems, (2) describe barriers to IFS in shellfish food

systems, and (3) explore levers for transformative change to achieve IFS and re-establish thriving shellfish food systems for the benefit of both people and nature.

2. Methods

2.1 Researcher Positionality and Limitations

This research project presents a Western academic perspective on the subject matter. It recognizes that any work involving sea gardens is incomplete without involvement of the First Nations communities that hold unceded rights to the territory where shellfish food systems flourish, and the unceded rights to the knowledge that the shellfish food systems belong to.

I recognize that terms like Indigenous Food Sovereignty and Indigenous self-determination cannot be defined in this Western academic space as these terms are as varied and nuanced as the communities and cultures they involve. Attempting to define these terms would constrict this diversity. Instead, I strive to synthesize Indigenous perspectives from the literature as the foundation of this approach. In addition, I acknowledge that the terms Indigenous Peoples and First Nations are used in different ways by different people. For the purposes of this research project, the term Indigenous Peoples is used when broadly referring collectively to First Nations (status and non-status), Métis, and Inuit in a national or international context. The term First Nations is used to refer specifically to Indigenous communities that do not include Métis or Inuit, most often used in this research project to discuss Indigenous communities in coastal BC that are deeply connected to shellfish food systems.

This research project is meant to contribute to the ongoing conversation about management of natural resources, specifically relating to shellfish food systems (including sea gardens) and the restoration of the relationship between humans and nature more generally. Within the schedule of this student project, there was not an appropriate amount of time for meaningful and substantive engagement with Indigenous organizations and individuals. As a result, this is a literature-based piece of research. The recommendations developed in this paper are synthesized from the literature, and are not intended to prescribe the singular pathway to achieving Indigenous Food Sovereignty in shellfish food systems as specific recommendations may or may not be applicable in every situation. If this work was advanced any further, the next step would be to engage with First Nations communities that hold unceded rights to the territory where shellfish food systems

exist in BC in order to explore how the framework presented in this paper could be used as a tool to further their own objectives in a more context-specific manner.

2.2 Data Collection

This research project used a literature-based approach to compile data to address the three research objectives. This approach consisted of the grey and scholarly literature on IFS (to address Objective 1), shellfish management systems (including sea garden management; to address Objective 2), transformative change (to address Objective 3), and shellfish food systems (to address Objectives 1, 2, and 3).

Participant-based data collection methods like interviews or focus groups were not used because the appropriate level of community engagement for those methods did not align with the short timeline of the research project. Instead, this research project synthesizes the established dialogue around shellfish food system management, IFS, and transformative change so that it can be leveraged and built upon by future shellfish food system restoration initiatives. Given the literature-based nature of this research project, a complete analysis of barriers and levers for IFS is beyond the scope as this would require in-depth interviews with a variety of participants, including Indigenous communities.

2.3 Data Analysis

This research project applied a descriptive mixed methods approach to data analysis using NVivo 12. First, inductive coding was used to identify themes about IFS already established in the literature. These themes were used to synthesize a Framework for IFS. This Framework was then applied to shellfish food systems by deductively analysing the literature on shellfish food systems following the Framework for IFS. Second, deductive coding following the Framework for IFS was used to describe each barrier based on what components of IFS it impedes. Third, deductive coding following IPBES's (2019) levers and leverage points framework was used to explore how to instigate transformative change in shellfish food systems to overcome the barriers to IFS.

3. Results & Discussion: Barriers and Levers for Shellfish Food Systems

This section begins by presenting frameworks for exploring barriers to IFS (Section 3.1) and levers for transformative change (Section 3.2). Following this, barriers and levers are described thematically using a common structure. First, specific background information is provided to contextualize the barriers. Second, barriers are characterized by which elements of the Framework for IFS they impede (presented in Section 3.1.1). This includes analysis of relevant legislation or programs to help contextualize the barriers. Third, levers are explored to overcome each barrier using a framework for transformative change (presented in Section 3.2.1). Relevant case studies are presented to further explore how levers function to overcome barriers. A summary table is provided at the end of this barriers and levers section (Section 3). It should be recognized that this discussion on barriers is not exhaustive and as such should not be considered the full extent of evidence. It should also be recognized that levers and recommendations may not be applicable in every situation as even within the scope of Indigenous shellfish harvesting on the coast of BC there are diverse contexts.

3.1 Indigenous Food Sovereignty

Food sovereignty is a concept developed in the La Via Campesina movement of global farmers at the World Food Summit of 1996, and has been constantly evolving since (Nyéléni, 2007). Though it is a global movement for social change towards more democratic food systems, food sovereignty is place-based in nature as the histories, politics, ecologies, and cultures of a region mean a diversity of struggles faced on the pathway towards food sovereignty (Desmarais & Wittman, 2014). This place-based nature means that there can be no universal definition or understanding of food sovereignty.

Despite having different meanings in different contexts, there are many useful definitions and frameworks for food sovereignty to convey general understanding of the concept. A commonly referred to definition from the International Forum for Food Sovereignty in Nyéléni, well over 15 years ago, is “people’s right to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (Nyéléni, 2007, p. 9). Similarly, a universally-acknowledged framework for food sovereignty is the Six Pillars framework (Nyéléni, 2007) that includes (1) focuses on food

for people, (2) values food providers, (3) localizes food systems, (4) puts control locally, (5) builds knowledge and skills, and (6) works with nature.

Indigenous Food Sovereignty (IFS) is related to the food sovereignty movement but expands upon it to interweave Indigenous ideologies into the foundation of the concept. For example, members of the Indigenous Circle during the People's Food Policy process added a seventh pillar, 'food is sacred,' to the Six Pillars framework of food sovereignty. This seventh pillar underlines how IFS differs from more general food sovereignty (Kneen, 2012). The 'food is sacred' pillar encompasses how food "derives from the essential relationships between human beings and the natural elements, including all other creatures" and thus is a gift of life that cannot be commodified (Kneen, 2012, p.4).

IFS also differs from the food sovereignty movement in that it focuses on issues that face Indigenous Peoples specifically. Where food sovereignty is often focused on building new local food systems to counter the industrialized food system, IFS is about protecting, conserving, and restoring Indigenous food systems. This means IFS is more focused on valuing traditional food practices and networks in the face of the ongoing negative impacts of colonialism (Desmarais & Wittman, 2014).

When discussing IFS, it is important to understand that the term 'sovereignty' originated as a Western concept that often refers to the idea of full authority and ownership. In the context of IFS, the idea of 'sovereignty' doesn't necessarily translate to sole ownership over the lands, animals, and plants that provide food. Rather, it suggests elements of self-determination and places emphasis on respectful inter-dependency between communities and with the land (Desmarais & Wittman, 2014). Morrison (2011) describes the Indigenous eco-philosophy that grounds the understanding of 'sovereignty' in IFS as "reinforc[ing] the belief that humans do not manage the land, but instead can only manage our behaviours in relation to it" (p. 99). This shows how IFS is not based on ownership over the land, but more about the relationship with the land.

3.1.1 Framework for Indigenous Food Sovereignty

As discussed with the concept of food sovereignty, IFS is place-based so it can have diverse meanings and indicators in different contexts (Morrison, 2011). This section does not attempt to

define IFS, but rather presents a framework (referred to here as “the Framework for IFS”) that describes the core elements of IFS discussed frequently in the literature. These elements should not be interpreted as a rigid checklist, but instead as areas to delve into deeper discussion.

The Framework for IFS presented here was developed based on two concepts from the literature on IFS (Figure 1; Table 1). The central blue circle in Figure 1 is based on Morrison (2011), where the four principles were identified by Elders, traditional harvesters and community members in discussions facilitated by the BC Food Systems Network Working Group on Indigenous Food Sovereignty (see Table 1 for descriptions of principles). These four principles are extensively referenced in the literature on IFS (e.g., Desmarais & Wittman, 2014; Kepkiewicz & Dale, 2019) and thus form the core of this paper’s Framework for IFS. The outer yellow circle in Figure 1 is based on Jernigan et al.’s (2021; a team of Indigenous and non-Indigenous researchers) seven indicators for Indigenous community capacity building and health (see Table 1 for descriptions of indicators). Because this paper is more recent, it has not had as much time for uptake so it is unclear how widely accepted and used the indicators will be. However, these seven indicators are included in this paper’s Framework for IFS because they offer a practical perspective. Jernigan et al. (2021) is one of the only papers to date that identifies indicators to build community capacity for IFS. Each principle and indicator that make up the four core elements of the Framework for IFS is detailed in Table 1. This Framework for IFS enables deeper discussion on barriers that impede the realization of IFS in shellfish food systems. Greater depth is achieved by describing each element of IFS with both principles that identify the foundations of the concept, and indicators that visualize what achieving IFS looks like.

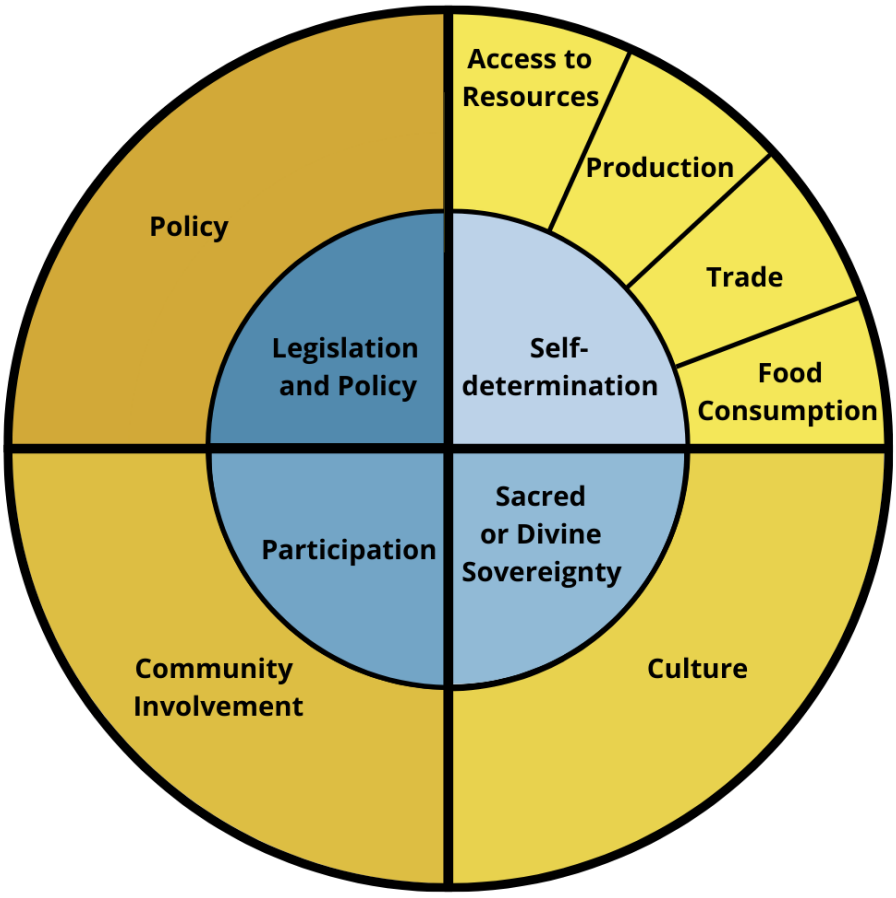

Figure 1. Framework for Indigenous Food Sovereignty (IFS) applied in this research based on Morrison's (2011) four principles as the elements in the centre blue circle, and Jernigan et al.'s (2021) seven indicators as the elements in the outer yellow circle. Each principle (in blue) has been paired to the indicator(s) (in yellow) that it aligns closely with. The Framework enables deeper discussion on barriers that impede the realization of IFS in shellfish food systems. Greater depth is achieved by describing each element of IFS with both principles that identify the foundations of the concept, and indicators that visualize what achieving IFS looks like.

Table 1. Details of the Framework for Indigenous Food Sovereignty and how it applies to shellfish food systems.

Element of Indigenous Food Sovereignty	Principle from Morrison (2011)	Indicator from Jernigan et al. (2021)	Application to Shellfish Food Systems
SELF-DETERMINATION *Access to Resources*	'Self-determination in this context refers to the freedom and ability to respond to [their] own needs for healthy, culturally-adapted Indigenous foods. It represents the freedom and ability to make decisions over the amount and quality of food [they] hunt, fish, gather, grow and eat. Indigenous food sovereignty thus promotes freedom from dependence on grocery stores or corporately-controlled food production, consumption and distribution in the industrialized food system.'	'[The] community has access to enough farmland, water resources, and natural resources to ensure the production of culturally appropriate foods for the entire community. The costs allow for small farms to develop and sustain production in [the] community. In [the] community water resources are kept pollution free and used for long-term agricultural production. In [the] community there is access to seeds for culturally significant crops that are easily accessible by local farmers. Individuals in [the] community have the knowledge and skills to grow crops and tend to wildlife.]	The freedom and ability to respond to their own needs requires access to resources including: - Access to shellfish beds (which includes access to boats for transportation to beaches). - Shellfish beds that have safe levels of marine biotoxins and other contaminants. - Access to opportunities to seed clams when needed/desired. - Individuals have the knowledge and skills of traditional sea garden management to tend to productive shellfish beds.
SELF-DETERMINATION *Production*		'There are enough food producers within [the] community to maintain adequate production for the community. Food production, from farm to table, is controlled and regulated by the community.'	The freedom and ability to make decisions over the amount and quality of food requires control over food production including: - There are enough food harvesters/tenders within the community to maintain adequate production of clams for the community. - Food production is controlled/regulated by the community.

Element of Indigenous Food Sovereignty	Principle from Morrison (2011)	Indicator from Jernigan et al. (2021)	Application to Shellfish Food Systems
SELF-DETERMINATION *Trade*	[Copied from above] 'Self-determination in this context refers to the freedom and ability to respond to [their] own needs for healthy, culturally-adapted Indigenous foods. It represents the freedom and ability to make decisions over the amount and quality of food [they] hunt, fish, gather, grow and eat. Indigenous food sovereignty thus promotes freedom from dependence on grocery stores or corporately-controlled food production, consumption and distribution in the industrialized food system.'	'In [the] community food prices are fair and affordable for all community members. Food markets are profitable enough to maintain long-term success. There is a balance of food items that are coming into the community and going out of the community.'	- Clams are affordable for all community members. - Community members are free to trade or sell their harvest.
SELF-DETERMINATION *Food Consumption*		'In [the] community [they] maintain sufficient access to affordable healthy foods and minimize processed food and fast food consumption. All community members have sufficient food access, and food distribution systems are in place to provide for low-income individuals. In [the] community adequate food options are available to all community members to ensure the health needs of each individual are met.'	The freedom from dependence on the industrialized food system requires control over food consumption including: - There is sufficient access to clams to minimize processed food and fast food consumption and help meet the health needs of each individual. - Community members have sufficient access to clams, and clam food distribution systems are in place to provide for low-income individuals or individuals who cannot harvest.

Element of Indigenous Food Sovereignty	Principle from Morrison (2011)	Indicator from Jernigan et al. (2021)	Application to Shellfish Food Systems
LEGISLATION AND POLICY *Policy*	'Indigenous food sovereignty attempts to reconcile Indigenous food and cultural values with colonial laws, policies and mainstream economic activities. It thereby provides a restorative framework for a coordinated, cross-sectoral approach to policy reform in forestry, fisheries, rangeland, environmental conservation, health, agriculture as well as rural and community development.'	'In [the] community, policies are in place to ensure local farms are able to access the resources needed to maintain production, and the over-use of natural resources are regulated. Policies are in place in the schools in [the] community to ensure school menus are nutritious; the schools are making efforts to provide healthy and traditional foods to children. [The] community has policies in place to ensure sustainability of food resources, wildlife, and natural resources that are culturally significant. Food councils are in place within the towns in [the] community to investigate food production, food security, and health.'	Reconciliation of colonial laws with Indigenous food and cultural values requires policy change in fisheries (shellfish fisheries specifically), environmental conservation and parks, health and rural community development including: - Policies that ensure communities are able to access resources to maintain shellfish beds and overuse of clam resources are regulated. - Policies that place emphasis on clams in schools (e.g., field trips to sea gardens and making traditional foods more accessible to school programs). - Policies that safeguard the sustainability of clams as culturally significant food. - Food councils that investigate food production/security and health as it relates to clams.

Element of Indigenous Food Sovereignty	Principle from Morrison (2011)	Indicator from Jernigan et al. (2021)	Application to Shellfish Food Systems
PARTICIPATION *Community Involvement*	'Indigenous food sovereignty is fundamentally based on "action," or the day-to-day practice of nurturing healthy relationships with the land, plants and animals that provide [them] with [their] food. Continued participation in Indigenous food-related action at all of the individual, family, community and regional levels is fundamental to maintaining Indigenous food sovereignty as a living reality for both present and future generations.'	'[The] community has many knowledge holders, such as elders, who are able and willing to pass on knowledge. In [the] community [they] provide pathways to transfer food knowledge and restore traditional food practices. Educational activities and programs are in place to pass on traditional knowledge, nutrition, and food practices to youth in [the] community. [The] community supports women's rights and equality to promote well-being and traditional agricultural practices among youth.'	Community involvement through actions is the basis for nurturing healthy relationships to the land and therefore the food, including: - Knowledge holders are able/willing to pass down knowledge (this could involve specific activities/events such as community sea garden restoration days that promote knowledge transfer). - Educational activities promote the value of clams as traditional foods (such as field trips to sea gardens with traditional preparing/consuming of clams). - Women play a central role in harvesting clams, supporting traditional harvesting practices.
SACRED OR DIVINE SOVEREIGNTY *Culture*	'Food is a gift from the Creator. In this respect, the right to food is sacred and cannot be constrained or recalled by colonial laws, policies or institutions. Indigenous food sovereignty is ultimately achieved by upholding [their] long-standing sacred responsibilities to nurture healthy, interdependent relationships with the land, plants and animals that provide [them] with [their] food.'	'Culturally appropriate foods are prioritized in [the] community. The crops and wildlife needed for cultural foods and traditions are available and affordable to all in [the] community. There are adequate opportunities for traditional ecological knowledge to be shared amongst [the] community.'	Culture and food are deeply linked through the sacred responsibility to nurture relationships with the land, including: - Clams are culturally significant as a food and are therefore prioritized. - Clams are available and affordable. - Knowledge is transferred within the community.

The Framework for IFS pairs the foundational principles of IFS with practical indicators that provide a vision for what achieving IFS could look like. Combined, the principles and indicators form four elements of IFS that can be used to discuss barriers to realizing IFS in specific contexts. The following section (Section 3.1.2) details how this Framework can be applied to shellfish food systems in the context of First Nations communities in BC, which lays the foundation to discuss how barriers impede specific elements of IFS.

3.1.2 Application of Framework to Shellfish Food Systems

The principles and indicators that make up the Framework for IFS were developed by Morrison (2011) and Jernigan et al. (2021) with a generic food system in mind so that they could be applicable to many contexts. However, geographic or spatial 'place' is an important factor in understanding what IFS actually means for specific food systems. Therefore, exploring what these principles and indicators mean in the context of shellfish food systems in First Nations communities in BC is central to a deeper discussion of barriers to IFS. These context-specific elements include shellfish production (e.g., access to the intertidal zone free from unacceptable levels of contaminants), shellfish harvest management systems (i.e., the Canadian Shellfish Sanitation Program), sea garden management practices, and the cultural value of shellfish. The application of the Framework for IFS to shellfish food systems in First Nations communities in BC is explored in the right-hand column of Table 1.

3.2 Transformative Change

An important part of the IFS concept is the interconnected systems it is tied to (not just the food system but also ecological, economic, cultural, etc. systems). Central to IFS is the transformation of these systems to align with the elements of IFS described in the Framework for IFS. Desmarais and Wittman (2014) describe food sovereignty (including IFS) as being about the "fundamental transformation of existing structures, ways of thinking and being" (p. 1169). Thus, transformative change is key to achieving IFS. Transformative change is system-level change that involves fundamental shifts in current social, institutional, economic, and behavioural structures of society (IPBES, 2019).

Looking at the bigger picture, transformative change is widely recognized as necessary to realizing a sustainable future (detailed by the Sustainable Development Goals [SDGs] agreed

upon by United Nations Member States; IPBES, 2019). The SDGs describe a "blueprint for peace and prosperity for people and the planet" (United Nations Department of Economic and Social Affairs, n.d., para. 1). An integral part of peace and prosperity for people and the planet is a sustainable relationship between humans and nature, and also that no one gets left behind in the transformation to this sustainable future. It follows that Indigenous rights must be recognized (e.g., through mechanisms such as the implementation of the United Nations Declaration on the Rights of Indigenous Peoples [UNDRIP], which the government of Canada recognizes requires transformative change to implement; Department of Justice Canada, 2021). There are overlaps between the transformative change required for a sustainable future and achieving IFS. Thus, the next section (Section 3.2.1) will introduce a framework for transformative change towards a sustainable future in the context of paths forward for realizing IFS.

3.2.1 Levers and Leverage Points

Though it is well understood that transformative change is necessary to realize IFS (among other parts of a sustainable future), understanding what actions lead to the necessary change presents more of a challenge. The IPBES Global Assessment introduces a set of elements necessary for a sustainable future that could apply to work towards IFS: levers and leverage points (IPBES, 2019). This framework identifies systemic changes (levers) at pivotal points in social, political and economic systems (leverage points) for transformative change (Figure 2).

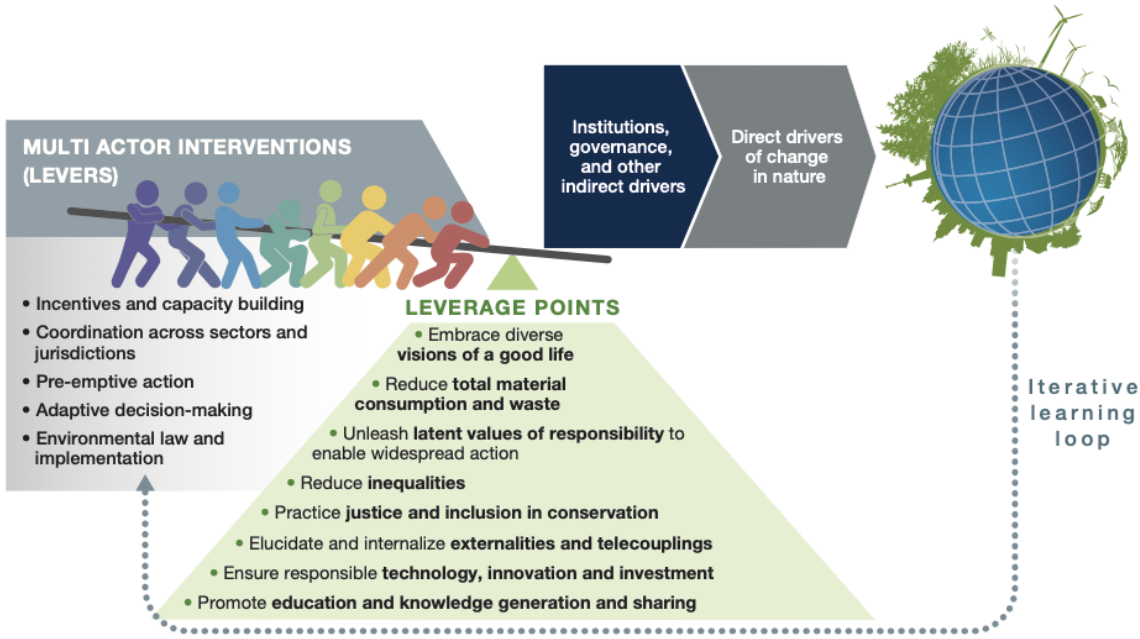

Figure 2. Transformative change for sustainable futures involves management/governance interventions (levers) at pivotal points in systems (leverage points). Reprinted from "Levers and leverage points for pathways to sustainability," by K.M. Chan et al., 2020, *People and Nature, 2*, 699.

As shown in the left side of Figure 2, there are five levers that are types of intervention. Incentives and capacity building focuses on reforming subsidies so that they directly improve social and environmental outcomes. Coordination across sectors and jurisdiction, pre-emptive action, and adaptive decision-making all work to improve management by reforming organizations, programs, and policies to make them pre-emptive, inclusive, integrated, robust to uncertainty, and geared towards the complexity of social and ecological systems. Environmental law and implementation is about bolstering environmental laws and policies.

As shown in the center of Figure 2, there are eight leverage points that highlight where it is most critical to intervene. Because this framework is oriented towards a sustainable future more broadly than achieving IFS in shellfish food systems, some leverage points are more applicable than others. Key leverage points for realizing IFS are reducing inequalities, practicing justice and inclusion in decision-making, and promoting education and knowledge generation and sharing. Reducing inequalities refers to striving for equity (not solely equality) across incomes, genders, races and classes, that often have been instilled through historical and ongoing colonialism.

Practicing justice and inclusion in decision-making means meaningfully and substantively including Indigenous Peoples and local communities in governance and management in a way that respects their inherent rights. Promoting education and knowledge generation and sharing focuses on acknowledging and integrating diverse knowledge systems to build a more holistic understanding of global systems. How these leverage points (and levers described above) relate to realizing IFS will be explored in the following sections (Sections 3.3, 3.4, 3.5, and 3.6) as pathways forward to overcome specific barriers to IFS.

These levers and leverage points instigate transformative change because they isolate areas where changes can have the biggest impact. Thus, the levers and leverage points are crucial opportunities to bring about the necessary changes in our societies, whether that be a sustainable future or more specifically, bringing about IFS (though, again, not all leverage points may be highly applicable to IFS as they are focused on sustainable futures more broadly). In this way, this framework provides the foundations for exploring pathways forward to overcoming barriers to IFS.

3.3 Shellfish Contaminants

3.3.1 Background: Marine Biotoxins, Microbial Pathogens, & Chemical Contaminants

Bivalves, including clams, are filter-feeders which means they filter the water in their environment to consume the plankton in the water column (Lattos et al., 2021). Because of their filter-feeder behaviour, bivalve shellfish are highly sensitive to the water quality of their marine environment. As they filter the water for plankton, they can accumulate contaminants that can pose a risk of injury to human health (Canadian Food Inspection Agency [CFIA], 2021b). These contaminants come from a variety of sources including sources from both human activities and naturally occurring phenomena. Shellfish contaminants can be organized into three categories: marine biotoxins, microbial pathogens, and persistent chemical/metal contaminants (hereafter referred to as chemical contaminants). Each contaminant category has different sources and impacts on humans.

Marine biotoxins are a group of contaminants that are naturally produced by phytoplankton. High levels of marine biotoxins in shellfish are associated with harmful algal blooms (HABs), also called ‘red tide.’ However, ‘red tide’ is a misconception because not all red algae produce

biotoxins, and water that is clear can still have high levels of toxins (Bouchouar et al., 2014). It is important to be aware of marine biotoxins as they can cause severe harm to humans that consume shellfish contaminated with them (CFIA, 2021a). Marine biotoxins fall into three main groups based on the diseases they are associated with: Paralytic Shellfish Poisoning (PSP), Amnesic Shellfish Poisoning (ASP), and Diarrhetic Shellfish Poisoning (DSP), each of which is summarized in Table 2. First, PSP is caused by saxitoxins produced by the dinoflagellates *Alexandrium*, *Gymnodinium*, and *Pyrodinium*. PSP is associated with both gastrointestinal and neurologic symptoms as saxitoxins block sodium channels in neurons. PSP is cause for concern because in severe cases, paralysis of respiratory muscles due to the toxin can lead to respiratory arrest and death. Second, domoic acid is a toxin produced by diatoms *Pseudo-nitzchia*, *Nitzchia*, and *Amphora* and causes ASP. ASP is associated mainly with neurological symptoms including short-term memory loss but can also cause gastrointestinal symptoms. Domoic acid causes an influx of calcium in neurons resulting in cell death. Third, the dinoflagellates *Dinophysis* and *Procentrum* produce okadaic acid, dinophysis toxins, and pectinotoxins which are associated with DSP. These toxins inhibit intestinal cellular dephosphorylation causing gastrointestinal symptoms. The toxins that cause all three diseases are not destroyed by heat in cooking, and there are no sensory cues (e.g., taste, smell, sight) that identify toxic shellfish.

Table 2. Summary of marine biotoxins that can be found in shellfish in western Canada, the phytoplankton that produce them, what disease they cause, the physiological response in humans, and associated symptoms in humans.

Phytoplankton	Biotoxins	Disease	Physiological Mechanism of Effect	Symptoms
Dinoflagellates: *Alexandrium*, *Gymnodinium*, and *Pyrodinium*	Saxitoxins	Paralytic Shellfish Poisoning (PSP)	Toxins block sodium channels in neurons.	Gastrointestinal (e.g., nausea) & neurological (e.g., muscle paralysis)
Diatoms: *Pseudo-nitzchia*, *Nitzchia*, and *Amphora*	Domoic acid	Amnesic Shellfish Poisoning (ASP)	Toxins cause an influx of calcium in neurons resulting in cell death.	Gastrointestinal (e.g., nausea) & neurological (e.g., memory loss)
Dinoflagellates: *Dinophysis* and *Procentrum*	Okadaic acid, dinophysis toxins, and pectinotoxins	Diarrhetic Shellfish Poisoning (DSP)	Toxins inhibit intestinal cellular dephosphorylation	Gastrointestinal (e.g., nausea)

Microbial pathogens are a group of contaminants that includes both bacteria and viruses. Bacteria and viruses are collectively referred to as microbial pathogens as they are both introduced from the same sources: contamination from human or animal fecal matter (CFIA, 2021b). Most pathogens originate from human activities in what is commonly called pollution (e.g., discharge from wastewater treatment plants, dredging, malfunctioning septic systems, or agricultural or wild animals). However, one bacterium in particular, *Vibro*, occurs naturally (CFIA, 2021b). Regardless of their source, bacteria concentrations are measured using fecal coliforms as a proxy for concentrations of many other bacteria, which would indicate fecal pollution. These other bacteria include *Streptococci*, *Salmonella*, and *Typhoid*. Viruses of note include Norovirus and Hepatitis A. Because the source of most pathogens relates to human activities, contamination of shellfish with pathogens is very specific to location (CFIA, 2021b). For example, shellfish in close proximity to urban areas and septic systems are more likely to be contaminated with microbial pathogens than shellfish in remote areas. This is of serious concern for humans because consuming shellfish contaminated with microbial pathogens pose a risk of injury to human health (CFIA, 2021b).

Chemical contaminants include chemicals such as heavy metals (e.g., mercury), hydrocarbons (e.g., petroleum), and pesticides (e.g., Dichlorodiphenyltrichloroethane [DDT]). Sources of chemical contaminants include mining and leaching of chemicals, urban and agricultural run-off, and pulp mills (CFIA, 2021b). Chemical contaminants of concern are those that are persistent, bioaccumulative, or toxic (Institute of Medicine, 1991). Chemical contaminants are cause for concern to humans as they are not destroyed by the heat treatment in the cooking process. Chemical contaminants such as mercury are characterized by long-term rather than acute effects (Wang et al., 2022). Over years of exposure, for example if you consume clams from a single contaminated beach your whole life, chemical contaminants could impact your health. Though chemicals such as mercury have been well studied in terms of their long-term effects (e.g., Wang et al., 2022), the newer category of pharmaceutical chemicals remains largely unknown (Kingdon, 2018). Pharmaceutical drugs get excreted by humans and flushed into our sewage systems. Since we do not currently have widely used technology to target the removal of drugs in our sewage treatment systems, these drugs end up in the ocean where they can be filtered into shellfish (Kingdon, 2018). For example, the drug Ibuprofen has been found in shellfish growing near Victoria, Canada (Krogh, Lyons, & Lowe, 2017). This is cause for concern because the impacts of pharmaceutical drugs like the Ibuprofen inside shellfish consumed by humans has not been well studied (Kingdon, 2018).

3.3.2 Barriers

Shellfish contaminants are becoming more prevalent in coastal waters. For example, the intensity and duration of HABs is increasing (Bouchouar et al., 2014). Shellfish beds in the Georgia Basin have trended towards decreasing water quality from 2007 to 2019 (Environment and Climate Change Canada [ECCC], 2021). Because of the health risks that shellfish contaminants pose to humans, the increase in contaminants threatens safe shellfish harvesting.

The threat to safe shellfish harvesting presented by high levels of shellfish contaminants is a barrier to the ‘self-determination: access to resources’ element of IFS. A key part of self-determination in IFS, as mentioned by Morrison (2011), is healthy, culturally-adapted Indigenous foods. This requires access to pollution-safe water resources as harvesting sites (Jernigan et al., 2021). Thus, beaches with unsafe levels of shellfish contaminants directly impede IFS because they restrict the possibility of healthy, culturally-significant foods.

3.3.3 Levers

Reducing contaminant levels in shellfish is key to achieving IFS in shellfish food systems. For marine biotoxins, being naturally occurring, there are few options for intervention besides increased monitoring (discussed in Section 3.4). However, most marine pathogens are related to human activities. This section will focus on those specifically related to human activities to explore the changes that can limit the pathways of marine pathogens to coastal waters.

The presence of marine pathogens is associated with sewage as a source of fecal matter. There are three main sources of sewage into marine waters: on-site sewage systems (OSS; also known as septic systems), sewage treatment plants (also known as wastewater treatment plants), and combined sewage overflows. Untreated sewage reaches marine waters when there are treatment failures or in storms when sewer systems are overflowing with rainwater resulting in outfalls from combined sewage overflows. In the Georgia Basin, septic leaks and overflows are responsible for 14% of harvest site closures due to contamination, while wastewater treatment plants are responsible for another 13% (ECCC, 2019 as cited in United States Environmental Protection Agency [EPA], 2021). Thus, actions that target sewage play a significant role in reducing barriers to IFS.

In BC, to prevent consumption of contaminated shellfish, management focuses on restricting harvest when contamination occurs rather than preventing contamination in the first place. For example, shellfish harvesting near a wastewater treatment plant is forced to stop when there are sewage leaks (CFIA, 2021b). Additionally, there are often permanent harvest closures near combined sewage outfalls. This is an incomplete solution that works to limit the consumption of contaminated shellfish but does so at a cost to shellfish harvesters and consumers. For example, risk management for shellfish focuses on the health risk of consuming contaminated shellfish but does not consider the health risks for Indigenous Peoples associated with not being able to consume shellfish as traditional foods (Fleming, 2019). Instead of focusing on restricting harvesting, levers for change should focus on prioritizing shellfish harvesting by improving sewage management. This aligns with a pre-emptive action lever for transformative change, where management moves from reactive (waiting for contamination before responding with closures) to proactive (implementing tools to reduce the levels of pollution that reach harvest sites). In recent years, there have been some initial changes in the direction of proactively

reducing wastewater pollution. For example, Metro Vancouver Regional District is upgrading the Iona Wastewater Treatment Plant to improve the water quality of discharge (Metro Vancouver, n.d.). However, since wastewater treatment plants and sewage and septic leaks are still a significant reason for harvest site closures, more pre-emptive upgrades to treatment plants and stormwater infrastructure are necessary.

Another form of pre-emptive action regarding sewage leaks is pollution identification and correction programs (PICs). PICs follow a three-component system to monitor and improve water quality (Hood Canal Coordinating Council, n.d.). First, they involve shoreline surveys to identify pollution threats. Once pollution hotspots are identified, they are tracked following up drainage patterns to the sources of pollution. And finally, the sources of pollution are fixed (usually by servicing on-site sewage systems [OSS; also known as septic systems]). A case study for pre-emptive action through PICs is the Hood Canal PIC in the Puget Sound of Washington State, USA. The Hood Canal PIC works pre-emptively by targeting sewage leaks before they occur, servicing OSSs before failures (Hood Canal Coordinating Council, n.d.).

Alongside pre-emptive action, the Hood Canal PIC uses incentives as a lever by offering rebates to OSS owners for OSS servicing, encouraging owners to reduce the risks of system failures (Hood Canal Coordinating Council, n.d.). Implementing something similar in BC that incentivizes maintenance for OSSs could have widespread benefits for the safety of harvesting sites. However, incentives are only one side of the issue. It is important to recognize that adding incentives will only get us so far without reforming subsidies that reinforce resource extraction and unsustainable activities (IPBES, 2019). For example, oil and gas subsidies such as those involved in Canada's Trans Mountain oil pipeline add a tremendous environmental cost that cannot be outweighed by actions such as adding incentives to service OSSs (Jonasson et al., 2019). However, these global systemic issues are beyond the scope of this research project.

In addition to pre-emptive action and reforming incentives, the Hood Canal PIC demonstrates another important lever: coordination across sectors and jurisdictions. Reducing silos in management by cooperatively working across sectors and levels of government is key to realizing co-benefits and identifying trade-offs among competing sustainability goals (IPBES, 2019). As previously established, IFS as a concept is deeply linked to many other systems (e.g., health, ecological, economic) and thus requires an integrated approach. The Hood Canal PIC has

embodied this by coordinating between the Washington Department of Health, Department of Ecology, various Counties and Tribes (Hood Canal Coordinating Council, n.d.). Integration across administrations to break down silos is something that should be prioritized in BC for working towards IFS, something that has been echoed in multiple other reports that discuss management of the BC coast (e.g., Sobocinski, 2021). Additionally, in the context of shellfish harvest and IFS, the leverage point of practicing meaningful substantive inclusion of Indigenous Peoples in decision-making should be a key feature of any collaboration.

Another important lever for preventing contamination rather than responding to it is the opposite of incentivizing: penalties for polluting. Implementing and enforcing robust environmental laws is necessary to reduce deterioration of environmental quality and in turn protect human and environmental health (IPBES, 2019). The EPA has applied powerful penalties by fining agricultural farms for runoff that negatively impacts shellfish beds (EPA, 2015). Enforcing water quality regulations is an important part of any plans to maintain and improve water quality for shellfish protection.

Overall, increases in shellfish contaminants are a barrier to IFS in shellfish food systems as they impede the ability to produce healthy culturally-adapted Indigenous foods. Because of the large role that sewage-related pathogens from OSSs have in shellfish contamination, targeting sewage releases with levers for change can have large impacts. Washington State has implemented regional PICs in Puget Sound which has led to the reopening of areas closed to harvest due to improving water quality (EPA, 2021). BC can learn from these programs and how they use levers like pre-emptive action, incentives, coordinating across jurisdictions, and environmental laws to have far-reaching impacts that instigate transformative change for IFS.

3.4 Shellfish Harvest Closures

3.4.1 Background: Canadian Shellfish Sanitation Program

As established in the previous section, consuming contaminated shellfish poses a health risk to humans. Though poor water quality causing shellfish contamination is an important barrier to IFS and harvesting shellfish, the monitoring system and shellfish harvest closure system in BC are also a significant part of the picture. In BC, shellfish harvest is regulated for safety of consumption by the Canadian Shellfish Sanitation Program (CSSP; CFIA, 2021a). This section

will provide an overview of this management system, analyse how the system impedes IFS, then explore levers for change using case studies from Alaska.

The CSSP is implemented by four main federal government departments: Health Canada, ECCC, CFIA, and Fisheries and Oceans Canada (DFO). Each department has their own role in ensuring that the CSSP functions to limit the harvest and consumption of contaminated shellfish.

Health Canada is not directly responsible for the implementation of the CSSP, but it does support the CSSP by establishing the standards, regulations, and policies for the safety of foods sold in Canada (CFIA, 2021a). In terms of supporting the implementation of the CSSP, Health Canada focuses on researching how the three contaminants (marine biotoxins, microbial pathogens, and chemical contaminants) can impact humans through consumption. There are four main ways that Health Canada provides this support to the CSSP. First, Health Canada provides scientific advice and analytical capacity for analysing food samples for microbial pathogens and chemical contaminants. Second, Health Canada acts as a national reference service for viruses such as *Vibrio.* Third, Health Canada provides risk management advice and communicates these risks to the public. And fourth, Health Canada executes health risk assessments on food hazards relating to shellfish sanitation (CFIA, 2021a). For example, Health Canada would produce health risk assessments on emerging food safety issues during an outbreak investigation and the findings would be used to inform risk management activities. The health risk assessment protocols are guided by the FAO and World Health Organization, which are responsible for developing international food standards (CFIA, 2021a). Thus, Canada's CSSP aligns with international guidelines.

ECCC is responsible for marine water quality testing and for identification of sources of pollution. Water quality testing is done through monitoring fecal contamination, which forms the foundation for sanitary control of shellfish. ECCC carries out comprehensive sanitary and bacteriological water quality surveys in shellfish harvest areas to classify shellfish harvest areas as suitable or unsuitable for shellfish harvest (CFIA, 2021a). For example, fecal coliform tests are used to identify bacterial contamination. There are three types of water quality surveys that are carried out based on prior knowledge of water quality and pollution sources in the area: comprehensive, annual review, and re-evaluation (CFIA, 2021a). The water quality surveys allow shellfish harvest areas to be classified into five main categories: approved, conditionally

approved, restricted, conditionally restricted, and prohibited. ECCC makes recommendations to DFO for the classification of shellfish harvest areas based on the findings of the water quality testing (CFIA, 2021a).

CFIA implements monitoring programs that manage marine biotoxins through testing shellfish tissue. Shellfish samples are collected for testing based on season, historical biotoxin levels, and harvesting activities (CFIA, 2021a). Shellfish harvest areas are recommended to be closed once biotoxins reach levels that can harm humans, levels which are established by Health Canada. For PSP, areas are closed once saxitoxins reach 80ug/100g. For ASP, harvest closure is when domoic acid levels are 20ug/g. For DSP, harvest areas are closed if either okadaic acid, dinophysis toxins or pectenotoxins reach 0.20ug/g (CFIA, 2021a). In cases where shellfish samples cannot be obtained, CFIA recommends closure based on previous knowledge in a particular area. Using results from shellfish testing, CFIA then recommends the closure of shellfish harvesting areas contaminated with marine biotoxins to DFO (CFIA, 2021a). In addition to monitoring marine biotoxins in shellfish, the CSSP manual states that the CFIA is responsible for licensing harvesters and enforcing regulations (CFIA, 2021a). Licensing includes any organization involved in the manufacturing, processing, treatment, preserving, grading, packaging, or labelling of foods. Licenses for shellfish include recreational, commercial, aquaculture, or Aboriginal licenses. However, a recent horizontal review of the CSSP has uncovered that it remains unclear as to if the CFIA plays a role in regulating the program (DFO, 2022b).

DFO is responsible for the opening and closing of shellfish harvest areas based on the recommendations from both ECCC (on water quality testing which indicates levels of microbial pathogens) and CFIA (on shellfish quality testing which indicates levels of marine biotoxins; CFIA, 2021a). DFO has the legal authority to enact the opening and closing of shellfish harvest areas under the *Fisheries Act* and supporting regulations (e.g., *Pacific Fishery Regulations* [1993], *Management of Contaminated Fisheries Regulations*). For example, the *Management of Contaminated Fisheries Regulations* indicate that the minister can close shellfish harvest areas when marine biotoxins, microbial pathogens, or chemical contaminants are present in the habitat to a degree that is recognized as a danger to public health (CFIA, 2021a). Thus, DFO is the main department that functions to regulate the CSSP. DFO is also responsible for communicating the opening and closing of shellfish harvest areas to the public.

In overview, the CSSP is implemented by the distinct but overlapping roles of three federal government departments, with Health Canada in a related but indirect role (Figure 3). Health Canada sets health standards that determine what contaminant levels are safe to consume in shellfish. Based on these levels, ECCC and CFIA monitor the water and shellfish for the three main contaminants (pathogens and chemicals in water quality tests, biotoxins in shellfish tests). ECCC and CFIA then recommend the closure of shellfish harvest areas that are contaminated with unsafe levels to DFO. DFO closes contaminated shellfish harvest areas under the authority of the *Fisheries Act* and communicates these closures to the public. Throughout this whole process, the CSSP manual states that the CFIA is in charge of licensing and enforcing regulations, though the reality of this statement remains unclear (CFIA, 2021a; DFO, 2022b).

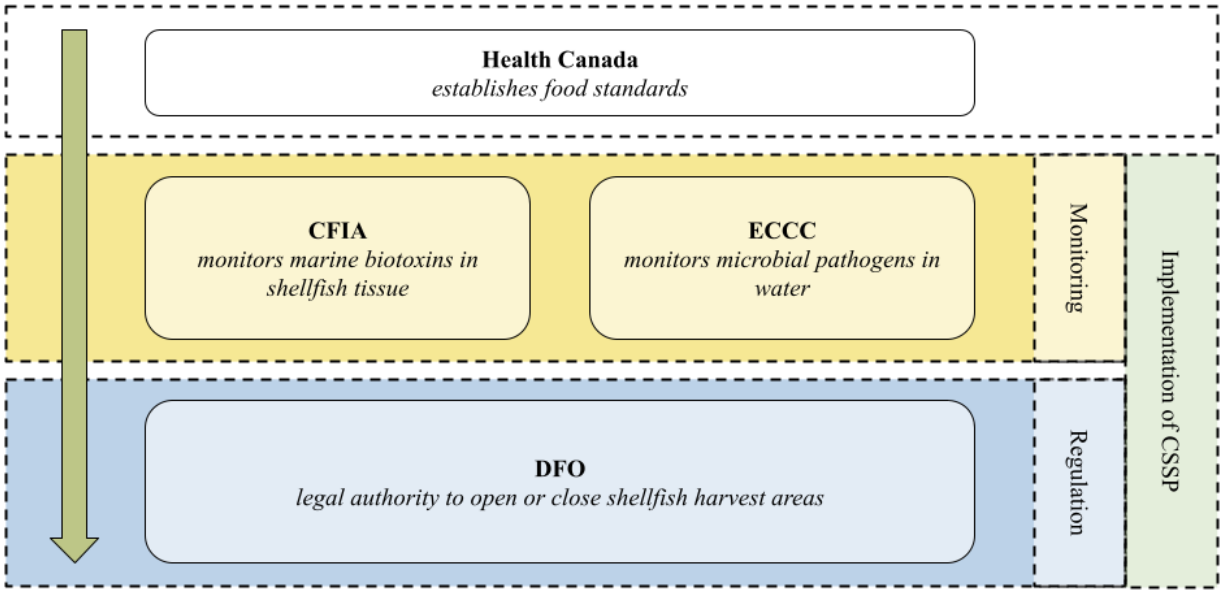

Figure 3. The Canadian Shellfish Sanitation Program (CSSP) is implemented by three federal government departments each with distinct roles: the Canadian Food Inspection Agency (CFIA), Environment and Climate Change Canada (ECCC), and Fisheries and Oceans Canada (DFO).

3.4.2 Barriers

In the Georgia Basin, beaches open to shellfish harvesting have decreased by 44% since 1989 (ECCC, 2019, as cited in EPA, 2021). Though decreases in water quality (as discussed in Section 3.3) explain a part of this trend, another large reason for the increased closures is lack of monitoring shellfish contaminant levels (Andrade-Rivas et al., 2022; McIntyre et al., 2021;

Bouchouar et al., 2014). A horizontal review of the CSSP found that the program is chronically underfunded, resulting in gaps in monitoring (DFO, 2022b). Because the CSSP works as a preventative measure, this means that when harvest sites are unable to be monitored due to capacity, they remain closed. Though this works to reduce the number of shellfish poisoning cases by limiting the harvest of un-tested shellfish, it also presents barriers to IFS.

The freedom and ability to make decisions over the amount of food produced is central to the 'self-determination: production' element of the Framework for IFS (Morrison, 2011). This includes that production is controlled and regulated by the Indigenous community (Jernigan et al. 2021). Control is removed from communities when there are regulations like those supporting the CSSP that prevent harvest (i.e., production in the Framework for IFS) at sites that may be safe but are closed because they have not been tested. This removes the ability of the community to decide what the desired amount of food harvested is on two levels. First, the CSSP is often unable to assess long-term site closures for re-opening because of capacity constraints (DFO, 2022b). This means that harvest closures are often maintained even if the water quality improves to a safe level because there has been no reassessment of the contaminant levels (Fleming, 2019). Second, the community has no pathway to work towards cleaning up and reopening sites (First Nations Health Authority [FNHA], 2022). This is because there are no regulatory triggers for site clean-up that are driven by the community. There are jurisdictional gaps in terms of who is responsible for cleaning up sites (FNHA, 2022; DFO, 2022b). These two causes for long-term harvest closures prevent the community from self-determining, controlling and regulating food production which is a barrier to IFS.

The CSSP also presents a barrier to the 'legislation and policy: policy' element in the Framework for IFS. Legislation and policy is about reconciling Indigenous foods and culture with colonial laws (Morrison, 2011). This element includes having policies in place to ensure the sustainability of cultural food resources and that access to these resources is maintained (Jernigan et al., 2021). Another important part of this element is the link between food and health (Morrison, 2011; Jernigan et al., 2021). The CSSP has significant gaps in delivery that perpetuate inequalities (DFO, 2022b). The mandate of the CSSP is to minimize health risks from the consumption of shellfish (DFO, 2022b). Under this mandate, the CSSP should provide support equitably to all harvesters (including commercial, recreational, and Indigenous) to minimize the risk that face

each group differently. Indigenous harvesting includes food, social, and ceremonial harvesting (FSC) and Indigenous harvesters are the only group that has rights to harvest shellfish recognized under Section 35(1) of the *Constitution Act*. However, Indigenous harvesters are not supported to the same extent as the commercial sector. For example, most shellfish testing for marine biotoxins is done in areas that are commercially significant rather than areas that support subsistence harvesting (McIntyre et al., 2021; Fleming, 2019). The remoteness of many First Nations communities means that they are often self-harvesting outside areas routinely tested for biotoxins (i.e., commercial harvest areas), which puts them at greater risk. In result, even though First Nations only account for 6% of the population of BC, they account for a quarter of PSP outbreaks (McIntyre et al., 2021).

Another gap in monitoring that has implications for Indigenous harvesters is the lack of monitoring for chemical contaminants. Traditional consumption of shellfish presents a different type of exposure to contaminants than commercial consumption, for which the existing regulations and guidelines do not account (Andrade-Rivas et al., 2022). Indigenous Peoples have higher consumption rates and frequency of use of country food sources (Health Canada, 2018). This is especially relevant given the long-term pathways of exposure that Indigenous harvesting could be characterized by (Wang et al., 2022; Andrade-Rivas et al., 2022).

Besides gaps in the equitable delivery of the CSSP, another barrier is presented by the categorization of FSC by the federal government. The DFO-regulated openings for FSC harvesting places constraints on Indigenous harvesters as the federal government does not recognize this as including the sale of resources for financial benefit (DFO, 2022a). This constraint is a barrier to the 'self-determination: trade' element of IFS as it limits First Nations' ability to take part in commercial harvesting. However, this does not align with how the federal government recognizes Indigenous rights to harvest in Section 35(1) of the *Constitution Act* and the inherent right of Indigenous Peoples to self-determination in the *UNDRIP Act*, which could argue that selling shellfish is a self-determined action.

The inequitable delivery of the CSSP and supporting legislation shows how Indigenous values are not represented in the shellfish management system. Therefore, these gaps in delivery should be filled to move towards the reconciliation of colonial laws and Indigenous values and therefore towards IFS.

3.4.3 Levers

Both the inequalities and lack of community control in the current shellfish management system must be overcome to achieve IFS. Therefore, increasing monitoring and testing capacity to ensure safe harvest sites can be open is an integral part of moving towards IFS. Such monitoring and testing programs should focus on two main levers for transformative change at specific leverage points. First, coordinating across sectors and jurisdictions to reduce inequalities, practice justice and inclusion in conservation. Second, adaptive decision-making that is specifically grounded in multiple ways of knowing and emphasizes knowledge sharing.

Coordinating across sectors and jurisdictions is a key for a phytoplankton monitoring and shellfish testing program especially on the coast of BC. This includes integrating not only across levels of government in Canada (federal, provincial, First Nations – and various departments within each) but also across colonial borders. Ecosystems do not follow political borders and thus collaboration is required when actions on one side of the border impact those on the other, like in the Georgia Basin (Sobocinski, 2021; McIntyre et al., 2021).

Implementing a coordinated monitoring program also presents opportunities to dismantle inequalities and promote justice and inclusion in conservation by meaningfully and substantively including Indigenous Peoples in such programs. This could mean providing financial support that enables Indigenous-led approaches. Sources of long-term funding are a common barrier to the development of Indigenous-led programming to support community needs (Olsen, 2019). First Nations often do not have appropriate levels of funding due to unequal power relationships with federal and provincial governments (Zurba et al., 2019). Rather than develop monitoring and testing programs at the federal or provincial level, the best use of resources may be to direct funding to Indigenous-led programs to fill the monitoring gaps.

Examples of such Indigenous-led programs are already in place in Alaska (e.g., Southeast Alaska Tribal Ocean Research [SEATOR]). SEATOR is a monitoring program led by 16 Tribes that conducts both phytoplankton monitoring and shellfish testing. Phytoplankton monitoring is done qualitatively by volunteers and employees that conduct a phytoplankton tow followed by an examination of the sample using a microscope to determine the abundance of each HAB species (Alaska Harmful Algal Bloom Network, n.d.). Shellfish testing is done using a receptor binding

assay which determines the concentration of paralytic shellfish toxins within the sample and can be compared to health standards set by the Federal Drug Administration in the US to determine if it is safe for consumption (Alaska Harmful Algal Bloom Network, n.d.). Because the State of Alaska does not monitor or regulate recreational, subsistence, or ceremonial harvesting (only commercial harvesting), these regional monitoring programs have worked to fill the monitoring gaps facing Indigenous harvesters (Alaska Harmful Algal Bloom Network, n.d.).

Adaptive decision-making should play an important role in any phytoplankton monitoring and shellfish testing program. Climate change, marine heatwaves, and ocean acidification are bringing uncertainty and a dynamic nature to shellfish harvest (King et al., 2021; Raymond et al., 2022; DFO, 2022b). As such, responding to these complexities should be built into any implemented program. A leverage point that can support dealing with these complexities is promoting knowledge generation and sharing. Implementing a monitoring program that recognizes the value of multiple ways of knowing can take advantage of a more holistic and less reductionist understanding of the environment (IPBES, 2019). Another element of this leverage point is knowledge sharing, which should be a key focus of a phytoplankton monitoring and shellfish testing program. Under the current shellfish management system, many Indigenous harvesters have felt there is sometimes unclear communication regarding shellfish harvest closures (McIntyre et al., 2021). There needs to be better knowledge sharing to reduce risks of Indigenous harvesters harvesting unsafe shellfish, for example by misinterpreting signage (McIntyre et al., 2021). Using the Indigenous-led monitoring programs in Alaska as a case study, there is transparency in terms of publicly reporting biotoxin levels as well as providing educational materials that detail how the monitoring works (Alaska Harmful Algal Bloom Network, n.d.).

BC needs a two-tiered phytoplankton monitoring and shellfish testing similar to Alaska's Indigenous-led monitoring programs. However, it remains unclear as to who should be responsible for developing this capacity. In the recent horizontal review of the CSSP, DFO concluded that the CSSP's mandate was unclear as to what the priority level of Indigenous harvesters is (DFO, 2022b). Federal mandate letters from 2021 show that the federal government's priority is reconciliation with Indigenous Peoples, which suggests that the CSSP should prioritize program support for Indigenous harvesters (DFO, 2022b). Another element

besides unclear mandates is that no health departments or organizations are involved in the implementation of the CSSP, which is a program centered on human health. In addition, the CSSP is implemented solely by federal departments and there are no mentions of Indigenous Peoples in the CSSP manual (Fleming, 2019). These factors indicate an overlooking of health risks to Indigenous Peoples such as the risks associated with restricted access to traditional foods.

Regardless of if the CSSP is mandated to fill this monitoring and programming gap, the gap currently still exists meaning that action is needed. In the time that it is taking for the CSSP to implement new programming to support Indigenous harvesters, other actors are stepping in, including the FNHA. The FNHA is piloting a project called We All Take Care of the Harvest which focuses on designing community-based monitoring programs modelled after SEATOR (FNHA, 2022). However, this program is in the pilot project stage and would require long-term sustainable funding to functionally operationalize. Perhaps the fact that other actors such as the FNHA are stepping in should be taken as indication that if the CSSP does not have the capacity to develop a monitoring program, this mandate should be shared with or moved to other actors that can more accurately represent the needs of the Indigenous harvesters.

3.5 Shellfish Harvest Site Access

3.5.1 Barriers

In addition to limited shellfish harvesting because of contamination and a lack of monitoring, another barrier to IFS in shellfish food systems is limited access to shellfish harvest sites. Access to shellfish harvest sites is limited due to land privatization, coastal zone development, and limited transportation. These are barriers to the ‘self-determination: access to resources’ element of IFS as shellfish harvest sites are a resource that is restricted.

Additionally, limited access to shellfish harvest sites is a barrier to the ‘legislation and policy: policy’ element of IFS as the Western paradigm of land ownership is grounded in colonial legal systems. The Western paradigm of land ownership is linked to the establishment of a capitalist economy and society (Kepkiewicz & Dale, 2019). Because the ‘legislation and policy: policy’ element of IFS is grounded in the reconciliation of colonial laws with Indigenous values, land ownership in its current form remains a barrier to IFS as it is not reconciled with Indigenous

values. The current paradigm of land ownership imagines land as a commodity with extractable value, whereas Indigenous values are grounded in reciprocal relationships with the land (Kepkiewicz & Dale, 2019; Ayers et al., 2012). Land ownership takes its form in intertidal zones as foreshore leases and private tenures (Hul'qumi'num Treaty Group et al., 2005). Docks, wharves and marinas have harvest restrictions around the structures. Access from land is restricted by waterfront private properties that occupy vast expanses of the shoreline (Hul'qumi'num Treaty Group et al., 2005).

Transportation to shellfish harvest sites is another barrier that limits access for Indigenous communities. This includes a lack of access to all-weather boats and/or the cost of gas (Olsen, 2019). Frequent access is needed, not just for harvesting but also for maintenance. Sea gardens, which are an integral part of the shellfish food system in First Nations communities in BC, require regular care from wall repairs to fluffing sediment (Olsen, 2019). When access is limited to when non-community members (e.g., Parks Canada staff) can transport harvesters to shellfish harvest sites, this removes the control from the community. Therefore, impeded access to easy and safe transportation is a barrier to the 'participation: community involvement' element of IFS as it places limitations on those who can be involved in the day-to-day actions of caring for the land.

3.5.2 Levers

The Western paradigm of land ownership is deeply rooted in our current social, economic and legal systems. Overcoming the problematic aspects of this paradigm is challenging. However, shifting towards a more equitable understanding of land 'ownership' (or responsibility) can be instigated by promoting discussions that challenge our understanding of land ownership. One key lever for this is the knowledge generation and sharing leverage point that promotes equal recognition of knowledge systems (IPBES, 2019). Knowledge systems have a key role in determining values and therefore enabling behaviour change. Broadening our views of how we relate to land can help facilitate exploring potential equitable land reforms.

Questions posed by Kepkiewicz and Dale (2019) that challenge our preconceived notions of land ownership include: What kinds of land relations might characterize a food-sovereign society? What are the challenges associated with envisioning the implementation of non-capitalist land

access arrangements? How do we create agroecological practices that challenge private property and support Indigenous struggles for land and diverse Indigenous food systems? These questions are necessary to address to overcome barriers to shellfish harvest sites access and move towards IFS.

The ideas of challenging our understanding of land ownership feature in the 'Land Back' movement. Exploring what it means to give land back to Indigenous Peoples is essential to overcome conflicts over land-use decisions (David Suzuki Foundation, n.d.). Kepkiewicz and Dale (2019) argue that land repatriation and restitution are necessary to move towards equitable governance practices. Further exploration of what constitutes equitable governance of land in the context of implementing UNDRIP is key, especially with the recent *UNDRIP Act*. Articles 11, 25, 26, and 29 highlight the rights of Indigenous Peoples regarding land, including their control over resources. Articles 8, 19, 26, and 27 dictate the responsibility of the State to halt the dispossession of Indigenous Peoples from their lands (UN General Assembly, 2007). The foundations for a paradigm shift in the legal understanding of land ownership have already been set and calls for follow through must be answered. Specifically regarding shellfish food systems, a shift in legal understanding of land ownership could open up beach access points to shellfish beds.

3.6 Culture

3.6.1 Barriers

The historical and ongoing impacts of colonialism that have produced the previously-discussed barriers have also resulted in a secondary and indirect barrier: cultural loss. Reasons for this loss of culture stem from decreases in opportunities to connect with Indigenous knowledge systems (including language, traditional practices, etc.; Turner & Turner, 2008). These factors have brought about a sense of disconnect from the land and resources and strain on family units that is grounded in the loss of traditional knowledge, family structures and relationship to the land (Ayers et al., 2012).

This loss of culture is a barrier to the 'sacred or divine sovereignty: culture' and the 'self-determination: food consumption' elements of IFS. The key part of the 'sacred or divine

sovereignty: culture' element of IFS is the sacred responsibilities and interdependent relationship with the land (Morrison, 2011). This element is supported by having adequate opportunities to share knowledge within the community (Jernigan et al., 2021). However, the perceived disconnect from the land threatens this relationship to the land (Ayers et al., 2012). The 'self-determination: food consumption' element places importance on all communities having sufficient food access supported by food distribution systems (Morrison, 2011). However, there are often too few food harvesters in the community, with the workload falling on a few 'super harvesters' (Olsen, 2019). These individuals take on the role of harvesting and distributing clams for the community for the health of the shellfish beds and people (Olsen, 2019). However, this system is far from ideal with these 'super harvesters' often not being well off, working instead for reciprocity, relationship building, and respect (Olsen, 2019).

3.6.2 Levers

Though there has been cultural loss as a result of decreased opportunities to carry out traditional practices relating to food, culture can be regained and redeveloped (Turner & Turner, 2012). A key lever for recovering culture is promoting education and knowledge sharing (IPBES, 2019). In the context of cultural restoration, this could mean both contemporary methods such as publications, videos, and interactive multimedia as well as traditional methods such as reinstating ceremonial practices and serving traditional foods at community gatherings (Turner & Turner, 2012).

Both contemporary and traditional methods are being used by the Eco-Cultural Gulf Islands Sea Garden Restoration Project (hereafter referred to as the Sea Garden Restoration Project) to successfully regain culture tied to shellfish food systems (CGN, n.d.-b). Since 2014, the Sea Garden Restoration Project has worked to restore two sea gardens in the Gulf Islands, led by the W̱SÁNEĆ and Hul'q'umi'num Nations (Parks Canada, 2015). The contemporary methods in this project that have supported cultural restoration include reports and videos that detail traditional food practices, the responsibilities to the land, and language relating to food and places (e.g., Olsen, 2019; Parks Canada, 2015). Traditional methods include providing opportunities for reconnecting with traditional practice relating to sea garden maintenance and shellfish harvesting, preparation, and consumption (W̱SÁNEĆ Leadership Council, n.d.; Parks Canada, 2015).

A key part of culture restoration is the involvement of both Elders and children (Turner & Turner, 2012; Olsen, 2019). Therefore, special consideration should be taken to involve youth in educational opportunities that instill the cultural importance of traditional foods like shellfish. An understanding of the cultural importance of shellfish can be facilitated through schools. For example, making traditional foods more accessible to school programs or having school field trips to sea gardens (Turner & Turner, 2012). The Sea Garden Restoration Project incorporated this focus in their restoration activities through the Learning by the Sea program (CGN, n.d.-b). This program provides First Nations and non-Indigenous youth the opportunity to visit sea gardens and learn about traditional practices. As well, it provides science and culture camps for First Nations youth to learn from Elders (and other knowledge holders) and scientists that study sea gardens (CGN, n.d.-b).

Table 3. Summary of barriers and levers for achieving Indigenous Food Sovereignty in shellfish food systems.

Barrier	References Related to Barriers	Element(s) of IFS Impeded	Pathways Forward	References Related to Pathways Forward	Lever or Leverage Point	Case Study
Shellfish contaminants (marine toxins, microbial pathogens, and chemical contaminants make shellfish unsafe for consumption)	Ayers et al. (2012), Bouchouar et al. (2014), EPA (2021), Hul'qumi'num Treaty Group et al. (2005), King et al. (2021), McIntyre, et al. (2021), Olsen (2019)	Self-determination: access to resources	Implement tools such as pollution identification and correction programs (PICs) that focus on reducing the amount of sewage that reaches harvest sites rather than waiting for sewage leaks to restrict harvesting, with the following attributes:			Puget Sound Pollution Identification & Correction Programs
			- Early servicing of on-site sewage systems as a preventative measure before failures.		Pre-emptive action	
			- Rebates offered as incentives for servicing on-site sewage systems.		Incentives and capacity building	
			- Coordinate and collaborate across areas to break down silos (e.g., governance levels, political and geographic jurisdictions, disciplines, sectors).	Sobocinski (2021)	Coordination across sectors and jurisdictions	
			- Collaborations must involve substantive inclusion of Indigenous Peoples in decision-making, potentially as representation on a board that has decision-making power.	McIntosh (2016), Olsen (2019)	Practice justice and inclusion in decision-making	
			Following implementation of pollution identification tools, introduce and enforce stronger environmental laws that penalize those that pollute.	Hul'qumi'num Treaty Group et al. (2005)	Environmental law	

Barrier	References Related to Barriers	Element(s) of IFS Impeded	Pathways Forward	References Related to Pathways Forward	Lever or Leverage Point	Case Study
Shellfish harvest closures (shellfish beds that may have safe levels of contaminants remain closed to harvest because of lack of monitoring / testing)	Ayers et al. (2012), Fleming (2019), Hul'qumi'num Treaty Group et al. (2005)	Self-determination: production, Legislation and policy: policy, & Self-determination: trade	Implement regional phytoplankton monitoring and shellfish testing programs that support the reassessment and reopening of safe harvest sites, with the following attributes:	Andrade-Rivas et al. (2022), Bouchouar et al. (2014), Fleming (2019), Hul'qumi'num Treaty Group et al. (2005)		Indigenous-led monitoring programs in Alaska (e.g., SEATOR)
			- Coordination across all levels of government in Canada (including First Nations) as well as across colonial borders from Alaska to Mexico to cover monitoring gaps.	Andrade-Rivas et al. (2022), Bouchouar et al. (2014), Fleming (2019), McIntyre et al. (2021)	Coordination across sectors and jurisdictions	
			- Collaborations must involve substantive inclusion of Indigenous Peoples, which in some cases may mean financial support to enable Indigenous-led programs.	Andrade-Rivas et al. (2022), McIntyre et al. (2021)	Reduce inequalities & Practice justice and inclusion in conservation	
			- Continuous evaluation of programming that makes room for adapting to changes such as newly identified phytoplankton toxins.	Sobocinski (2021)	Adaptive decision-making	
			- A focus on knowledge sharing (where appropriate) to improve communication of closures to communities	Bouchouar et al. (2014), Fleming (2019), McIntosh (2016), McIntyre et al. (2021)	Promote education and knowledge generation and sharing	

Barrier	References Related to Barriers	Element(s) of IFS Impeded	Pathways Forward	References Related to Pathways Forward	Lever or Leverage Point	Case Study
Shellfish harvest site access (land privatization, coastal development, and a lack of transportation options prevent harvesting)	Ayers et al. (2012), Hul'qumi'num Treaty Group et al. (2005), Kepkiewicz & Dale (2019), Olsen (2019)	Self-determination: access to resources, Legislation and policy: policy, & Participation: community involvement	Instigate conversations that challenge our understanding of land ownership by recognizing and valuing different ways of knowing and being, engaging Canadians with the Land Back movement to reinstate access to shellfish harvest sites.	Kepkiewicz & Dale (2019), Sobocinski (2021)	Promote education and knowledge generation and sharing	
Loss of culture (elders passing on, youth not having opportunities to learn)	Ayers et al. (2012), Fleming (2019), Olsen (2019), Turner & Turner (2012)	Self-determination: food consumption & Sacred or divine sovereignty: culture	Support cultural restoration through contemporary methods (e.g., publications) and traditional methods (e.g., reinstating ceremonial practices), with a focus on teaching the cultural importance of traditional foods to children.	Olsen (2019), Turner & Turner (2012)	Promote education and knowledge generation and sharing	Eco-cultural Gulf Islands Sea Garden Restoration Project

4. Conclusions & Recommendations

The management of the shellfish food system in BC has created barriers to IFS including limited shellfish harvesting due to contamination, lack of monitoring, limited access to shellfish harvest sites, and loss of culture. Despite reported gaps in the shellfish management system, there has been little change in the system over the past few decades (DFO, 2022b). This research project set out to support a paradigm shift in the management of the shellfish food system by identifying barriers and levers for change towards IFS (summarized in Table 3).

The Framework for IFS presented in Section 3.1.1 is a tool that can be used to identify barriers and prioritize what needs to happen to achieve IFS. The following recommendations are developed from the application of the Framework for IFS to a broad context based on the literature on shellfish food systems in BC. As such, they illustrate how the Framework for IFS can identify priority actions to achieve IFS, but these recommendations may not be applicable in every context. The next steps would be to explore the application of the Framework for IFS to specific contexts to understand how community objectives may be reached, which must involve communities in the central and leading role.

The four recommendations intended to support a paradigm shift in shellfish management are: (1) mandate an organization with the responsibility to support safe shellfish harvesting opportunities for Indigenous harvesters, (2) monitor and address shellfish contaminants, (3) educate government departments and coastal landowners about the implications of land ownership and Indigenous rights regarding shellfish harvest, and (4) enable and prioritize cultural resurgence in coastal First Nations shellfish food systems. Each of these recommendations is described in more detail below.

1. Establish an organization with the mandate to ensure safe shellfish harvesting opportunities for Indigenous harvesters: There is a gap in delivery of shellfish safety programming to Indigenous harvesters and it is unclear if this is included in the mandate of the CSSP (DFO, 2022b). The role of providing support for Indigenous shellfish harvesters should be centralized in an organization that has good representation from Indigenous communities identified or created for this purpose. Indigenous voices must be central in whatever organization becomes responsible for this mandate (Fleming, 2019). It is also important that there is long-term

sustainable funding to develop and implement shellfish safety programs such as those described in the second recommendation below. A potential pathway for the implementation of this recommendation is through BC's Declaration on the Rights of Indigenous Peoples Action Plan 2022-2027. Action 2.6 indicates BC's commitment to co-developing initiatives to advance stewardship of resources, associated with the desired outcome that Indigenous Peoples have meaningful and sufficient access to abundant and healthy traditional foods (BC, 2022). Therefore, this recommendation is directed at both the federal and provincial governments in parallel with First Nations in coastal BC to negotiate clearly defined roles, jurisdictional boundaries and funding for the mandate to support Indigenous shellfish harvesters.

2. Monitor and address shellfish contaminants in areas of BC that are prioritized for Indigenous harvesting: Shellfish safety programming should be implemented to equitably provide safe harvesting opportunities for Indigenous Peoples. Implementation of regional PICs is key to address sewage pollution issues; the geographic focus for PICs could be prioritized using information provided by ongoing coastal zone planning processes in BC (e.g., Marine Plan Partnership for the North Pacific Coast and other plans). Such programs should incorporate levers for transformative change by: (1) having incentives for servicing OSSs pre-emptively, (2) applying penalties for polluting, and (3) collaborating across organizations and governments. Collaborations should substantively include Indigenous Peoples in decision-making to acknowledge Indigenous rights and Indigenous knowledge systems. Alongside implementation of PICs to address microbial pathogen pollution issues, regional phytoplankton monitoring and shellfish testing programs are necessary to address monitoring gaps for marine biotoxins. Key characteristics of a biotoxin monitoring program include (1) collaboration, (2) adaptive decision-making, and (3) knowledge sharing. Improving knowledge sharing capacity is important to reliably communicate monitoring findings related to food safety to communities. This recommendation is directed at the organization mandated with supporting Indigenous harvesters (see Recommendation #1), to inform the design and functions of that organization. Organizations already stepping in to fill monitoring roles, such as the FNHA, should continue to contribute through further development of pilot projects (such as the We All Take Care of the Harvest project) that support movement towards IFS in shellfish food systems.

3. Collectively explore equitable reimaginings of land 'ownership' related to shellfish food systems in the context of reconciliation between Canada and Indigenous Peoples: Beyond barriers related to shellfish harvest site closures, shellfish harvest is limited by restricted access to beaches with shellfish beds. To overcome these limitations, we need to broaden our perceptions of land ownership to recognize inherent and constitutional Indigenous rights. Ongoing coastal zone planning processes in BC are already building awareness that will contribute to shifting perceptions; however, targeted information sharing is needed. For example, educating government representatives (DFO, BC Ministry of Land, Water and Resource Stewardship) and coastal landowners about Indigenous rights concerning access to shellfish harvest sites. This recommendation is directed at all people living in what is commonly known as Canada, involving people present in different capacities such as landowners, Indigenous Nations, and levels of Canadian government.

4. Enable and prioritize cultural resurgence in coastal First Nations shellfish food systems by facilitating opportunities for communities to engage with their culture: Shellfish harvest is indirectly restricted by a loss of culture. Cultural restoration occurs when community members engage with Indigenous knowledge systems and traditional practices such as sea garden management. Because of the key role that intergenerational connections have in the long-term survival of culture, a key focus of cultural restoration initiatives should include opportunities that bring together Elders and youth. Engaging youth in traditional food systems can be supported by school programs such as land-based learning experiences in sea gardens or access to traditional foods in schools. This recommendation is directed at federal and provincial levels of government as well as coastal First Nations in BC, who can collaborate on supporting opportunities for cultural resurgence. First Nations communities should continue to assert their rights, looking to model Indigenous-led programs like the case studies presented herein. Such programs are examples of how to support cultural resurgence and, more broadly, move towards IFS.

In conclusion, rebuilding shellfish food systems can be a step towards IFS for coastal First Nations communities in BC. However, this research describes a number of barriers to IFS, largely related to the past and ongoing impacts of colonialism. Pathways forward should focus on overcoming or reducing these barriers. As argued herein, one way is to use levers for

transformative change towards IFS to restore socio-cultural and ecological systems tied to the shellfish food system to the benefit of both humans and nature.

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