KPU | Institute for Sustainable Food Systems

BRINGING OUR FOOD SYSTEM HOME

Report on the Okanagan Bioregion Food System Project

About the ISFS

The Institute for Sustainable Food Systems (ISFS) is an applied research and extension unit at Kwantlen Polytechnic University that investigates and supports regional food systems as key elements of sustainable communities. Our work is primarily focused in British Columbia but also extend to other regions.

Our applied research focuses on the potential of regional food systems in terms of agriculture and food, economics, community health, policy, and environmental integrity. Our extension programming provides information and support for farmers, communities, business, policy makers, and others. Community collaboration is central to our approach.

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Bringing Our Food System Home

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Preface

I am pleased to write this preface to the Okanagan Bioregion Food System Project report.

Projects led by academic institutions like Kwantlen Polytechnic University further the conversation that we all must have to enable a thriving regional agricultural industry and a food-secure population. In utilizing a bioregion approach, the project has stepped beyond artificial boundaries on a map to focus on the shared similarities of climate, culture and place.

The Okanagan is one of the most important and productive agricultural regions in B.C., contributing greatly to the economics of the area and the well-being of its residents. Factors such as climate change, demographic shifts and evolving trade relationships can contribute to uncertainty about the future. One thing we know for certain, though, is that we all will need to eat. Agriculture within the Okanagan will continue to play a key role in providing safe and wholesome food. In utilizing different scenarios, the report allows the reader to examine what the future agricultural landscape and regional food self-reliance might look like depending upon the choices our society makes. It's important to understand the impacts that our choices today may have tomorrow with respect to economics, food self-reliance, environmental health and community development.

Regional food systems are important for the economic, social and ecological health of our communities. I'm encouraged that the report highlights the increasing need for agricultural production while using our resources sustainably and minimizing negative environmental impacts. The project encourages expansion of both farming and the regional post-production sector in the Okanagan. This also is a priority of the GrowBC, FeedBC, BuyBC initiatives that have been a key component of the Ministry of Agriculture, Food and Fisheries.

I am committed to collaborating with all stakeholders in enhancing agriculture and helping B.C. producers expand local food production.

The B.C. Food Security Task Force recommended the adoption of the United Nations Sustainable Development Goals. These goals are reflected in this report and include achieving food security and promoting sustainable agriculture. Protecting farmland is critical to the long-term success of the agricultural industry and food security. Additionally, providing opportunities for new entrants and the expansion of existing farmers and processors will support growth within the industry. We have the opportunity to not only capitalize on our strengths but also to develop new approaches and technologies that will aid in enhancing agriculture regionally and provincially.

I'm grateful that Kwantlen Polytechnic University undertook this project. Building awareness of the need for long-term, multi-stakeholder engagement to support the planning and development of sustainable regional food systems is an effort we can all support.

Sincerely,

Lana Popham
Minister of Agriculture, Food and Fisheries

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Introduction

The Okanagan Bioregion

The Okanagan bioregion lies within the traditional, unceded territories of the Syilx Okanagan Peoples. The northern portion of the Okanagan bioregion is also home to the Splatsin band of the Secwépemc Nation.

Since time immemorial, the Syilx Okanagan People have stewarded these lands according to their laws, customs, values, governance structures, and principles. Teachings in the *captikwɬ** (stories) provide instructions on how to live on and relate to the land so that future generations may continue to thrive in harmony with the *tmixʷ* (all living things)[1]. Generation after generation, Syilx Okanagan Peoples were self-reliant in this region, maintaining sustainable foodways that were rich in wild and foraged foods until the recent onset of colonization brought both the dispossession and degradation of their lands.

We recognize that the policies and practices of colonization have significantly impacted the ability of the Syilx Okanagan Peoples to engage in their traditional foodways. With this work, we imagine a future food system for the Okanagan bioregion that addresses the harmful colonial legacy and advances the potential for Indigenous self-determination, leadership and food sovereignty. *This study does not include the potential of wild and foraged foods in its consideration of food self-reliance. These are at the core of Indigenous foodways and should be considered in future research and local food system development.*

How is the Okanagan Bioregion Defined?

Bioregions are areas that share the same natural ecosystems and human culture. Defining a bioregion considers both the human and natural elements of the landscape, including the ecology, topography, water flows, economies and regional identities. Looking at food systems through a bioregional lens links human activities to the places that sustain them, recognizing that the health and well-being of humans and ecosystems are not separate outcomes, but inextricably linked. The bioregional scale is a functional scale to discuss and plan for food systems. It is small enough to promote coordinated planning, yet large enough to include the breadth of activities that make up the food system.

For this project, the Okanagan bioregion is defined as the three contiguous regional districts of the Okanagan (North Okanagan, Central Okanagan, and Okanagan - Similkameen). This area represents the valley between the Coast and Columbia mountains, drained by Okanagan Lake and its tributaries. Most contemporary settlements are located along the shores of Okanagan Lake, which, as a primary source of water in the hottest and driest region of the province, represents the lifeline for ecological integrity and the human economy.

**nsyilxcən terms and English translations are as they appear on the Okanagan Nation Alliance (ONA) website www.syilx.org. Indigenous Peoples of the Okanagan are the exclusive owners of their cultural and intellectual properties which is used in this report only through free, prior and informed consent in keeping with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).*

Map of the Okanagan Bioregion

For this study the Okanagan bioregion is defined as the three contiguous regional districts of North Okanagan, Central Okanagan and Okanagan - Similkameen.

Introduction

Syilx Perspectives: Land, Food and Family

Way'
I am happy to help introduce this Okanagan-based bioregional food initiative.

Land, food, family: for me and for Syilx Okanagan People, these are tightly woven together. *k̓ʷəlncutn*, the Creator, put us here and gave us the sacred responsibility to care for *tmixʷ* (all living things). For time immemorial, our knowledge institutions were based on knowing, respecting, and being sustained by these *tmxʷulaxʷ* (lands) and these *siwɬkʷ* (waters). This understanding was transmitted through our *captikwɬ* which are an ancient oral record of our people.

The Syilx Okanagan People are deeply rooted in this beautiful place. We are a distinct and sovereign Nation sharing the same land, *nsyilxcən* language, and culture. We are a transboundary people separated at the 49th parallel by the border between Canada and the United States. Our Syilx Okanagan Nation includes 7 member bands in B.C. and the Colville Confederated Tribes in northern Washington State. As caretakers of the land, it is our responsibility to act such that future generations may eat from these same places. This is how we thrived here for hundreds of generations. We do not think in terms of 10 or 20 years. We think in terms of those who are yet to be born. That is the lens. The decisions we make today affect our children, grandchildren, and all the children yet to be.

Many of our people have been fighting back against the loss of lands and access to traditional foodways for decades. The En'owkin Centre and the Okanagan Nation Alliance (ONA) are two Syilx Okanagan institutions that have been at the forefront of work to reclaim Indigenous food sovereignty and rejuvenate Syilx Okanagan foods and ecosystems for the well-being of our communities today, tomorrow, and always.

The ONA has been active in a wide range of traditional food security initiatives whether it is hosting on-the-land camps that support the sharing of harvesting practices or the long process of restoring *n'titxʷ* (Salmon Chief) to our waterways. Three decades ago, the sockeye salmon of the Okanagan basin were on the verge of extinction due to dams and poor water management by governments on both sides of the border. Salmon numbers were so low that it was only a matter of time. But our Syilx Okanagan leaders had a different vision. For us, salmon is central to connections between generations, communities, humans and non-humans, terrestrial and aquatic species, and transboundary watersheds. Our people called upon *n'titxʷ* through song and ceremony. The ONA spearheaded partnership and years of hard work that finally brought our sockeye back in record numbers.

"The work of shifting the Okanagan to a more regionally focused food system is a step towards reconnecting all of us to the land and its rhythms. This is part of the decolonization process that is challenging and painful—but so necessary. It is in line with the fundamental Syilx Okanagan principle that to care for the land is to care for the people."

Harvesting, like gardening, is grassroots and we honor those community members who quietly go about the work of gathering and sustaining their families through our traditional Indigenous foodways despite the challenges and limitations brought about by the current colonial system. We honour the stewardship and sacred responsibilities that are passed from generation to generation. We honour this bioregional project because it is about a different future for everyone. A regional perspective is grounded in the land under our feet. Healthy ecosystems mean healthy people. This work is both a responsibility and an opportunity.

For the good of all, for all time.

—*suiki?st*, Pauline Terbasket

Executive Director, Okanagan Nation Alliance

The Food System Challenge

Food systems are the resources, people, and activities that provide communities with food. This includes the flows of materials, knowledge, money and labour involved in farming, fishing, hunting, food distribution, processing, retail, preparation, and waste management. Our dominant food system relies on a highly globalized network of food supply chains that primarily aim to maximize output and profit. Efforts to increase efficiencies in this food system have resulted in market consolidation and concentration. For example, in Canada five companies control 80% of the grocery retail market[2], and two companies hold 40% of Canada's commercial bread-making market[3]. Globally, four companies control over 60% of global seed and pesticide sales[4,5]. This concentrated and globalized food system has supported many extractive practices at great social, environmental and economic costs, including;

Losses for the local economy: Residents in the Okanagan spend approximately $1.4 billion on food annually[6,7], however most of this does not stay in the local economy as it is spent on imported food and non-locally owned business.

Increased local vulnerability to disruptions: Consolidation and concentration in food supply chains increases local exposure to global changes and crises. This has been highlighted by the COVID-19 pandemic. Virus outbreaks in two of Canada's largest meat processing facilities, representing 70% of Canada's federally-licensed beef processing capacity[8], forced facilities to close temporarily and reduce their operating capacity. This had notable impacts across the supply chain[9] and underscored the vulnerability associated with the erosion of local food processing capacity.

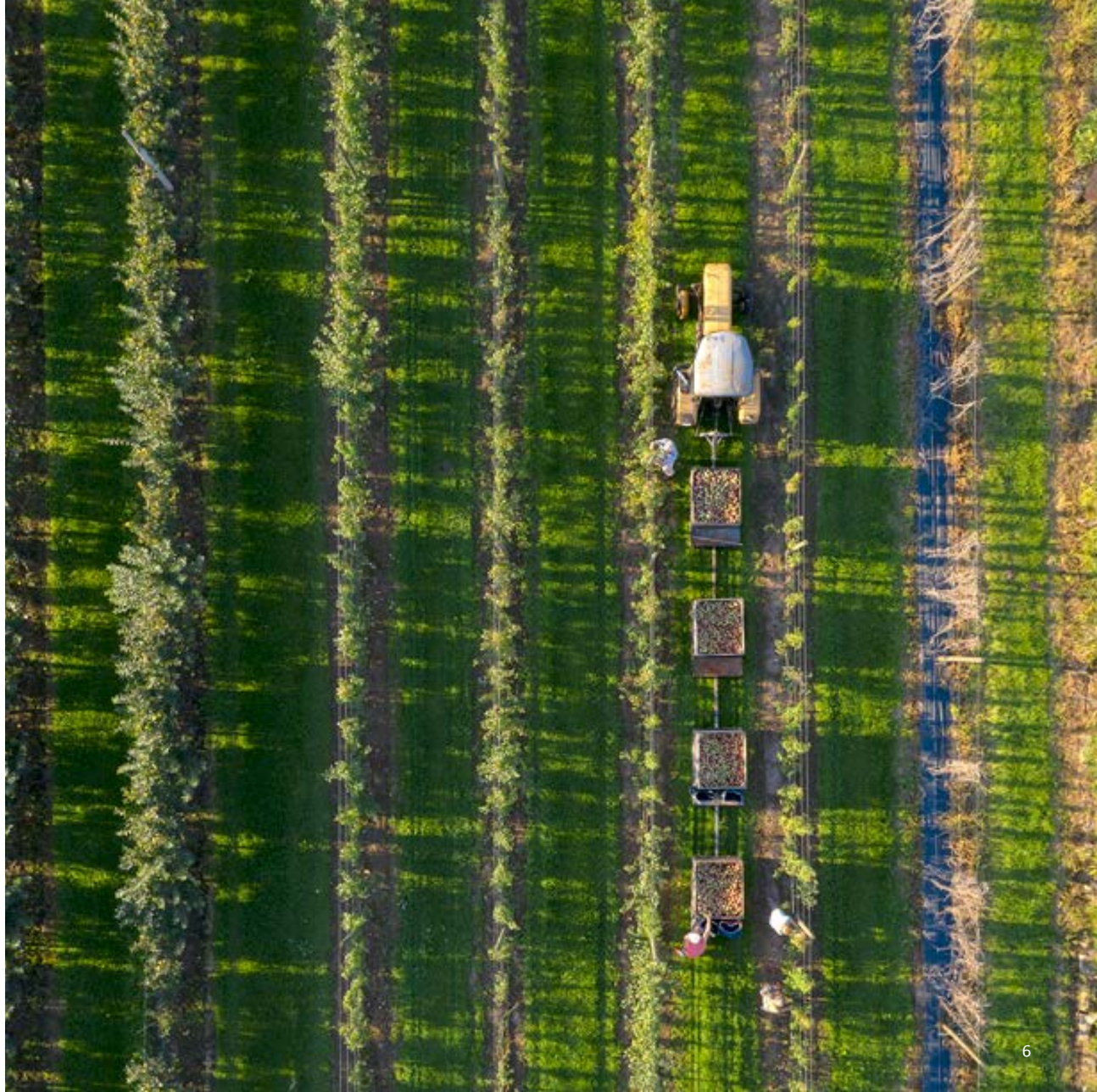
Increased gross farm profits, but not farmer livelihoods: While overall agricultural productivity and gross revenues in Canada have increased over the last 50 years, farmer livelihoods have remained stagnant, or declined, as agri-business input suppliers and service providers capture larger portions of farm income[10,11]. Today, many farmers depend on off-farm income and/or taxpayer funded farm support programs to make ends meet[12].

Eroding ecological health: Globally and locally, unsustainable farming practices and efforts to continuously increase production have resulted in freshwater pollution, soil erosion, and biodiversity loss. In B.C. and the Okanagan, the conversion of native habitats to agriculture has had significant impacts on biodiversity. For example, 11% of the grasslands in B.C.'s Southern Interior have been converted for agriculture. Agriculture has also been a primary driver behind the loss of 63% of the Okanagan's black cottonwood ecosystems and 75% of the wetlands in the Okanagan and Fraser River Delta[13].

The Opportunity of Regional Food Systems

Communities, governments and citizens are increasingly looking to regional food system alternatives to address the complex social, economic and ecological challenges described above. Evidence suggests that regional food systems can increase local economic benefits as food expenditures are captured locally[14], increase transparency between food system practices and impacts[15], promote value chains with more equitable outcomes[16], and encourage deeper public engagement and relationship building in communities[17].

While there is growing interest in regional food system development, local-level data and information describing the economic, social and ecological outcomes of such a food system remain sparse. This project aims to address this gap by providing information specific to the Okanagan that can guide data-driven conversations among communities and decision-makers seeking to strengthen regional food systems.



Agriculture in the Okanagan

The Okanagan bioregion is home to some of the best quality farmland in B.C. The semi-arid climate is suitable for production of a wide range of crops and livestock. This includes tree fruit and wine grapes, which grow well in few other regions in Canada. Nearly 50% of the farms in the Okanagan bioregion grow tree and vine fruits, collectively accounting for 24% of the cultivated land area. Fruit and wine grape production also contribute significantly to the economy. The interior tree fruit industry generates an estimated $130 million annually in wholesale revenue, and contributes $900 million to the provincial economy[18]. B.C.'s wine sector, which is also primarily located in the Okanagan, contributes an estimated $2.8 billion dollars to the provincial economy annually[19].

The bioregion also produces livestock products including dairy, poultry, eggs, and beef. Land for pasture, hay, silage and livestock feed grain production accounts for 62% of the currently cultivated area in the bioregion. While a relatively small number of farms produce dairy and poultry, production from these supply-managed sectors in the bioregion is significant. Much of the beef cattle and forage production is located in the North Okanagan, as well as in the Similkameen watershed. The region also produces vegetables, small fruit and berries, root crops, and grains for human consumption. Due to the semi-arid climate and limited summer precipitation, crop production relies on irrigation through most of the growing season.

In 2016, there were 3,210 farms in the bioregion. The majority of these were small, family-type farms, operating on less than 70 acres, and earning less than $100,000 in annual gross farm receipts[20]. Agriculture sectors in the bioregion employed 12,754 people in 2016, which amounts to 28% of the province's farmworkers[21]. Agriculture, particularly the tree fruit sector, relies on an influx of seasonal workers during the growing season. Tree fruit sectors alone employ approximately 7,500 temporary seasonal workers annually[22].

Colonialism & Agriculture

This report addresses food self-reliance based on the agricultural capacity in the Okanagan bioregion. While agriculture is a foundational component of settler society, it is not central to the traditional foodways of the Syilx Okanagan and Secwépemc Peoples[23]. However, some Indigenous cultures have, and continue to, engage in different forms of food cultivation, there is a strong tension between agricultural-based food systems and traditional, Indigenous foodways.

It must be acknowledged that agriculture has been used as a colonial instrument to dispossess Indigenous people of their land throughout Canada's history[24]. At the same time, extractive colonial economies, including agriculture, have stripped much of the lands and waters accessible to Indigenous Peoples of their ecological integrity and productive capacity.

Indigenous food sovereignty—the rights of Indigenous Peoples to determine and practice the foodways that best support the physical and spiritual health of their communities—is critical to reconciling Canada's colonial legacy. This is in line with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as stated in Article 20: *"Indigenous peoples have the right to maintain and develop their political, economic and social systems or institutions, to be secure in the enjoyment of their own means of subsistence and development, and to engage freely in all their traditional and other economic activities. Indigenous peoples deprived of their means of subsistence and development are entitled to just and fair redress"*[25].

Indigenous food sovereignty is critical to advancing a food system that is nourishing for all people. Recognizing the colonial role of agriculture and working toward a sustainable future where both settler and Indigenous communities can practice their chosen foodways, including hunting, fishing and gathering, is key to moving forward.

Food System Modelling

The food system and its outcomes are influenced by many overlapping forces and trends, including population growth, land use, shifting diets, consumer preferences, market forces, political will, and climate change. The decisions we make today and how we react to changing circumstances will have an impact on our future food systems. This project highlights the opportunity of regional food system development in the Okanagan, while also demonstrating the trade-offs embedded in our food system decisions. The objective is to inform data-driven conversations around the trajectory of food system development by imagining alternative futures that may be overlooked in the current economic and political environment in B.C.

This is the second study of its kind, following the Southwest B.C. Bioregion Food System Design Project, completed in 2016[26].

A series of research briefs accompanying this report provide additional information on the following topics:

- Food self-reliance modelling
- Water supply and demand
- Impacts of agriculture on wildlife and biodiversity
- Impacts of agriculture on carbon stocks
- Economic impacts of regional food systems
- Social capital and regional food systems
- Regional food value chain development
- Nutrient management
- Food system policy

The Food System Model

This project uses computational models to assess food system outcomes. There are three models that collectively generate the food self-reliance, environmental and economic data:

- A **food self-reliance model** estimates the percentage of the bioregional food need that can be satisfied by local crop and livestock production
- An **environmental conservation model** measures the impacts of agriculture on habitat quality
- An **economic input-output model** assesses the economic potential associated with different food system scenarios

The data produced by these models are not predictive. Model outputs are best used to compare between scenarios to understand trends and relative impacts, rather than describe definitive outcomes. The models operate with the following key conditions, or assumptions:

- Crop and livestock production take place on land in the Agricultural Land Reserve (ALR), with the exception of cattle grazing, which can take place on suitable grazing land outside of the ALR
- People in the bioregion choose local food whenever available
- Food produced locally first goes to feed the local population before being exported
- For all regionalized scenarios, feed grain and silage for livestock are imported and therefore not produced in the bioregion
- Economic conditions are similar to 2016

Calculating Food Need

Despite a widespread interest in dietary habits and food self-reliance, there is no data that thoroughly tracks food consumption patterns in B.C. or Canada. This project estimated food need for a “typical” diet in Canada by combining two datasets. The first tracks the stocks and flows of food commodities across the country, and is used as a proxy for Canadian food preferences. The second provides nutrition recommendations to the Canadian public by age and sex. Our method assumes that residents continue to eat foods that cannot be grown locally (e.g., mango) and eat fresh foods out of their season of local availability (e.g., fresh strawberries in January). The foods modelled included:

Fruits and Vegetables

Apple, canned	Blueberry, canned	Corn, fresh	Mushroom, fresh	Potato, sweet, fresh
Apple, dried	Blueberry, fresh	Corn, frozen	Onion, fresh	Potato, white, fresh
Apple, fresh	Blueberry, frozen	Cranberry, fresh	Orange, fresh	Pumpkin and squash, fresh
Apple, frozen	Broccoli, fresh	Cucumber, fresh	Orange, juice	Radish, fresh
Apple, juice	Broccoli, frozen	Date, fresh	Papaya, fresh	Raspberry, frozen
Apple, pie filling	Brussel sprouts, fresh	Fig, fresh	Pea, canned	Rutabaga, fresh
Apple, sauce	Brussel sprouts, frozen	Grape, fresh	Pea, fresh	Shallot, fresh
Apricot, canned	Cabbage, fresh	Grape, juice	Pea, frozen	Spinach, frozen
Apricot, fresh	Carrot, canned	Grapefruit, fresh	Peach, canned	Strawberry, canned
Asparagus, canned	Carrot, fresh	Grapefruit, juice	Peach, fresh	Strawberry, fresh
Asparagus, fresh	Carrot, frozen	Guava, fresh	Pear, canned	Strawberry, frozen
Avocado, fresh	Cauliflower, fresh	Lemon, fresh	Pear, fresh	Tomato, canned
Banana, fresh	Cauliflower, frozen	Lemon, juice	Pepper, fresh	Tomato, fresh
Bean, green, canned	Celery, fresh	Lettuce, fresh	Pineapple, canned	Tomato, juice
Bean, green, fresh	Cherry, fresh	Lime, fresh	Pineapple, fresh	Tomato, pulp, paste, puree
Bean, green, frozen	Cherry, frozen	Mango, fresh	Pineapple, juice	Turnip, fresh
Beet, canned	Coconut, fresh	Manioc, fresh	Plum, fresh	
Beet, fresh	Corn, canned	Mushroom, canned	Potato, frozen	

Meat and Alternatives	Milk and Alternatives	Fat and Oils	Grains
Bean, canned	Buttermilk	Butter	Barley
Beef	Buttermilk, powder	Margarine	Corn flour and meal
Chicken	Cheese, cheddar	Salad oils	Oats
Egg	Cheese, cottage	Shortening	Rice
Mutton and lamb	Cheese, processed		Rye
Peanut	Cheese, variety		Wheat
Pork	Chocolate milk		
Turkey	Milk, partly skimmed 1%		
	Milk, partly skimmed 2%		
	Milk, skim		
	Milk, skim, concentrated		
	Milk, skim, powder		
	Milk, standard 3.25%		
	Milk, whole, concentrated		

Scenarios & Indicators

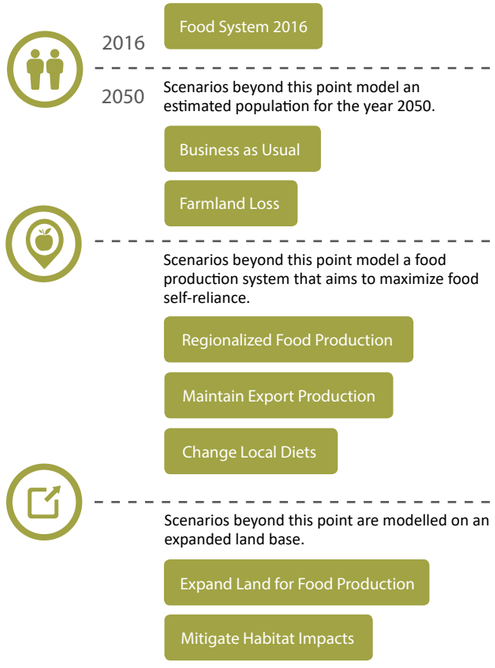
This project models a series of future “what-if” scenarios to explore the potential of regional food system development in the Okanagan bioregion. Each scenario reports a suite of indicators to illustrate the outcomes and trade-offs associated with food system trends and decisions.

Food System Scenarios

This project models eight unique food system scenarios. The first scenario (Food System 2016) models the existing food system conditions in 2016. This presents a picture of the current food system, and acts as a baseline against which other scenarios can be compared.

By 2050, population growth and climate change will have an impact on the Okanagan's food system. How these, and other changes, shape the food system in the bioregion over the next 30 years, and beyond is still unknown. Today's decisions and actions will have significant effects on how the food system takes shape along with its social, ecological and economic outcomes. The "what if" scenarios for 2050 modelled in this study do not aim to predict the future, but rather explore hypothetical food system trajectories with the goal of illustrating the outcomes and trade-offs embedded in our decisions.

Scenarios at a Glance



Food System 2016 Scenario

(2016)

> *Population: 362,000 people*
> *Food need: 332,000 tonnes*
> *Land in production: 40,000 hectares*
> *Food production: 236,000 tonnes*
> *Food production system: current (2016)*

What are the current food self-reliance, environmental and economic outcomes of the Okanagan food system?

The Food System 2016 scenario uses available data from 2016 to model conditions that most closely align with the existing food system in the Okanagan bioregion, including current agricultural practices and food production.

Population Growth in the Okanagan

The population in the bioregion is estimated to increase to 517,000 by the year 2050[27]. The Regional District of Central Okanagan (RDCO) is currently the most populous region in the Okanagan, and the area where the most population growth is anticipated. The population in the RDCO is projected to increase by approximately 60%. Population in the Regional District of North Okanagan and the Regional District of Okanagan-Similkameen are estimated to increase by 30% and 20%, respectively.

Business as Usual Scenario

(Business as Usual)

> *Population: 517,000 people*
> *Food need: 479,000 tonnes*
> *Land in production: 40,000 hectares*
> *Food production: 236,000 tonnes*
> *Food production system: current (2016)*

The population in the bioregion is expected to increase by approximately 40% by the year 2050. What if the local population and food need increases, but there is no change to the amount or types of food produced locally?

This scenario explores a food system in the year 2050, where the population and associated food need increases while the agriculture sector in the bioregion remains as it is in 2016. In this scenario, there is no change in the types or quantities of food produced, or the amount of land used for food production.

Farmland Loss Scenario

(Farmland Loss)

> *Population: 517,000 people*
> *Food need: 479,000 tonnes*
> *Land in production: 32,000 hectares*
> *Food production: 189,000 tonnes*
> *Food production system: current (2016)*

Population growth, farmland prices, and climate change will continue to have an impact on the availability and use of farmland in the bioregion into the future. What if we do not protect and utilize this resource?

How different factors might individually or collectively impact the availability and accessibility of land for food production in 2050 is uncertain. To illustrate the food system impacts of farmland loss, this scenario models a 20% (8,000 hectare) reduction in the land area available to produce food in 2050, relative to the 2016 scenario.

Farmland Price, Use and Access

The affordability of farmland has implications for the region's capacity to produce food. While B.C.'s Agricultural Land Reserve (ALR) aims to protect farmland by regulating land use activities, protection alone is not sufficient to ensure its use for agriculture[28,29]. Currently, approximately 50% of land protected in the ALR is not used for food production[30]. While some of this land is natural, a significant portion is used for non-farming activities such as rural estate development or golf courses.

The high cost of farmland is seen as one of the key contributors to its use for non-farming purposes, particularly in areas close to urban centres. In these regions, a combination of land use competition, fiscal policies and speculative ownership can exert upward price pressures on farmland[31]. As land prices increase beyond the means of farmers, it is effectively removed from the land base available for food production.

In 2019, Farm Credit Canada reported farmland prices in the Okanagan as high as $103,000/acre[32], the most expensive in the province. Farmland prices in B.C. have increased an average of 10% annually between 2009 and 2017[33]. Over the same period, farmer incomes in many sectors have remained relatively constant at levels that are often insufficient to support families and carry the large mortgages required to purchase land. For example, the net operating income for fruit and nut farms in B.C. over this period of time ranged from approximately $17,000 to $60,000 annually[34].

Ensuring the next generation of farmers can access land is critical to supporting the long term viability of agriculture in B.C. In the Okanagan, fewer than 9% of farmers have a written succession plan to ensure the land is farmed after their retirement[35]. While renting is often used as a strategy to address land access where prices are prohibitive, renting farmland is not a long-term solution to this challenge. Policies and programs to maintain the affordability of farmland for new entrant farmers are important measures to ensure the viability of agriculture into the future.

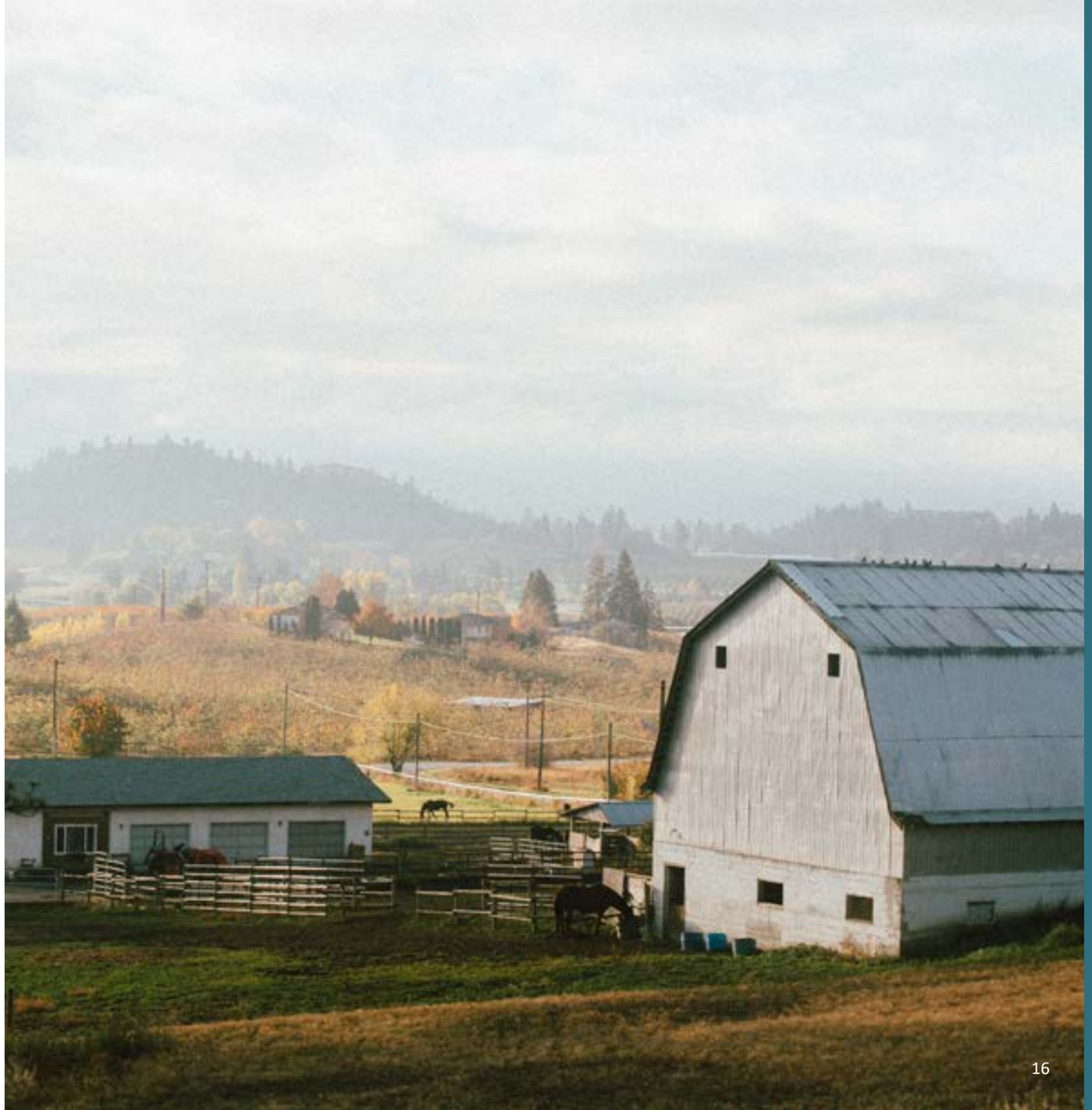
Policy Area: Supporting Farmland Access for Farmers

Maintaining Farmland Affordability:

In France, Sociétés d'Aménagement Foncier et d'Établissement Rural (SAFER) are regional agencies, composed of local and national governments, farmer's organizations, and financial cooperatives that support rural economic development and farmland protection. SAFERs have the pre-emptive right to buy farmland on the market in order to resell it to interested farmers. They can also suggest a lower price if the asking price is judged to be higher than market value for agricultural use[36].

Facilitating Land Access for Farmers:

The Toronto Region Conservation Authority (TRCA) has partnered with community non-profits and farms to establish and support four farms on public lands, facilitating both access to land for urban growers and farmer training. The farms range from 3-15 ha and host education and training programs as well as produce vegetables for sale to the local community[37]. Systemic inequities that disproportionately present land access barriers for racialized and Indigenous communities are central considerations in this area.



Regionalized Food Production Scenario
(Regionalized)

Population: 517,000 people
Food need: 479,000 tonnes
Land in production: 40,000 hectares
Food production: 302,000 tonnes
Food production system: regionalized

In 2016, over 230,000 tonnes of food was imported to meet local food needs. What if local food production shifted to better meet the food needs and preferences of the local population?

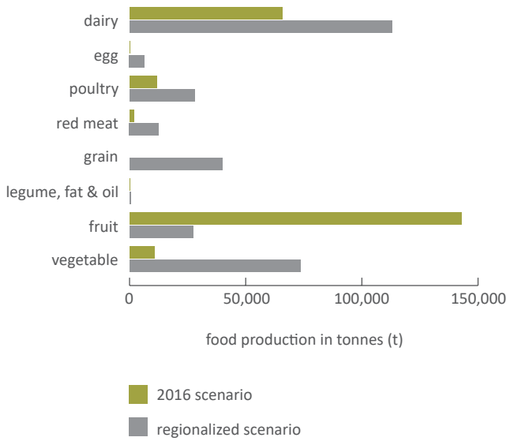
This scenario explores the outcomes of shifting to a mix of crop and livestock production in the bioregion that best meets local food needs. A regionalized food production system aims to first and foremost satisfy the dietary needs and preferences of the local population. In this scenario, land dedicated to crops currently produced for export, such as tree fruit, is reduced to increase production of foods to satisfy local food need. The total land base available for food production remains the same as in 2016.

Scenarios that model a regionalized food system assume that food processing, storage and distribution capacity exist in the bioregion to deliver locally produced food to local consumers.

Feeding the Okanagan with Regionalized Food Production

A regionalized food production system aims to produce a mix of crop and livestock to most efficiently meet local food needs on the available agricultural land base. With a shift to regionalized food production in 2050, there is an increase in production across all food types, with the exception of fruit. Fruit production, which is primarily for export, decreases by 80%. Food system modelling does not consider wine grapes to be a food crop. Therefore the area dedicated to wine grape production is reallocated to food production for local consumption.

Total Food Production in 2016 and Regionalized Scenarios



Maintain Export Production Scenario
(Mantain Exports)

Population: 517,000 people
Food need: 479,000 tonnes
Land in food production: 40,000 hectares
Food production: 373,000 tonnes
Food production system: regionalized

Apple, sweet cherry and wine grape are significant production sectors in the Okanagan. What if the production of these fruit crops was maintained while the bioregion shifts to regionalized food production?

Tree fruit and wine grape production is important to the regional identity and economy in the Okanagan, which is one of the few regions in Canada well suited for the production of these crops. In 2016, apple, sweet cherry and wine grape production accounted for 8,580 ha of cultivated area (21% of the total cultivated area). Currently, most of what is produced locally is exported from the bioregion or used in the production of wine and other beverages that do not contribute to food self-reliance. This scenario explores the outcomes of a 2050 regionalized food system if the area dedicated to apple, sweet cherry and wine grape production were maintained at 2016 levels.

Change Local Diets Scenario
(Change Diets)

Population: 517,000 people
Food need: 440,000 tonnes
Land in food production: 40,000 hectares
Food production: 226,000 tonnes
Food production system: regionalized

Assuming food production continues to prioritize local food need, what if people living in the bioregion adopt more environmentally sustainable diets?

There is growing consumer awareness about the health and environmental impacts of the types of food we eat. This is signaled by the increased popularity of plant-based diets, emerging markets for alternative protein products, as well as recent changes to dietary recommendations in Canada's Food Guide[38].

This scenario compares the baseline diet, used for all other scenarios, with an alternative diet that decreases the consumption of livestock products (dairy, eggs, meat). This "Planetary Health Diet" is based on the work of the EAT Lancet Commission, and is designed to meet global human and environmental health targets. Dietary recommendations in the new Canada Food Guide closely resemble the Planetary Health Diet modelled by the EAT Lancet Commission[39].

Comparing Different Diets

Baseline Diet

This diet is based on two sources of information, the old Canada Food Guide (prior to 2019) and the "Food Available in Canada" dataset from Statistics Canada. The Food Guide provides nutrition recommendations by age and sex to determine dietary needs. The Statistics Canada dataset tracks stocks and flows of food commodities in Canada and is used as a proxy for Canadian food preferences[40]. With the exception of the change diets scenario, all scenarios model a baseline diet.

Planetary Health Diet

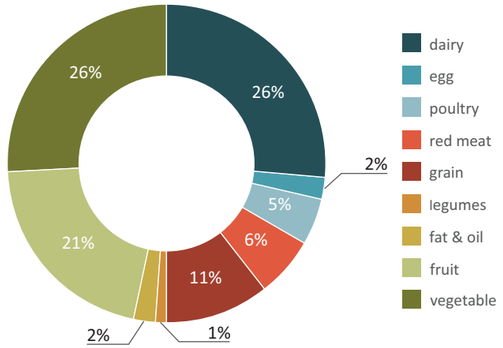
This diet is based on the EAT Lancet Commission's Planetary Health Diet, created to optimize human health and environmental sustainability. This diet prioritizes plant-based foods, consisting primarily of a diversity of vegetables, fruits, whole grains, legumes, nuts and seeds. Animal proteins, saturated fats, refined grains, highly processed foods and added sugars are limited[41].

Diet Choice

It is important to note shifting diets is not only a matter of personal choice or consumer preference. Health, financial, or cultural factors influence the adoption of alternative diets. For example, alternative protein sources promoted by the Planetary Health Diet may not be affordable, available, or culturally appropriate to all people.

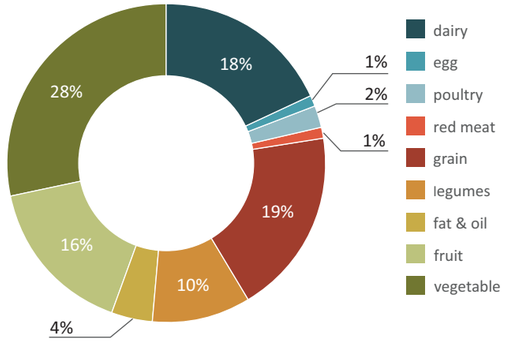
Baseline Diet Composition

Percentage of diet satisfied by different food groups.



Planetary Health Diet Composition

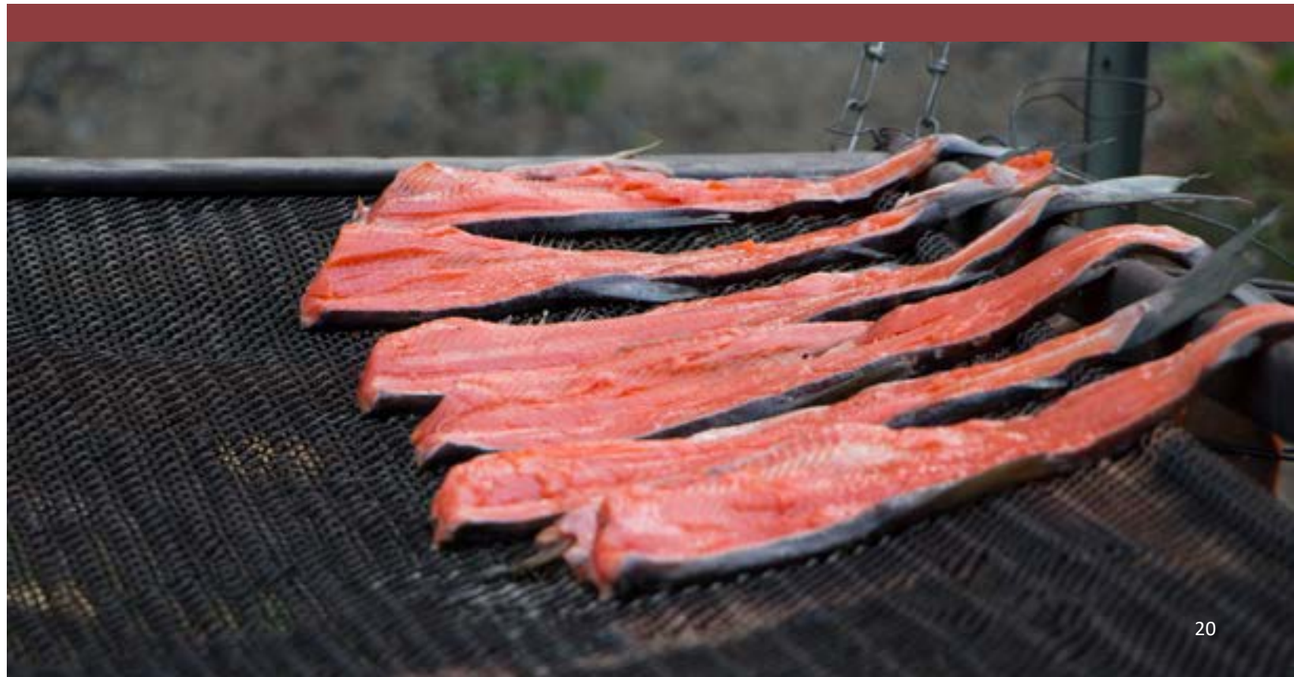
Percentage diet satisfied by different food groups.



Syilx Diet Change and Health

Prior to contact with European settlers, the Syilx Okanagan People enjoyed a diet rich in wild and foraged foods including an abundance of salmon and game, berries, plants, and nourishing roots. *N'titx*^{w} (salmon) is one of the four food chiefs of the Syilx Okanagan People and is central to their culture. Prior to colonization, *n'titx*^{w} was a dietary staple and prized trade good with Indigenous tribes from as far away as the Prairies. Colonial policies and practices stripped Syilx Okanagan Peoples of access to much of their traditional lands and severely restricted the ability of Indigenous communities to hunt, fish and gather traditional foods. These same colonial policies and practices also degraded ecosystems and reduced the abundance of Indigenous foods to the point of causing the near extinction of the salmon runs that had supported the Syilx Okanagan for time immemorial. The shift to Western diets, high in ultra-processed foods with sugar, fats, and salt, have resulted in poor health outcomes for Indigenous Peoples in the Okanagan bioregion and across Canada[42,43].

Leadership from the Okanagan Nation Alliance has resulted in the restoration of *n'titx*^{w} in the Okanagan River system. There has also been a reintroduction of a local food fishery to improve health outcomes for Nation members as well as revive important cultural practices[44]. Encouragingly, recent research conducted in Syilx Okanagan communities suggests that consuming even a modest amount of traditional foods can improve the overall diet quality of individuals[45].



Expand Land for Food Production Scenario
(Expand Land)

> *Population: 517,000 people*
> *Food need: 479,000 tonnes*
> *Land in production: 70,000 hectares*
> *Food production: 361,000 tonnes*
> *Food production system: regionalized*

Only a portion of the bioregion's agricultural land is currently used to grow food. What if food production expands to all areas suitable for agriculture?

This scenario expands food production onto all land suitable for agriculture in the bioregion, increasing the cultivated land base by approximately 30,000 ha. Agricultural production in the Okanagan is dependent on access to irrigation water. To highlight this constraint, the expansion of agricultural production is limited to ALR land that is reasonably close to a water supply. While this scenario illustrates some land-based constraints to agricultural expansion, the availability of water and the maintenance of ecological flows must be carefully considered in the Okanagan's food system future.

Mitigate Habitat Impacts Scenario
(Mitigate Impacts)

> *Population: 517,000 people*
> *Food need: 479,000 tonnes*
> *Land in production: 57,000 hectares*
> *Food production: 296,000 tonnes*
> *Food production system: regionalized*

Agriculture can have negative impacts on wildlife habitats. What if efforts are made to prioritize habitat protection when expanding land for food production?

Much of the agricultural land in the Okanagan not in production is natural grass, shrub, or forested land. These lands are critical to the health of plants, animals, ecosystems and Indigenous foodways. Agriculture has been a primary driver of habitat loss and degradation[46].

This scenario explores the potential to mitigate some of the habitat related impacts associated with agricultural expansion by protecting critical habitats, and implementing on-farm habitat enhancements such as hedgerows and riparian buffers.

Assumptions for Determining Irrigation Access

The availability of water and the maintenance of ecological flows must be carefully considered in the Okangan's food system future. Hypothetical access to irrigation for the Expand Land and Mitigate Impacts scenarios was determined according to criteria adopted from the Provincial Agricultural Water Demand Model irrigation build out[47]. For these scenarios, agricultural production was expanded to include land in the ALR under 750m in elevation and within 2km of a water supplier or within 5km of a major lake. Proximity to a water source does not mean that there will be sufficient available water at the source to satisfy demand and maintain the integrity of freshwater ecosystems. In fact, the majority of streams in the Okanagan are fully allocated, and water suppliers have limited capacity to supply additional agricultural land[48,49].

Species at Risk in the Okanagan

The dry pine forests and low-elevation grasslands of the Okanagan bioregion are among the most endangered ecosystems in Canada. These endangered ecosystems are often located in the same productive, rich valley bottoms where human activities, including agriculture, take place. The bioregion is home to more endangered, threatened, and rare amphibians, birds and mammals than any other part of B.C. This includes 30% and 46% of the province's red-listed and blue-listed species at risk, respectively[50]. Among these species at risk are the tiger salamander, great basin spadefoot toad, western rattlesnake, American white pelican, burrowing owl, sage thrasher, pallid bat, badger, grizzly bear, wolverine, and California bighorn sheep. Many of these species exist nowhere else in the world.

Protecting sensitive habitats from degradation is the most effective way to protect biodiversity and species at risk. It is often the reserve lands of Syilx Okanagan communities that have retained the highest concentrations of species at risk in the bioregion. This can be credited to limited agriculture on those lands, and the preservation of critical habitats that help support traditional Indigenous foodways.

Food System Indicators

Food system indicators illustrate the relative impact of changing important variables such as land available for food production, population size, diet, or habitat protection measures. Throughout this report, indicator values are presented and compared between scenarios to highlight food system outcomes and trade-offs.

Indicators at a Glance

Food Self-Reliance & Consumption Indicators

- Food Self-Reliance
- Food Imports
- Ecological Footprint of Food Consumed

Agriculture & Environment Indicators

- Greenhouse Gas Emissions from Agriculture
- Crop Nutrient Need & Nutrient Availability
- Agricultural Water Requirements

Habitat & Carbon Stock Indicators

- Wildlife Habitat Capacity
- Habitat Connectivity
- Carbon Stocks

Economic & Employment Indicators

- Gross Domestic Product
- Tax Revenue
- Employment Income
- Jobs

Food Self-Reliance & Consumption Indicators

Food Self-Reliance

Measures the proportion of the population's diet that could be satisfied by locally produced food. To measure food self-reliance for this project, it is assumed that all food produced in the bioregion first goes to satisfy bioregional need. Food need is based on a diet that satisfies average Canadian food preferences and Canada's Food Guide recommendations. Food self-reliance is limited to land-based food components of the diet only; fish and seafood, as well as beverages, are excluded.

Food Imports

Measures the commodity weight (tonnes) of crop and livestock products that are imported to the Okanagan bioregion to meet local food need not satisfied by local production.

Ecological Footprint

Measures the area of biologically productive land and sea (biocapacity), in global hectares (gha), required to meet the population's food need and to absorb associated carbon emissions. This includes all of the food consumed; foods grown locally, and food imported from outside the bioregion. Both the total and per capita ecological footprint for food consumed in the bioregion are reported.

Distinguishing Between Food Self-Reliance and Food Security

In this study, food self-reliance is represented as the proportion of the Okanagan population's diet that could be satisfied by bioregionally produced food. It compares the quantity and types of food produced in the bioregion to the dietary requirements of the local population. In this context, it is used as a proxy for food system regionalization, and represents the potential food self-reliance for the bioregion.

Increasing food self-reliance depends on a number of factors beyond agriculture. Land must be available for food production, and there must be infrastructure to process, store and distribute food. Achieving local food self-reliance also requires sufficient skilled labour and is highly dependent on the management of important resources such as water, nutrients and waste. Ecological integrity is therefore critically linked to a region's food self-reliance potential. Of note, this study does not include the potential of the wild and foraged foods that are at the core of Indigenous foodways. This is an area where more work is required through a collaborative approach with Indigenous communities.

Local governments have been increasingly interested in strengthening food self-reliance as a way to improve local food system outcomes. While food self-reliance estimations can help understand the potential of regional food systems, it is not a proxy for food security. Increasing the availability of local food does not ensure food access for all people. In B.C. and across Canada, poverty and financial barriers to food at the household level are the most prevalent causes of food insecurity[51]. Food security is also impacted by issues such as housing costs and income inequalities[52,53]. Pursuing food self-reliance must therefore be done in tandem with efforts to address socio-economic disparities through focused policy efforts.

Agriculture & Environment Indicators

Greenhouse Gas Emissions from Agriculture

Measures the amount (tonnes) of carbon dioxide equivalents (CO_2e), of three major greenhouse gases (carbon dioxide, nitrous oxide, and methane) from agricultural production in the bioregion. It includes emissions from on-farm fossil fuel use, fertilizer applications for crop production, manure management, and enteric fermentation (digestion) in ruminant livestock.

Crop Nutrient Need

Reports the quantity (tonnes) of nitrogen (N) phosphorus (P) and potassium (K) that need to be added to the soil, through either fertilizers or natural processes, to restore the nutrients removed through crop production in the bioregion.

Nutrient Availability

Reports the quantity (tonnes) of N, P and K contained in organic waste streams in the bioregion that could be recycled to meet crop nutrient needs. Organic waste streams include a variety of waste sources such as livestock manure, food waste, food processing waste, human excreta, etc.

Agricultural Water Requirements

Estimates the volume of water (cubic metres) required for crop irrigation and livestock watering in the bioregion. Water requirements are estimated from the Agricultural Water Demand Model[54]. Irrigation rates assume 'typical' climatic conditions (modelled using precipitation and temperature data from 2010), and average agricultural water management practices. Agricultural water requirements do not include water used for non-production food system activities such as food processing, cooking, etc[55].

Crop Nutrient Need & Nutrient Availability Indicators

All crops require nutrients to grow. When crops are harvested, nutrients are removed from the soil. Historically, nutrients were replenished from natural processes and organic sources, such as compost or animal manures. Contemporary agriculture largely relies on synthetic fertilizers to replenish soil nutrients. These are often mined from finite resources such as phosphate rock, and potash ore, and produced with fossil fuel intensive processes. The dependence of agriculture on synthetic fertilizers from non-renewable sources is a growing sustainability concern [56,57].

Crop nutrient need and nutrient availability indicators are reported for three essential macronutrients, nitrogen (N), phosphorus (P) and potassium (K). Comparing the two indicators illustrates the potential for nutrients from organic waste streams to meet crop nutrient needs, if properly recovered and reused. Recovering nutrients from organic waste streams into agricultural systems can reduce both the potential for environmental pollution, and the dependence of agriculture on synthetic nutrient inputs from non-renewable sources.

Habitat & Carbon Stock Indicators

Wildlife Habitat Capacity

Measures the overall value of land cover to regional wildlife as habitat for feeding, breeding, and shelter. The capacity is determined based on the proportions of various types of agricultural and non-agricultural land cover and is rated on a scale of 0 (low) to 100 (high). In this project, Wildlife Habitat Capacity was measured on the ALR land base, which includes both cultivated areas and uncultivated lands with natural vegetation.

Habitat Connectivity

Measures the permeability of the landscape to wildlife. In this study, connectivity is determined by the size and distribution of isolated areas of natural habitat, or patches, in the landscape. These are areas of non-production perennial vegetation such as woodlands, mixed grasslands, hedgerows, and riparian buffers. Connectivity is measured using two values: proximity (average nearest habitat patch) and density (number of habitat patches) in representative sample areas within the bioregion.

Carbon Stocks

Measures the amount of carbon stored in aboveground woody, non-production perennial vegetation such as trees and shrubs. This represents carbon that was previously in the atmosphere that is now stored in vegetation (biomass). Carbon stored in the soil and below ground portions of perennial vegetation is not accounted for in this project. Agricultural land and pasture can also store carbon in soil through sustainable practices, however, this complex dynamic is not included in the calculated carbon stocks for this project.

Measuring Habitat Quality

The habitat value of the landscape is difficult to measure with a single metric. This study looks at two indicators to examine how well-suited the landscape mosaic is to wildlife (wildlife habitat capacity) and how well distributed and connected natural areas are throughout the region (habitat connectivity). These indicators, in combination with targeted local assessments for species of concern, can help shape the implementation of on-farm practices and critical habitat conservation to support the biodiversity of the Okanagan bioregion.

Economic & Employment Indicators

Gross Domestic Product (GDP)

Estimates the monetary value gained for all goods and services associated with primary agriculture, food processing, and other related industries. It reflects the difference between the value of final products and the value of the input or intermediate costs of production.

Tax Revenue

Estimates the value of federal, provincial, and municipal tax revenue collected from individuals and businesses involved in the bioregion's food system. Provincial and federal tax revenues include personal and corporation income taxes, PST, GST, other commodity taxes (such as gas tax), and taxes on factors of production (such as licences). Municipal tax revenues include taxes on production (such as business licences), and property taxes.

Employment Income

Measures the gross income earned by employees in primary agriculture, food processing and other related industries. This includes income earned by self-employed persons and unincorporated businesses.

Jobs

Estimates the number of full-time equivalent (FTE) jobs generated in agriculture, food processing and related food system sectors in the bioregion. The measure accounts for seasonal/temporary, part-time, and full-time positions. 1 FTE is calculated based on a full-time employee working 35 hours per week for 50 weeks (1,750 hours) per year.

Economic Analysis

This project uses the Regional Input-Output (I-O) model of British Columbia to estimate economic impacts. The I-O model categorizes economic impacts into three types:

- **Direct impacts:** measure economic activity from food production and processing.
- **Indirect impacts:** measure economic activity from supplier industries in the supply chain.
- **Induced impacts:** measure economic activity from food production and supplier industry employees spending their earnings.

Indicators report the total economic impacts, which are the sum of direct, indirect, and induced impacts. The economic impacts in this study are limited to the impacts of food commodities. For example, economic impacts of the winemaking industry are not considered beyond the production of grapes.

The Economic Impacts of Buying Local Food

In a 2018 survey of B.C. residents, 80% of respondents cited supporting the local economy as a motivation for buying local food[58]. In another recent consumer survey collecting information about food access concerns and perceptions during the first wave of the COVID-19 pandemic, B.C. residents indicated that they wished to support local producers and see more locally grown products available at an affordable price[59]. When food expenditures are dedicated to non-local businesses and imports, the majority of these dollars leave the community by the end of the business day[60]. However, when a food system is dominated by locally owned businesses, with consumers choosing local food more often, food expenditures are more readily recirculated in the local economy. For example, expenditures at a locally owned grocery store that sources local products can help support farmers in the region, who in turn support local businesses by purchasing supplies and inputs and acquiring services such as equipment repair. In this way, money can exchange hands several times within the community, increasing the economic benefit to the region. Buying local food also encourages the establishment of new food system businesses that support local food processing, distribution and retail[61].

The I-O model can help us estimate regional economic impacts of increased consumer purchase of local food. If, for example, consumers in the bioregion double the amount of spending on locally grown fresh food including fruit, vegetable, egg, meat and dairy products, this results directly in increased regional economic activities. Total regional GDP is estimated to increase by $14 million; total employment income by $9 million, and tax revenue by $2 million. In addition, 222 additional full-time equivalent jobs would be created locally.

Current Conditions

This section reports the results of the Food System 2016 scenario, which models current food system conditions, including present day agricultural practices and food system activities.

Food Self-Reliance & Consumption Indicators

Food Self-Reliance: 38%

Based on crop and livestock production, the bioregion could satisfy 38% of the dietary requirements of the local population.

Food Imports: 223,000 tonnes

To meet additional food need not satisfied by locally produced food, 223,000 tonnes of imported food were required.

Ecological Footprint: total: 470,000 gha per capita: 1.3 gha

The total ecological footprint of food consumed in 2016 is 470,000 global hectares (gha). Based on the population of the bioregion in 2016 this translates to an ecological footprint of 1.3 gha per person for food consumed.

Ecological Footprint of Food and the "Fair Earth Share"

It is estimated that 1.6 gha per person is available to meet all our resource needs: food, shelter, clothing, transportation, etc. This is known as the "Fair Earth Share". Based on our current patterns of consumption in Canada, per capita ecological footprint is 8.1 gha on average[62]. Considering other needs, it is estimated that food needs should account for approximately 25% of our total ecological footprint[63]. In the Okanagan, the ecological footprint of food currently accounts for 81% of the "Fair Earth Share". Reducing the ecological footprint associated with food, and reducing consumption in other areas, is necessary to bring our ecological footprint in closer alignment with the "Fair Earth Share".

Food Self-Reliance by Food Group

Food self-reliance is not the same for every food group. In the 2016 scenario, food self-reliance for the total diet is 38%. However, the food self-reliance for some food groups, particularly dairy and poultry, is much higher. Comparatively, the potential food self-reliance in grain, legumes and eggs show that current production is much lower than the dietary requirements of the local population.

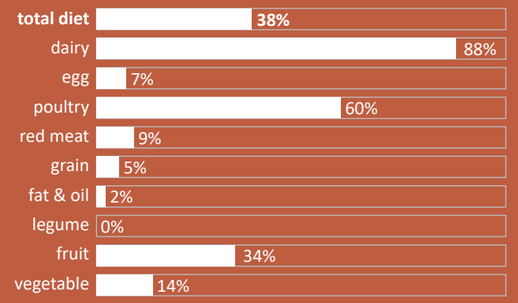
The Okanagan is a significant producer of tree fruits. In 2016, 143,000 tonnes of fruit was produced, which far exceeds the population's food need. However, potential food self-reliance for fruit was only 34%. Since local diets were modelled to reflect local consumption patterns, they include fruit that is eaten out of season as well as fruit that cannot be produced in the bioregion (e.g. tropical fruit and citrus).

When food production is regionalized to meet local food need, food self-reliance for the total diet increases to 69%, but food self-reliance does not increase equally across all food groups. Even with a larger population, the bioregion could reach 100% food self-reliance in eggs and poultry and increase food self-reliance in dairy to 92%. It is important to note that high levels of food self-reliance for animal products rely on imported feed grain for livestock.

In the regionalized scenario food self-reliance for fruit increased from 34% in 2016 to 37%. For vegetables food self-reliance increases from 14% in 2016 to 68%. While these foods can be grown efficiently in the bioregion the level of food self-reliance depends on the dietary preferences of the local population. As long as people in the bioregion continue to consume fresh fruits and vegetables during winter months, and foods that cannot be grown in the bioregion, it is not possible to further increase food self-reliance for these food groups.

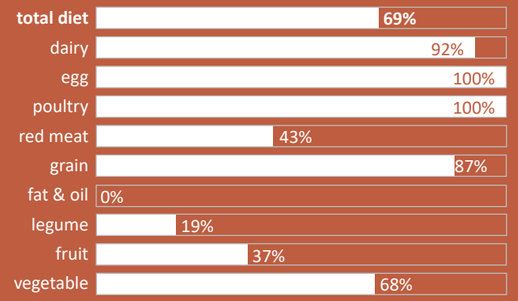
Food Self-Reliance for the Okanagan in 2016

Percentage of local diets satisfied by locally produced food.



Food Self-Reliance for a Regionalized Food System in the Okanagan in 2050

Percentage of local diets satisfied by locally produced food.



Climate Change and the Food System

The impacts of climate change are already being felt in the Okanagan bioregion. Three of the most severe wildfire seasons (2003, 2017, 2018) have taken place in the past 13 years[64]. The year 2017 also brought severe flooding to Kalamalka Lake, while flooding in Okanagan Lake and its tributaries are occurring year after year[65]. By the 2050's, climate change in the bioregion is expected to bring;

Warmer temperatures year round: While temperatures are expected to increase year round, summer and fall temperatures are increasing faster than other seasons.

Hotter summers: The number of days per year with temperatures of 30°C or more is expected to increase by more than three times, from a regional average of 6 to 22 days.

Warmer winters and less snowfall: The average number of days per year where temperatures remain below 0°C is expected to decrease from 73 to 44. Warmer winter temperatures are expected to reduce winter snowpack.

Less summer precipitation: While the average annual precipitation is expected to increase, the majority of this increase will occur during spring and fall. Summers are expected to become drier.

More frequent extreme events: Increased instances of wildfires, droughts, floods and landslides are expected as the region experiences more intense cold season rain events, reduced summer precipitation and increased summer temperatures.

Climate change presents significant challenges for agriculture in the bioregion. These include increasing water demand, reduced water supply, changing crop suitability, changes in pest species and pest population dynamics, droughts, floods, heat stress, etc. While climate change is expected to increase the length of the growing season and can present opportunities for certain crops, the combined impact of these climatic changes will also challenge the productivity and viability of the sector. Recognizing and accounting for climatic shifts will be critical for food system planning into the 21st century.

Policy Area: Climate Change Mitigation in the Food System

Provide Support for Regenerative Agriculture:

Park City, Utah has identified regeneration as one of four priority areas in local climate and sustainability planning, with a focus on increasing carbon sequestration in agricultural soils and protected open space. In 2018, the City began to explore the use of regenerative agriculture* practices on city-owned land to increase carbon capture potential in soils and help address local greenhouse gas emission reduction targets[66]. They have introduced cattle and rotational grazing to control noxious weeds, restore soil and improve ecosystem health.

Invest in Waste-to-Energy Infrastructure Development:

A waste to energy plant in the City of Surrey, built in 2014 has the capacity to process 115,000 tonnes of organic waste annually[67]. The facility is the largest of its kind in North America and has the potential to advance waste diversion objectives in Metro Vancouver's Integrated Solid Waste and Resource Management Plan. The facility processes organic waste into renewable natural gas and compost that is available for purchase for residential and agricultural applications.

**Regenerative agriculture aims to improve soil health, sequester carbon, increase biodiversity and reduce dependence on external inputs. This includes farming practices such as reduced tillage, integrated livestock, cover cropping, and biologically-based pest management.*

Agriculture & Environment Indicators

Greenhouse Gas Emissions from Agriculture: 113,000 tonnes of CO_2e

In 2016, agriculture in the bioregion produced a total of 113,000 tonnes of CO_2e. The total emissions produced from agriculture in the bioregion represent approximatley 5% of B.C.'s total greenhouse gas emissions from agriculture for 2016[68].

Crop Nutrient Need: 10,800 tonnes Nutrient Availability: 14,100 tonnes

Nutrients available in organic waste streams, such as manure, food waste, and human excreta, are greater than crop nutrient needs for N, P and K. Recovering these nutrients for crop production in the bioregion could reduce the risk of environmental pollution while also reducing the dependence on synthetic fertilizer inputs. However, the ability to recycle nutrients from organic waste streams depends on available technology and recovery processes, which will always be less than 100% efficient.

Agricultural Water Requirements: 225 million m^3

An estimated 225 million m^3 of water is required for agriculture in the bioregion. Irrigated forage crop production required the most water, accounting for approximately 60% of total agricultural water need.

Habitat & Carbon Stock Indicators

Wildlife Habitat Capacity: 72/100 (High)

The high wildlife habitat capacity rating for the Okanagan is reflective of the relatively large proportion of natural lands, such as woodlands and grasslands, within the Agricultural Land Reserve.

Habitat Connectivity: density: 11,935, proximity: 149m

Accessible, connected natural habitats allow for wildlife to more safely live on and move through farmland. Across the agricultural landscape there are 11,935 habitat patches, or "islands" of natural habitat. Wildlife must traverse an average of 149 metres without the safety of cover between patches. While the impacts of this degree of fragmentation and natural habitat distribution are location and species dependent, their values can be used to estimate habitat quality impacts in future scenarios.

Carbon Stocks: 3.7 million tonnes

Non-production, perennial, woody vegetation accounts for 3.7 million tonnes of stored carbon in the bioregion. This amount of stored carbon is equivalent to the emissions generated from driving 2.9 million cars for a year[69].

Grassland Carbon Storage

This study does not measure the carbon capture potential in soil, grasses and other herbaceous vegetation and therefore underestimates total carbon stores in the bioregion. The majority of grasslands in B.C. are found in the southern interior of the province, including the Okanagan bioregion. Grasslands are known as one of the landscapes with the highest potential to store carbon, most of which is stored below ground in plant roots and soil. Global assessments have found that grassland ecosystems store over 30% of the global stock of carbon found in terrestrial ecosystems[70]. These ecosystems have the potential to act as a long term carbon sink, that under proper management, could contribute significantly to climate change mitigation.

Economic & Employment Indicators

Gross Domestic Product: $134 million

Total GDP impact generated from food production and related goods and services in 2016 is $134 million. Of this, food production contributes $112 million (direct impact), all supplier industries generate $20 million (indirect impact), and employees in the food system and related industries contribute $2 million (induced impact) by spending their earnings in the Okanagan bioregion.

Tax Revenue: $17 million

Food production and related industries in the Okanagan generated a total tax revenue of $17 million. Of this, $9 million was distributed to the federal government, $5 million to the provincial government and $3 million to local governments.

Employment Income: $84 million

Total Employment income earned through wages and salaries from food production and related goods and services in 2016 is $84 million.

Jobs: 2,303 FTE

Food production and related goods and services generate 2,303 full time equivalent (FTE) jobs in 2016. Of these local jobs, 83% are in primary agriculture (crop and livestock production), 14% are in food processing, and 3% are in other related industries.

Connecting Regional Food Systems

The post-production sector, including food aggregation, processing and distribution, is critical for realizing the food self-reliance and economic outcomes associated with regionalized food production. This sector includes the people, infrastructure and networks that transform raw agricultural products into saleable, consumable goods, and transports food from field to fork[71].

Policy and regulatory environments developed to support global-industrial supply chains have created barriers to the development of regional post-production businesses and infrastructure. For example, current national and international trade agreements and obligations are often in direct opposition of efforts to regionalize food systems, particularly when it comes to food processing, distribution and institutional procurement[72,73]. Industrial land use competition in urban and near urban areas, land use planning and zoning can also restrict the development of regional post-production businesses and infrastructure.

As demand for locally grown food increases, new models are emerging to facilitate food aggregation, processing, and distribution within regions. These models are redefining producer-consumer relationships and have the potential to address local economic development, increase market access to small and mid-scale producers, develop trust between supply chain actors, and address food access challenges in communities.

To better understand what a regionally scaled post-production sector in the Okanagan could look like, this research included an evaluation of the characteristics of business and infrastructure types in regional food supply chains. The study revealed that the solutions are not purely market-driven. At the local level, there is a need for comprehensive policy reform that removes existing regulatory barriers to create supportive environments for the post-production sector. There is also a need for greater coordination and policy alignment across local, provincial and federal jurisdictions.

Policy Area: Support for a Regional Post-production Sector

Zoning for Post-production Infrastructure:

Conditional zoning in Granville County, North Carolina was established to allow for agriculturally related activities not considered bona fide farming in the rural buffer zone[74]. This includes agricultural processing, cold storage facilities, farmers markets, farm stands, microbreweries, wineries, and community and regional meat processing facilities. In this case, zoning decisions are made on a case-by-case basis to ensure that proposals meet zoning standards and support agriculture in the region.

Municipal Support for the Post-production Sector:

The Montpellier Market of National Interest (MIN) emerged from Montpellier Métropole's (France) food and agroecology policy[75]. The innovative food processing, distribution and networking hub was developed on city-owned land. The facility houses a number of processing businesses and supports sustainable agriculture and local supply chains in the region.

2050 Scenario Outcomes

Scenarios provide information to support dialogue and decision making. Future “what - if” scenarios explore the potential of a regional food system in the Okanagan. Indicator values can be used to compare food self-reliance, environmental and economic outcomes across each of these scenarios.

Food Self-Reliance & Imports

Food self-reliance is impacted by the population size, land area, and the mix of crop and livestock production in the bioregion. It is worth noting that for most of the 10,000+ year history of human activity in this bioregion, the Indigenous Peoples of these lands were food self-reliant and that this has changed only in the past century since colonization.

Comparing the 2016 and Business as Usual scenarios illustrates how a growing population can impact food self-reliance. With the current mix of crop and livestock production, food self-reliance decreases from 38% in 2016 to 33% as the population increases in the Business as Usual scenario. At the same time, the associated dependence on food imports increases to meet local food need.

With a 2050 population, the Farmland Loss scenario illustrates that a 20% reduction in the amount of land available to be used for food production decreases food self-reliance to 28% and further increases reliance on imports.

Changing the mix of crops and livestock grown in the bioregion to prioritize local food need can substantially increase food self-reliance. This is demonstrated in the Regionalized scenario. Scenarios with regionalized food production have approximately twice the food self-reliance potential as those that model the existing crop and livestock mix.

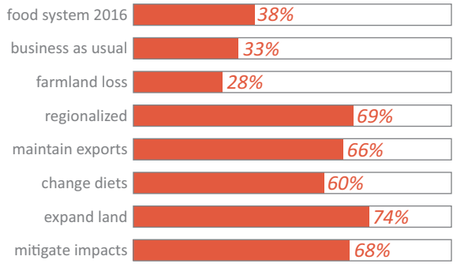
The area dedicated to producing tree fruit crops for export (sweet cherry, apple and wine grape) has a relatively small impact on food self-reliance. The Maintain Exports scenario illustrates that maintaining these export production sectors at 2016 levels only reduces food self-reliance by 3%, relative to the Regionalized scenario.

The Expand Land scenario highlights that there is sufficient agricultural land in the Okanagan to reach 74% food self-reliance, which approaches the theoretical maximum level of food self-reliance for the bioregion based on the current diet. Attaining this level of food self-reliance requires both a shift to regionalized food production and putting additional agricultural land into production.

The Mitigate Impacts scenario shows a small decrease in food self-reliance from the Expand Land scenario as land is removed from production to protect critical habitat and establish on-farm habitat protection measures. This illustrates the potential trade-offs between food self-reliance and wildlife protection.

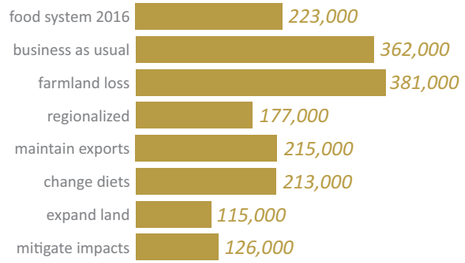
Food Self-Reliance for Total Diet

Percentage of local diet satisfied by locally produced food.



Food Imports

Tonnes (t) of food imported to satisfy local food need.



Maximum Food Self-Reliance

The maximum potential food self-reliance for the bioregion is calculated to be 77% based on the current diet and available land. Maximum food self-reliance will always be less than 100% as long as the population's dietary preferences include food that must be imported, such as out-of-season foods and foods that cannot be produced in the bioregion. In the Okanagan, food self-reliance may also be impacted by irrigation access and water availability. Achieving maximum food self-reliance would require use of lands beyond reasonable irrigation access and increase water demand and increase agricultural water demand to 466 million cubic metres annually.

Out of Sight, Out of Mind

Understanding externalized food system costs

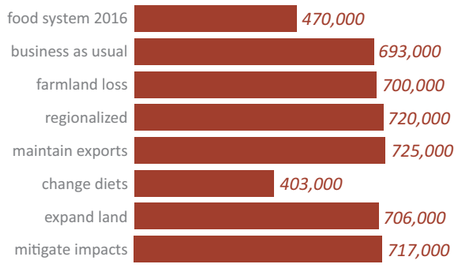
There are costs associated with all food system activities. Some costs are obvious and factored into food prices, such as expenses for agricultural inputs or labour. There are also less obvious, externalized costs. For example, when pesticides and fertilizers contaminate water bodies, kill off-target species, or degrade habitat, the costs are borne by the communities and ecosystems where food is produced. In a highly globalized food system, this is often far away from where food is ultimately consumed.

There are also externalized costs associated with food system labour. Food workers are essential to providing food for society, highlighted by their declaration as essential workers during the COVID-19 pandemic. However, many food workers are frequently underpaid and working in unsafe conditions [76]. While cheap labour can increase profits for some food system actors, food workers and the communities in which they live bear the costs through impacts to their health and wellbeing. It is important to note that low wage food work is often performed by women and racialized communities[77], who are disproportionately impacted by externalized food system costs.

Regionalizing the food system is not a silver bullet solution to addressing externalized costs. However, regional food systems are better positioned to mitigate the social and environmental costs of food production by increasing both local awareness and capacity to address them through policy. In comparison, externalized impacts are neither understood, nor locally influenced, if they are taking place in distant communities. For example, this report demonstrates that expanding local agriculture to provide for local food needs could increase greenhouse gas emissions and habitat degradation. However, when these impacts take place close to home, we can better understand the trade-offs associated with different agricultural practices and work to achieve better outcomes through targeted policy and best practices. Similarly, just labour practices can more readily be established if the outcomes are locally seen and understood.

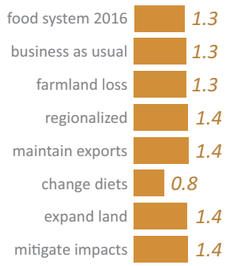
Total Ecological Footprint for Food Consumed

Global hectares (gha) required to meet the total food need of the population.



Per Capita Ecological Footprint

Global hectares (gha) required to meet an individual's food need.



Ecological Footprint

The total ecological footprint increases from the 2016 to the Business as Usual scenario due to increasing population in 2050. However, per capita ecological footprint for these two scenarios is unchanged because there is no change to local diets.

Assuming the same diet, there is also little change in the ecological footprint when a regionalized food production system is adopted. Importantly, this result demonstrates that the increasing consumption of locally grown food does not necessarily decrease the associated environmental impacts. Other factors such as yield, production methods and diet can have a greater impact on ecological footprint than where the food is produced.

The most significant reduction in ecological footprint can be seen in the Change Diets scenario, which models a diet that reduces the consumption of meat and other livestock products, relying more heavily on plant-based alternatives for protein.

Ecological Footprint of Meat Consumption

Meat consumption has a big impact on the ecological footprint of food consumption. Diets higher in meat products result in higher ecological footprints because of the resources and greenhouse gas emissions involved in producing meat. If a vegetarian diet were adopted in the bioregion in 2050, the per capita ecological footprint would be 0.6 gha, 40% lower than the per capita ecological footprint in 2016. For a vegetarian diet, per capita ecological footprint is 25% lower than the planetary health diet modelled in the Change Diets scenario, which still includes some meat consumption. Pulses and legumes (lentils, peas and beans) are often used as alternatives to animal proteins. These crops have a lower ecological footprint, and require less energy and water to produce than meat products[78].

Does it Grow Here? Social Capital and Regional Food Systems

What is Social Capital?

Social capital refers to the relationships, trust, and reciprocity between individuals in a community[79] that facilitate cooperation, collaboration or collective action in response to challenges[80]. For example, a community with a high degree of social capital might be better positioned to respond to the COVID-19 pandemic through the organization of mutual aid networks or other forms of community organizing and support. Additionally, social capital positively influences a number of measures of community wellness such as quality of life, individual well-being and crime rates[81]. In essence, social capital is the glue that holds society together.

Social Capital and Regional Food Systems

Enhanced social capital is a largely unexplored dimension of regional food system development, but is now considered an important tool for assessing the benefits of regional food systems. From an Indigenous perspective, social capital has always been grounded in, and reinforced by, the community and family on-the-land activities involved in traditional foodways. In the Okanagan bioregion, communities recognize the value of social capital for their community members, but have yet to explore how regional food systems may strengthen social capital in their communities.

With high rates of population growth and a long history of local food production, the Okanagan bioregion is an ideal area to study the connection between regional food systems and social capital. Social capital is considered a potential benefit of regional food systems because these food systems can facilitate relationships and trust between consumers and producers through social interaction. In this study, local food system actors in the Okanagan Bioregion described, through surveys and interviews, how they created social relationships by participating in the regional food system. Participants pinpointed the important spaces such as farmers markets, food co-ops, and community gardens in building relationships and trust.

This study found that in the Okanagan bioregion, a connection exists between participating in the regional food system and building social capital among local food system actors. This suggests that a well-developed regional food system has the potential to enhance community-level social capital through social interaction. By investing in regional food systems, community leaders and policy makers can positively influence social relationships in their community and make connections that are important for community cohesion, well-being, and development.

Greenhouse Gas Emissions

Assuming consistent agricultural practices, the greenhouse gas (GHG) emissions from agriculture are most significantly impacted by the amount of agricultural activity and the type of crop and livestock products produced.

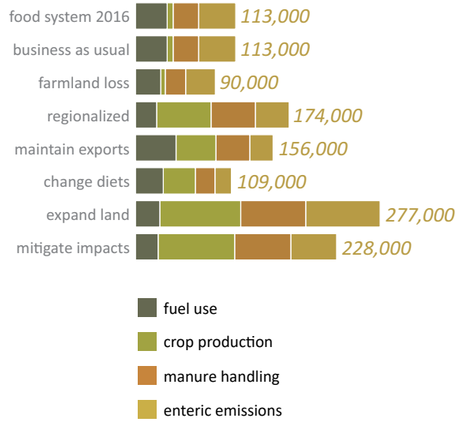
The Regionalized scenario prioritizes the production of higher yield crop and livestock products to optimize food self-reliance. The associated increase in food production results in an approximate 50% increase in GHG emissions relative to the 2016 scenario.

The Expand Land scenario increases the area of land in food production which corresponds to approximately 2.5 times the greenhouse gas emissions, relative to the 2016 scenario. In this scenario, some land is dedicated to the production of beef, which is not produced in the Regionalized scenario, contributing to the elevated GHG emissions.

Reducing the consumption of livestock products results in lower GHG emissions from agriculture. Livestock production is relatively emissions intensive due to manure handling and storage, enteric emissions from ruminant livestock, as well as emissions associated with feed production. The Change Diets scenario, which significantly decreases consumption of livestcok products, results in a 40% reduction in greenhouse gas emissions from agriculture compared to the Regionalized scenario modelled with the baseline diet.

Greenhouse Gas Emissions from Agriculture

Tonnes (t) of carbon dioxide equivalent (CO_2e) emissions from agriculture.



Local Food Consumption and Greenhouse Gas Emissions

This study models the greenhouse gas emissions associated with agriculture in the bioregion. The data shows that increasing local food consumption and food self-reliance does not necessarily result in lower emissions from agriculture. However, in a regionalized food system, we bring food production and associated impacts “home”, and therefore increase our capacity to mitigate them through locally developed policies and best practices. These could include reducing and appropriately managing food and agricultural waste (e.g. manure, crop residue), reducing dependence on fossil fuel-based fertilizers, and improving the carbon capture potential of soils through regenerative agricultural practices.

Nutrient Need & Availability

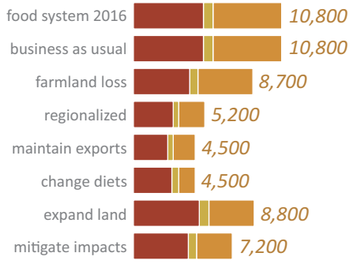
Comparing crop nutrient need and nutrient availability illustrates the potential for the nutrients from organic waste streams to meet crop nutrient needs in the bioregion, if properly recovered. Recovering nutrients from organic waste streams and recycling them into agricultural systems can reduce both the potential for environmental pollution from nutrients in organic waste, and the dependence of agriculture on synthetic nutrient inputs from non-renewable sources.

In all scenarios, there are more than enough nutrients in organic waste streams in the bioregion to meet crop nutrient needs. Closing the loop, and improving nutrient recycling, depends on policy development, the application of best management practices and new technologies. Given that nutrient availability is greater than crop nutrient need, additional management measures are required to mitigate pollution from excess nutrients in waste. This could include exporting recovered nutrients for use as fertilizers in other regions.

The amount of organic waste, and therefore nutrient availability, increases with population growth and livestock production. In the Business as Usual scenario, the larger population results in greater nutrient supplies from additional food waste and human excreta. Similarly, scenarios which produce more livestock, such as the Regionalized and Expand Land scenarios, are associated with higher nutrient availability. In these scenarios there is also an increased risk of environmental pollution, if nutrients in waste streams are not properly managed.

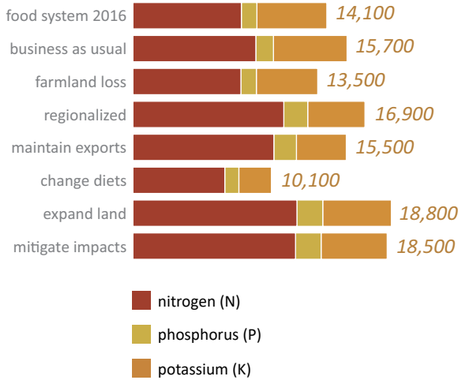
Crop Nutrient Need

Tonnes (t) of nutrients required to support crop production.



Nutrient Availability in Organic Waste

Tonnes (t) of nutrients available in organic waste streams.



Closing the Nutrient Loop in the Bioregion

The bioregion could meet a large portion of crop nutrient needs from organic residuals, reducing both the dependence of the bioregion on synthetic fertilizers and the risk of pollution from nutrients in waste streams. However, recovery and management remain significant challenges in closing the loop.

Management practices, technology and infrastructure determine if nutrients in organic residuals are recovered for use in crop production, rather than being lost as pollution in water bodies and landfills. The scenarios modelled suggest that there is sufficient N, P, and K in organic waste streams in the bioregion to meet crop needs for these nutrients. Nutrient recovery potential will never be 100%. Current best practices developed using innovative technologies and processes result in nutrient recovery rates ranging from 70-90%. The existing rates of recovery and reuse in the bioregion are much lower.

There are facilities in the Okanagan that process biosolids from municipal wastewater, and in some communities planning is underway for large-scale processing of municipal food waste. Existing programs and policies in the bioregion also aim to reduce the amount of food waste in landfills through household and small-scale composting, however these residuals are rarely recirculated into the food system. For many communities infrastructure costs, safety and public perception are barriers to widespread nutrient recycling.

This study recognizes the potential for the bioregion to recover nutrients to meet much of the local crop nutrient need. This potential recovery could reduce both environmental pollution from nutrient surpluses and dependence on synthetic, mined and imported fertilizers. However, recovering value from organic waste streams and investing in efficient nutrient recycling and distribution remain important areas of work to advance regional food systems and local sustainability goals.

Policy Area: Manage Organic Waste and Improve Nutrient Cycling

Municipal Leadership for a Circular Food Economy:

Circular food economy approaches aim to develop resource flows whereby organic by-products are used and recirculated in the food system[82]. Guelph-Wellington (Ontario) aims to develop Canada's first circular food economy. Through municipal leadership, and strategic partnerships with universities, community organizations, the City of Guelph and Wellington County have launched a plan to jointly increase food access, business innovation and waste recovery. The plan articulates a vision that maximizes the use of food system inputs and outputs to eliminate waste, optimize economic value and mitigate negative environmental impacts[83].

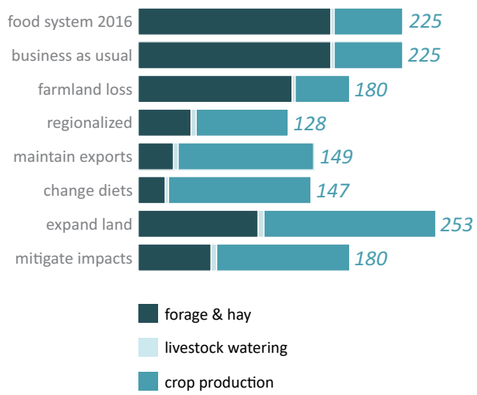
Agricultural Water Requirements

The total agricultural water requirements for the bioregion are influenced by the production of water-intensive crops or livestock. The Regionalized scenario shifts production away from irrigation-intensive crops, particularly forage, and water use decreases relative to the 2016 scenario. It is important to note that, since the model assumes that feed grain is imported, water requirements exclude the water needed to grow feed grain. In this way, a significant portion of the bioregion's water needs are exported outside of the bioregion.

The Expand Land and Mitigate Impacts scenarios limit the expansion of agricultural production based on proximity to either a major lake or water purveyor, but still require more water than the Regionalized scenario. The proximity to a water source does not mean that there will be sufficient available water at the source to satisfy demand and maintain the ecological integrity of freshwater ecosystems. In fact, the majority of streams in the Okanagan are fully allocated, and water suppliers have limited capacity to supply additional agricultural land[84,85].

Agricultural Water Requirements

Volume (m^3) of water required for agriculture, in millions.



Climate Change and Increasing Water Demand

Future scenarios estimate water requirements based on 2010 climatic conditions, which is considered a 'typical' climate year, neither anomalously hot/dry nor cool/wet. Data was not available to model water requirements for future climatic changes in the year 2050. As a result, agricultural water requirements reported likely underestimate irrigation demand for the 2050 scenarios, as climate change and the associated higher summer temperatures are predicted to increase agricultural irrigation requirements[86]. While water demand estimates do not account for predicted climate changes in 2050, looking into the past can help to understand how increased summer temperatures and drought conditions can impact agricultural water demand. For example, 2003 was a drought year in the Okanagan. In this hot and dry year, water demand for agriculture was approximately 40% higher than 2010.

Agricultural Water Use in the Okanagan

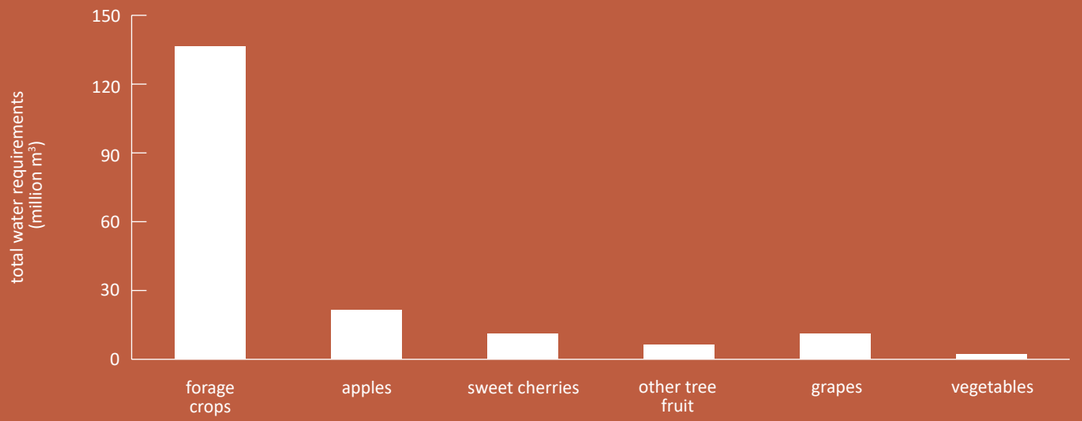
Agriculture water requirements for crop irrigation and livestock watering currently comprise over 50% of the total water demand in the Okanagan. The Agricultural Water Demand Model (AWDM) estimates irrigation and livestock water requirements based on climate, crop type, irrigation systems, soil conditions and management[87]. With information from the AWDM, it is possible to estimate the total irrigated area of major crops in the Okanagan bioregion, their average irrigation requirements, and the associated water demand. Forage crops, which also represent the largest crop area, have the largest total water demand. On a per hectare basis, forage is the most water intensive crop among those most widely grown in the region. Grapes have the lowest irrigation requirement.

Irrigation Rates and Total Irrigated Area, 2016

	irrigation rate (m^3/ha)*	total irrigated area (ha)
forage crops	7,557	17,964
apples	6,160	3,484
sweet cherries	6,502	1,700
grapes	3,335	3,396
other tree fruit	7,159	888
vegetables	4,697	468

*irrigation rates modelled using 2010 climate conditions

Agricultural Water Requirements for 2016 by Crop Group



Meeting Human and Ecosystem Water Needs in Uncertain Conditions

Aquatic ecosystems require different types of flow conditions throughout the year to support life and ensure long term wellbeing. For example, there must be sufficient water present in streams for flushing, linking to side channels and supporting the migration, spawning, and rearing of different fish species. Water management practices in B.C. have often overlooked the needs of aquatic ecosystems, which, combined with other forms of habitat degradation, have resulted in declines in fish populations [88].

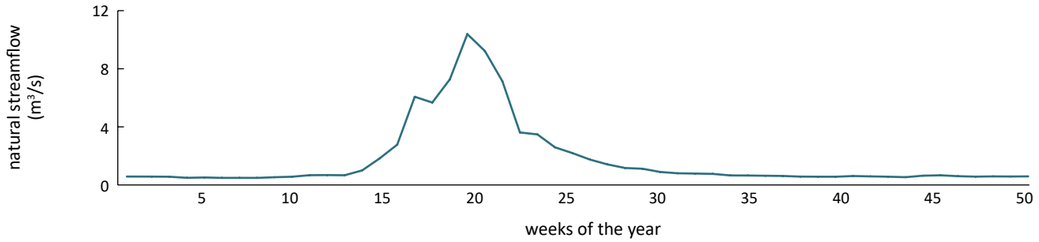
In the Okanagan, the majority of precipitation falls as snow during the winter months, accumulating as snowpack at high altitudes. Consequently, the majority of runoff occurs as the snowpack melts during the months of April, May and June. This flow pattern puts water supply out of step with demand, which peaks during the growing season, and highlights the importance of water storage early in the year to satisfy increased demand later in the summer and fall. The figures on the opposite page illustrate this flow pattern for Trout Creek, near Summerland in the South Okanagan.

Variable streamflow levels from year to year are typical in the Okanagan. For example, in Trout Creek, the mean annual discharge from 1996-2017 is estimated to range from a minimum of 0.95 m^3/s in 2003, to a maximum of 8.34 m^3/s in 2017[89]. As a result, water availability in the region can vary substantially from year to year. Dry years can cause water stress with the potential for harm to both the ecology and livelihoods in the region. Furthermore, climate change projections in the region suggest that drought years will occur with increased frequency and intensity in the coming decade[90]. Changes in mountain snowpack are cited as the *"most important factor controlling the timing and amount of water that is available in the Okanagan basin"*[91]. Reduced snow accumulation in winter would reduce streamflow levels and, combined with expected increased demand, may reduce water availability and intensify existing competition among water users as well as between human and ecosystem needs.

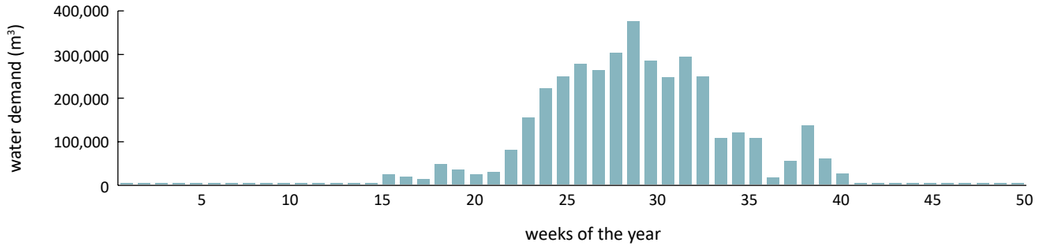
Managing water for human and ecological wellbeing will require coordinated drought planning, water conservation, and water storage planning. Additionally, the choice of crop and production systems has important consequences for water demand in the region. Matching the most appropriate crops and food system to the Okanagan's semi-arid climate is an important consideration. Similarly, assuring high levels of irrigation efficiency is essential. Watershed-level governance and science-based policy development, such as the ongoing initiatives of the Okanagan Nation Alliance and the Okanagan Basin Water Board, will continue to be critical.

Median Naturalized Streamflow and Weekly Water Demand for Trout Creek

Median naturalized streamflow (m3/s) (modelled) for Trout Creek, derived from mean weekly flow 1996-2017 [92].



Weekly water demand (m3) for Trout Creek, modelled using 2010 climate data [93].



Policy Area: Prioritizing Fresh Water Ecosystems in Water Policy

The Katherine and Daly Rivers in Northern Australia rely on discharge from the Tindall Aquifer for sufficient year-round flow and ecosystem function. The Tindall Water Aquifer Water Allocation Plan was developed to promote sustainable allocation of aquifer discharge between extractive, environmental and Indigenous cultural uses. The total extraction limit is determined each year based on annual rainfall and modelled recharge rates to the aquifer and rivers. Water is first reserved to sustain ecological and cultural requirements, and the residual is then allocated for extractive use. The plan aims to ensure that sufficient water levels are maintained in aquatic systems to meet environmental and cultural needs, even in drought years [94].

Wildlife Habitat Capacity

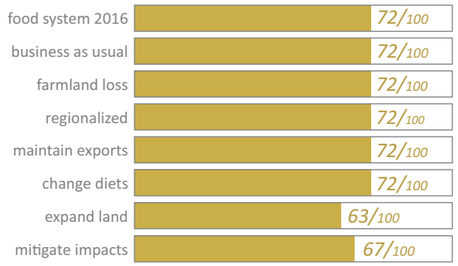
Wildlife habitat capacity, determined by the type of land use and land cover, assesses the ability of different landscapes to support wildlife. The high wildlife habitat capacity rating for the Okanagan is reflective of the relatively large proportion of natural lands, such as woodlands and grasslands, within the Agricultural Land Reserve in the bioregion. In scenarios where there is no change to the area of land used for food production, the wildlife habitat capacity remains high.

Expanding the cultivated area in the bioregion decreases wildlife habitat capacity. The losses of critical habitat areas, including riparian woodlands, and natural wetlands, are reflected in a 9-point reduction in wildlife habitat capacity (from High to Moderate), which is substantial given the overall percentage of natural land cover in the bioregion.

The Mitigate Impacts scenario aims to reduce the negative impacts of agricultural expansion on wildlife through two measures. First, this scenario excludes critical habitat areas from agricultural expansion and maintains these areas as natural lands. Second, this scenario implements hedgerows and riparian buffers on agricultural landscapes to improve habitat values on farms. By protecting critical habitat and implementing on-farm wildlife enhancement measures, the wildlife habitat capacity improves relative to the Expand Land scenario, from 63 to 67/100.

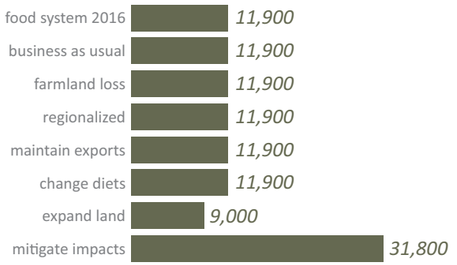
Wildlife Habitat Capacity

Quality of land cover for wildlife in the agricultural landscape.



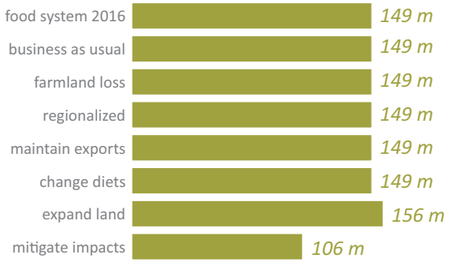
Habitat Connectivity

Number of natural habitat patches (density).



Habitat Connectivity

Average distance in metres (m) between natural habitat patches (proximity).



Habitat Connectivity

Expanding food production to uncultivated areas decreases wildlife habitat connectivity within the agricultural landscape. This can be seen in the Expand Land scenario. In this scenario, proximity, the average distance between habitat patches, increased by an average of 4m. Density, the number of habitat patches, decreased by 2,858 patches.

The quality of agricultural landscapes for wildlife habitat varies according to both the land and species. Farmland can support more biodiversity by providing a diverse mosaic of land types that can be used by more species alongside other conservation measures like protected parks. For example, both songbirds and raptors benefit from orchards and pastures as habitat areas, while a number of species, such as ground-nesting birds and ungulates, can use unimproved pasture for feeding and breeding. While cropland can provide value for wildlife in the region, natural Okanagan ecosystems are irreplaceable for many species.

In the Mitigate Impacts scenario, protecting critical habitat areas and implementing hedgerows and riparian buffers mitigates some of the negative impacts of agricultural expansion on wildlife habitat connectivity. This is done by increasing the number of habitat patches and reducing the average distance between them, enhancing the overall network of land hospitable to wildlife.

Habitat connectivity remains the same for scenarios that model the same cultivated area.

Agricultural Expansion and Wildlife Habitat Impacts

This study assesses the hospitality of the agricultural landscape to local wildlife based on both cropland and natural, or uncultivated areas within the Agricultural Land Reserve. The conversion of natural lands comes with important trade-offs that should be considered in planning for the future. Natural lands are instrumental to the health of plants, animals, ecosystems and Indigenous foodways.

Overall, the loss of habitat areas in the Expand Land scenario is small, however the greatest amount of habitat loss occurs in some of the most critical, and rare habitat areas. For example, expanding agricultural production would result in the greatest losses in riparian woodlands (58% converted) and natural wetlands (46% converted). These areas have been assigned a Very High conservation rank, and make up only a small portion of the land area in the ALR. This study demonstrated that rare, sensitive ecosystems can be at disproportionate risk for agricultural conversion as food production expands.

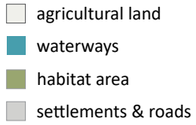
The Mitigate Impacts scenario results in approximately 13,500 ha in critical habitat protection and habitat enhancements, reducing the overall loss of natural land by 8%. The connectivity of habitat areas in the landscape is also greatly improved. This analysis provides insight into the potential landscape improvements landowners could make to enhance on-farm and regional habitat. Current recommendations for improving habitat connectivity in the Okanagan have identified hedgerows, riparian buffers, and other common farm features as ideal to improve both farmscape and landscape level connectivity[95]. Collaborations between regional government, conservation organizations and landowners can work together to identify areas where these landscape changes are most beneficial and assess the best way to implement improvements through existing programming and policy.

Maps 1 and 2 illustrate the impacts of agricultural expansion on natural habitats for a landscape sample in the bioregion. Critical habitat protection and implementation of habitat enhancements (i.e. riparian buffers and hedgerows) are shown in Map 3 which illustrates these mitigation measures implemented on the same landscape sample.

Map 1: 2016 Food System Scenario

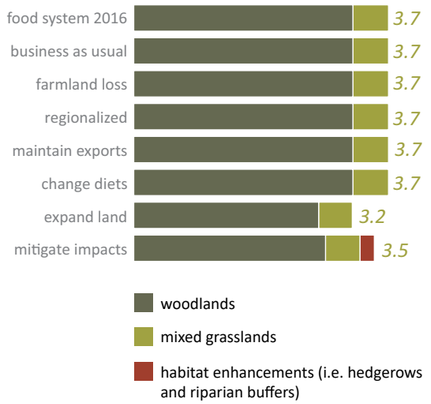
Map 2: Expand Land Scenario

Map 3: Mitigate Impacts Scenario



Carbon Stocks

Tonnes (t) of carbon stored in non-production, woody vegetation, in millions.



Carbon Stocks

Converting natural lands to agricultural land reduces aboveground carbon storage in non-production, perennial vegetation, such as trees and shrubs. This dynamic can be seen in the Expand Land scenario where carbon stocks decrease to 3.2 million tonnes. This loss of stored carbon is equivalent to that generated from 400,000 cars driving for a year. Implementing habitat protection, riparian buffers and hedgerows in the Mitigate Impacts scenario has the potential to build up these stocks on expanded cultivated land by establishing natural, perennial vegetation in the bioregion. However, stored carbon in this scenario is still lower than scenarios that do not expand the cultivated area in the bioregion. It is important to note that, because this indicator excludes changes in below-ground carbon, such as soil, carbon stocks are underestimated.

All other scenarios report the same level of carbon storage as the land base is assumed to maintain the same area of perennial, non-production, woody vegetation as in 2016. While the shift to a regionalized food production system alters the crop and livestock mix, it does not impact existing aboveground carbon stocks in natural areas such as hedgerows, riparian areas, and forest stands.

Gross Domestic Product & Tax Revenue

Total gross domestic product (GDP) and total tax revenue for the Business as Usual scenario are similar to the 2016 scenario as there are no changes to local food production. When more food is produced locally, more economic activity is generated, increasing linkages between industries and yielding higher economic impacts. With the shift to a regionalized food production system more food is produced and the economic impacts increase relative to 2016.

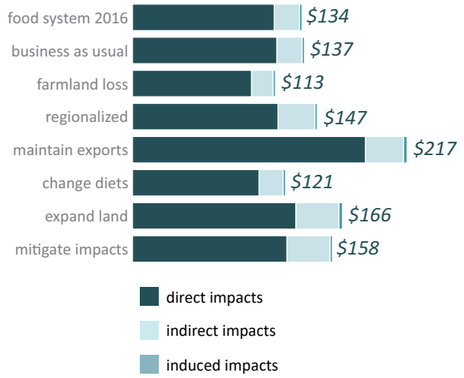
When less food is produced locally, as illustrated in the Farmland Loss scenario, there is a decrease in economic linkages and activities and therefore a decrease in all economic indicators. Total GDP decreases to $113 million from $134 million in 2016. Total tax revenue also decreases.

The highest economic impacts are associated with a regionalized food system that maintains the export fruit production sector. In the Maintain Exports scenario, GDP increases to $217 million, and tax revenue increases to $28 million.

Note that the induced GDP impacts (generated from spending of employees and workers in primary crop and livestock production sectors and their supplier industries) are relatively small and similar across all scenarios. The size of the induced impact implies that only a small portion of income earned is recirculated in the local economy. This is largely due to the dependence of goods and services produced outside the bioregion. Shifting towards more local food production and consumption has the potential to raise GDP impacts overall, but has little effect on the induced GDP impacts unless other sectors of the economy are sufficiently regionalized. That is, if other economic sectors in the Okanagan were regionalized, and dominated by local businesses who were able to produce goods and services, more of the locally earned income could circulate within the Okanagan's economy, further increasing GDP impacts.

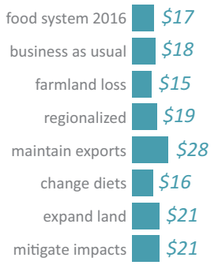
Gross Domestic Product

Total gross domestic product generated by food system activities, in millions (2016 value).



Tax Revenue

Total tax revenue (municipal, provincial, federal) generated by food system activities, in millions (2016 value).



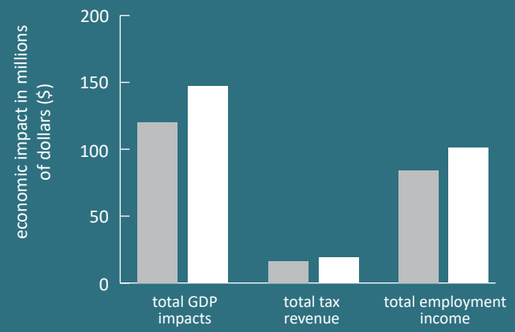
The Value of Food Processing

Increasing the capacity to produce and process food locally can increase economic activities and linkages among related industries[96]. Shifting to a regionalized food production system in the bioregion could increase local food production by over 65,000 tonnes. The economic impacts generated from such a shift are influenced by the scale and capacity of the local food processing sector.

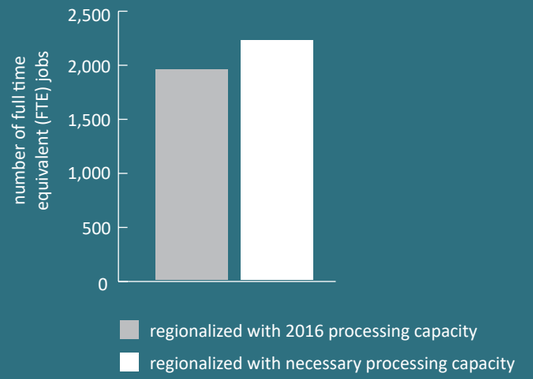
To illustrate the economic impacts of a local food processing sector, two different food processing capacities were compared in a regionalized food system. The first reflected the same processing capacity that existed in the bioregion in 2016, and the second reflected additional capacity to support the processing required in a regionalized food production system. When necessary processing capacity is available locally, more raw food can be processed into value-added products. As a result, the total value of processed foods produced in the bioregion increases by $105 million. Total GDP impacts increase by $27 million, 23% higher than the GDP impacts of a comparable scenario with existing (2016) processing capacity. The number of FTE jobs increases by 268.

These results illustrate the role of the processing sector in generating economic impacts. Increasing the capacity of the local processing sector raises the total value of food produced locally. This, in turn increases local GDP, employment income, tax revenue, and number of jobs.

Economic Impacts of Food Processing



Employment Impacts of Food Processing



Employment Income & Jobs

The total number of full time equivalent (FTE) jobs decreases slightly in the Regionalized scenario relative to 2016. This is primarily due to the decrease in labour intensive agricultural production sectors, particularly tree fruit. In the Regionalized scenario total employment income increases despite the decrease in total overall employment. This is primarily due to the increase in jobs in the processing sector, where employees earn more money relative to primary production. The average annual earnings for employees in the primary agriculture and food processing sectors is $27,000 and $48,000, respectively.

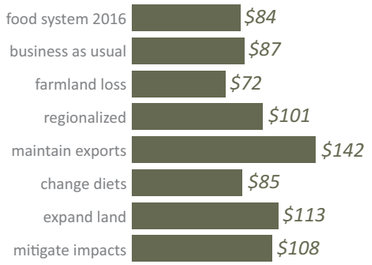
The Maintain Exports scenario results in the highest total employment income and number of jobs across all scenarios. The number of FTE jobs increases to 3,600 when the major fruit sector is maintained, highlighting the significant labour requirements of these sectors. The most significant increase in employment from the Regionalized scenario comes in the primary agriculture sector.

Foreign Labour and Agriculture in the Okanagan

In the Okanagan, tree fruit and wine grape production requires an influx of seasonal labour during the growing season. Much of this labour is currently provided by an estimated 6,000 temporary foreign workers primarily from Mexico and the Caribbean[97]. The COVID-19 pandemic shed light on both the dependence of the fruit production sector in the Okanagan bioregion on foreign labour, and the health and safety risks disproportionately experienced by these essential food system workers[98,99].

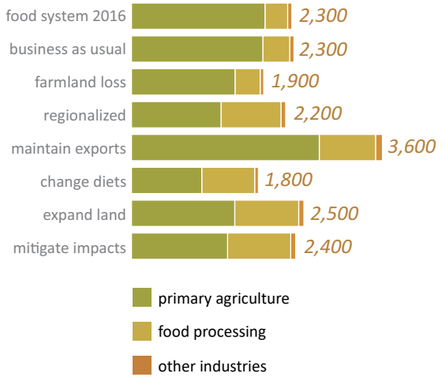
Employment Income

Total employment income generated by food system workers, in millions (2016 value).



Number of Jobs

Number of full-time equivalent (FTE) food system jobs, by sector.



Nurturing the Next Generation of Farmers

Since the 1980s, the population of farmers in Canada has decreased by one third, and the average age of farmers has steadily increased[100]. Today, the average age of farmers in B.C. is 56[101]. Many major agriculture and food system sectors across the province now rely on skilled agricultural workers from outside Canada through federally-administered programs such as the Temporary Foreign Worker program[102].

The declining farming population, lack of succession planning, and increasing dependence on foreign labour could create challenges in meeting the demand for skilled agriculturalists in the future. Sustaining a thriving agricultural sector in the bioregion, and beyond will require adequate farmer livelihoods, training programs, and ongoing professional support.

Future employment estimates in this report are based on current agricultural practices. It is estimated that a shift to more regenerative, ecologically sound farming practices will create a greater demand for skilled agricultural labour. Richard Heinberg, of the Post Carbon Institute, suggested that the shift to regenerative agriculture and the requisite food system change will require about 50 million farmers across North America[103]. In other words, approximately 20% of the population will need to be directly involved in producing food in regenerative ways. In B.C. today, less than 2% of the population works on farms.

To support this transition, investment is needed in agriculture education programs designed to prepare aspiring farmers in regenerative farming. Extension education for farmers and applied research is also needed to develop farming methods to meet regional food demand and steward the land and resources upon which food systems depend.

Understanding Food System Trade-offs

This study highlights the potential of a regional food system and the trade-offs embedded in our food system decisions. While model outputss are not definitive or predictive, the scenarios highlight the following key trends;

The Okanagan bioregion could substantially increase food self-reliance: Producing a mix of crops and livestock that prioritize local food need can double food self-reliance for the bioregional population. If additional agricultural land were brought into production, food self-reliance could further increase.

Increasing the consumption of locally produced food does not reduce the environmental impacts associated with the food system, but changing diets does: Reducing the consumption of livestock products lowers the ecological footprint of the food we consume, as well as greenhouse gas emissions from agriculture.

There are sufficient nutrients in organic waste streams to meet crop needs in the bioregion if they are recovered and recycled: Recycling nutrients from organic waste streams can reduce the risk of environmental pollution, and dependence on synthetic fertilizers. Closing nutrient cycles in the bioregion will require improvements in waste management technology and infrastructure.

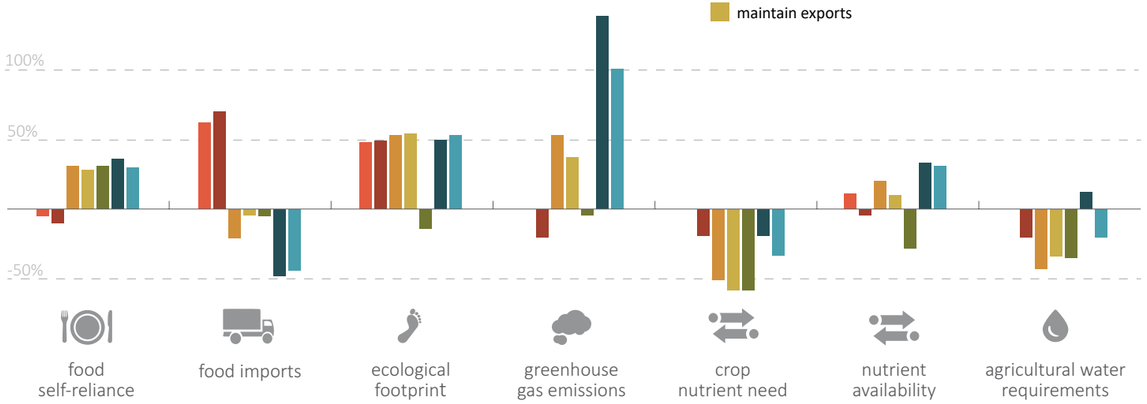
Prioritizing water-efficient crops can reduce the bioregion's water use: Forage crops are the most abundant and among the most water-intensive crops grown in the bioregion. Production of more water-efficient crops is one avenue to significantly reduce the bioregion's agricultural water demand. While importing feed for livestock can reduce the agricultural water demand locally, doing so transfers the associated water demand to the regions where livestock feed is grown. Efficient use of water for both crop and livestock production is critical.

Indicator Performance

Percentage change from 2016 conditions for indicators.

Scenarios

- business as usual
- farmland loss
- regionalized
- maintain exports
- change diets
- expand land
- mitigate impacts

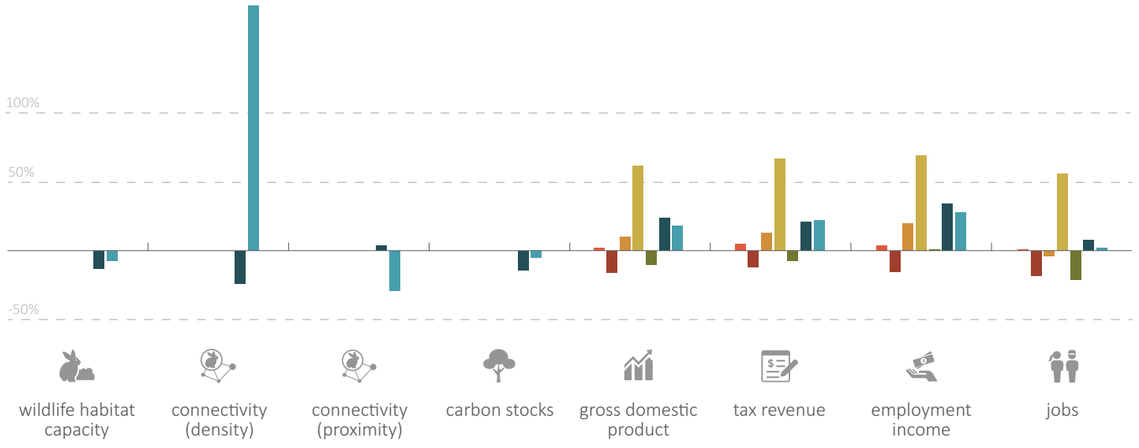


Expanding the agricultural land base onto natural lands erodes habitat quality and carbon stores: The Okanagan bioregion has a rich natural landscape which is diminished with land conversion for agriculture. While strategically protecting critical habitat and implementing on-farm habitat enhancements can help mitigate some of these adverse impacts, the conversion of natural land to agricultural production comes with environmental trade-offs.

A regionalized food system can increase local economic benefits: Moving toward a more regionalized food system can increase GDP, tax revenue, and employment income associated with the food system. The highest local economic benefits are associated with a regionalized food system that still maintains wine grape and tree fruit production for export.

Realizing the local economic and food self-reliance benefits of a regionalized food system depends on establishing the necessary post-production capacity: Increasing the capacity to process food locally can increase GDP, tax revenue and employment income while also creating well paying jobs in the bioregion.

Ultimately, there is no single scenario to optimize all the desired outcomes of a bioregional food system. Communities will need to weigh the various benefits and drawbacks to make the best decisions for their local context and priorities.



2050 Scenario Outcomes

Shaping Our Food System

This section explores the context for food system decision making, illustrates a compelling vision and outlines principles for food system planning in the bioregion.

Planning for an Uncertain Future

This study explores the food self-reliance, ecological and economic potential of a regional food system in the Okanagan bioregion. The results described in this report rely on a number of critical assumptions including:

- Population growth is aligned with future projections
- Agricultural land is used for food production
- Farming is an economically viable and desirable career path
- A local post-production sector is developed
- Water is available to support food production
- Crop yields remain stable
- Global food supplies and distribution networks remain stable
- Skilled labour is available where and when required
- Local residents consistently choose local food

While assumptions are necessary when modelling scenarios, the future remains uncertain. There is a need to acknowledge that climate change in the 21st century brings the potential for repeated disruptions and compounded emergencies that can challenge these assumptions. Flooding, drought, wildfires, geopolitical instability, resource constraints, sea-level rise - all have the potential to disrupt our capacity to produce and distribute food both locally and globally.

Existing highly globalized and consolidated food supply chains distance us from the communities and landscapes that produce our food. Global challenges, such as the COVID-19 pandemic, have highlighted the vulnerability of our current food system and have increased interest and investment in strengthening regional capacity. While maintaining access to food produced outside the bioregion can help ensure food access at a population level in the event of local disruptions, there is increasing evidence that regionalization could be an important driver of resilience in an uncertain future.

Regional Food System Roadmap

This report presents data about current conditions, and possible future food system outcomes in the Okanagan. Ultimately, the future food system will be shaped by communities in the bioregion working together to weigh local priorities and trade-offs. Shared vision and extensive collaboration across bioregion communities and jurisdictions is key. The roadmap provides a comprehensive data-informed vision for what is possible*, and describes a regionalized food system in the Okanagan where:

1. **Local food infrastructure provides opportunities for year-round local food access** and helps to build relationships between producers and consumers. Local policy and regulatory environments encourage **new food system businesses to emerge.**

2. **High quality tree fruits are produced for local consumption and export.** This local production is supported by post-production infrastructure to allow **more value to be captured in the bioregion.**

3. Landscape level habitat protections **mitigate negative impacts of food production to enhance habitat quality and connectivity.** These restore and protect local biodiversity.

4. **Locally produced food is physically and financially accessible to residents.** Public institutions source food locally establishing consistent markets and increasing healthy food access.

5. **Farmland is protected and financially accessible to farmers.** Farm ownership, operation and employment are all **economically viable and fulfilling career paths.**

6. **Nutrients are recovered and recycled from organic wastes** and converted into soil amendments. Closed loop nutrient management reduces the risk of environmental pollution and the dependence on synthetic fertilizer imports.

7. **Regionally-based education programs and agricultural research** support farmers to meet the growing demand for local food, and adapt to climate change and other food system challenges.

8. Indigenous Peoples can practice **traditional foodways.** Settler communities honour and support **Indigenous self-determination and food sovereignty.**

**The roadmap is based on food system priorities identified by stakeholders in the Okanagan Bioregion. See Hansen, Emily, Kristi Tatebe, Wallapak Polasub & Kent Mullinix.(2019). Okanagan Bioregion Food System Stakeholder Feedback Summary:* https://www.kpu.ca/sites/default/files/OBFSDP%20Stakeholder%20Feedback%20Summay%20Report_FINAL_0.pdf

Shaping Our Food System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FARMER'S MARKET
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Principles for Regional Food System Development

Comprehensive Policy Development

This project demonstrates the interconnected nature of agricultural, environmental and economic outcomes of the food system. The complex nature of food systems requires a comprehensive approach to planning and policy development. Historically, food systems have been addressed through "siloed" approaches to planning across levels of government[104,105]. Adopting more comprehensive approaches to plan across the food system at the local level could reduce conflicting policy goals and build support for common objectives.

A comprehensive approach requires that food policy is integrated across domains and planning scales. This is often referred to as adopting a "food system lens" for planning and policy development. Incorporating food policy considerations into comprehensive planning documents, land use and zoning, economic development, social planning, climate change, etc. can be an effective strategy for comprehensively embedding food system considerations[106]. For example, considering the impacts of the built environment on food access, the relationship between farmland protection and rural economies, or the affordability of housing on food security, are all intersections between food systems and existing areas of local government planning.

Collaborative Planning

The boundary of the food system extends beyond that of any single community, municipality or planning agency. The bioregional approach addresses this by looking at the food system at a scale that links areas with common ecology, culture, climate and human economy. The boundaries of a bioregional food system must be addressed through collaborative processes that involve Indigenous and non-Indigenous governments, community organizations, civil society and the private sector. Collaboration could involve collecting and sharing food system data and information between local jurisdictions, or developing shared visions for the food system. Adopting collaborative approaches can help to align the food system priorities of communities within a region, leading to more strategic planning and resource allocation for regional food systems development.

The population in the Okanagan bioregion is expected to grow by 43% over the next 30 years. Much of this growth is likely to occur in the bioregion's urban centres. Increasingly, planning for food systems must consider the critical urban-rural linkages. These linkages include not only the flow of food from rural to more urban areas, but also the flow of labour, resources and waste across the bioregion. Collaborative planning approaches must cross traditional planning boundaries at the municipal level while also integrating diverse perspectives. Food policy councils or groups have been one avenue for collaborative planning, bringing together diverse food system interests to inform and take part in local level policy development.

Integrated Local Metrics

Data collection is an important component of developing public policy and monitoring its impacts. As local governments become increasingly active in policy and planning in the food system, there is a need to select and monitor metrics that represent the comprehensive and locally integrated nature of food systems planning. In Canada, food system performance has been measured at provincial and national scales with an often singular focus on economic growth and outcomes. Outcomes related to health, community and individual well-being, and ecological integrity are not often considered when evaluating food system policy.

This project presents local level food systems metrics across the domains of food consumption, agriculture, environment and economy. Integrating these types of metrics with existing local level data on health, affordability and community well-being has the potential to present a more comprehensive picture of local level food system outcomes and connections.

Equity

Food system outcomes and opportunities are not equally afforded. Food system inequalities are often structured around systemic racism, colonialism and other forms of oppression and disenfranchisement that disproportionately disadvantage Indigenous and racialized communities[107]. This is visible in patterns of food insecurity, wages and job security, and workplace safety issues. For example, rates of household food insecurity in Canada are highest among Black and Indigenous households[108]. Black Canadians reported experiencing moderate or severe food insecurity 2.8 times more frequently than White Canadians[109], and household food insecurity is approximately two to four times more prevalent among Inuit, First Nations, and Métis households[110]. For the Syilx Okanagan Peoples, this is the result of being dispossessed of most traditional lands and the ensuing degradation of the region through the non-Indigenous development of agriculture, industry, and urban areas. Addressing the issue of "Land Back" for Indigenous Peoples, and adopting measures to eradicate systemic inequities is essential to establishing a regional food system that benefits all.

With the understanding that negative food system outcomes disproportionately impact certain communities, adopting an equity based approach to local food systems planning and development is imperative. Such an approach requires policy development processes that center the perspectives, knowledge and lived experiences of the communities that are most acutely impacted by societal inequities, namely racialized and Indigenous communities.

Final Thoughts

Rapidly shifting cultural, ecological and economic realities, are increasingly challenging the status quo within the food system and beyond. The data and information provided in this report aim to support comprehensive, data-informed decision making to empower municipalities, regional districts, First Nations governments, civil society groups and private sector actors to imagine and build a sustainable food system for the 21st century. Inspiration can be drawn from the longer history of the bioregion and the many generations of Indigenous Peoples who were food self-reliant in this place, as well as from the Syilx Okanagan communities of today and their committed efforts to maintain and revitalize Indigenous foodways. Ultimately, food system transformation will require a broad view of the linkages between food system components and cooperation across jurisdictions. Communities will need to challenge the status quo, re-think economic and community development, and re-evaluate policies, programs and structures so that they serve the goal of equitable, sustainable food systems that nurture the communities where they are rooted.

Image Citations

pg. 3 Salmon Fishing, *Okanagan Nation Alliance*
pg. 4 Harvesting, *Okanagan Nation Alliance*
pg. 20 Salmon, *Okanagan Nation Alliance*
pg. 39 Peaches, *Ben Johnson*
pg. 46 Market Table, *Jean-Philippe Marquis*
pg. 65 Carrot Washing, *Jean-Philippe Marquis*
pg. 69 Regional Food System Illustration, *Lindsay Peltz*

Endnotes

Introduction

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About the Okanagan Bioregion Food System Project

Communities and governments are increasingly looking to strengthen regional food systems as a way to address many complex challenges. However, there is a lack of data-driven information about how, and to what extent, regional food systems can benefit local communities in terms of economic, environmental, and social impacts and the inevitable trade-offs. The Okanagan Bioregion Food System Project provides such information to local governments and communities to support dialogue, decision-making and planning in the Okanagan around sustainable, resilient food systems that nurture our communities now and into the future.

The Okanagan Bioregion Food System Project considers and builds upon existing food system planning and other related work to support local and regional food systems in the bioregion.

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