THE FUTURE OF OUR FOOD SYSTEM

Report on the Southwest BC Bioregion Food System Design Project

KPU | Institute for Sustainable Food Systems

About 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. We focus predominantly on British Columbia but also extend our programming 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 stewardship. Our extension programming provides information and support for farmers, communities, businesses, policymakers, and others. Community collaboration is central to our approach.

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For permissions, contact:
Dr. Kent Mullinix
Director, Institute for Sustainable Food Systems
kent.mullinix@kpu.ca

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Food System Design Project

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Foreword

William Rees, Ph.D

Professor Emeritus, Environment and Resource Planning, School of Community and Regional Planning, University of British Columbia, and co-author of *Our Ecological Footprint*

Society is only three square meals away from revolution.

—Leon Trotsky [i]

H. sapiens is an enigmatic species. Humans have evolved high intelligence, making us uniquely capable of reason and logical analysis; no other species can plan ahead, using available evidence to shape its own future.

But there is a problem. Humans are also endowed with behavioural predispositions that were once adaptive but have become impediments to survival today. In particular, humans are inherently short-sighted. Most people favour the here and now over future possibilities and distant places, a trait that economists have formalized as "social discounting." This built-in myopia dilutes our ability to plan for the future.

To complicate matters, humans are myth-makers. While other species take the world as it comes, people socially construct shared perceptions of reality. Much of what we take to be "truth"—our various cultural narratives, religious doctrines, political ideologies, and academic paradigms—are largely products of the human mind. These stories are massaged and polished by social discourse and negotiation and ultimately elevated to the status of received wisdom by common agreement.

Most importantly, people "act out" from socially constructed beliefs as if they were ultimate truths. This is not a problem when a cherished myth resonates well with external reality, but what if our construct is little more than a shared illusion? Allegiance to ill-conceived myths and paradigms—the denial of contrary evidence—has presaged the collapse of countless social organizations, governments, and even whole societies since the dawn of civilization.

What has all this got to do with food? Food is the ultimate resource, yet myopia and denial are defining characteristics of society's prevailing approach to food security. Food (and, often, agricultural land) is treated just like any other commodity, subject to the vagaries of market economics. And markets are intrinsically short-sighted—prices reflect current supply and demand with no capacity to factor in likely future conditions. Moreover, contemporary neoliberal economics is "hands-off" economics, socially constructed to minimize government intervention (so much for long-term planning) and to optimize a single value: efficiency (who can be against efficiency?). Efficiency, in turn, demands local specialization in a few commodities supplemented by trade for everything else. This creates monocultures and potentially unsustainable producer and consumer dependencies. Meanwhile, increasing competition in global markets drives producers to externalize ecological costs such as soil and water pollution and bid down local wages. In short, the economic paradigm that is shaping what (and even whether) we will produce and consume in coming decades ignores such values as community cohesion, equity, regional self-reliance, economic diversity, and ecological stability while simultaneously inhibiting public planning for global change.

Little sign of high intelligence here, and too bad, given that significant change is a certainty. This is the Anthropocene. Global warming and increasingly unpredictable climate is already upon us, biodiversity is plunging, soils are eroding and water tables falling, an energy crisis has been headed off only by a slowing global economy but will return (particularly significant because "modern agriculture is the use of land to convert petroleum into food" [ii]), sea level rise and desertification are likely to destroy vast areas of agricultural land and displace millions of desperate people, and such trends can only increase geopolitical tensions and the likelihood of resource wars.

Meanwhile, most of the official world remains in a socially constructed bliss-bubble. Blinded by the prevailing myth of perpetual growth and continuous technological progress, we are not quite able to admit that these trends may herald a global food crisis. Consider the following burst of (effectively self-cancelling) optimism from the UN Food and Agriculture Organization:

> "Barring major upheavals coming from climate change and the energy sector or other events that are difficult to foresee—such as wars or major natural catastrophes leaving long enduring impacts—*world agriculture should face no major constraints to producing all the food needed for the population of the future*, provided that the research/investment/policy requirements and the objective of sustainable intensification continue to be priorities." [iii]

What this really says is if none of the highly likely events that could prevent it from happening actually happens, and everything needed to make it happen does happen, then world agriculture will have no problem producing all the food needed for future populations. This is an impossibility theorem; there will be "major constraints" in meeting global food demand.

This is why everyone concerned about food and food security in Southwest BC—anywhere, actually—should be interested in the present study: *The Future of Our Food System* assumes from the outset that the system must adapt to changing biophysical and geopolitical realities. It is increasingly unwise for any region to become excessively dependent on potentially unreliable external sources of supply or to commit an excessive part of its own productivity to external markets. With cool intelligence and a steady eye on the future, this project explores alternative scenarios for expanding food production and processing in the bioregion and asks whether regional self-reliance can be increased while minimizing ecological costs. These are questions every bioregion should be asking.

In the case of Southwest BC, the answers raise an ominous yellow flag. In baseline year 2011, the bioregion's 2.7 million people had only .06 hectares of arable land per person, including grazing land; by 2050, when the population is expected to be 4.3 million, the ratio falls to only .04 hectares per person. This actually compares unfavourably to the already (arguably inadequate) global figure of .20 hectares arable land per person, exclusive of grazing land. Tellingly, *it currently takes about .50 hectares per person of arable land to produce the average North American diet.*

We should therefore not be surprised (but should be alarmed) that under the most optimistic scenario, with most of its arable land in production, Southwest BC could become only 57% food self-reliant by 2050 (assuming a standard recommended Canadian diet). This is twice the performance available from business as usual but leaves the region's people heavily dependent on imports from elsewhere—imports that may well not be available.

It is clearly time to rethink the region's entire development trajectory—indeed, the world's development trajectory. The predicament revealed in *The Future of Our Food System* is typical of modern urbanizing regions. Food (in)security may well become the defining anxiety of the early Anthropocene. The only question is whether the world community can abandon its dangerous illusions, accept the evidence of a gathering storm, and apply humanity's much-vaunted high intelligence to planning a way through.

There should be enough incentive: if the world fails to maintain the three-meal buffer, chaos and anarchy will not be far behind.

Chapter 1

The Challenge

What Is Needed for a Sustainable Future?

Our food system is far from sustainable. It is dependent on diminishing supplies of oil and fresh water and threatened by global warming. Its adverse environmental impacts, such as groundwater contamination, habitat destruction, soil degradation and loss, and enormous greenhouse gas emissions contributing to global warming are undisputed.[1] In BC, as elsewhere, food price increases, food insecurity, diet-related disease, and the economic marginalization of farmers and loss of revenue from the local economy is also of concern.[2] In Southwest BC, we spend an estimated $8.6 billion on food annually,[3] but much of this does not stay in the local economy because it is spent on imported food or in non-local food system businesses.

Climate change, food and energy price instability, and dietary preferences are limiting the capacity of our food system to provide sufficient food. Our food system future seems tenuous, and perhaps the only thing we know for certain is that our population will continue to grow, requiring more food to sustain it. We need to purposefully address the challenge of providing food for all, in sustainable ways, well into the future.

A sustainable future requires a sustainable food system.

Some argue that localizing food systems will better ensure a sustainable, resilient food supply into the future. Local food systems are characterized by greater food self-reliance, which is defined as the ability to satisfy local food needs with food grown locally. Local food systems are purported to have greater social benefit,[4] reduce negative environmental impacts associated with bringing food from farm to plate,[5] improve community health, nutrition, and food safety,[6] and strengthen economies.[7]

In BC, food security experts have identified food self-reliance as a key climate change adaptation strategy[8] and argue that increasing local fruit and vegetable production capacity makes sense in a future where imports may not be as available or as cheap.[9]

Organizations across the province have mobilized around the themes of food, land, culture, and ecological sustainability. Increasingly, local governments and the private sector are supporting local food systems as vehicles for community and economic development. In Southwest BC, many local governments have introduced policies supportive of food system localization and residents are increasingly interested in the concept.

Despite a growing interest in food system localization, there remains little information about how or to what degree it can realistically address our food system sustainability concerns. We are at a critical moment in history where issues of climate change, food security, energy, and local economics are rapidly converging. The choices we make about our food system could potentially mitigate some of these issues or make them worse. Good information is needed to help us make decisions about our future.

Chapter 2

Sustainable Food System Design

The Project

This multidisciplinary food system design project was initiated to explore the food self-reliance, environmental stewardship, and economic potential of a local food system in the Southwest BC bioregion. This bioregion is a highly productive and important Canadian agricultural area, one of Canada's largest and fastest growing metropolitan areas, and a place similar to other North American jurisdictions where agricultural and food system capacity is threatened by competing economic interests.

This project aimed to provide regionally specific, data-driven information about:

- the potential to increase Southwest BC food production and processing for local markets
- whether and to what extent increasing local food production could improve food self-reliance, benefit the provincial economy, and create jobs
- the detrimental environmental impacts of food production in Southwest BC and strategies to reduce them

The project modelled a number of different future food system scenarios that represent the possible outcomes of choices we face. When compared to our current situation, these future scenarios can be used to help identify and understand the impacts of our decisions, the options and outcomes that we could seek to achieve, and those we would like to avoid.

What Is a Food System?

When we talk about food—its origin and availability, quality and safety, and how it affects our lives and communities—we tend to immediately focus on agriculture and defer to the farming sector for information, answers and direction. But farming is only one component. Food system characteristics and outcomes are dependent on many other multi-faceted, extensive, and interdependent elements that are as equally important as farming.

Indeed, it is increasingly acknowledged that the direction and outcomes of our food system should not reflect agriculture and food business interests alone. The American Planning Association, in its 2007 Policy Guide on Community and Regional Food Planning, had this to say: “Food is a sustaining and enduring necessity. Yet among the basic essentials for life—air, water, shelter, and food—only food has been absent over the years as a focus of serious professional planning interest. This is a puzzling omission...”[10]

Many are becoming aware of the concept of food systems. Examination and discourse around food’s relationship to community, economy, and environment has shifted from agriculture to the food system as a whole. Lisa Chase and Vern Grubinger describe a food system as “an interconnected web of activities, resources and people that extends across all domains involved in providing human nourishment and sustaining health, including production, processing, packaging, distribution, marketing, consumption and disposal of food.” The authors go on to say that our food systems are reflective of and responsive to the social, cultural, economic, health, and ecological conditions in which they exist. These interacting conditions occur or are imposed at multiple scales, from national and provincial to city and household. These conditions, regardless of scale, must be compelled to work in concert to achieve the characteristics and outcomes of the food system we want for our communities and a sustainable future.[11]

What Is a Bioregion?

Bioregions are generally defined as areas that share similar topography, plant and animal life, and human culture; they are not just geographical or political areas delineated by lines on a map but are conceptual as well. Bioregionalism adheres to the notion that human settlement and land use patterns must be viewed as integral, functional components of ecosystems rather than as separate, unrelated entities.[12]

The Southwest BC Bioregion

Sustainable agriculture and food systems should be fully linked to and reflective of the ecology and environmental capacity of where they occur. Therefore, food systems should be assessed and planned for at the bioregional scale.

While a bioregion may be broadly characterized by natural boundaries, the inclusion of human components such as municipalities, regional and electoral districts, transport routes, land use patterns, and traditional hunting and gathering areas are necessary to delineate boundaries that are meaningful to a bioregion's inhabitants.

The Southwest BC bioregion includes Metro Vancouver, the Fraser Valley, Squamish–Lillooet, Sunshine Coast, and Powell River Regional Districts, and traditional territories of the Coast Salish Peoples.[13]

Scenarios

Scenarios are data-driven stories created to explore the relationships between factors in a system and to illustrate the outcomes of different decisions. Scenarios do not predict what will happen nor prescribe a particular approach.

A baseline and four future scenarios were modelled. The Baseline reports on the current food system status. The four future scenarios include an assumed 60% increase in population from the Baseline, and each explores a different possibility for localizing the Southwest BC bioregion's food system in 2050.

By 2050, the impacts of population growth and climate change on our local food system will be evident. Near enough to plan for, 2050 is also far enough away that we can start now for effective food system planning and action to implement our preferred food system future and have enough time to realize ambitious, meaningful goals.

Food System Scenario Modelling

To explore food system futures in the Southwest BC bioregion, ISFS developed a computational model of agricultural land use and associated food self-reliance and environmental outcomes. The model used optimization methodology and the best available data.

2011 Baseline

The Baseline reports on the current impacts and outcomes of food production in the Southwest BC bioregion, using data from the Census of Agriculture (2011). It provides a reference point against which outcomes from future scenarios can be compared.

2050 Business-as-Usual Food Production (BAU)

The first future scenario explores a future food system in which the only change from 2011 is an increased population. This scenario illustrates the food self-reliance, environmental, and economic outcomes of maintaining the current allocation of crop and livestock production.

2050 Increase Food Self-Reliance (Increase FSR)

The second future scenario explores a future food system in which the only change from the BAU scenario is the strategic reallocation of crop and livestock production to meet local food need and increase food self-reliance. The aim of this scenario is to satisfy as much of the bioregion's 2050 food need as possible, without expanding land in food production.

2050 Mitigate Environmental Impacts from Agriculture (Mitigate Impacts)

The third future scenario builds upon the second, Increase FSR, to explore a future food system that mitigates some of agriculture's key environmental impacts. Changes from the Increase FSR scenario are the implementation of a nutrient balance (nitrogen and phosphorous) and habitat enhancements (hedgerows and riparian buffers).

2050 Expand Agricultural Land in Production (Expand Land)

The fourth future scenario builds upon the third, Mitigate Impacts, to explore a food system in which currently unfarmed but arable land is brought into food production. The only change from the Mitigate Impacts scenario is an increase in the amount of agricultural land under production. Crop and livestock production continue to be reallocated to increase food self-reliance and measures to mitigate environmental impacts continue to be implemented.

Indicators

Indicators provide specific information on the outcomes and impacts of the modelled food system scenarios. Indicator values are not predictive of the future. Rather, they represent the value of a particular set of variables that has been modelled for illustrative purposes.

For each scenario, this project modelled 15 indicators in the areas of food production and ecological and economic impact.

No data is available on how much of the food produced in Southwest BC is consumed within the bioregion and how much is exported. Similarly, no data is available on how much of the food imported to the bioregion is consumed in Southwest BC, as some of it may be sent on to other regions. The amounts reported here assume that the bioregion's population chooses to consume local products over imported products whenever possible. Therefore, the reported amounts of food production for the local market are likely to be greater than what actually occurred. Likewise, the reported amounts of food imports are likely to be smaller than what actually occurred.

Economic Multipliers

An economic multiplier is a factor that describes the extent to which a change in one economic activity impacts other dimensions of the economy. The larger the multiplier, the greater the economic impact. The value of a multiplier is impacted by factors such as the types of industries affected by the change, the nature of linkages between those industries, and their labour–capital ratio. In general, larger multipliers result when industries use a high percentage of local inputs. Labour-intensive industries may result in larger employment multiplier.

Food Self-Reliance

Food self-reliance measures the proportion of the population's diet that could be satisfied by locally produced food. It compares the quantity and types of food in the diet of the bioregion's population (the food need) to the quantity and types of food produced there. To measure food self-reliance for this project, it was assumed that all food produced in the bioregion is consumed there, and that any food produced in excess of the population's need for that food is exported. It was also assumed that livestock are fed with imported grain feed but locally produced hay and pasture. The measure is based on a diet that satisfies average Canadian food preferences and Canada's Food Guide recommendations. In this project, we measured food self-reliance for the land-based components of the diet only.

Ecological Footprint

The ecological footprint of food consumption measures the area of biologically productive land and sea (biocapacity) required on an ongoing basis to meet the population's food need and to absorb associated carbon emissions. Measured in global hectares (gha), ecological footprint accounts for all of the food consumed: foods grown locally plus food imported from outside the bioregion. Food grown in the bioregion for export (any food produced in excess of the population's need for that food) is not included in the bioregion's ecological footprint.

Greenhouse Gas Emissions

Greenhouse gas emissions measure the amount of greenhouse gases, expressed as carbon dioxide equivalents (CO_2e), produced as a result of agricultural production on land within the bioregion. It includes emissions from on-farm fossil fuel use, manure or synthetic fertilizer applied to crops (including livestock feed crops), manure management, and enteric fermentation (digestion) in ruminant livestock. It does not account for emissions from food that is imported.

Carbon Stocks

Carbon stocks measure the amount of carbon dioxide equivalents (CO_2e) stored in the aboveground woody parts of non-production perennial vegetation (trees and shrubs). This carbon was previously in the atmosphere. When woody vegetation is cleared from the land, it is assumed that associated carbon stocks are lost as carbon dioxide to the atmosphere where they contribute to global climate change. Carbon stored in the soil and belowground portions of perennial vegetation are not accounted for in this project.

Wildlife Habitat Capacity

Wildlife habitat capacity measures the overall value of an area as habitat for regional species. It is determined by 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 modelled agricultural land only.

Habitat Connectivity

Habitat connectivity measures the distance wildlife can travel via non-production perennial vegetation through the agricultural landscape. It is determined by the size and distribution of non-production perennial vegetation, measured using representative sample areas within the bioregion. It is a relative indicator that can be used to compare scenarios. Connectivity is a critical aspect of habitat quality; isolation of important habitats, such as forest stands, leads to greater risk for wildlife populations. Ideally, connectivity would allow wildlife to move through an agricultural landscape with little need to enter human-dominated areas.

Nutrient Surplus (N and P)

Nutrient surplus measures the quantity (kilograms per hectare) of nitrogen and phosphorous contained in the manure of livestock raised in the bioregion relative to the quantity of those same nutrients needed for crop production in the bioregion. A nutrient surplus can be an environmental pollutant.

Food Production

Food production measures the commodity weight of crop and livestock products grown and raised on farms in the bioregion. Amounts represent the weight of raw food products at the time of farm gate sale.

Food Imports

Food imports measures the commodity weight and monetary value of crop and livestock products imported to meet food need not satisfied by local production. Food imports represent a loss of economic opportunity from Southwest BC.

Total Employment

Total employment measures the number of full-time equivalent positions (FTEs). It accounts for seasonal/temporary, year-round, part-time, and full-time positions. FTEs are calculated based on a full-time employee working 35 hours per week for 50 weeks (1,750 hours) per year.

Total Output

Total output measures the monetary value of raw and processed food products produced in the bioregion as well as goods and services from all industries associated with food production in the bioregion.

Total Gross Domestic Product

Total gross domestic product (GDP) measures the unduplicated 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.

Total Employment Income

Total 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.

Total Tax Revenue

Total tax revenue measures the value of federal, provincial, and municipal tax revenue collected from individuals and businesses involved in the Southwest BC 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.

Economic Analysis

The challenge of estimating economic impacts of any future food system is that there are many unknowns. Our economy is ever-changing and influenced by complex linkages between industries, fluctuating costs, dynamic demand and supply, and an evolving policy environment. As our economic activities change in the future, the relationship between these components will change as well.

The 2011 Input-Output (I-O) Model, developed and run by BC Stats, was used to model estimates of economic impacts. The model assumes a static environment, estimating what impacts would result from the modelled activities if they had occurred, in this case, in 2011 (with 2011 dollar value). Economic results presented here are therefore not predictive of future economic impacts. Rather, they can be used to compare across scenarios based on performance in 2011's economic environment.

I-O modelling is a widely used, data-informed methodology for economic analysis. The I-O model categorizes economic impacts into three types: direct, indirect, and induced.

- Direct impact measures economic activity in BC that results from crop and livestock production and food processing that occurs in Southwest BC.
- Indirect impact measures economic activity in BC that results from supplier industries in the production chain in BC.
- Induced impact measures economic activity in BC that results from food production and supplier industry employees spending their earnings in BC.

Indicator names that include "total" measure the sum of direct, indirect, and induced impacts.

2011 Baseline

Population: 2.7 million people
Food need: 2.6 million tonnes
Food produced: 1.1 million tonnes
Arable land: 165,000 hectares
Land in production: 101,000 hectares

Current Context

Southwest BC comprises densely populated urban zones surrounded by more sparsely populated peri-urban and rural areas.

The bioregion has approximately 165,000 hectares of arable land (class 1–6 lands). This is land in the Agricultural Land Reserve and Crown land suitable for farming or grazing. In 2011, an estimated 101,000 hectares were in production.

Southwest BC's relatively warm, wet weather, little variation in monthly temperature, and fertile soils make it a prime agricultural area. It is currently a major centre for the production of dairy, eggs, turkey, and chicken, all of which are supply-managed commodities. Supply management is a system that helps better ensure that food supply meets demand, and that farmers receive prices that cover their costs of production and provide adequate profit.

The bioregion is also a major producer of cranberries, blueberries, raspberries, greenhouse vegetables, potatoes, and various other horticultural crops. The production and sale of greenhouse vegetables, vegetables for processing, and storage crops are regulated by the BC Vegetable Marketing Commission.

Land Classes

Lands in Canada are categorized into seven classes based on their suitability and potential for agriculture. Class 1–4 lands can be used for a wide range of crops. Class 5–6 lands can only be used for pasture. Class 7 land is not suitable for any agricultural use.

Agricultural Land Reserve

Established in 1973, the Agricultural Land Reserve (ALR) is a provincial zoning designation in which agriculture is recognized as the priority use and non-agricultural uses are controlled. Despite this, urban, industrial, rural residence, and other non-farm uses continue to threaten farmland. Private and publicly owned ALR parcels, for example, can be removed from the ALR on a case-by-case basis through an exclusion application process.

In 2014, controversial legislation was passed that split the ALR into two zones. Additional non-farm uses are now permitted in Zone Two, which makes up 90% of provincial ALR land.[14] Reclassification of ALR lands into two zones demonstrates that the legislation is subject to change and represents a serious erosion of the ALR's mandate to preserve agricultural land and encourage farming. This will ultimately erode provincial food security capacity.

Southwest BC's ALR land is primarily in Zone One. A small area in the Squamish–Lillooet Regional District is in Zone Two.

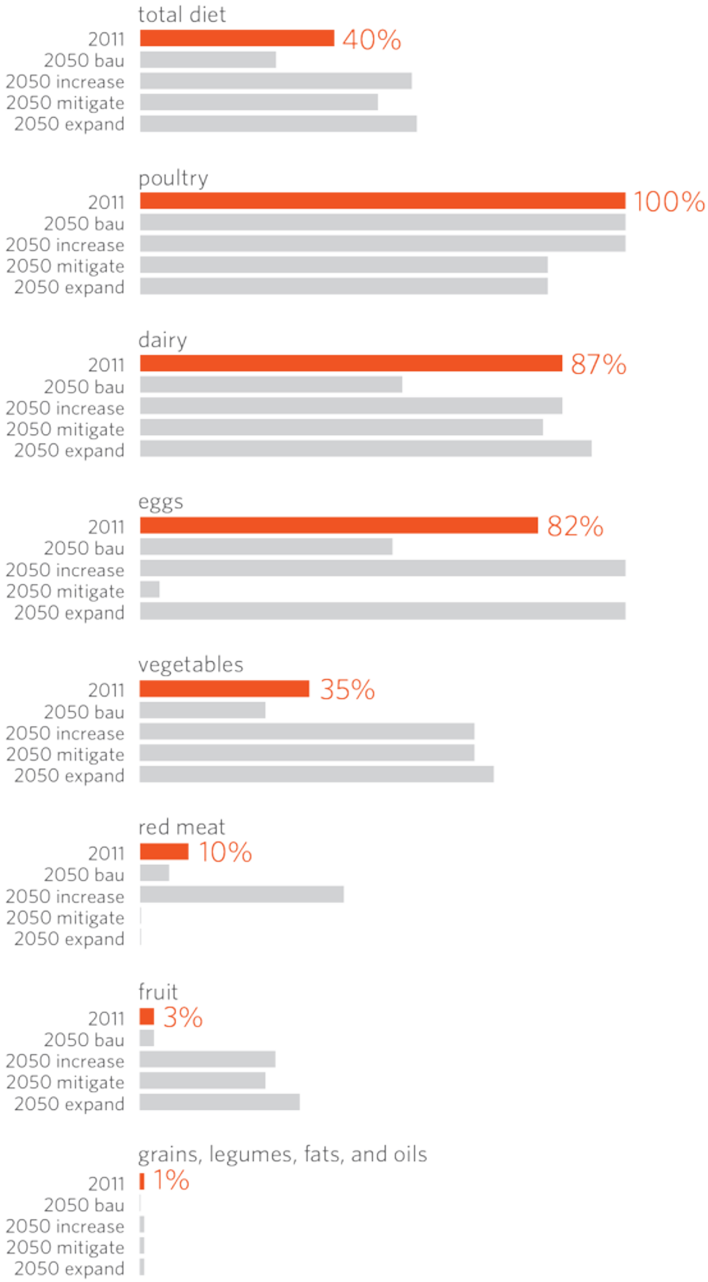
Food Self-Reliance: 40%

Food self-reliance in Southwest BC can be broken down by food commodity. Relatively high levels of self-reliance in dairy (87%), eggs (82%), and poultry (100%) reflect the regional dominance of these supply-managed commodities. Self-reliance in red meat (pork, beef, and lamb) is low (10%).

Vegetable production is significant in the bioregion, with vegetable self-reliance at 35%. However, self-reliance in fruit is very low (3%), in part because food need includes many tropical and subtropical fruits that are not grown in Southwest BC. Self-reliance in grains, legumes, fats, and oils is even lower (1%) and is unlikely to change in the future without substantial intervention—given that the bioregion's climate is well suited to fruit and vegetable crops, that fruits and vegetables command higher revenues per acre, and that the price of agricultural land is so high.

Food Self-Reliance

Percentage of diet that could be satisfied by locally produced foods



Self-Reliance and Livestock Feed Imports

The source of livestock feed greatly influences food self-reliance calculations. In 2011, the crop mix in Southwest BC included very little livestock feed grains, which made the bioregion very dependent on imported feed. With imported feed, Southwest BC was able to raise enough livestock to achieve 100% food self-reliance in poultry, 87% self-reliance in dairy, 82% self-reliance in eggs, and 10% self-reliance in red meat. Comparatively, without imported feed the bioregion could have achieved only 10% self-reliance in dairy, and insufficient feed would have been available to raise other livestock, resulting in 0% self-reliance in poultry, eggs, and red meat.[15]

The implications of livestock self-reliance on that of the whole diet are striking. By relying on imported feed, Southwest BC was able to achieve 40% food self-reliance for the whole diet. If imported feed had not been available, total dietary self-reliance would have been only 12%.[16]

Dependence on livestock feed imports from other regions is not unique to Southwest BC. It is consistent with a global trend toward the decoupling of livestock production from a local land base, which has drastically shifted global patterns of land and water use as well as shifted the production of nutrients from animal manures away from a balance with crop need.[17] Southwest BC exemplifies these shifts: the concentration of livestock operations in the Fraser Valley Regional District, enabled by feed imports, is a source of ongoing environmental concern as it has been linked to nitrogen contamination of groundwater.[18]

Measures of food self-reliance in the 2011 Baseline scenario and all 2050 scenarios include livestock feed imports. However, whether or not importing feed can be thought of as a truly self-reliant practice is debatable.

Ecological Footprint: 2.6 million gha

The ecological footprint of all food consumed in the bioregion, whether produced locally or imported, is 2.6 million gha; this much biologically productive land and sea is required to meet the bioregional population's current food need and absorb associated carbon emissions. This amounts to 0.97 gha per person, which is over half of the fair Earth share each person has to meet their needs for shelter, transportation, clothing, food, and services.

Greenhouse Gas Emissions: 800,300 t CO_2e

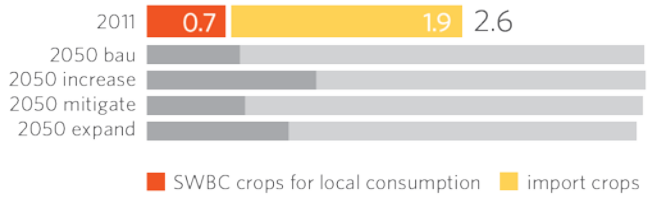
At 800,300 t CO_2e emissions per year, Southwest BC agriculture contributes 40% of the province's total greenhouse gas emissions from agriculture.

Carbon Stocks: 5.3 million tonnes

Forty percent of agricultural land in Southwest BC is covered with non-production perennial vegetation (trees and shrubs), amounting to 5.3 million tonnes of stored carbon. The value of these carbon stocks is 24.3 times greater, on average, than the annual greenhouse gas emissions of all Southwest BC food production. These stocks represent significant capture of greenhouse gases and mitigation of climate change.

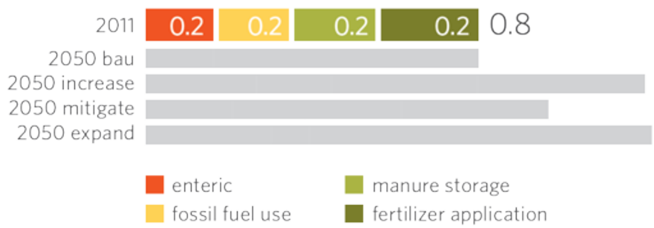
Ecological Footprint

Global hectares required to meet the food need of SWBC's population, in millions



Greenhouse Gas Emissions

Tonnes of CO_2e emitted annually from SWBC agricultural production, in millions

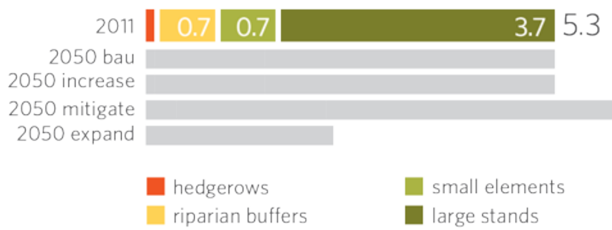


Sensitive Habitats

Much of Southwest BC's farming takes place on the nutrient-rich soils beside rivers and other waterways. These riparian zones are bio-diverse, sensitive areas that that provide habitat for many species. Farming in riparian zones compromises or eliminates critical habitat, contributes to silting in of waterways and exacerbates the potential for detrimental agrichemical contamination of our waters—all of which negatively impact ecological integrity and biodiversity.

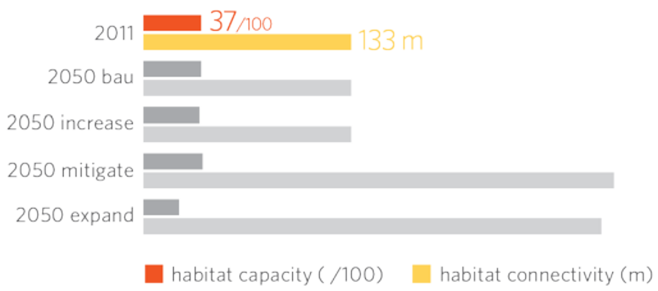
Carbon Stocks

Tonnes of carbon stored in non-production perennial vegetation, in millions



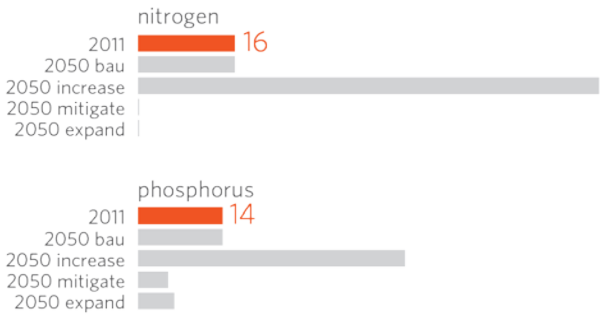
Habitat Capacity and Connectivity

Quality of land cover for wildlife



Nutrient Surplus

Surplus nitrogen and phosphorus from animal manure, in kilograms per hectare



Wildlife Habitat Capacity: 37/100 (Low)

Agricultural crops and non-production perennial vegetation on farms contribute habitat for wildlife. In Southwest BC, contiguous forest stands are the most important type of habitat; wetlands, pastures, berry crops, and riparian grasslands are used less frequently or by fewer species; and agricultural fields used for annual crops are the least valuable type of habitat in the bioregion.[19] Agricultural land uses have replaced what was once important habitat, resulting in overall low wildlife habitat capacity on the bioregion's agricultural land.

Habitat Connectivity: 133 metres

Habitat connectivity within actively farmed land in the bioregion is limited. Sampling has indicated that wildlife are only able to move an average of 133 metres before encountering a break in habitat. This is because agricultural fields have insufficient patches of non-production perennial vegetation, which are important corridors for wildlife movement. This lack of connectivity between habitats prevents wildlife from accessing important locations for feeding and breeding and increases the likelihood that they must enter or cross areas used intensively by humans.

Nutrient Surplus: N +16 kg/ha, P +14 kg/ha

In 2011, both nitrogen and phosphorus from manure production were found in modest surplus across Southwest BC. While these values seem to suggest that manure production and crop requirements are nearly in balance across the bioregion, measuring at this scale obscures the fact that animal production is concentrated within some parts of the bioregion. With such concentrated areas, and with the amount of fertilizers that are likely being applied across the bioregion, large quantities of nutrients are being lost to the environment.

Water Quality

An earlier project (2001) found large areas in the Fraser Valley had surplus nitrogen applications in excess of 120 kg/ha per year, in some areas as high as 300 kg/ha per year, and suggested that a nitrogen surplus of 100 kg/ha per year is the upper limit for minimizing water quality impacts.[20] These types of surpluses have been linked to nitrogen contamination of the Abbotsford–Sumas aquifer, an important drinking water source within the bioregion.[21] Modelling of soils around this aquifer has predicted that applications of synthetic fertilizer at a rate as low as 46 kg/ha could result in 10 mg of nitrogen per litre loaded at the water table,[22] which is the maximum allowable concentration according to the Canadian Drinking Water Guidelines.

Agriculture and Greenhouse Gas Emissions

Each type of greenhouse gas makes a different contribution to global warming, depending on its capacity to trap heat. Agriculture generates large amounts of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4), and the latter two gases are particularly potent. One unit of methane is 28–36 times more potent a greenhouse gas than carbon dioxide, and nitrous oxide is 265–298 times more potent.

Agriculture is a major contributor to global greenhouse gas emissions.[23] The largest sources of global agricultural emissions are from enteric fermentation from digestion (methane) in ruminant animals like dairy cows and beef cattle at 40% of agricultural emissions, manure left on pasture (nitrous oxide and methane) at 16% of emissions, and use of synthetic fertilizers (nitrous oxide) at 13%.[24] In Canada, agricultural production is one of the largest contributors to national greenhouse gas emissions, contributing 8% of total Canadian emissions in 2013.[25] In British Columbia, the agriculture sector is responsible for 3% of annual provincial emissions—approximately 2 million tonnes CO_2e per year.[26]

These figures capture the emissions from agricultural production only. Additional greenhouse gases, mostly carbon dioxide from fossil fuel use, are emitted in the processing, packaging, and transportation of food. It has been estimated that, globally, the food system contributes as much as half of all human-produced greenhouse gases.[27]

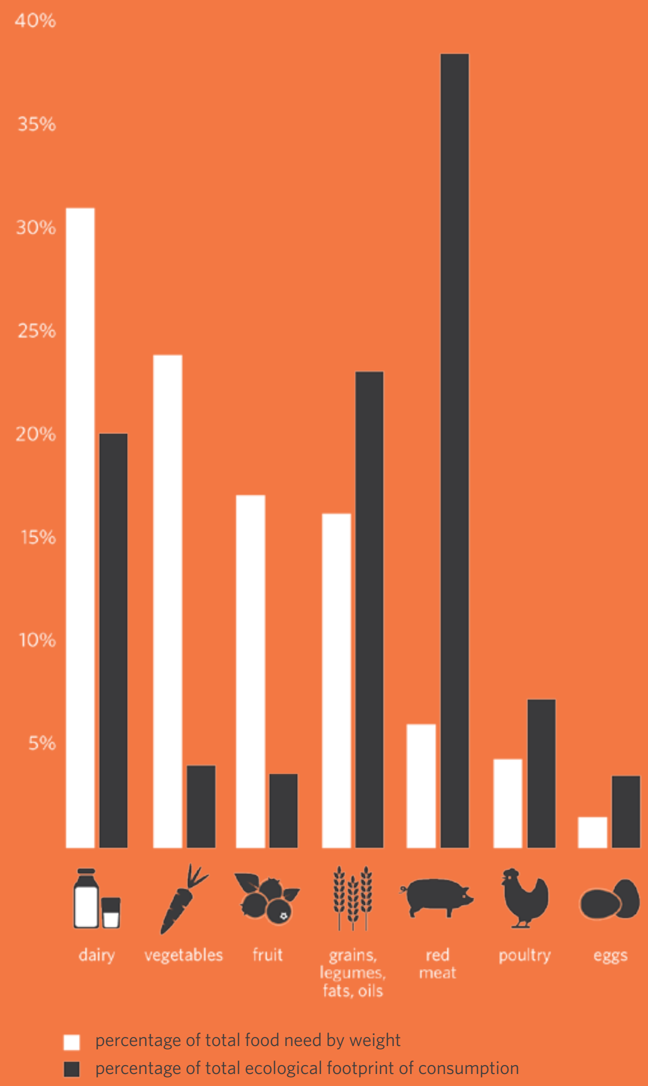
Food Need and Ecological Footprint

The bioregion's food need is met with foods produced locally and imported. The ecological footprint per tonne of food commodity may be smaller for some local foods (milk, eggs, many vegetables), but for other foods the import may have the smaller footprint (many fruits, red meat, grains). The reason is usually yield.

However, the difference in ecological footprint between local and imported foods plays a smaller role in the total footprint of food consumed than does dietary preference. Red meat, for example, makes up 38% of the ecological footprint of bioregional food need, but only 6% of food need by weight. One tonne of beef (no matter where it is produced) has an average footprint of about 9 gha while one tonne of fruit has an average footprint of 0.38 gha, and the average vegetable, 0.24 gha.

When we grow food locally, it may not dramatically reduce the ecological footprint, but it allows us to take more direct responsibility for the environmental impacts of our food consumption.

Food Group Contribution to Total Food Need and Ecological Footprint of Consumption



Food Production: 1.1 million tonnes

Southwest BC agricultural products go to two markets—the local (bioregional) market and the export market. In 2011, the bioregion produced 1.1 million tonnes of food. If we assume that residents chose locally produced food over imports, to satisfy food need Southwest BC would have sold 79% (856,000 tonnes) of its product in the local market. The remainder, which exceeded bioregional food need, would have been exported.

Food Imports: 1.8 million tonnes

While producing food for local and export markets, Southwest BC simultaneously imports products. The food import necessary to meet outstanding food need in 2011 (the food need not met by local production) is estimated at 1.8 million tonnes, valued at $1.6 billion. This value represents a significant loss of potential economic activity in Southwest BC, and if captured could substantially enhance the local economy.

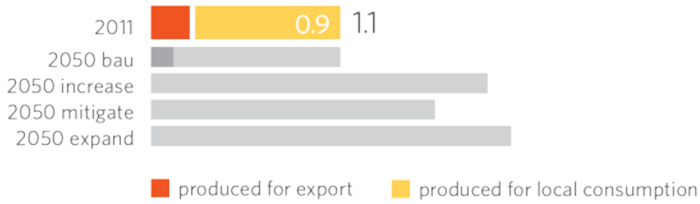
Total Employment: 16,580 FTEs

The production of 1.1 million tonnes of food and associated goods and services in 2011 required 16,163 employees. In agriculture, employees often work longer hours than is standard. Therefore, 16,580 full-time equivalents (FTEs) were associated with this number of employees.

Of the 16,580 FTEs, 40% were in agriculture, 28% were in food processing, and 32% were in all other linked industries. The employment multiplier was 8.65 FTEs (estimated): for every $1 million increase in the production of raw and processed food products in BC, 8.65 FTEs were generated.

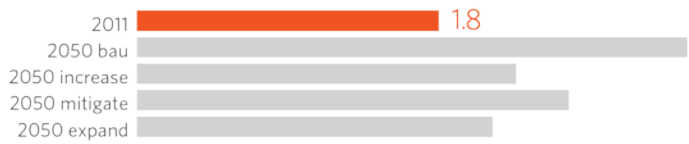
Food Production

Tonnes of food produced in SWBC, in millions



Food Imports

Tonnes of food imported to meet outstanding food need in SWBC, in millions

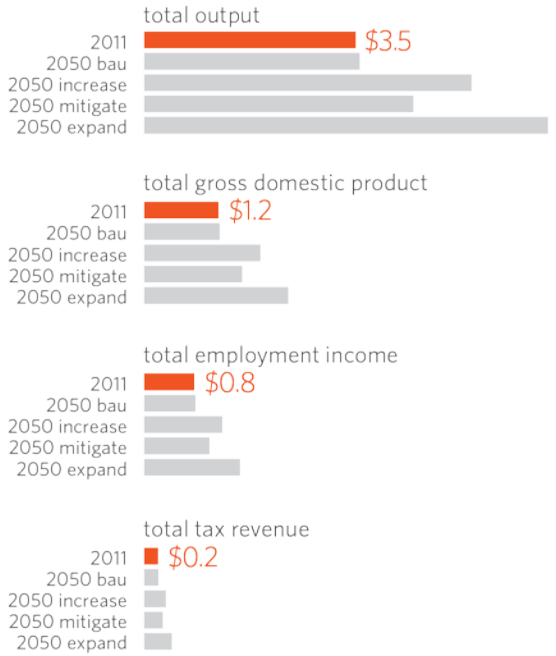


Total Employment

Number of full-time equivalent positions in agriculture and related industries

Financial Impacts

Dollar value of estimated impacts, in billions (2011 value)



Supplier Industries

Suppliers from across the province support food production in the bioregion. Direct suppliers include, for example, manufacturing (agricultural machinery and equipment), primary agriculture (nursery and poultry hatchery), and wholesale trade (sales of agricultural supplies and materials such as fertilizer and seed). Examples of indirect suppliers include transportation and warehousing, finance, insurance, real estate sales, and rental and leasing. Many industries are also stimulated as a result of employees' spending; these include retail trade, accommodation, and food services.

Total Output: $3.5 billion

The value of raw and processed food products (direct output) was $1.9 billion. Additionally, indirect output from all supplier industries generated $1.4 billion in goods and services, and employees in all related industries spending their earnings in the economy stimulated another $200 million in economic activity.

The total output resulting from food production in the bioregion was $3.5 billion. The total output multiplier was 2.82; for every $1 million increase in raw and processed food production, total output increased by $2.82 million.

Total Gross Domestic Product: $1.2 billion

The production of 1.1 million tonnes of food generated $1.2 billion in GDP: $603 million of direct, $501 of indirect, and $124 million of induced impact. The total GDP multiplier was 0.64 (estimated); for every $1 million increase in raw and processed food production, GDP increased by $640,000.

Total Employment Income: $834 million

Employment income in 2011, earned through wages and salaries, was $834 million. Of this, employees in primary agriculture earned $254 million. Fruit, vegetable, dairy, and meat processing employees earned $201 million, and employees in other industries earned $379 million. The income multiplier was 0.44 (estimated); for every $1 million increase in raw and processed food production, employment income increased by $440,000.

Tax Revenue: $230 million

In 2011, tax revenue of $230 million was distributed to the federal government ($133 million), provincial government ($76 million), and municipal governments ($21 million). The tax revenue multiplier was 0.12 (estimated); for every $1 million increase in raw and processed food production, tax revenue increased by $120,000.

2050 Business-as-Usual Food Production

Population: 4.3 million people
Food need: 4.2 million tonnes
Food produced: 1.1 million tonnes
Arable land: 165,000 hectares
Land modelled: 101,000 hectares

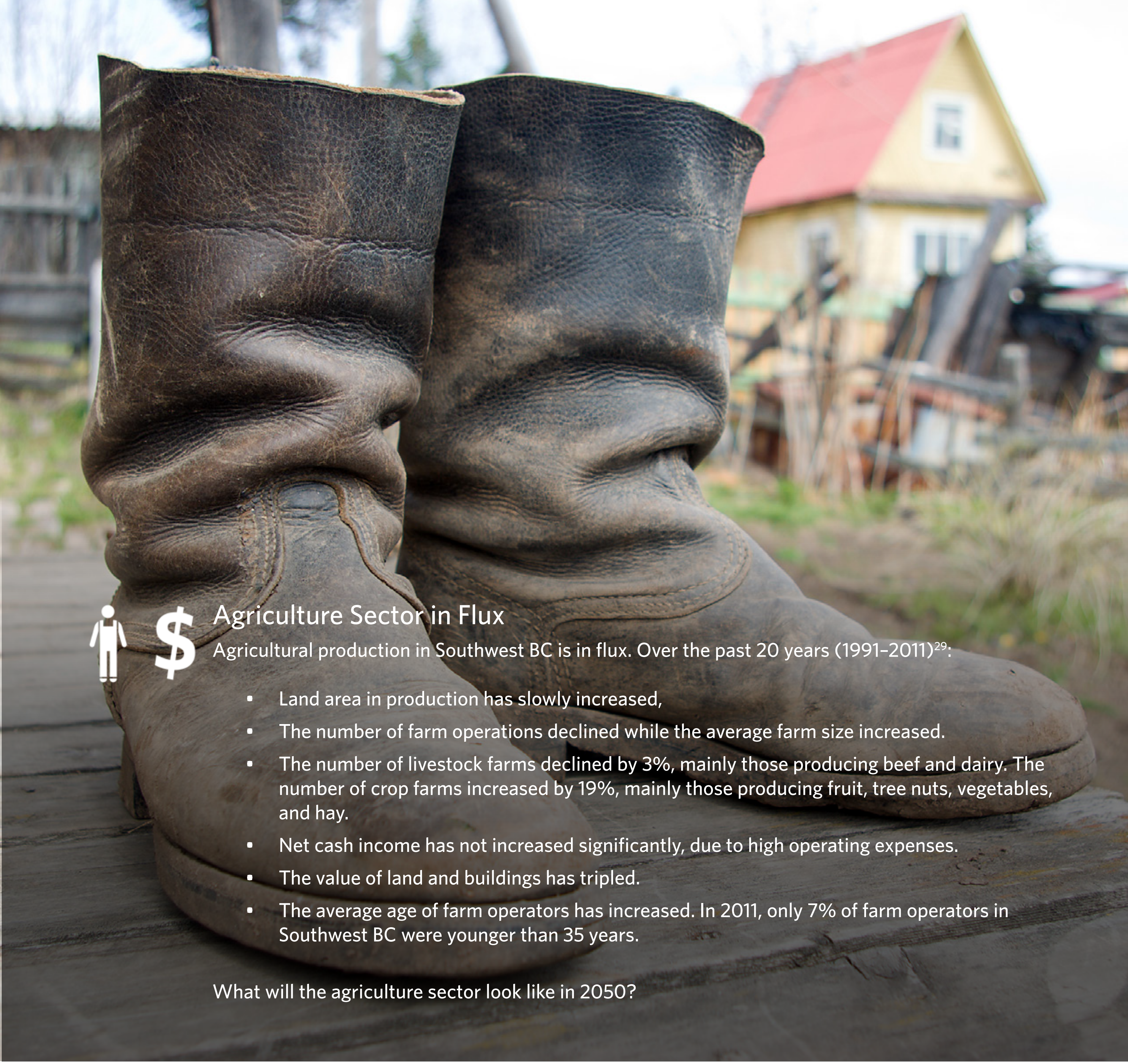
- allocated to production: 101,000 hectares (class 1–6 lands)

Future Context: An Increasing Population

In an imagined future where population and food need increase but the mix and amount of crops and livestock produced do not change, how would the bioregion fare?

Southwest BC's population is projected to increase by 60% over 2011 levels by the year 2050.[28]

This business-as-usual future scenario models outcomes based on agricultural land in production in 2011 continuing to be farmed in 2050 and used in the same way—farming practices, crop yield, and land requirements for livestock remain the same.



Agriculture Sector in Flux

Agricultural production in Southwest BC is in flux. Over the past 20 years (1991–2011)[29]:

- Land area in production has slowly increased,
- The number of farm operations declined while the average farm size increased.
- The number of livestock farms declined by 3%, mainly those producing beef and dairy. The number of crop farms increased by 19%, mainly those producing fruit, tree nuts, vegetables, and hay.
- Net cash income has not increased significantly, due to high operating expenses.
- The value of land and buildings has tripled.
- The average age of farm operators has increased. In 2011, only 7% of farm operators in Southwest BC were younger than 35 years.

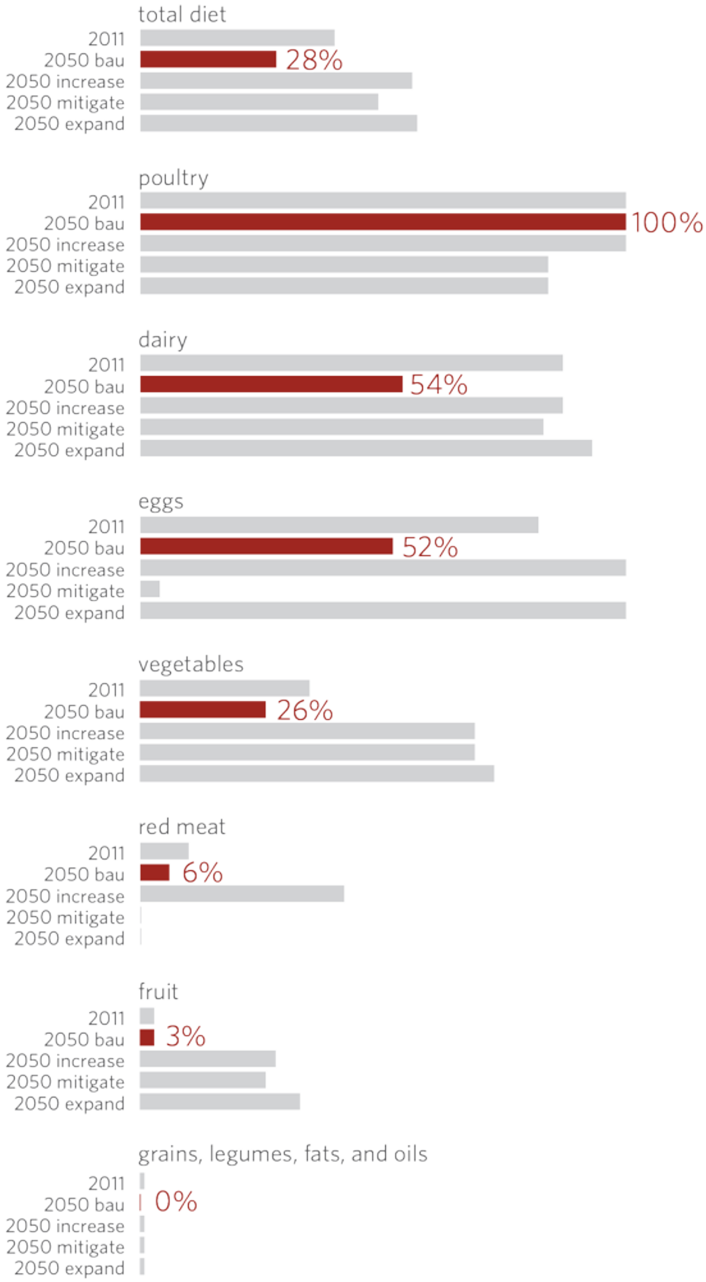
What will the agriculture sector look like in 2050?

Food Self-Reliance: 28%

With a larger population and greater food need, but no increase in food production, Southwest BC would experience a dramatic decrease in food self-reliance—falling from 40% food self-reliance in 2011 to only 28% in 2050. Food self-reliance decreases would occur across all food types with the exception of poultry, which was produced in excess of food need in 2011 and would remain at 100% self-reliance in 2050.

Food Self-Reliance

Percentage of diet that could be satisfied by locally produced foods



Calculating Food Need

Despite a widespread interest in dietary habits and food self-reliance, data that thoroughly and accurately track food consumption patterns at the local, provincial, or national levels do not exist. Food system researchers have used various methods to estimate food consumption or "food need." This project estimated food need by combining two datasets—one that tracks the stocks and flows of food commodities across the country and is a suitable proxy for Canadian food preferences, and one that provides nutrition recommendations to the Canadian public by age and sex.[30] Our method assumes that residents continue to eat foods that cannot be grown here (e.g., mango) and to eat fresh foods out of their season of local availability (e.g., fresh strawberries in January). To satisfy need for these foods, imports are required. The foods modelled included the following:

Fruits and Vegetables

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

Meat and Alternatives

Bean, canned
Beef
Chicken
Egg
Mutton and lamb
Peanut
Pork
Turkey

Milk and Alternatives

Buttermilk
Buttermilk, powder
Cheese, cheddar
Cheese, cottage
Cheese, processed
Cheese, variety
Chocolate drink
Milk, partly skimmed, 1%
Milk, partly skimmed, 2%
Milk, skim
Milk, skim, concentrated
Milk, skim, powder
Milk, standard, 3.25%
Milk, whole, concentrated

Fats and Oils

Butter
Margarine
Salad oils
Shortening

Grains

Barley
Corn flour and meal
Oats
Rice
Rye
Wheat

Ecological Footprint: 4.2 million gha

The biologically productive land that would be required to meet food consumption needs and absorb the associated carbon emissions in 2050 is 4.2 million gha—60% more than what was required in 2011. This reflects the nearly identical increase (59%) in food need required by the larger population. The per capita footprint increases slightly from 0.97 gha in 2011 to 0.98 gha.

Greenhouse Gas Emissions: 800,300 t CO_2e

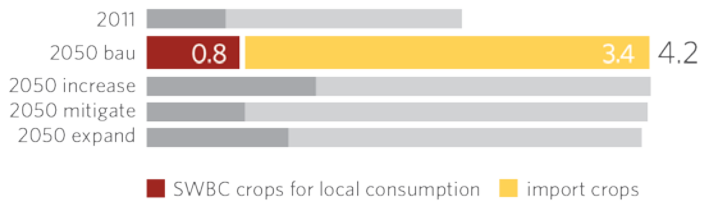
Greenhouse gas emissions in 2050 would be the same as in 2011: 800,300 tonnes CO_2e. Because specific agricultural land uses are unchanged from 2011, the same type and number of livestock are assumed to be present, and the same type and number of crops are assumed to be produced.

Carbon Stocks: 5.3 million tonnes

With agricultural land uses and land covers unchanged from 2011, 40% of agricultural land in Southwest BC would continue to be covered with non-production perennial vegetation (trees and shrubs), amounting to 5.3 million tonnes of carbon.

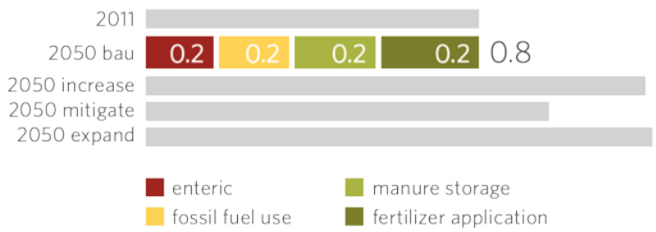
Ecological Footprint

Global hectares required to meet the food need of SWBC's population, in millions



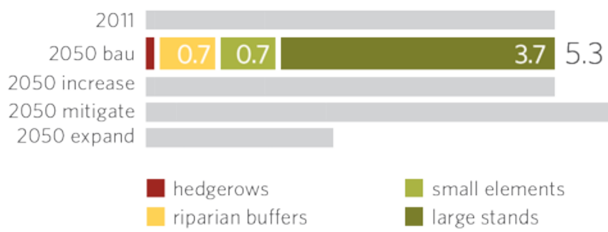
Greenhouse Gas Emissions

Tonnes of CO_2e emitted annually from SWBC agricultural production, in millions



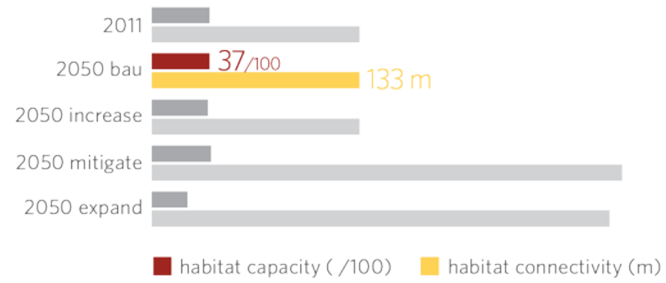
Carbon Stocks

Tonnes of carbon stored in non-production perennial vegetation, in millions



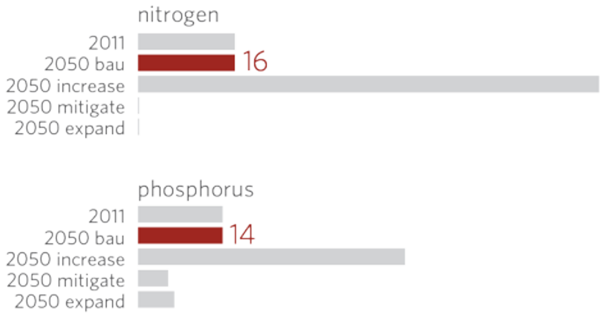
Habitat Capacity and Connectivity

Quality of land cover for wildlife



Nutrient Surplus

Surplus nitrogen and phosphorus from animal manure, in kilograms per hectare



Wildlife Habitat Capacity: 37/100 (Low)

Unchanged from 2011, the agricultural crops and non-production perennial vegetation on farms would continue to contribute habitat for wildlife at a low level.

Habitat Connectivity: 133 metres

Unchanged from 2011, wildlife would be able to move an average of 133 metres before encountering a break in habitat.

Nutrient Surplus: N +16 kg/ha, P +14 kg/ha

With no change in agricultural land uses from 2011, both nitrogen and phosphorus from manure production would continue to be found in modest surplus across Southwest BC. As in 2011, while these values seem to suggest that manure production and crop requirements are nearly in balance across the bioregion, measuring at this scale obscures the fact that animal production continues to be concentrated within some parts of the bioregion. It continues to be likely that, in these areas, large quantities of nutrients would be lost to the environment, contaminating groundwater.

Food Security and Insecurity

At the household level, food security refers to people's ability to access and afford sufficient nutritious, safe, and culturally appropriate food. When this is not achieved, food insecurity is experienced. Household food insecurity is an issue both globally and here at home, and it is clearly a socioeconomic problem, not an agricultural one.

The global food system produces more than enough food to feed the world's population. Yet approximately 800 million people suffer from hunger each year[31] and an estimated 3.1 million child deaths annually are the result of under-nutrition.[32]

Over 9% of Canadians are food insecure, and the rate is slightly higher in BC. Food insecurity is strongly correlated with socioeconomic status; those in lower income brackets, Aboriginal people, and single-parent families headed by women are far more likely to experience food insecurity. In the lowest income bracket, the rate of food insecurity in Canada is 50%. Food insecurity is also strongly correlated with the cost of housing; as housing costs rise, an individual's ability to buy food declines.[33]

At a community, regional, or national level, food security refers to the ability to feed a population. As we have globalized our food system, focusing on specialized commodity production for export markets, we have simultaneously lost our capacity to feed ourselves. Should the global system fail, food insecurity could be experienced on a large scale.

Farmland Price and a Sustainable Bioregional Food System

Increasing bioregional food self-reliance to the fullest extent will require farming more land. Many aspiring young farmers are ready, willing, and able to start farming, but are hampered in doing so because farmland is priced at levels higher than can be serviced by agriculture. In Metro Vancouver, farmland is priced at \$150,000 to \$350,000 per acre. Smaller parcels close to the urban boundary—those perfectly suited for start-up and small-scale, direct-market farming—are most expensive.

What is driving these high prices is unsubstantiated, but anecdotal evidence suggests that purchase for rural residences and speculation are major contributing factors. Farmland is being bought and sold for non-farming purposes, and agriculture simply cannot compete economically. Some offer that leasing farmland is a viable alternative to land ownership. Though leasing may be financially feasible, it does not enable the long-term planning and work necessary to develop a viable farm business or enable land stewardship.

To develop and sustain a robust bioregional food system in Southwest BC, we are going to have to deal with the issue of prohibitive farmland prices. Undoubtedly, doing so will require pointed, powerful policy and regulation.[34]

Food Production: 1.1 million tonnes

The amount of food produced and its farm gate value would be the same as in the 2011 Baseline scenario—1.1 million tonnes valued at $1.6 billion. However, more of the food produced in Southwest BC would be consumed locally due to changes in food need resulting from overall population growth as well as a demographic shift.

Food Imports: 3.2 million tonnes

Food imports would nearly double what was experienced in 2011 to 3.2 million tonnes valued at $2.9 million. This represents a sizable loss of potential economic activity in Southwest BC's economy, and an economic development opportunity to capture.

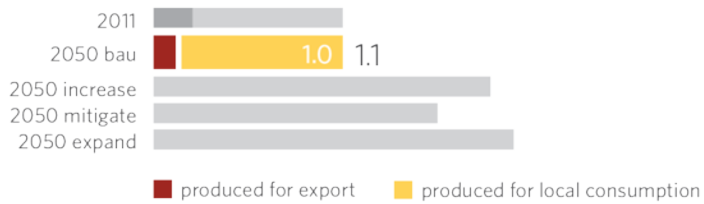
Total Employment: 16,879 FTEs

The production of 1.1 million tonnes of food and associated goods and services in 2050 would require 16,879 FTEs. This nearly 2% increase in the number of FTEs when compared with the 2011 Baseline scenario reflects a redistribution of raw and processed product to meet the change in food need.

The employment multiplier is estimated to be 8.60 FTEs; for every $1 million increase in the production of raw and processed products, 8.60 FTEs would be generated.

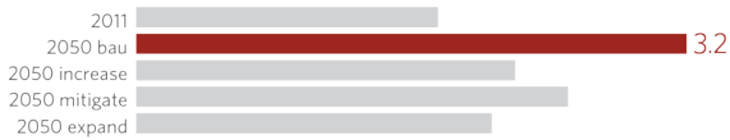
Food Production

Tonnes of food produced in SWBC, in millions



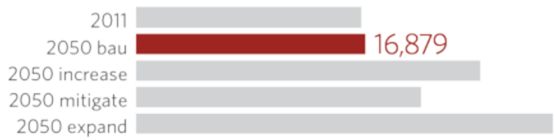
Food Imports

Tonnes of food imported to meet outstanding food need in SWBC, in millions



Total Employment

Number of full-time equivalent positions in agriculture and related industries



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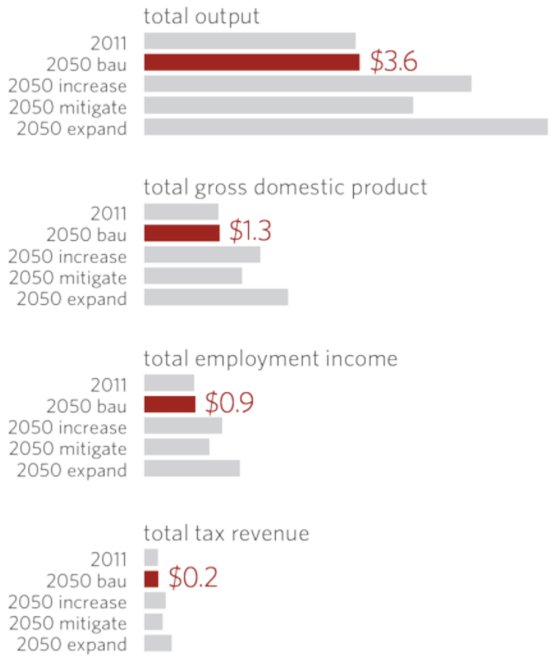
Financial Impacts

Dollar value of estimated impacts, in billions (2011 value)



Total Output: $3.6 billion

The value of raw and processed food products (direct output) would be $2.0 billion. Additionally, indirect output from all supplier industries would generate $1.4 billion in goods and services, and employees in all related industries spending their earnings in the economy would stimulate $204 million—totalling $3.6 billion. The total output multiplier is estimated to be 2.81; for every $1 million increase in raw and processed food production, total output would increase by $2.81 million.

Total Gross Domestic Product: $1.3 billion

The production of 1.1 million tonnes of food would generate $1.3 billion in GDP: $617 million of direct, $511 of indirect, and $127 million of induced impact. This slight increase over 2011 reflects the change in types of commodities exported as a result of a shift in food commodities consumed locally. The total GDP multiplier is estimated to be 0.64; for every $1 million increase in raw and processed food production, GDP would increase by $640,000.

Total Employment Income: $851 million

Employment income in 2050 earned through wages and salaries would be $851 million. Of this, employees working in primary agriculture would earn $253 million. Employees in fruit, vegetable, dairy, and meat processing would earn $208 million, and employees in other industries would earn $390 million. The income multiplier is estimated to be 0.43; for every $1 million increase in raw and processed food production, employment income would increase by $430,000.

Tax Revenue: $236 million

In 2050, tax revenue of $236 million would be distributed to the federal government ($136 million), provincial government ($78 million), and municipal governments ($22 million). The tax revenue multiplier is estimated to be 0.12; for every $1 million increase in raw and processed food production, tax revenue would increase by $120,000.

2050 Increase Food Self-Reliance

Population: 4.3 million people
Food need: 4.2 million tonnes
Food produced: 2.0 million tonnes
Arable land: 165,000 hectares
Land modelled: 101,000 hectares

- allocated to production: 87,000 hectares (class 1–6 lands)
- not allocated to production: 14,000 hectares (class 5–6 lands)

Future Context: Reallocating Food Production Activities

This future scenario tests whether a strategic reallocation of crop and livestock production activities across the modelled agricultural land base could meet more of Southwest BC's food need and therefore increase the bioregion's food self-reliance. The modelled land base in this scenario is the same as that in production the 2050 Business-as-Usual (BAU) scenario and the 2011 Baseline scenario, though only 87,000 hectares are ultimately allocated to production by the model. These lands can and should still contribute to a multi-functional agricultural landscape, through food production and provision of ecosystem services.

Reallocating production activities would allow the bioregion to produce more of the foods needed by its population. Food commodities that were produced in surplus and exported would have their production reduced, while commodities that were needed but under-produced in the bioregion would have their production increased. The goal is to increase food self-reliance without increasing the amount of land under production.

Land Availability and Use

Current feed regimes for beef, dairy, and lamb require hay produced on land classes 1–4 and pasture on land classes 1–6. Given this assumption, model results indicate that when production activities are reallocated to increase food self-reliance, all class 1–4 lands are required for food production; none is available for hay. Without hay production, livestock cannot be supported and therefore pasture is not needed, leaving some class 5–6 lands idle.

Class 5–6 lands that are idle can and should contribute to a multi-functional agricultural landscape and food production. For example, they could be strategically identified for retention or establishment of forest stands for carbon storage and improved wildlife connectivity. They could provide refuge and forage for pollinators and other insects that are beneficial to farming. They could even be used for 100% pasture-based livestock production, a method we did not model because it is not commonly used in Southwest BC currently.

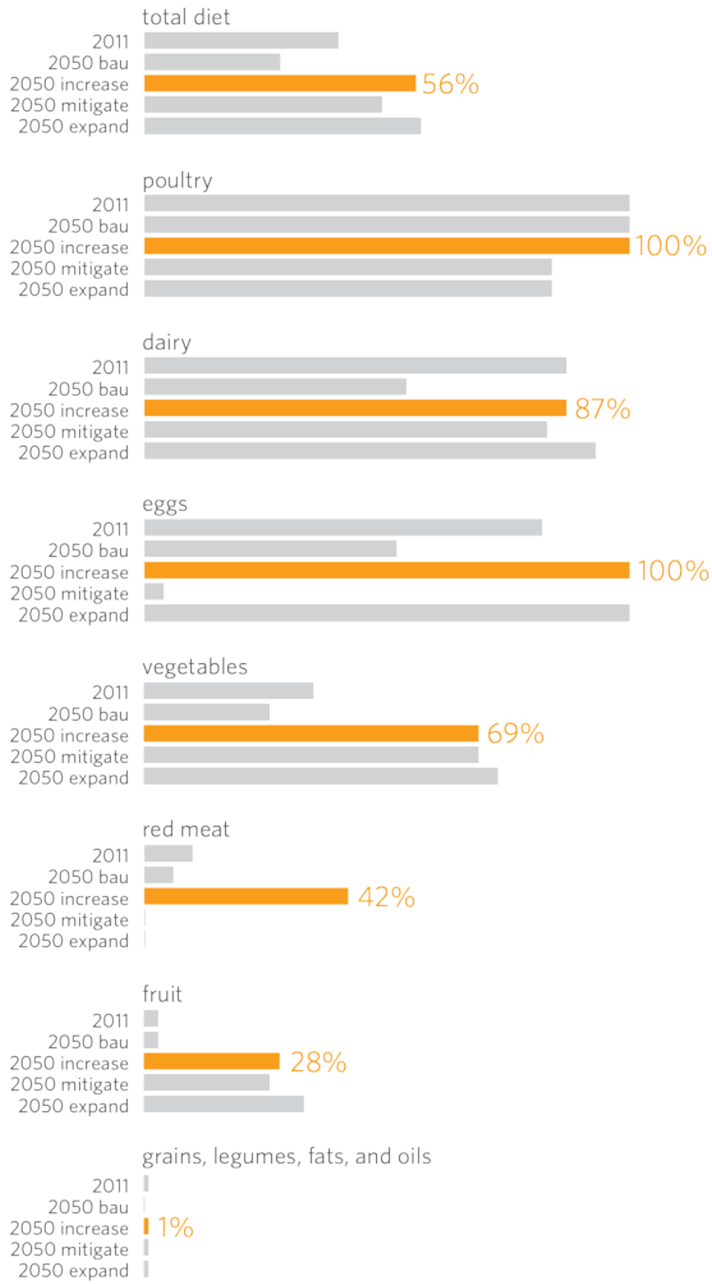
Food Self-Reliance: 56%

Reallocating crop and livestock production activities in Southwest BC with intent to increase food self-reliance would achieve 56% self-reliance—doubling the food self-reliance outcome of 2050 BAU scenario. Food self-reliance gains would be seen across all food types except grains, legumes, fats, and oils.

In this scenario, 100% self-reliance in eggs, poultry, and pork would be achieved on less than 1% of total land in production. Importing feed grain makes such intensive production possible—only barn space for the livestock would be required. Since we assume that local hay and pasture are required even when grain feed is imported, raising dairy cattle, beef cattle, and lamb requires more land.

Food Self-Reliance

Percentage of diet that could be satisfied by locally produced foods



Future Water Availability

Population and climate change in the Southwest BC bioregion will influence future water need and availability. Unless water-use practices change, water demand for domestic purposes and to supply industries such as agriculture will increase along with population increases in Southwest BC. Climate change projections for the area (through to the 2080s) suggest higher annual precipitation volumes with a seasonal shift: fall and winter becoming more wet and summers becoming drier.[35] Snow pack, which feeds rivers, streams, and irrigation lines, will be substantially less; water will be in shorter supply throughout the agricultural growing season.

Anticipated higher growing season temperatures, irrigation water shortages, and excessive springtime (planting) and fall (harvest) precipitation will affect agricultural productivity. More frequent severe storm and flooding events may also disrupt production.

Ecological Footprint: 4.2 million gha

Southwest BC's ecological footprint would remain the same as the 2050 BAU scenario at 4.2 million gha. Though proportions of various types of agricultural production activities have changed (and therefore the amounts of specific food commodities produced have shifted), the resulting total ecological footprint would remain effectively unchanged.

Greenhouse Gas Emissions: 1.2 million t CO_2e

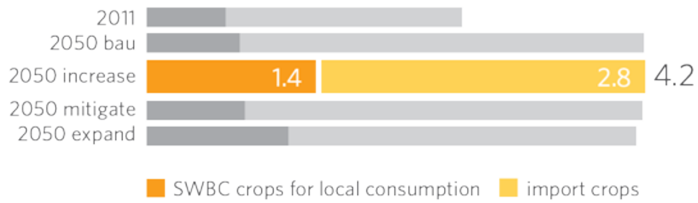
As a consequence of reallocating agricultural production for increased food self-reliance, greenhouse gas emissions associated with agricultural production would increase by about 50% over the 2050 BAU scenario to 1.2 million t CO_2e. Dairy, red meat, vegetables, and fruit are the commodities that contribute most to this increase.

Carbon Stocks: 5.3 million tonnes

With agricultural land uses and land covers unchanged from the 2050 BAU scenario (and the 2011 Baseline), 40% of agricultural land in Southwest BC would continue to be covered with non-production perennial vegetation (trees and shrubs), amounting to 5.3 million tonnes of carbon.

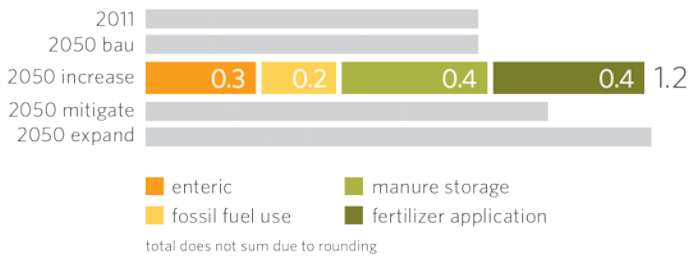
Ecological Footprint

Global hectares required to meet the food need of SWBC's population, in millions



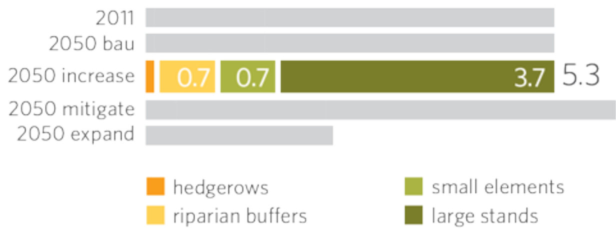
Greenhouse Gas Emissions

Tonnes of CO_2e emitted annually from SWBC agricultural production, in millions



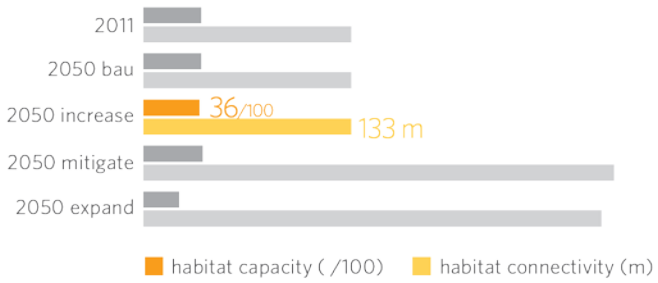
Carbon Stocks

Tonnes of carbon stored in non-production perennial vegetation, in millions



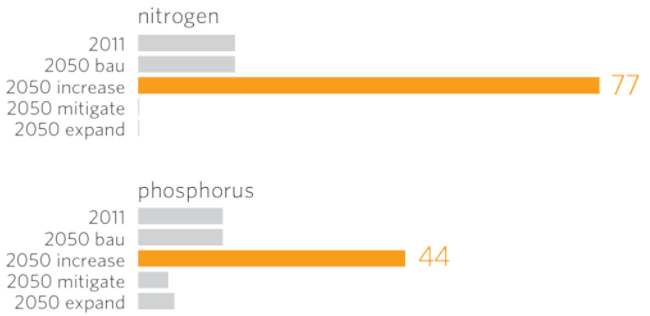
Habitat Capacity and Connectivity

Quality of land cover for wildlife



Nutrient Surplus

Surplus nitrogen and phosphorus from animal manure, in kilograms per hectare



Wildlife Habitat Capacity: 36/100 (Low)

Increasing food self-reliance would result in a negligible decrease to wildlife habitat capacity. Despite a tripling of the amount of land devoted to annual vegetable production compared to the BAU scenario, the amount of fallow agricultural land would increase by nearly six times, and though this reallocation of food production activities would result in a landscape that is less intensively farmed, the low quality of fallow land would not contribute substantially to the capacity for wildlife habitat.

Habitat Connectivity: 133 metres

Connectivity would remain low at 133 metres, as it was in the 2050 BAU scenario (and 2011 Baseline). Because no additional land is brought into production, increasing food self-reliance would not impact habitat connectivity. Low connectivity makes wildlife especially vulnerable to habitat disturbances.

Nutrient Surplus: N +77 kg/ha, P +44 kg/ha

The reallocation of production activities to increase food self-reliance would result in large nutrient imbalances: surplus nitrogen from livestock manure would increase by nearly 500% over the BAU scenario and 2011 Baseline to 77 kg/ha and surplus phosphorous would increase by over 300% to 44 kg/ha. These sizable nutrient surpluses would result from the large increase in manure and associated nutrients from increased livestock production without equivalent increase in the amount of nutrients required for crop production. Such a surplus would lead to serious impacts on air quality, drinking water resources, and aquatic habitat.

Ecological Footprint:

Why doesn't growing more local food reduce the size of the ecological footprint?

Increasing food self-reliance in Southwest BC has little effect on the size of the ecological footprint. By comparing ecological footprints for food produced in the bioregion with food produced outside and imported to the bioregion, we see that the ecological footprint of our food need is influenced more heavily by the kinds of foods consumed than by where they are produced.

Some crops have an ecological footprint advantage when grown locally while others do not. This is largely due to production yields, transportation energy emissions, and on-farm energy emissions. A food commodity may have a higher yield when grown outside the bioregion, but transportation emissions to reach Southwest BC must be factored in. A commodity grown locally may have a lower yield, requiring more land and on-farm energy use (from machinery) per unit of production, but no transportation energy emissions. In the case of livestock products, feed yield and livestock diets must also be factored in.

About 77% of food commodities that make up the bioregion's food need can be grown locally, and these same commodities can also be imported. Of 45 such crops, there is a local advantage for 16 crops, an import advantage for 16, and the remaining 13 show little difference in ecological footprint between locations of production. No general statement can be made about whether local or imported food crops have an ecological footprint advantage. Each crop and livestock product must be assessed individually.

Carrots can be grown with higher yields outside of Southwest BC. However, the yield advantage for carrots is not high enough to overcome the addition of shipping emissions to the footprint, giving locally produced carrots the footprint advantage.

Conversely, for apricots, import yields are so high that despite the addition of shipping emissions, imported apricots have a much lower ecological footprint than apricots grown in Southwest BC.

Chicken imported to the bioregion has a smaller ecological footprint per tonne than chicken raised in Southwest BC (with imported feed). This is because the typical diet fed to chickens outside the bioregion has a smaller footprint than the diet fed to chickens in Southwest BC.

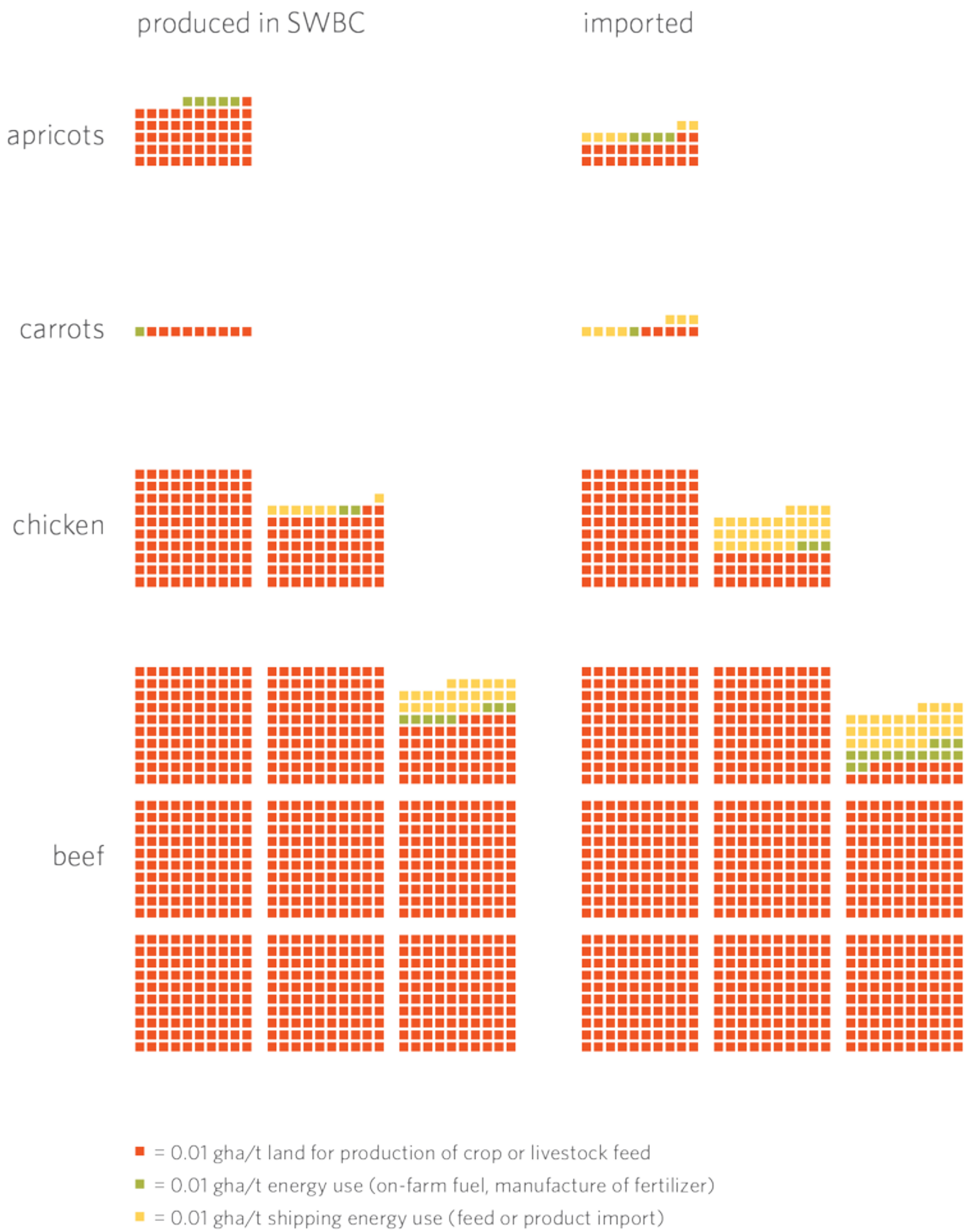
For beef, imported and locally raised livestock (with imported feed) have almost the same ecological footprint per tonne. The diet fed to livestock raised outside the bioregion has a slightly smaller land-use footprint than that of Southwest BC livestock, while the footprints of on-farm energy use and of shipping are somewhat higher.

Yield

The most significant factor determining the total ecological footprint of a fruit, vegetable, grain, or feed crop is yield, suggesting that we should seek to determine what agricultural methods maximize yields without negatively impacting the environment. However, we must be thoughtful about displacing lower-footprint import crops with higher-footprint local crops.

Ecological Footprint Comparison

Global hectares (gha) required to produce one tonne (t) of a specified food commodity



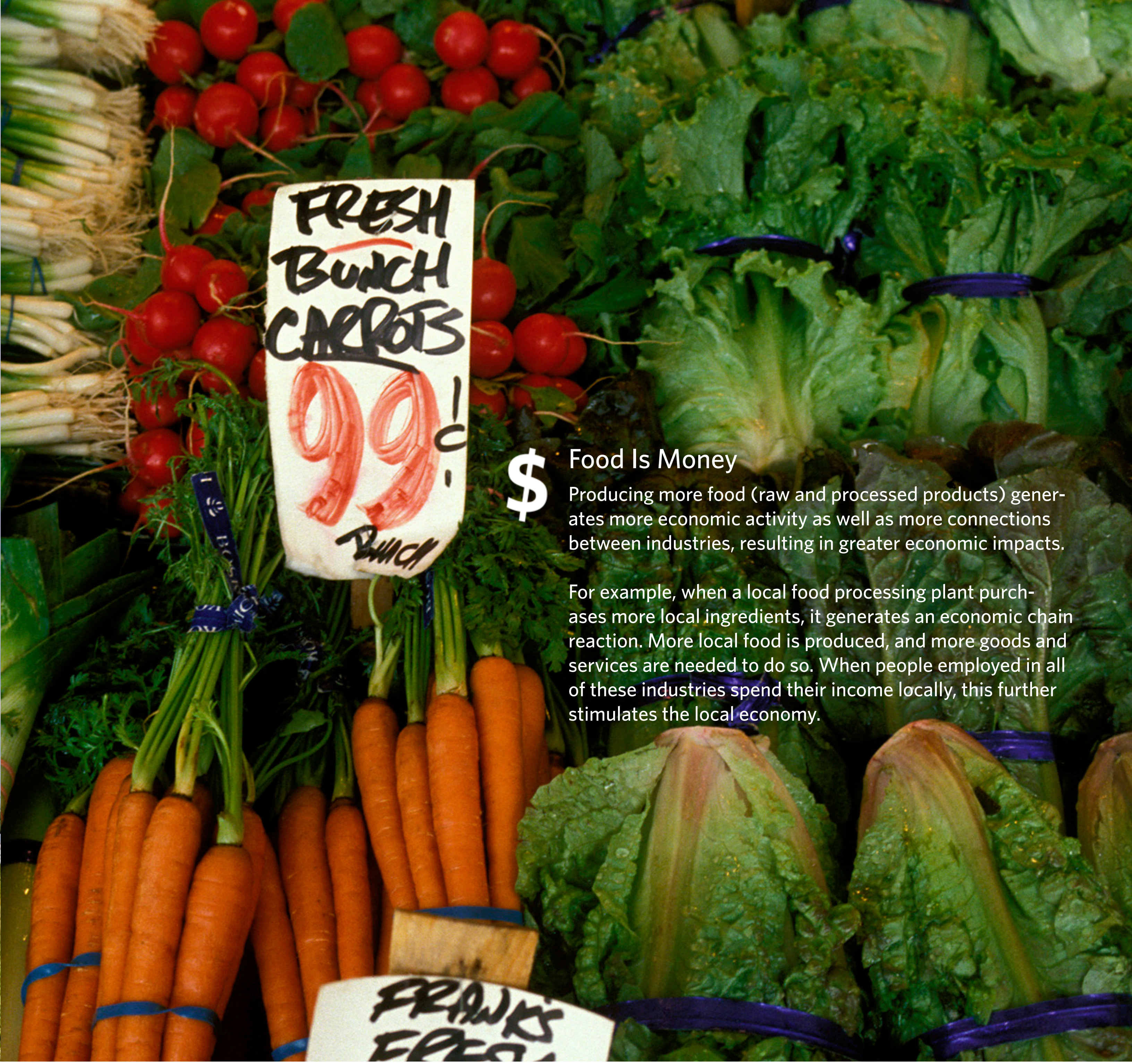
Not All Farming Is the Same

Most of the food produced in Southwest BC is done so conventionally, using synthetic fertilizers and pesticides and antibiotics. Therefore, the Statistics Canada data used in this study, and the study outcomes, likely reflect the impacts and outcomes of conventional production. Though it was not possible to compare the outcomes of conventional and organic production, it is important to understand how these farming methods can make a difference in our food system.

The advantages and benefits of organic agriculture are being revealed by scientific evaluation. Overall, organic and conventional crop yields are similar, though sometimes somewhat higher or lower depending on crop and conditions.[36] Organically farmed soils can recover more quickly from severe weather events[37] and contribute more to climate change mitigation by sequestering more carbon[38] than conventional soils. Organic farms use less energy, fertilizer, and pesticides than their conventional counterparts.[39] Organic farms are economically viable, sometimes more so than conventional farms, and can create more jobs in the local economy because they require more labour.[40]

Farming methods impact food quality. Compared to conventionally produced foods, organic foods have been found to contain higher concentrations of antioxidants (which are linked to reduced risk of certain diseases and cancers)[41] and omega-3 fatty acids (which protect against cardiovascular diseases and dementia).[42] Consumer demand for organic food is growing. The value of Canada's organic food market tripled from 2006 to 2013, and in 2013 over 66% of BC residents bought organic food on a weekly basis.[43]

The adoption of organic farming methods could go a long way toward achieving integrated food self-reliance as well as economic and environmental stewardship goals in Southwest BC.



$ Food Is Money

Producing more food (raw and processed products) generates more economic activity as well as more connections between industries, resulting in greater economic impacts.

For example, when a local food processing plant purchases more local ingredients, it generates an economic chain reaction. More local food is produced, and more goods and services are needed to do so. When people employed in all of these industries spend their income locally, this further stimulates the local economy.

Food Production: 2.0 million tonnes

Food produced in the bioregion would increase by over 80% when compared to the 2050 BAU scenario, from 1.1 to 2.0 million tonnes, with a farm gate value of $2.1 billion. Reallocating food production activities would mean that land previously used for pasture or to grow hay, silage, and feed grain would be used instead to produce food for human consumption. Now optimized for food self-reliance, all food produced locally would be consumed locally, leaving none for export.

Food Imports: 2.2 million tonnes

The increase in food production, though sizable, would not meet Southwest BC's food need. Meeting the food need of 4.2 million tonnes would require 2.2 million tonnes of food imported, valued at $2.0 billion. However, the cost of imports would be less than that in the 2050 BAU scenario.

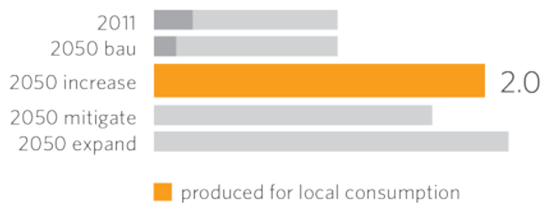
Total Employment: 25,323 FTEs

Producing 2.0 million tonnes of food and associated goods and services would require 25,323 FTEs—a 50% increase in the amount of FTEs compared to the 2050 BAU scenario. This increase reflects increasing levels of food processing and the differing employment requirements between various food production and processing activities and other related industries.

The employment multiplier is estimated to be 8.50 FTEs; for every $1 million increase in the production of raw and processed products, 8.50 FTEs would be generated.

Food Production

Tonnes of food produced in SWBC, in millions



Food Imports

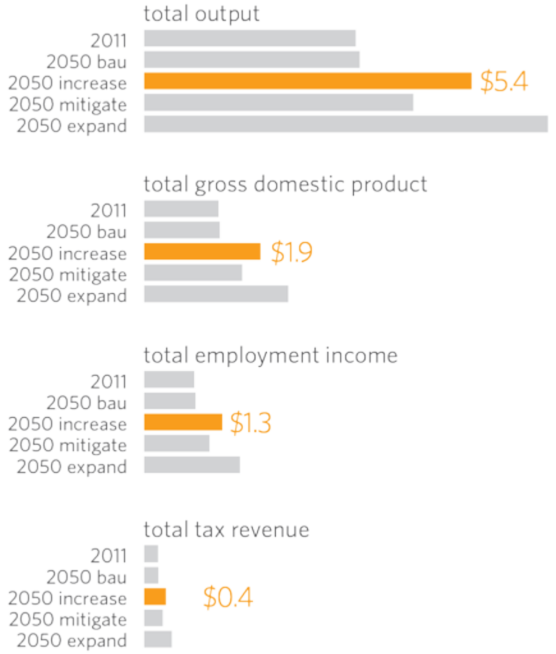
Tonnes of food imported to meet outstanding food need in SWBC, in millions

Total Employment

Number of full-time equivalent positions in agriculture and related industries

Financial Impacts

Dollar value of estimated impacts, in billions (2011 value)



Accounting for Losses

Reallocating production activities across the land base has an economic cost that must be accounted for. For example, in this project, when hay production is reduced in favour of vegetables, the net economic impacts of vegetable production take into account the losses in hay production as well as losses in related industries.

Total Output: $5.4 billion

The value of raw and processed food products (direct output) would be $3.0 billion. Total output is nearly 50% greater than that of the 2050 BAU scenario, totalling $5.4 billion. The increased amount of processing activity affects all aspects of economic impact.

In addition to the direct output, indirect output from all supplier industries would generate $2.1 billion in goods and services, and employees in all related industries spending their earnings in the economy would stimulate $310 million. The total output multiplier is estimated to be 2.81; for every $1 million increase in raw and processed food production, total output would increase by $2.81 million.

Total Gross Domestic Product: $1.9 billion

The production of 2.0 million tonnes of food would generate $1.9 billion in GDP: $940 million of direct, $786 of indirect, and $193 million of induced impact. This is more than a 50% increase over the 2050 BAU scenario and reflects the significant increase in food production. The total GDP multiplier is estimated to be 0.64; for every $1 million increase in raw and processed food production, GDP would increase by $640,000.

Total Employment Income: $1.3 billion

Employment income earned through wages and salaries would be $1.3 billion. Of this, employees in primary agriculture earned $328 million. Employees in fruit, vegetable, dairy, and meat processing earned $347 million, and employees in other industries earned $613 million. The income multiplier is estimated to be 0.43; for every $1 million increase in raw and processed food production, employment income would increase by $430,000.

Tax Revenue: $362 million

Tax revenue of $362 million would be distributed to the federal government ($206 million), provincial government ($121 million), and municipal governments ($35 million). The tax revenue multiplier is estimated to be 0.12; for every $1 million increase in raw and processed food production, tax revenue would increase by $120,000.

2050 Mitigate Environmental Impacts

Population: 4.3 million people
Food need: 4.2 million tonnes
Food produced: 1.6 million tonnes
Arable land: 165,000 hectares
Land modelled: 101,000 hectares

- allocated to production: 79,000 hectares (class 1–6 lands)
- not allocated to production: 22,000 hectares (class 5–6 lands)

Future Context: Taking Environmental Responsibility for Food Production

In the Increase FSR scenario, where food production activities were reallocated to increase food self-reliance, both self-reliance and economic activity increased at the expense of the environment. In this scenario, some negative environmental impacts are mitigated by enhancing habitat and implementing a nitrogen balance. The modelled land base in this scenario is the same as that in production in the 2050 BAU scenario and the 2011 Baseline scenario, though 79,000 hectares are ultimately allocated to production by the model.

Non-production perennial vegetation is commonly planted on farms to mitigate the negative impacts of agricultural activities. This vegetation also enhances wildlife habitat. The most common habitat enhancements are riparian buffers, which fall along natural farm boundaries at waterways, or hedgerows, which run along property boundaries.

Implementing a nitrogen balance deliberately restricts food production to the level at which nitrogen cycles in the agroecosystem in amounts that are just right—the quantities of nitrogen produced by livestock never exceed the nitrogen required for crop fertility. Balancing nitrogen also brings phosphorous closer to balance. This approach prevents environmental contamination from surplus nutrients.

Finding Balance

A nutrient surplus represents potential nutrient losses as pollutants to the environment. Nitrogen and phosphorus runoff and leaching can contaminate surface water and groundwater. A nutrient deficit indicates that there is not enough manure to supply crop nitrogen and phosphorus needs, requiring nitrogen-fixing cover crops or synthetic fertilizers. Both of these issues can be solved when nutrients are in balance.

Food Self-Reliance: 49%

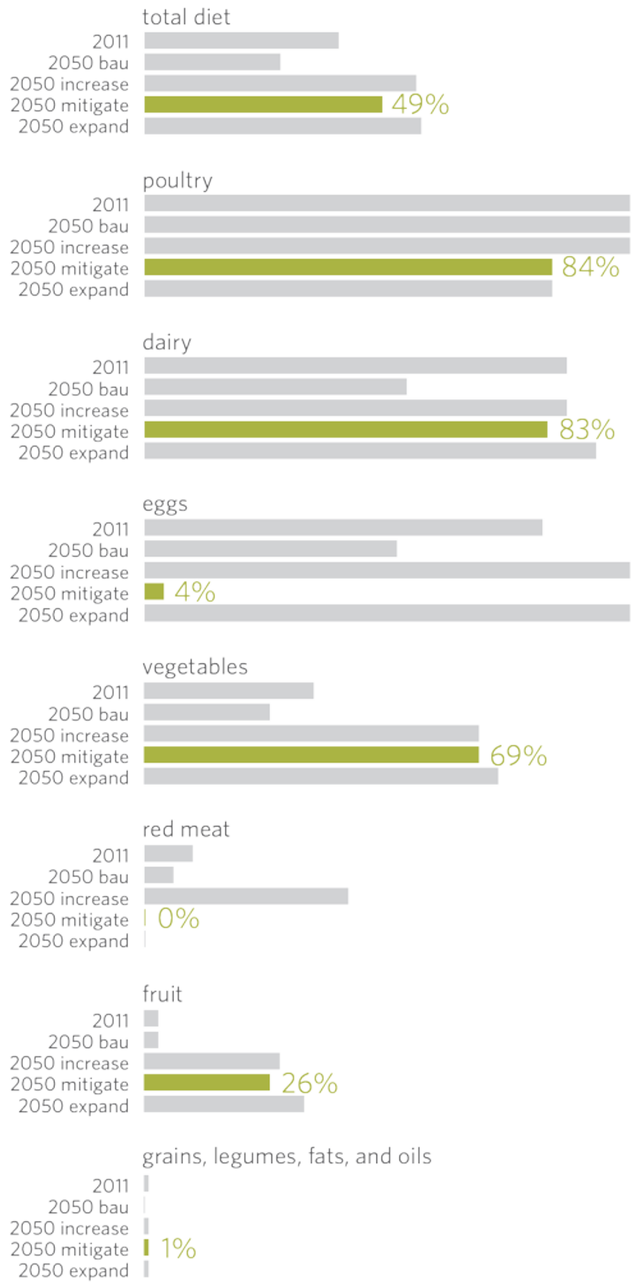
Mitigating the adverse nutrient and habitat impacts resulting from reallocating crop and livestock production activities in the Increase FSR scenario would decrease food self-reliance to 49%. Maintaining the nutrient balance of nitrogen would require a significant decrease in the production of eggs and red meat and a slight decrease in the production of dairy and poultry from the Increase FSR scenario. Though self-reliance for the total diet is 7% lower than that achieved in the Increase FSR scenario, it is 21% higher than that achieved in the BAU scenario.

Less Production, Lower Self-Reliance

Implementing a nitrogen balance would reduce food production and the level of self-reliance possible in Southwest BC.

Food Self-Reliance

Percentage of diet that could be satisfied by locally produced foods



The Importance of Habitat

The human population of the Southwest BC bioregion shares the land with diverse wildlife. The bioregion is internationally recognized as a global hotspot for biodiversity—for large mammals, rare amphibians, numerous pollinators, and iconic fish species. This biodiversity is critically important to the healthy functioning of local ecosystems. The conversion of forests and wetlands to agriculture over the past 150 years has displaced many important species or forced them to live in places intensively used for human activities—like roadway boulevards and street trees, back yards, parks, and landfills.

Adding habitat enhancements on agricultural land, such as riparian buffers or hedgerows, provides important spaces for wildlife to create homes, breed, and find food. Perennial plant species support some of the wildlife, such as birds and bees that farmers rely on to pollinate crops and control pests. Through the use of these habitat enhancements, farmland can contribute to many environmental stewardship objectives in addition to increasing food self-reliance.

Ecological Footprint: 4.2 million gha

With mitigation measures in place, Southwest BC's ecological footprint in 2050 would be reduced by less than 1% (25,000 gha)—representing no effective change from the Increase FSR and BAU scenarios.

Reduced production of approximately 100,000 tonnes of red meat (pork) and 12,000 tonnes of fruit would require that these commodities be imported to meet local food need. As imports, pork and many fruit commodities have lower ecological footprints than their locally produced counterparts. However, reduced production of eggs and dairy in the bioregion would require imports that have a higher ecological footprint than their locally produced counterparts. These ecological footprint gains and losses effectively cancel each other out.

Greenhouse Gas Emissions: 976,000 t CO_2e

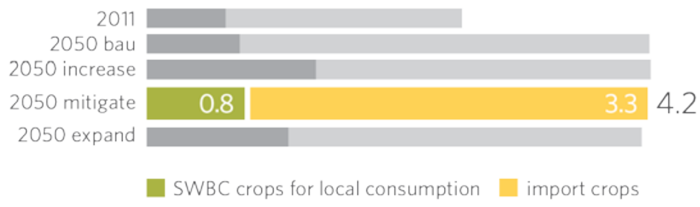
Mitigation measures would reduce the greenhouse gas emissions of food production by 19% when compared to the Increase FSR scenario. Most of this reduction results from decreases in livestock production: 15% less dairy, 96% less eggs, 12% less poultry, and 42% less red meat. Though greenhouse gas emissions from Southwest BC would be reduced, the emissions associated with the dairy, eggs, poultry, and pork imported to meet the region's food need would still be emitted elsewhere.

Carbon Stocks: 6.1 million tonnes

Over the 39-year period of 2011–2050, habitat enhancements implemented across Southwest BC would cumulatively capture 3.0 million tonnes CO_2e. This represents a 21% increase in carbon stocks over the Increase FSR and BAU scenarios. Both hedgerows and riparian buffers make valuable contributions to carbon storage, but riparian buffers have greater carbon storage potential due to their size and composition.

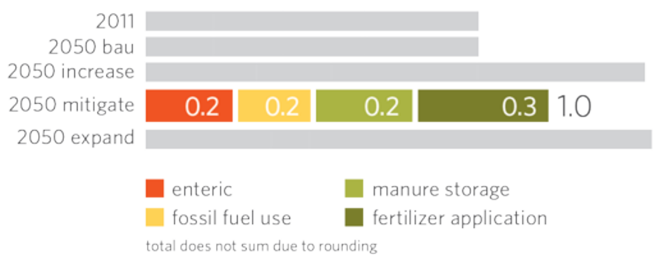
Ecological Footprint

Global hectares required to meet the food need of SWBC's population, in millions



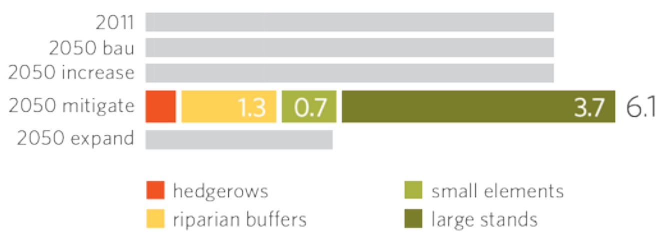
Greenhouse Gas Emissions

Tonnes of CO_2e emitted annually from SWBC agricultural production, in millions



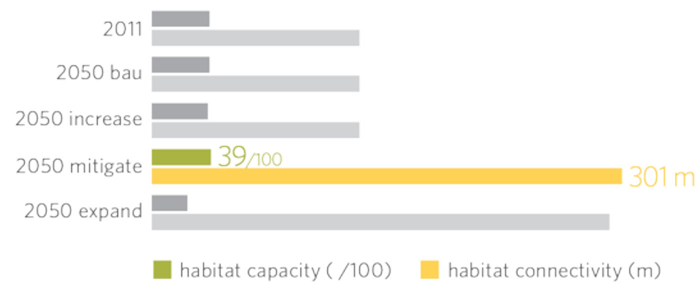
Carbon Stocks

Tonnes of carbon stored in non-production perennial vegetation, in millions



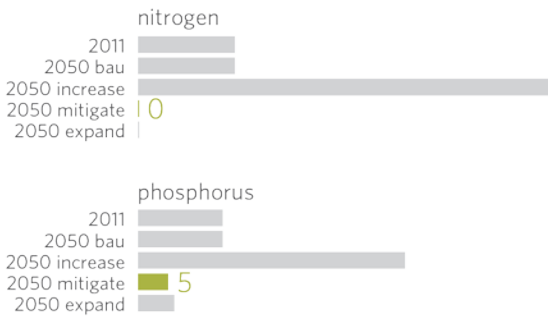
Habitat Capacity and Connectivity

Quality of land cover for wildlife



Nutrient Surplus

Surplus nitrogen and phosphorus from animal manure, in kilograms per hectare



Wildlife Habitat Capacity: 39/100 (Low)

Habitat enhancements would result in only a modest increase of wildlife habitat capacity from the Increase FSR and BAU scenarios. Despite adding significant amounts of vegetation in riparian areas and hedgerows along parcel boundaries, the total habitat area contributed by the enhancements is small compared to the bioregion as a whole. This does little to change the overall "low" wildlife habitat capacity. Substantially improving bioregional wildlife habitat would require conserving and expanding larger, contiguous forests.

Habitat Connectivity: 301 metres

Enhancing hedgerows and riparian buffers would augment the existing network of non-production habitat area and result in substantial benefit to habitat connectivity—an increase of 126% when compared to Increase FSR and BAU scenarios. However, doing so would reduce available agricultural land by 8,151 hectares (9%). Though connectivity would be only 14% of the potential distance, enhancements would significantly improve the ability of wildlife to move through agricultural areas.

Nutrient Surplus: N +0 kg/ha, P +5 kg/ha

In this scenario, implementing the nitrogen balance results in the substantial reduction of egg, dairy, and poultry production and the complete elimination of pork production. Though nitrogen would be balanced, phosphorus would maintain a modest surplus of 5 kg/ha. This would result from the inherent difference in the nitrogen to phosphorus ratio of manure production and crop requirements. A nitrogen balance could also be achieved with other combinations of reduced livestock production, though none would result in as great a level of overall food self-reliance as achieved in this scenario.

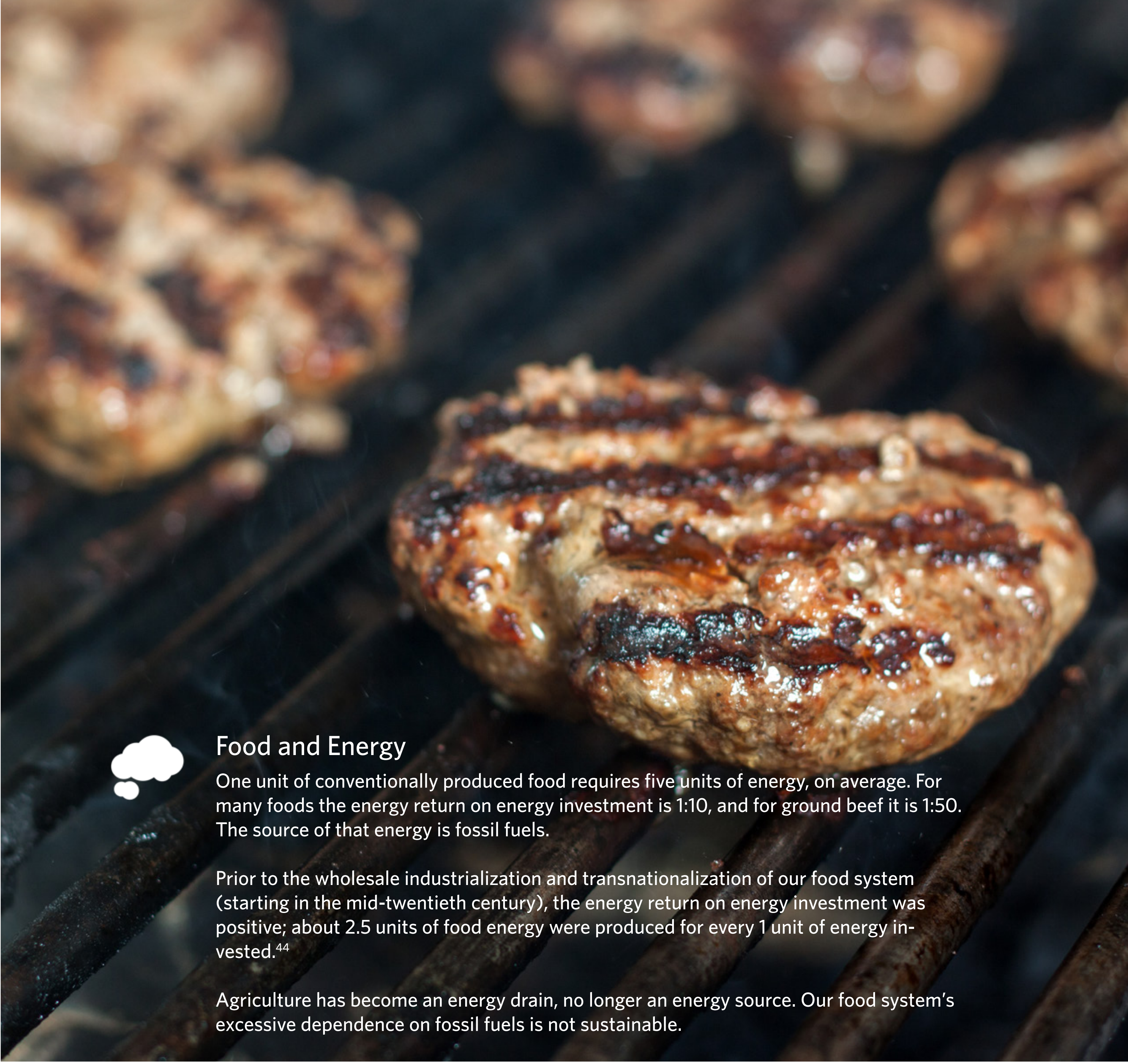
Producers would potentially be able to meet their crop nutrient demands without relying on synthetic fertilizers, simultaneously preventing nutrient loss to air and water. To achieve this potential, however, manure must be moved from where it is produced to where it is needed—ideally, this would be in close proximity to minimize transport.

Habitat, Carbon Stocks, and Nutrient Surpluses

Planting more vegetation for riparian buffers and hedgerows would increase the amount and connectivity of habitat and the amount of carbon stored across the bioregion.

Using more land for hedgerows or riparian buffers would impact nutrient surpluses. Increasing these habitat areas would slightly reduce the area devoted to crop production and therefore decrease the amount of nutrients required for these crops, which would further constrain the amount of livestock that could be produced without resulting in a nutrient surplus.

Enhancing hedgerows and riparian buffers can mitigate the risk of nutrient loss from farms and associated environmental contamination by reducing overland runoff and capturing nutrients.



Food and Energy

One unit of conventionally produced food requires five units of energy, on average. For many foods the energy return on energy investment is 1:10, and for ground beef it is 1:50. The source of that energy is fossil fuels.

Prior to the wholesale industrialization and transnationalization of our food system (starting in the mid-twentieth century), the energy return on energy investment was positive; about 2.5 units of food energy were produced for every 1 unit of energy invested.[44]

Agriculture has become an energy drain, no longer an energy source. Our food system's excessive dependence on fossil fuels is not sustainable.

Food Production: 1.6 million tonnes

Food produced in the bioregion would decrease by nearly 20% when compared to the 2050 Increase FSR scenario, from 2.0 to 1.6 million tonnes. Some of the agricultural land previously used for food production would be devoted to habitat enhancement. Implementing the nitrogen balance would require a decrease in livestock production from the Increase FSR scenario.

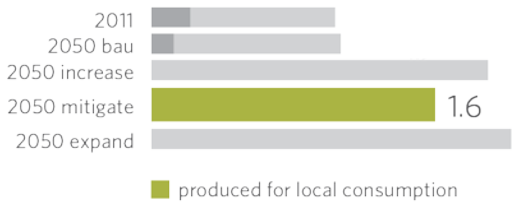
All food produced locally would be consumed locally, leaving none for export. Food imports of 2.5 million tonnes would be required to meet food need, worth $2.5 billion. Though imports would cost more than the Increase FSR scenario, the cost is less than in the BAU scenario, indicating that more economic activity would occur in the bioregion.

Total Employment: 20,973 FTEs

Producing 1.6 million tonnes of food and associated goods and services would require 20,973 FTEs—a 17% decrease in the amount of FTEs when compared with the Increase FSR scenario, but a 23% increase in FTEs when compared with the BAU scenario. The employment multiplier is estimated to be 8.38 FTEs; for every $1 million increase in the production of raw and processed products, 8.38 FTEs would be generated.

Food Production

Tonnes of food produced in SWBC, in millions



Food Imports

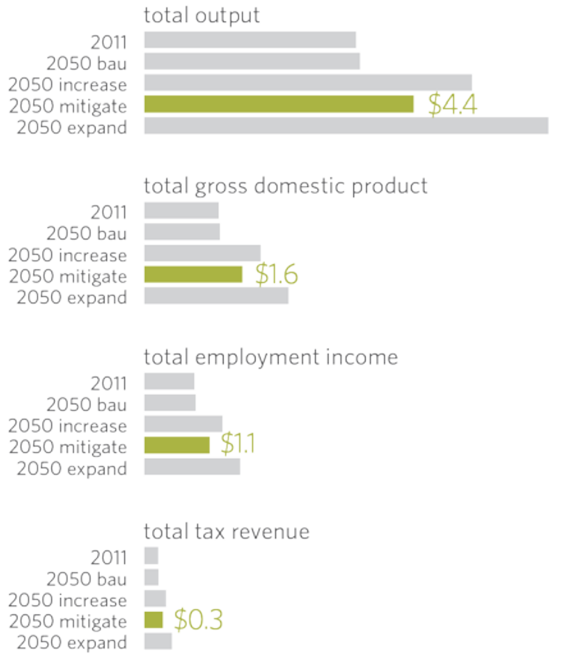
Tonnes of food imported to meet outstanding food need in SWBC, in millions

Total Employment

Number of full-time equivalent positions in agriculture and related industries

Financial Impacts

Dollar value of estimated impacts, in billions (2011 value)



Total Output: $4.4 billion

The value of raw and processed food products (direct output) would be $2.5 billion. Total output at $4.4 billion would be almost 20% less than that of the Increase FSR scenario, but over 20% more than the BAU scenario. The increased amount of processing activity would continue to affect all levels of economic impact.

In addition to the direct output, indirect output from all supplier industries would generate nearly $1.7 billion in goods and services, and employees in all related industries spending their earnings in the economy would stimulate $259 million. The total output multiplier is estimated to be 2.77; for every $1 million increase in raw and processed food production, total output would increase by $2.77 million.

Total Gross Domestic Product: $1.6 billion

The production of 1.6 million tonnes of food would generate $1.6 billion in GDP: $812 million direct, $642 indirect, and $161 million of induced impact. This is 15% less than the Increase FSR scenario but 30% more than the BAU scenario. The total GDP multiplier is estimated to be 0.65; for every $1 million increase in raw and processed food production, GDP would increase by $650,000.

Total Employment Income: $1.1 billion

Employment income earned through wages and salaries would be $1.1 billion. Of this, employees in primary agriculture would earn $261 million. Employees in fruit, vegetable, dairy, and meat processing would earn $291 million, and employees in other industries would earn $526 million. The income multiplier is estimated to be 0.43; for every $1 million increase in raw and processed food production, employment income would increase by $430,000.

Tax Revenue: $307 million

Tax revenue of $307 million would be distributed to the federal government ($173 million), provincial government ($104 million), and municipal governments ($30 million). The tax revenue multiplier is estimated to be 0.12; for every $1 million increase in raw and processed food production, tax revenue would increase by $120,000.

2050 Expand Agricultural Land in Production

> Population: 4.3 million people
> Food need: 4.2 million tonnes
> Food produced: 2.1 million tonnes
> Arable land: 165,000 hectares
> Land modelled: 165,000 hectares
> - allocated to production: 125,000 hectares (class 1–6 lands)
> - not allocated to production: 40,000 hectares (class 5–6 lands)

Future Context: Farming More Land, Responsibly

If more arable land were used for food production, how would the bioregion fare in terms of food self-reliance? The modelled land base in this scenario contains all of the arable land in the bioregion—165,000 hectares—representing a greater than 50% increase in the amount of land in production when compared with the 2011 Baseline. Ultimately, 125,000 hectares of class 1-6 lands were allocated to food production, leaving 40,000 hectares of class 5-6 lands unallocated. As in other scenarios, these unallocated lands can and should still contribute to a multi-functional agricultural landscape and food production.

This scenario builds on the previous two scenarios (Increase FSR and Mitigate Impacts) to test how food self-reliant Southwest BC could be if more arable land were brought into production while also taking responsibility for some of agriculture's negative environmental impacts.

Ecological Footprint per Capita

Earth has a limited amount of biologically productive land and sea. Given the global population, available biocapacity is 1.7 global hectares per person, per year. This is referred to as our “fair Earth share”—the amount of land and sea required to meet all of our livelihood needs: food, shelter, clothing, transportation, and other services and material goods.

Currently, our ecological footprint is 6.0 global hectares per person, per year—a value far in excess of a fair Earth share.[45]

The ecological footprint of food consumption in Southwest BC in the Expand Land scenario would be 0.97 gha per person, which is equal to that in 2011 and a slight decrease from the 0.98 gha per person in the BAU scenario. Given that Canadians should be trying to reduce the ecological footprints of their lifestyle needs in order to achieve a fair Earth share, reducing the ecological footprint of our food consumption is critical for a sustainable future.

Food Self-Reliance: 57%

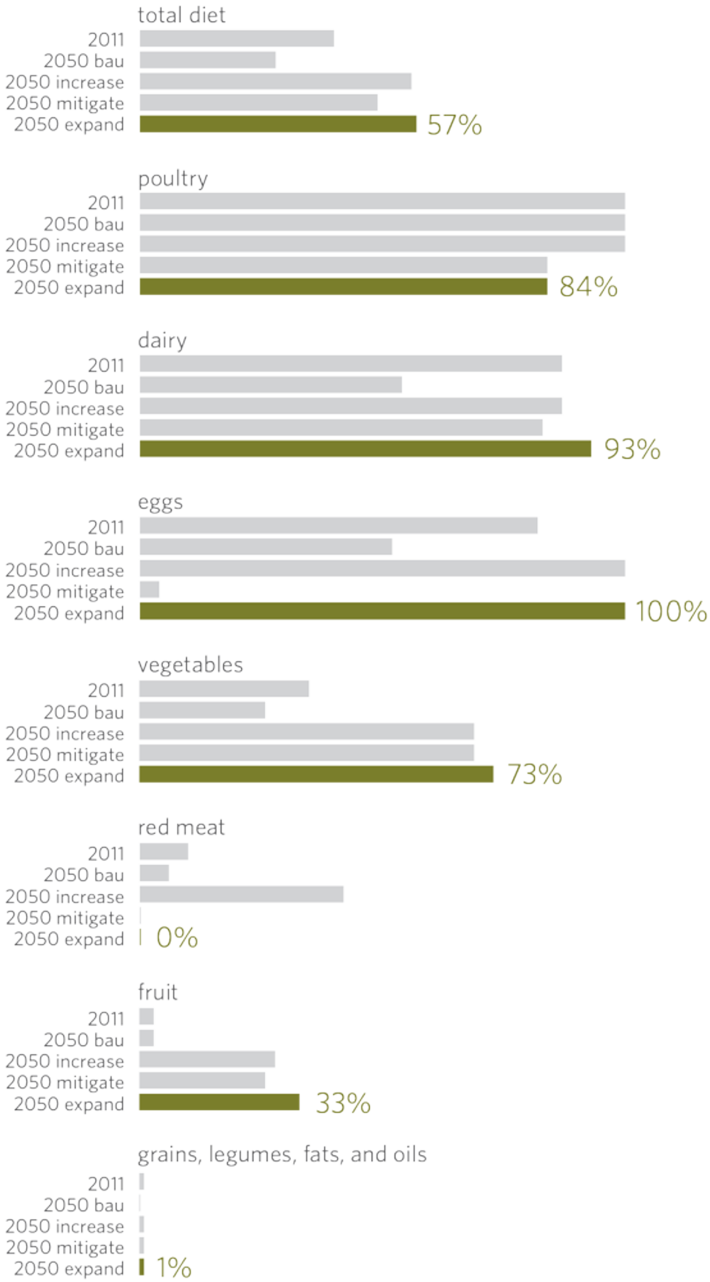
Increasing the amount of land in production would increase Southwest BC's level of food self-reliance to 57%, doubling that of the BAU scenario and slightly exceeding the Increase FSR scenario. Compared to the Mitigate Impacts scenario, food self-reliance would increase in dairy (from 83% to 93%), eggs (from 4% to 100%), fruit (from 26% to 33%), and vegetables (from 69% to 73%).

Accepting Responsibility

This scenario provides the highest level of food self-reliance for the bioregion and it emits the largest quantities of local greenhouse gas emissions. Higher local emissions may be viewed in a positive light: by producing more food at home, we can accept responsibility for the environmental impacts associated with our food consumption. We may be able to take local action to reduce or compensate for these negative impacts.

Food Self-Reliance

Percentage of diet that could be satisfied by locally produced foods



Minimizing and Mitigating Loss of Carbon Stocks

Expanding agricultural land to increase food self-reliance entails the clearing of perennial vegetation and associated loss of carbon stocks, and measures to compensate for this loss should be implemented. Examples of such measures include increasing soil organic matter and planting or maintaining hedgerows or riparian buffers.

Of all types of perennial vegetation, large forest stands make the greatest contribution (57%) to carbon stocks on agricultural land in the Southwest BC bioregion. Therefore, the best way to minimize the loss of carbon stocks when expanding agriculture is to strategically maintain existing large forest stands. By integrating perennial vegetation on farmland and protecting key forested areas, agricultural land can sequester carbon, thereby contributing to more than just food production objectives.

Ecological Footprint: 4.1 million gha

With more land in production, but different types of food commodities being produced than in the BAU and Increase FSR scenarios, the ecological footprint would be reduced by 2% from those scenarios. Compared to the Mitigate Impacts scenario, the ecological footprint would be reduced by 1%. The 1% reduction would be mostly from increased dairy and egg production in the bioregion: both of these commodities have smaller ecological footprints when produced in Southwest BC than when imported.

Greenhouse Gas Emissions: 1.2 million t CO_2e

The nearly 30% increase in greenhouse gas emissions when compared with the Mitigate Impacts scenario would be a direct result of increased food production. Producing more dairy and eggs would result in greater enteric emissions (from dairy cow digestive systems) and emissions from dairy cow and layer hen manure. Producing more fruit and vegetables would result in greater emissions from fertilizer application.

Fossil fuel use on farms would be lower than in all other scenarios because there is no greenhouse vegetable production and greenhouses burn substantial amounts of fossil fuel for heat. To achieve a nitrogen balance, field-produced crops that use manure for fertilizer would be prioritized over greenhouse crop production, which does not.

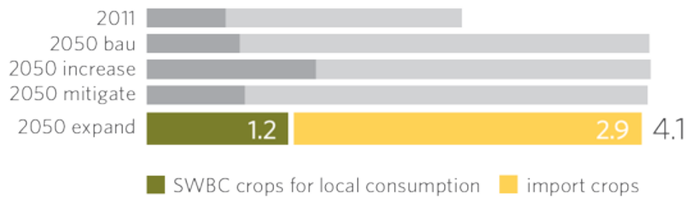
Carbon Stocks: 2.3 million tonnes

With habitat enhancements offsetting some of the loss, total carbon stocks would be 2.3 million tonnes, which is 62% lower than the Mitigate Impacts scenario.

Expanding the amount of land in production would entail removing significant amounts of perennial vegetation over the 39-year period of 2011–2050, resulting in the emission of 16.4 million t CO_2e. The habitat enhancements implemented in this scenario would offset some of the loss. Over the course of their maturation, habitat enhancements would have the capacity to capture 5.4 million t CO_2e. As a result, net CO_2e emissions associated with changes in perennial vegetation over the 39-year period are 11.0 million tonnes.

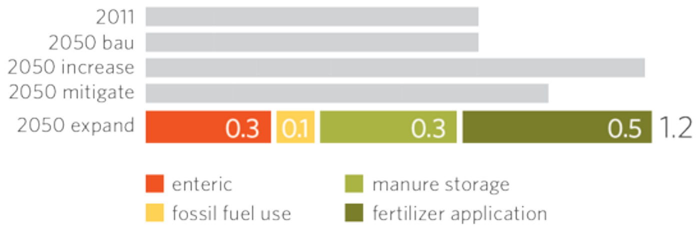
Ecological Footprint

Global hectares required to meet the food need of SWBC's population, in millions



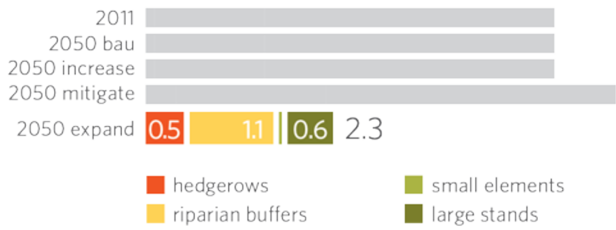
Greenhouse Gas Emissions

Tonnes of CO_2e emitted annually from SWBC agricultural production, in millions



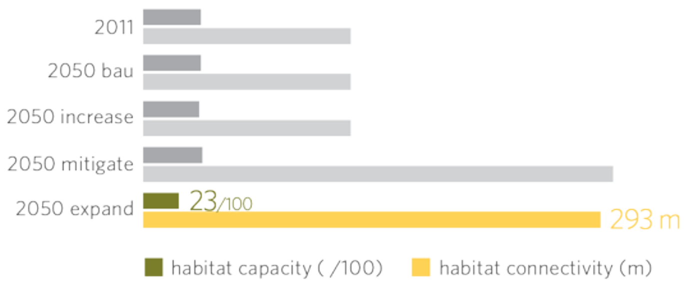
Carbon Stocks

Tonnes of carbon stored in non-production perennial vegetation, in millions



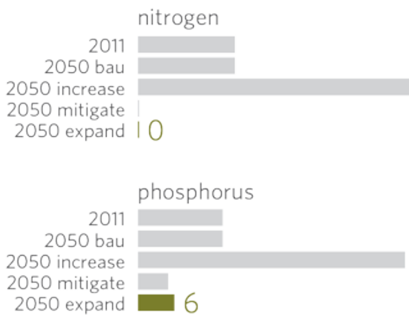
Habitat Capacity and Connectivity

Quality of land cover for wildlife



Nutrient Surplus

Surplus nitrogen and phosphorus from animal manure, in kilograms per hectare



Wildlife Habitat Capacity: 23/100 (Very Low)

With the loss of non-production perennial vegetation to agricultural expansion, even with riparian and hedgerow enhancements, overall habitat quality would drop to 23—a 39% decrease compared to the Mitigate Impacts scenario and a 37% decrease compared to the BAU scenario.

Habitat Connectivity: 293 metres

Connectivity of 293 metres, though slightly decreased, is functionally comparable to the Mitigate Impacts scenario where agricultural land in production was not expanded. Though connectivity between small habitat patches would improve with the use of these enhancements, given the extent of agricultural land expansion, a network of hedgerows and riparian buffers would not be able to compensate for the loss of connectivity once provided by the lost network of large, contiguous forests.

Nutrient Surplus: N +0 kg/ha, P +6 kg/ha

As in the Mitigate Impacts scenario, implementing a nitrogen balance results in a nitrogen surplus of zero and a small phosphorous surplus of 6 kg/ha. In the expanded area, production could be done in a way that keeps the nutrients from manure production in balance with crop requirements, at least at the scale of the bioregion. Preventing sub-regional concentration of livestock (and associated manure) production would remain important.

The extensive loss of non-production perennial vegetation due to agricultural expansion would result in an increased risk of nutrient runoff to waterways. The riparian enhancements implemented in this scenario mitigate some of this risk.

Fruit and Vegetable Processing and Storage

Increasing primary agricultural production requires adequate storage and processing infrastructure in order to strengthen the local food system. Despite Southwest BC's mild climate, seasonality is still limited—vegetables cannot be field-grown year round. It is therefore essential to extend the storage life of fruits and vegetables for off-season consumption and to satisfy consumption preferences.

More food processing done locally leads to more local economic growth. Primary agricultural production brings only modest economic value, but higher values are reached when there is a supply chain to aggregate impacts from agricultural suppliers to primary producers and then to food processors and distributors.[46] Increasing food production without a plan for how this food will be processed (and distributed) may prevent higher levels of food self-reliance and economic benefit from being achieved.

A 2050 Southwest BC population of 4.3 million people would consume fresh 86,000 tonnes of fruit and 305,000 tonnes of vegetables, and would consume processed 115,000 tonnes of fruit and 78,000 tonnes of vegetables. These increased production levels would require more cold storage and processing capacity.

Different fruits and vegetables require different types of storage and post-harvest handling procedures in order to maintain their quality into the off-season. Some fruits can be stored in a closed environment where the temperature, humidity, and gaseous content of the storage atmosphere are controlled, extending shelf life substantially. Some vegetables require lower temperatures to maintain their crispness and freshness for extended periods. Roots and tubers must be cured to store for long periods.

The types of primary processing considered here are those that change the physical character of the fruit or vegetable. This includes canning, freezing, juicing, and dehydrating. Vegetables are primarily consumed frozen and canned while fruits are typically consumed juiced, dried, and frozen.

Adequate future storage and processing infrastructure in 2050—representing a great increase over 2011 levels—would reduce the amount of imported food required in 2050 and generate more local economic activity. Developing needed processing and storage capacity will be critical to advancing food self-reliance.

This project did not address the specific post-production infrastructure requirements for a bioregional food system. This is an important area for additional work.

Food Production: 2.1 million tonnes

With more agricultural land under production and reallocated for food self-reliance, food produced in the bioregion would be greater than in all other 2050 scenarios, even with mitigation measures in place. The increase is almost 30% greater than the Mitigate Impacts scenario and nearly double that of the BAU scenario. The 2.1 million tonnes of food produced in the bioregion would have a farm gate value of $2.1 billion and would be consumed entirely in the bioregion, leaving none for export.

Food Imports: 2.1 million tonnes

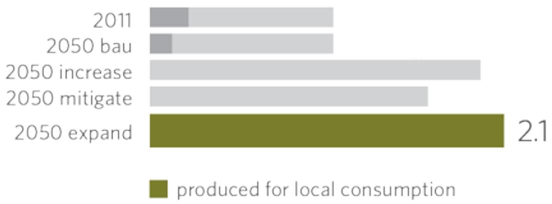
Food imports of 2.1 million tonnes, worth $1.9 billion, would be required to meet food need. Imports would cost less than in all other 2050 scenarios, thereby stimulating and keeping more economic activity in Southwest BC.

Total Employment: 30,670 FTEs

Producing 2.1 million tonnes of food and associated goods and services would require 30,670 FTEs. This is the greatest number of FTEs of all 2050 scenarios, reflecting the increase in food production. The employment multiplier is estimated to be 8.18 FTEs; for every $1 million increase in the production of raw and processed products, 8.18 FTEs would be generated.

Food Production

Tonnes of food produced in SWBC, in millions



Food Imports

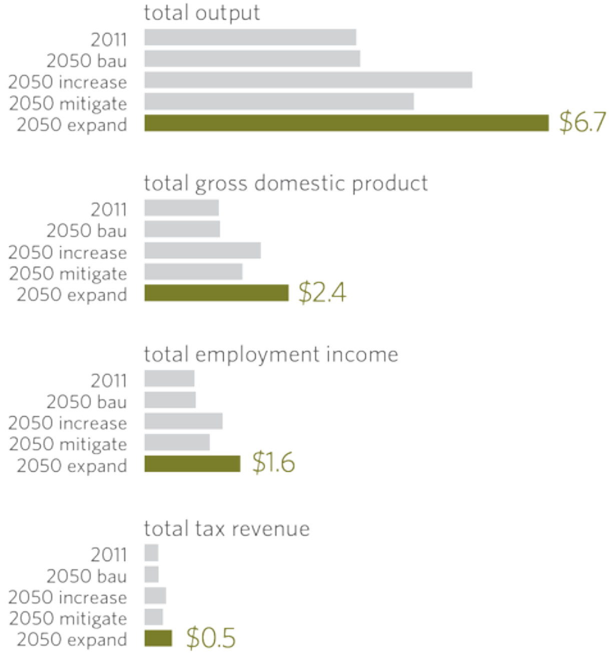
Tonnes of food imported to meet outstanding food need in SWBC, in millions

Total Employment

Number of full-time equivalent positions in agriculture and related industries

Financial Impacts

Dollar value of estimated impacts, in billions (2011 value)



Total Output: $6.7 billion

The value of raw and processed food products (direct output) would be $3.8 billion. With more food produced, the total output of $6.7 billion would be greater than all other 2050 scenarios: more than the BAU scenario by 85%, and more than the Increase FSR scenario by 50%. The increased amount of processing activity would continue to affect all levels of economic impact.

In addition to the direct output, indirect supplier industries would generate $2.5 billion in goods and services, and workers in all related industries spending their earnings in the economy would stimulate $382 million—reaching $6.7 billion in total output. The total output multiplier is estimated to be 2.78; for every $1 million increase in raw and processed food production, total output would increase by $2.78 million.

Total Gross Domestic Product: $2.4 billion

The production of 2.1 million tonnes of food would generate $2.4 billion in GDP: $1.2 million direct, $974 indirect, and $238 million of induced impact. This is significantly higher than that of all other 2050 scenarios. The total GDP multiplier is estimated to be 0.63; for every $1 million increase in raw and processed food production, GDP would increase by $630,000.

Total Employment Income: $1.6 billion

Employment income earned through wages and salaries would be $1.6 billion, more than in all other 2050 scenarios. Of this, employees in primary agriculture would earn $314 million. Employees in fruit, vegetable, dairy, and meat processing would earn $445 million, and employees in other industries would earn $819 million. The income multiplier is estimated to be 0.42; for every $1 million increase in raw and processed food production, employment income would increase by $420,000.

Tax Revenue: $457 million

Tax revenue of $457 million would be distributed to the federal government (nearly $255 million), provincial government (nearly $156 million), and municipal governments ($46 million). The tax revenue multiplier is estimated to be 0.12; for every $1 million increase in raw and processed food production, tax revenue would increase by $120,000.

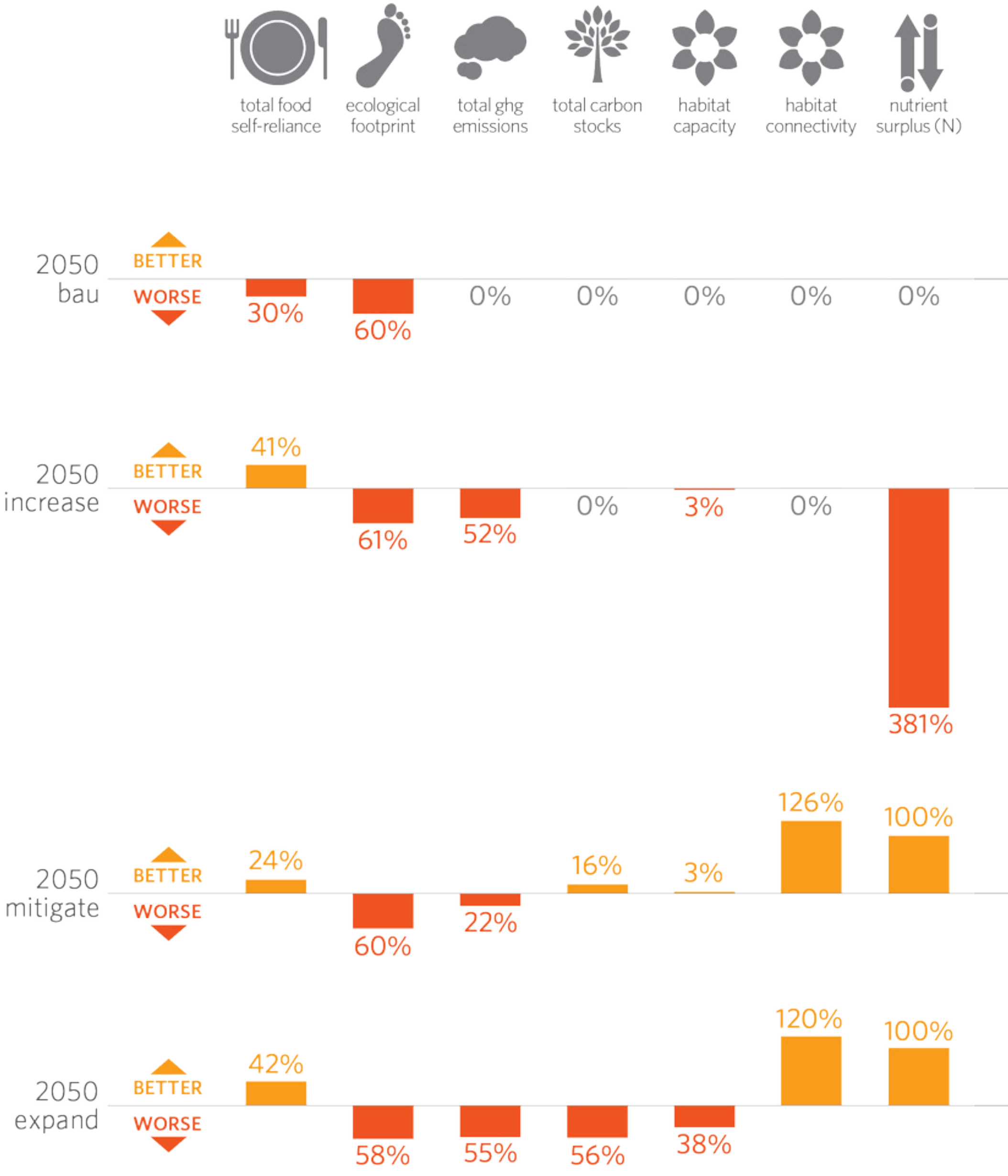
Comparing Possible Futures

2050 Business as Usual

Relative to 2011, with an increase in population but no increase in or diversification of food production, self-reliance and imports would worsen (the latter by increasing). With the exception of the ecological footprint, which would worsen due to the increase in population, environmental indicator values would not change. Though no more food would be produced locally, a small shift in local food need resulting from demographic change, and an increase in food processing, would very slightly improve economic performance.

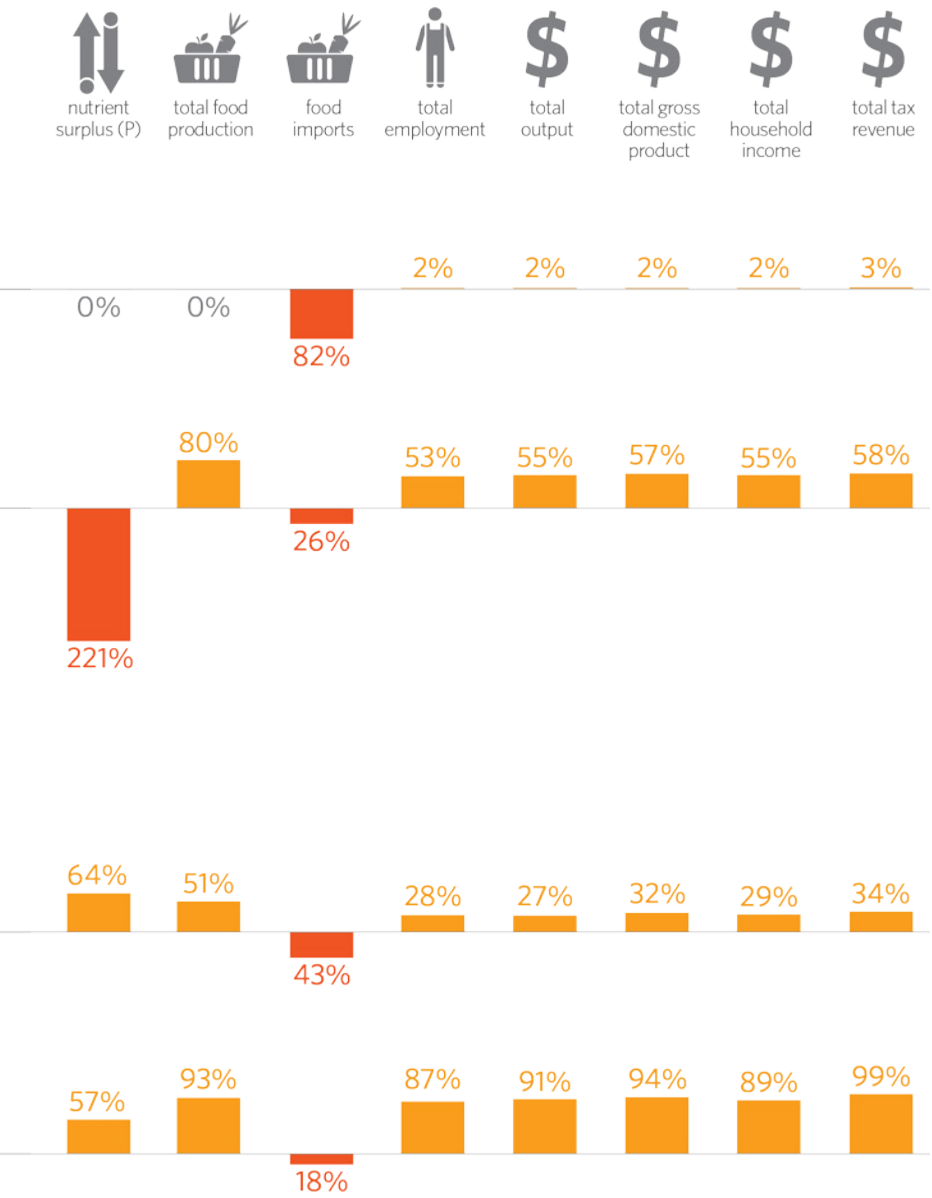
2050 Increase FSR

Relative to 2011, reallocating crop and livestock production to meet local food need would improve food production, food self-reliance, economic performance, and food imports (which would improve by decreasing). Carbon stocks and habitat connectivity values would remain unchanged because no additional land would be cleared for food production. However, performance of all other environmental indicators would worsen relative to 2011 as a result of increased food production and population.



Comparison of Performance for All Scenarios

% change from 2011 conditions



2050 Mitigate Impacts

Relative to 2011, implementing habitat enhancements would slightly decrease the amount of available land, and the implementation of a nitrogen balance would limit the production of livestock products. Despite this, food production, food self-reliance, and all economic indicators would still improve, though not as much as in the Increase FSR scenario. The ecological footprint would worsen due to population growth, and GHG emissions would worsen due to the increase in food production. The performance of all other environmental indicators would improve due to the implementation of habitat enhancements and a nitrogen balance.

2050 Expand Land

Relative to 2011, significant improvements to food production, food self-reliance, and all economic indicators would be possible by increasing land in production and reallocating production activities, even while mitigating environmental impacts. Expanding land in production would result in worsened indicator values for carbon stocks, habitat connectivity, and habitat capacity. A worsened ecological footprint would result due to population growth. Worsened GHG emissions would reflect the increase in food production in the bioregion (rather than at import production locations). Nutrient surpluses would be mitigated by the implementation of a nitrogen balance.

Indicator Recommendations:

What is required to advance each indicator for the better?

Food Self-Reliance

Shifting the mix of crop and livestock production in Southwest BC would increase food self-reliance, even with population growth. Although it is possible to grow a wide range of crops in the bioregion, prioritizing the production of specific vegetables, fruits, and livestock over hay and pasture is necessary if goals of increasing food self-reliance are to be achieved.

Ecological Footprint

Changing dietary preferences could substantially reduce the ecological footprint of Southwest BC food need. Red meat has a very high ecological footprint compared to other food commodities. Substituting meat alternatives (legumes) for all meat products while maintaining egg and dairy consumption—a vegetarian diet—would reduce the ecological footprint of food consumption by 37% when compared with the 2050 BAU scenario's conventional diet. Further, reallocating production activities to optimize food self-reliance for a vegetarian diet would result in an ecological footprint 40% smaller than the 2050 BAU scenario.

Greenhouse Gas Emissions

Although increasing local food production would result in a corresponding increase in emissions from agriculture in the short term, it presents a long-term opportunity to reduce emissions through changes to diet (less meat) and to farming practices. Emissions from manure and fertilizer application to farm fields, for example, can be reduced by adopting best management practices for application rates and timing and manure storage methods.

Carbon Stocks

Maintaining existing large forest stands, which currently store the greatest amount of carbon on agricultural land in Southwest BC, would keep this carbon out of the atmosphere. To the extent that some are cleared for food production, other measures to mitigate associated loss of stored carbon could be implemented. Examples of mitigation measures include: increasing soil organic matter, planting new hedgerows or riparian buffers, and maintaining existing perennial vegetation along parcel boundaries and waterways.

Wildlife Habitat Capacity

The most effective enhancements for habitat capacity would be to plant extensive perennial hedgerows along field boundaries and riparian buffers along waterways, protect high-value habitats such as wetlands, and cultivate perennial crops such as berries and nuts. However, the capacity for habitat on Southwest BC farmland would remain relatively poor regardless of habitat enhancements implemented. Improving capacity to a "moderate" level would likely pose a high trade-off with lowered food production and self-reliance.

Habitat Connectivity

Establishing hedgerows and riparian buffers would result in a more extensive network of wildlife habitat that facilitates ease and safety of movement, with minimal trade-offs for food production.

Nutrient Surplus (N and P)

Strategically increasing crop and animal production with an appropriate mix would maintain a balance between the amount of nutrients produced and required, thereby minimizing the risk of nutrient losses to the environment.

Economic Impact (All)

Increasing food production in accordance with local food need and increasing local food processing capacity would increase the economic contribution of Southwest BC's food system to the provincial economy. The processing sector is key to stimulating the regional food system economy as it adds value to farm products and creates more links within the regional food supply chain.

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What Are the Economic Benefits of a Bioregional Food System?

Building a bioregional food system is a strategy that can help to rectify negative outcomes of the global market system and simultaneously promote regional economic and community development.

Regionalizing food systems creates jobs and business opportunities that are secure in the long term because we all have to eat and always will. It also links the food system to the region's larger economic and community aspirations. Far more of the money spent in a regional food system supports local food system business owners who pay taxes locally and participate in their community and the local economy every day. The expenditure of their incomes will flow through and multiply in the local economy instead of quickly leaving it.

Lessening our dependence on a volatile transnational food system makes good sense as global supply and demand dynamics continue to result in food price increases that outpace inflation. Certainly, as our population grows, it will be more and more critical to produce as much nutritious food as possible in an adaptable, resilient, and environmentally sound system that also enhances our local economy. In so many ways, our food system is the foundation of our future.

Chapter 9

Our Food System, Our Choice to Make

It's Up to Us

Our food system should provide the kinds of wholesome, nutritious foods we need and want. It should also buffer us from the uncertainties of global economics and climate change, better position us to address critical environmental issues, and contribute substantially to our local economy.

We can choose our preferred food system future. It needn't primarily serve the objectives and fill the coffers of a handful of transnational corporations. Rather, our food system future can serve our purposes and meet our priorities. But doing so requires making choices.

Many would have us accept that a free market dictates the nature and economics of our food system. But the free market does not really exist, certainly not in our food system: law, policy, and regulation significantly determine its character, function, and outcome both locally and globally. Indisputable examples of this include BC's Agricultural Land Reserve, Canada's Supply Management system, and the international North American Free Trade Agreement (NAFTA). All of these, and other policy and regulation, dramatically influence our agri-food system and its economic, environmental, social, and food self-reliance outcomes. Our economy in all of its dimensions is of our making. People chose and worked to achieve our contemporary food system, and we can choose and create our food system future.

Informed decision making leading to policy development and implementation is key. But to make good decisions we require information. This project has sought to bring data-driven information to the discussion of our food system future. And the findings clearly indicate—for community leaders, planners, and policy makers—the necessity of thoughtful, targeted action if greater levels of bioregional food self-reliance and related community sustainability goals are to be achieved. It is also clear that ongoing assessment of the impacts and outcomes of our food system must occur.

The bottom line is that, in addition to global issues, we are facing a number of pressing local challenges: an increasing population, threatened farmland, environmental degradation, and BC's economic vitality and the strength of its agricultural sector. Our project investigated the potential of a more sustainable, bioregional food system to address these local challenges. It demonstrated that such a food system could play an important part of a comprehensive vision for a sustainable future for Southwest BC.

Many Southwest BC residents are motivated to support a bioregional framework that brings the food economy home. Our food system can and should operate to achieve what we want it to. It really is up to us.

Applying the Findings

The data and information herein can serve as the basis for constructive discussion, decision making, and planning at municipal, regional district, First Nation, and provincial government levels. It can inform Agricultural Area Plans, Official Community Plans, and other policies and economic development strategies. It will also be useful for business people investing, or considering investing, in the food system.

This project also brings focus to the concept of a "bioregion" and, in doing so, the necessity of aligning our communities and economic activities, including food provision, to our immediate environment and the ecology of where we live. This project should help readers better understand if and how localizing our food system can contribute to achieving environmental stewardship, economic development, and sustainability goals, making clear their interdependence.

Planners, agriculturists, business people, policy makers, community activists, and researchers need better, more complete information to advance a preferred food system—be it regional, global, or something in between. The project's methods can be applied at any scale or to any place, and the models can be easily altered to investigate other food system potentials and "what-if" scenarios. We encourage others to build upon this project to get the answers they need to advance a more sustainable food system.

The project presents an assessment of the Southwest BC bioregion's contemporary food system and the potential for a more food self-reliant future that is as accurate and realistic as the currently available data allow. This project revealed many serious gaps in the information required to fully understand the impacts and outcomes of our food system; these are areas worth further investigation.

For more information on project methodology and outcomes, see additional reports (research briefs and journal articles) posted at www.kpu.ca/isfs.

Southwest BC Bioregion Food System Design Project

The Project and Its Goals

The Southwest BC Bioregion Food System Design project was conceptualized at ISFS in 2012 and conducted from 2013–2016. The project was conceived as a "research project within a research project," with the broad goals of developing a method to delineate the interconnected economic, food self-reliance, and environmental stewardship potentials of a bioregional food system and then applying the method to the Southwest BC bioregion. To our knowledge, this project is the first of its kind.

This document is one means used to present project findings. It is intended for a broad audience and provides the highest level of information. Supporting it is a series of Research Briefs that provides more detailed explanation of research methods and project outcomes. Elements of this project will also be reported in peer-reviewed academic journals. To view these other documents, please visit www.kpu.ca/isfs.

The project developed a model to evaluate the contemporary food system and conduct "what-if" analysis of future scenarios. Dozens of scenarios were generated to evaluate and understand the relational impacts of selected conditions and food system attributes. Ultimately, the five scenarios presented in this book revealed meaningful and demonstrative relational outcomes.

Substantial, critical project startup funding was received from the Real Estate Foundation of British Columbia (REFBC). ISFS's funding request to REFBC was bolstered by letters of support from the BC Agriculture Council, the Agricultural Land Commission, and Metro Vancouver.

Engagement

In 2014, ISFS held a series of six workshops across the bioregion and conducted an online survey to discuss and gather feedback on project objectives and food system design parameters, engaging 106 food-system stakeholders. Three objectives were identified as priorities: 1) Increase self-reliance in agriculture production, 2) Strengthen and enhance local farms and ancillary businesses, and 3) Minimize external inputs and optimize soil, water, and air quality.

Stakeholders expressed a sincere desire to develop a bioregional food system that would focus on the viability of farms and farming, create a local food economy where dollars stay in local communities, and prudently use the bounty of the bioregion while respecting and protecting the environment. Stakeholders believed that growing food in Southwest BC is important, that protecting the livelihood of current farmers and opening the doors for new farmers is critical, and that the way we grow food must not negatively impact the ecological systems that support us.

During the project the project team briefed and sought feedback from many municipal and regional district staff, city councils, agriculture and food system advisory committees, and community organizations. All 39 municipalities and regional districts in Southwest BC were contacted about the project. Ultimately, we provided a project briefing to 32, received project endorsement from 23, and funding from 9. Many community organizations also endorsed the project.

Team

Executing this complex project required a multidisciplinary team of researchers working closely together.

Core Team Members

Kent Mullinix, Director (ISFS)
Caitlin Dorward (ISFS)
Cornelia Sussmann (ISFS)
Wallapak Polasub (ISFS)
Sean Smukler (University of British Columbia)
Caroline Chiu (ISFS)
Anna Rallings (ISFS)
Caitriona Feeney (ISFS)
Meidad Kissinger (Ben Gurion University of the Negev)

Contributing Members

Ermias Aferworki (ISFS), production costs and yields
Sofia Fortin (ISFS), communications
Dawn Morrison (ISFS), Indigenous food system perspectives
Katie Robinson (ISFS), nutrition and diet
Jan Thompson (KPU), water resources

Greg Harris (Kwantlen Polytechnic University), Denver Nixon (Oxford University), and Lenore Newman (University of the Fraser Valley), delineating the bioregion

Advisory Committees

The project benefited from ongoing review and feedback from an at-large project advisory committee and a senior academic research methodology advisory committee.

Support

Endorsements with Funding

City of Burnaby
City of Langley
City of New Westminster
City of North Vancouver
City of White Rock
District of Maple Ridge
District of Squamish
Squamish–Lillooet Regional District
Township of Langley

Endorsements from Local Governments

Bowen Island Municipality
City of Abbotsford
City of Pitt Meadows
City of Port Coquitlam
City of Port Moody
City of Richmond
City of Vancouver
Corporation of Delta
District of Mission
District of North Vancouver
Metro Vancouver
Resort Municipality of Whistler
Sunshine Coast Regional District
Village of Pemberton

Community Organizations

BC Agricultural Land Commission
BC First Nations Agricultural Association
BC Food Systems Network
Bowen Agricultural Alliance
Delta School District
Farm Folk City Folk
Food Matters Chilliwack
Fraser Health
Invest North Fraser
Langley Community Farmers Market Society
Langley Environmental Partners Society
New Westminster Community Food Action Committee
Richmond Food Security Society
Small Scale Food Processor Association
Surrey Board of Trade
Surrey / White Rock Food Action Coalition
Vancouver Food Policy Council
Whistler Centre for Sustainability
White Rock and Surrey Naturalists Society

Other Financial and In-Kind Supporters

Kwantlen Polytechnic University
Real Estate Foundation of British Columbia
R. Howard Webster Foundation
Vancouver City Savings Credit Union (Vancity)
Vancouver Foundation

Endnotes

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