

ASSET MAP FOR BC'S FISHERIES & AQUACULTURE SECTOR



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GENOME BRITISH COLUMBIA

Vision

Genomics will revolutionize many aspects of our lives and provide solutions to humankind's challenges.

Mission

Genome British Columbia leads academia, government and industry in the growth of a world-class genomics R&D cluster to deliver sustainable social and economic benefits to British Columbia, Canada and beyond, through:

- Excellent projects and technology platforms,
- Innovative applications for the life sciences cluster,
- Strategic regional, national & international collaborations, and
- Proactive leadership in exploring societal impacts of genomics.

Genomics is the science that aims to decipher and understand the entire genetic information of an organism (i.e. microorganisms, plants, animals and humans) encoded in DNA and corresponding complements such as RNA, proteins and metabolites.

The knowledge and innovations emerging from this field are finding solutions to complex biological challenges, while at the same time raising questions of societal and economic importance.

Genomics has already brought huge economic and societal gains to Canadians through better healthcare, improving food quality, safety and production and protecting our environment and natural resources.

Looking ahead, genomics will be the foundation of Canada's growing bio-economy (all economic activity derived from life science-based research), which is estimated to be responsible for some 2.25 per cent of GDP, or about \$38 billion, by 2017.

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EXECUTIVE OVERVIEW

BC's abundant natural resources are at the foundation of the province's economic prosperity and have shaped its social and cultural development for centuries. BC is bounded by 2.5% of the world's coastline and contains 20,000 lakes and 105 river systems, with more than 100 native fish and shellfish species. These natural resources host thriving fisheries and aquaculture, employing 13,900 British Columbians and contributing 2.2 billion in direct industry revenues annually to the province¹. Interest in sustaining and increasing productivity from these natural resources has supported development of knowledge infrastructure associated with management of capture and culture fisheries. BC's world-class scientific and technological capacity is enabling improved habitat management, stock assessment, rearing and genomics-led understanding of individual species.

This report provides a map of assets related to activities in BC's aquaculture and fisheries sector that will benefit from advances in genomics and biotechnology. Identification and synergistic use of these assets are critical to innovation that improves sector productivity and sustainability.

Key assets of BC's fisheries and aquaculture sector:

Natural aquatic resources

- > 80 native fish, shellfish and marine plant species
- 20,000 lakes freshwater lakes
- 105 different river systems of rivers
- 25,000 km of coastline (2.5% of the world's coast line)

Industry

- 4 major finfish aquaculture companies producing Atlantic salmon and other salmonids
- 3 major companies and >100 smaller incorporated and individual owned companies producing shellfish
- 7,300 licensed harvesters
- A network of support industries (from feed to fish health products and services, to environmental impact assessment, and tourism)
- More than 15 industry associations

¹ *British Columbian's Fisheries and Aquaculture Sector, 2012 Edition* document prepared by BC Stats (www.bcstats.gov.bc.ca)

- Significant national and international investment firms and company infrastructure

Infrastructure

- 44 government- or community-run hatcheries and numerous private facilities
- 130 ocean-based (finfish) aquaculture farm sites
- 160 shellfish production sites
- >230 processing facilities, transportation and marketing expertise, infrastructure
- Significant wild harvest infrastructure, marinas, boats and shipyards etc.
- Diverse funding for basic research to commercialization

Science

- 6 colleges and universities with relevant expertise or training programs in aquaculture, fisheries and natural resource management.
- 10 major provincial, federal and private research centers
- > 100 researchers in public institutions working across areas from fish habitat to fish health
- High-through-put genomics infrastructure including the sequence of the salmon genome
- International collaborations

Opportunities for Genomics to Support Sector Productivity and Sustainability

BC's bio-based assets (industry, scientific and infrastructural) that have developed about BC's bountiful natural aquatic resources provide innumerable opportunities to improve the sustainability and productivity of the sector including:

- Conservation and Population: Genomics can help us monitor wild fish migration; understand differences in wild and farmed stocks; population health and species abundance.
- Fish Health: Genomics can help in the development of therapeutics and vaccines; understand infectious diseases and parasites; study interactions between farmed and wild fish, and can provide new tools to track and manage pathogens.
- Ecosystem Integrity: Genomics can help us support species survival and genetic variation, as well as the sustainability of coastal and inland water ecosystems.
- Production: In conjunction with selective breeding programs, genomics can help address major production issues such as disease management, diet optimization, response to adverse environmental conditions and overall hatchery effectiveness.
- Social License: Genomics can help clarify risks in the sector and contribute to evidence-driven policy and regulation

Application of genomics in these areas will speed the delivery of innovations and associated economic and social benefits to the First Nations and other citizens, municipalities, businesses and government BC.

INTRODUCTION

An Overview BC's Fisheries and Aquaculture Sector

BC's natural aquatic resources support four different but related sub-sectors, each bringing a range of social and economic benefits to the province and the citizens of BC: aquaculture (the culture of fish, shellfish and plants), wild capture fisheries, recreational fisheries (capture of fish for sport), and a First Nation fisheries (for food, culture and subsistence). Seafood is the province's largest agri-food export, contributing \$870 million of the province's total agri-food exports of \$2.5 billion². Along with fish and seafood processing, the sector contributes close to \$667.4 million (2011) to provincial GDP each year³. The sector employs an estimated 13,900 British Columbians (wages and salaries of ~\$388million), most of who work in establishments associated with the large sport fishing industry. Total revenue for the B.C. seafood sector annually is more than \$2 billion CAD (2011)⁴.

The majority of sector along the northern, western and eastern coasts of Vancouver Island (Port Hardy, Port McNeil, Campbell River, Tofino, Baynes Sound), Haida Gwaii, the Fraser Valley and Lower Mainland, and interior lakes and waterways.

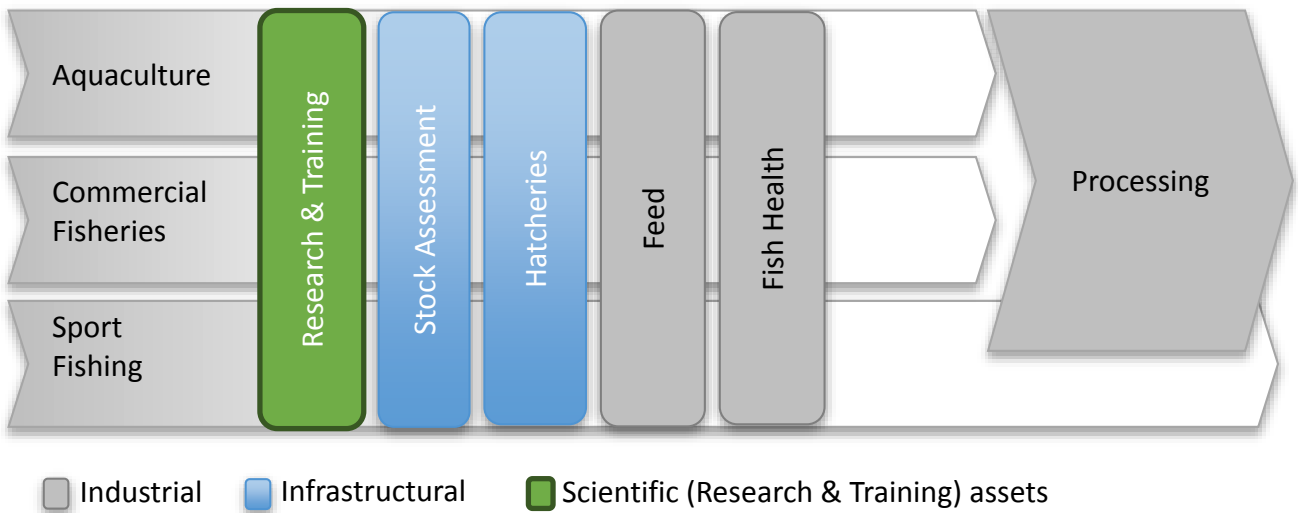
Around various sector activities, distinct industries have been established and essential infrastructure and world leading scientific research capacity has been developed to sustain a vibrant fisheries and aquaculture sector in the Province. Much of this infrastructure and research capacity is associated with the study, culture and rearing of fish and associated ecosystems. The biological basis of these scientific and infrastructural assets, mean that BC's fisheries and aquaculture sector is well positioned to benefit from recent advances in genomics and related technologies in BC over the last decade. Figure 1 illustrates the place of these assets within the industries of BC's fisheries and aquaculture sector.

² *2012 Export Highlights British Columbia Agrifoods*, British Columbia Ministry of Agriculture, revised February 2014, www.agf.gov.bc.ca/stats/Export/2012BCAgrifoodsExportHighlights.pdf

³ *British Columbian's Fisheries and Aquaculture Sector, 2012 Edition, Op. Cit.*

⁴ *British Columbian's Fisheries and Aquaculture Sector, 2012 Edition, Op Cit.*

Figure 1. BC's Fisheries and Aquaculture Assets



Box 1: BC's aquatic resources support four different sub-sectors:

First Nation Fisheries

Fish are integral to the First Nations' culture and economic livelihood. Aboriginal livelihoods have developed around the use of fish and aquatic resources for food, social and ceremonial purposes. Today many of coastal First Nation communities have to rely on such natural resources for their livelihood. Fisheries and aquaculture contribute significantly to the economy and rural subsistence economy in First Nation bands in BC.

Aquaculture

In BC the rearing of fish in hatcheries dates back to 1850s when governments engaged in the incubation and hatching of different species—many of them non-native (e.g. Pacific oyster from Japan, and more recently Atlantic salmon). A system of hatcheries developed across the province and by the 1950s they were producing approximately 750 million native species (e.g. freshwater trout and salmon) annually for wild stock enhancement and recreational fishing. Much of this hatchery enhancement of native species continues today.

Commercial farming of salmon in BC and Canada began in the 1970s –then about ten years later in Norway and Scotland. The industry was established along BC's Sunshine Coast, with farms run largely as small-scale operations with small businesses or families rearing fish in hatcheries before transferring them to net pens close to shore for easy harvest. The industry grew slowly in the early years, expanding to the more remote areas along the coast of Vancouver Island as farmers learned how and where to grow fish. The industry expanded significantly from the mid-1980s to the mid 1990s to comprise 121 sites. There has been considerable consolidation within the industry since that time and today three companies headquartered in Campbell River run the majority of farms in BC.

Atlantic salmon is the primary aquaculture species in BC, representing 95% of all finfish aquaculture operations, and is the province's largest agricultural export. Tilapia, sablefish (grown out in sea water),

sturgeon and trout are also grown on a commercial scale in lakes and recirculation aquaculture systems in BC. Oysters, mussels, clams and scallops represent the primary shellfish grown on a commercial scale, with the majority of production occurring off the West coast of Vancouver Island and in inlets off the Strait of Georgia. Gross output of aquaculture in BC (2011) is \$473M, roughly half of the Canadian total (Canada \$896M).

Capture Fisheries

Harvesting of wild fish and shellfish from BC's waters has been practiced by First Nations people for thousands of years for internal trade and later, for trade with Europeans. By the late 1800s a capture fisheries, and an aboriginal food fishery, had been established in BC and advances in fishing gear and processing technology established capture fisheries as an integral part of BC's economy. Fraser River sturgeon and sockeye salmon were overfished in the early 1900s and throughout that century there were cycles of abundance of Pacific salmon species, but Fraser River sturgeon never fully recovered

Today BC's capture fisheries are centered on the East and West coast of Vancouver Island, the Gulf of Georgia, Haida Gwaii, the Lower Mainland and Prince Rupert, and encompasses more than 100 different species of fish and shellfish. BC supports a number of commercial fishing companies operating trawl, gillnet and seine gear in both coastal and tidal waters, which contribute \$347M (landed value, 2011 data) to the province each year. This represents about 16% of Canada's landed value (\$2.1B). By weight, groundfish are the primary catch, followed by pelagic and finfish (primarily salmon, herring and tuna). Shellfish constitute a small volume by weight but account for just over a third of the total landed value. BC is the only province with a commercial salmon fishery.

Recreational fishing

BC's lakes, streams and tidal waters and stocks of salmon, steelhead, trout, and the long-lived white sturgeon attract anglers from BC and around the world each year. The catching (and sometimes, release) of fish for sport or recreation in BC provides significant economic benefit to the province through spending on transportation, food and lodging, fishing supplies and services and tax revenues. In 2010, over 400,000 BC residents and 110,000 non-residents caught 12 million fish (retained 33%) from BC waters. Salmonid species, in both freshwater and tidal waters, comprise the primary species for the sector, contributing in \$231 million in output and 2,280 jobs to the province annually (2010).

Regulation of Sector Activities

The Department of Fisheries and Oceans (DFO) is the lead federal agency for the sector maintaining principle responsibility for regulating activities of the aquaculture and fisheries sector (including Sustainable Aquaculture, Habitat management, Aquatic Animal Health, Ocean management, Fisheries resource management, Habitat management, Salmonid enhancement and Ocean forecasting).

The Fisheries Act is the principle piece of legislation used to manage and protect Canada's fishery resources. It applies to all fishing zones, territorial seas and inland waters of Canada and is binding to federal, provincial and territorial governments. The Fisheries Act dates to confederation and was amended most recently in November 2013. The ability of this one act to effectively govern both fisheries and the comparatively new activity of aquaculture is contended by some and the idea of

creating a federal Aquaculture Act has been proposed. Canada is the only major farmed seafood-producing country in the world without national legislation specifically designed to govern and enable its aquaculture industry.

The Canadian Food Inspection Agency plays a significant role in the sector. The Canadian Food Inspection Agency (CFIA) sets the food safety policies, requirements and inspection standards for fish products, federally registered fish and seafood processing establishments, importers, fishing vessels, and equipment used for handling, transporting and storing fish. Under the Health or Animals Act and Regulations, CFIA is responsible for Fish Health both in wild and farmed stocks. These include but are not limited to managing reportable diseases in Canada, domestic movement controls to risk disease movement, wide surveillance programs for farmed and wild fish, and import controls and outbreak management. These responsibilities supersede DFO Fish Health Management Responsibilities.

Capture Fisheries

Regulation for capture fisheries is entirely the responsibility of the federal government. DFO is responsible for assessing wild stocks and setting fisheries harvest quotas, and is responsible for the issuance and regulatory compliance of capture fisheries licenses. The basis of the mandate lies within the context of the Fisheries Act (R.S.B.C. 1996 Chapter 149) and Fish Inspection Act (R.S.B.C. 1996 Chapter 148), and accompanying regulations. Through these pieces of legislation and several Memoranda of Understanding (MOUs) with other agencies, the Ministry of Agriculture licenses: all fish processing plants, fish buying stations, fish brokers and fish vendors; harvesters of wild shellfish and marine plants. The province is responsible for fish once its landed and has responsibility for seafood processing.

Sport Fisheries

Activities within the tidal and freshwater sport fisheries are shared between federal and provincial agencies. Department of Fisheries and Ocean provides licenses for fishing in tidal waters and the province, through the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) issues licenses for freshwater fishing. Freshwater fisheries are governed by a number of provincial, regional and water-specific regulations, in addition to in-season regulations issued by FLNRO.

Aquaculture

British Columbia is unique in Canada in that the province does not have significant power or responsibility related to aquaculture management and development. As of

December, 2010, these powers and obligations lie with the Fisheries and Oceans Canada (DFO) who assume responsibility for the management and regulations of aquaculture in British Columbia including: regulation, monitoring and licensing all aquaculture operations in the province (with the exception of those sites culturing marine plants only), production volumes, species to be produced, fish health, sea lice levels, fish containment and waste control.

The Province of BC does, however, maintain control over the issuance of Crown land Tenures for the purpose of aquaculture use, and manage the business aspects of aquaculture such as work place health and safety within the province. However, the province does not play an essential role in regulating operations and fostering industry development of primary production.

Other

A number of other provincial and federal agencies govern different aspects of the sector, and organizations like the Marine & Aquaculture Stewardship Councils, Sea Choice and Ocean Wise provide third party assessments or certification of various processes or product.

Innovation & Investment Landscape

Historically, scientific and technological innovation has been driven by companies and businesses in the sector in order to improve the efficiency, productivity or sustainability of their operations. Innovations may also be introduced into the sector from international companies operating in the sector who introduce innovative new tools, products of processes.

BC's fisheries and aquaculture sector has already attracted significant private sector investment. The sector also benefits from a number of funding programs to support research and development or commercialization activities and continues to benefit from sector specific activities, some international in nature, as they arise (Appendix 1).

The federal government, through a number of agencies and programs provides funding for basic research and also for some market and commercialization activities. Canada's tri-council agencies, in particular the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Social Sciences and Humanities Research Council (SSHRC), are a major source of research funding for post-secondary institutions in Canada. The federal government is also supporting 12 Canada Research Chairs in BC in areas of direct relevant to the sector.

The Department of Fisheries and Ocean has provided funding for R&D in the sector to its scientists and to other stakeholders. Currently, DFO's Aquaculture Collaborative Research and Development Program (ACRDP) support a range of collaborative and research activities.

Since 2000, significant investment in genomics research has been made in BC and across Canada through Genome British Columbia and Genome Canada. In the last decade, close to \$40 million has been invested in genomics research in BC alone by these organizations (see Appendix 2). Funding for large scale projects like the Genomics Research on Atlantic Salmon Project (GRASP), the Consortium for Genomic Research on All Salmonids Project (cGRASP) and the International Cooperation Project to Sequence the Atlantic Salmon Genome (ICSASG) has established in the sector considerable scientific assets including salmon microarrays and the sequence of the salmon genome (pending 2014). This investment has enhanced significantly our understanding of salmonids and is expected to accelerate innovation in the sector.

International Partnership

Recent investment in genomics capacity in BC's fisheries and aquaculture sector has attracted significant interest from countries like Norway that support a thriving aquaculture and sport fishing sector. This has led to partnership on an international level with Norway and Chile to sequence the Atlantic salmon genome—a species of economic importance to all three countries.

International research collaboration is also occurring on a smaller scale between individual researchers at Canadian universities with various international partners.

The Global Context for BC's Fisheries & Aquaculture Resources Capture Fisheries

Globally, capture fisheries includes both marine and inland fisheries encompassing about 2500 species or groups of species, the majority of which are finfish. BC's capture fisheries center on the Pacific Northeast, an area of 8 Million km², of which 1.3 million km² are shelf area that encompasses several distinct "large marine ecosystems" including the California Current, the Gulf of Alaska, and Bering Sea.

BC's capture fisheries encompasses ~100 different, primarily marine species and is significantly smaller in landed volume and value than Canada's Atlantic ocean fisheries.. While a decline in global fisheries has been widely reported, the magnitude and trajectory of the decline in capture fisheries varies by region and by country. In BC, as in other parts of the world, fisheries in the region have undergone a series of regulatory

and market-driven reforms to fishery opening to stabilize the fisheries. BC's capture fisheries have been harvested at conservative levels for the last 15-20 years and are internationally recognized as sustainable. Here the focus remains on preservation of existing stock biodiversity and on sustaining wild stocks.

Annual harvests from the Pacific Northeast (ocean) are around 2-3 million tonnes, primarily gadidae (cod, pollock, hake etc.), followed by salmonids and flatfish. BC's harvest (171,100 tonnes) is a fraction of this, and comprised primarily of finfish and groundfish (20,600 and 99,700 tonnes respectively) and shellfish (13,600 tonnes)⁵. BC, like Canada, is a net exporter of fish (wild and cultured), exporting close to 60% (by value) to the US and ~ 30% to Asian countries⁶. Canada is one of the world's leading seafood exporter.

Aquaculture

Salmon aquaculture is at the heart of BC's aquaculture sector. It is also the fastest growing food production system in the world, accounting for 70% (2.4 million tonnes) of the global salmon production. With global production of ~1.5 million tonnes annually, farmed Atlantic salmon (there is no significant wild Atlantic salmon fisheries) contribute the lion's share of the global salmon production (wild and farmed).

Although salmon species can be found in most geographic regions, British Columbia is one of the few regions of the world that can support Atlantic salmon, a species that prefers sheltered waters and temperatures between 8-14C. Producing ~75,000 tonnes annually, British Columbia is a relatively small producer on the global scale. Canada (BC and the Maritimes combined) accounts for just 8.2% of global farmed salmon production, ranking 4th behind Norway, the UK and Chile, with Australia and the Faeroe Islands rounding-out the top six.

Most salmon is sold gutted on ice and historically, thanks to a combination of logistics and perishability, different countries have had discrete markets. This is changing however with frozen and value added salmon finding markets further from home and the markets become more globalized. Today salmon remains a high-value commodity with a global market, and like most commodity markets has experienced price volatility in recent years.

⁵ *British Columbia Seafood Industry Year in Review 2012*. British Columbia Ministry of Agriculture. 2013. Available at: <http://www.agf.gov.bc.ca/stats/YinReview/Seafood-YIR-2012.pdf>

⁶ *2012 Export Highlights British Columbia Agrifoods*, British Columbia Ministry of Agriculture, revised February 2014, www.agf.gov.bc.ca/stats/Export/2012BCAgrifoodsExportHighlights.pdf

Aquaculture is governed by regulations aim to protect the environment, the fish, and the consumer. In all salmon producing regions, a license to operate is required. The license sets production limits for individual locations and the industry and the licensing regime varies by jurisdiction. As described in the preceding section, Canada has a relatively complex and fragmented regulatory regime. In addition, in recent years a number of countries have established various 'quality' schemes, including third party certification, to improve the quality, safety, welfare, or environmental sustainability of farmed Atlantic salmon. Examples of these schemes include:

- Industry-led schemes, e.g. [Scottish Quality Salmon](#).
- Retailer-led schemes, e.g. UK supermarket quality schemes; the Label Rouge government-led scheme in France (www.agriculture.gouv.fr).
- Global 'third party' schemes, e.g. Aquaculture Stewardship Council and the Best Aquaculture Practices (BAP) of the Global Aquaculture Alliance
- Niche market schemes (e.g. Organic salmon schemes, welfare schemes such as [Freedom Foods](#) in Australia).

There is, however, no one agreed upon global standard for aquaculture production excellence and the existence of multiple standards and certification programs, each claiming to be superior to the other, are creating confusion in the market place⁷. See: <http://www.globalsalmoninitiative.org/>

Deriving Value from BC's Aquatic Resources

Understanding the BC landscape for fisheries and aquaculture and recognizing the associated assets is essential to developing innovations to improve the productivity and sustainability of the sector and delivering economic and social benefits for BC.

This report describes the assets related to the inputs and bio-based support industries associated with BC's fish resource. This report does not consider assets associated with aquatic plants, or assets associated with downstream, value-added products and services (e.g. nutraceuticals or pharmaceuticals). In addition it does not include asset associated with habitat conservation. These assets may be included in future versions of this report.

⁷ <http://www.aquaculture.ca/files/Global-Market-Report-Apr2010.pdf> provides a useful overview of the landscape for quality standards and certifications relating to aquaculture.

BC SECTOR ASSETS

Industry Assets

Aquaculture

BC supports a vibrant fish and shellfish aquaculture industry. Atlantic salmon is the primary species grown, dominating shellfish production and culture of other species by more than 10-1. The salmon farming industry has seen significant consolidation over the last decade and now three companies head-quartered in Campbell River, make up the majority (>95%) of production. The industry has long attracted significant investment and the three largest companies are now listed on the Norwegian Stock Exchange. These companies are vertically integrated, operating hatcheries and they keep and spawn their own broodstock fish for production. Significant stock assessment, breeding and fish health expertise is also maintained in-house.

The industry also supports smaller operations typically farming other salmonids. Creative Salmon is North America's only major producer of indigenous Pacific Chinook salmon and West Coast Fishculture is rearing steelhead in Lois Lake. Most of these companies are also vertically integrated, maintaining broodstock for breeding and processing fish for wholesale of fillets.

Land-based aquaculture is commonly used for production of salmon smolt and broodstock in commercial and enhancement operations, and is used for the production of alternative species such as sturgeon (Target Marine Products Ltd) and tilapia (Sumas Lake Aquafarm). It is also being adopted for the culture of native sablefish species that require both land-based and sea pen culture (Sable Fish Canada). Several groups are now also piloting recirculation aquaculture systems (RAS) for large-scale salmonid production from hatch to grown-out (e.g. Namgis Project, Taste of BC, Golden Eagle Aquaculture). (See Table 1 for a list of the primary BC producers)

The shellfish aquaculture industry is comprised of many small producers (>100 companies), many operating a single aquaculture site. Few shellfish growers are vertically integrated, and the majority of growers buy seed for grow-out on lease sites and sell their product to processors.

Island Scallops (scallops) Mac's Oysters (oysters and clams), Fanny Bay Oysters (oysters) and Stellar Bay Shellfish (oysters and clams) are the largest shellfish companies in BC and have some form of vertical integration. Island Scallops is a fully integrated shellfish producer, engaging in hatchery production, farming, processing, and marketing of several shellfish species. The company owns more than 16% of all

shellfish culture area in British Columbia and is Canada's largest private marine research hatchery.

Collectively, the aquaculture sector also supports a number of bio-based industries including production and supply of fish feeds, fish health companies and companies supplying eggs or related breeding services or products (below and Appendix 4).

Capture Fisheries

BC's capture fisheries support a large number of small companies and family run operations and a few larger companies. The Canadian Fishing Company (Canfisco) is by far the largest company operating in BC. Canfisco operates the largest fleet of fishing vessels in British Columbia and has major processing facilities in Prince Rupert and Vancouver, including its affiliate, Delta Pacific Seafoods. A handful of other processing companies are also vertically integrated.

There is a high degree of specialization within the industry with companies restricting their activities to a particular list of species, and either the harvesting or processing side of the business. However, there are close links between harvesters and processing companies, sometimes through vertical integration, sometimes through joint or shared ownership, and sometimes through longstanding informal arrangements.

Access to wild fisheries is provided to the license eligibility holder, or the harvester although many harvesters operate under a corporate structure rather than individually for a variety of reasons. Many fisheries, but not all⁸, operate on a quota system—established in mid 1900s to balance harvesting of wild fish with maintenance of wild stocks. Department of Fisheries and Ocean, in consultation with other parties, perform assessments of wild stocks annually, and sets total allowable catch (TAC) for particular species based on this information. Harvesters and processors both rely heavily on solid stock assessment and other science to set species-specific TAC that maximizes the value of the resource without impacting its long-term sustainability. Hatcheries (see below and Appendix 6) are used for enhancement of some wild stocks (e.g. salmonids and, on a very small scale, geoduck fisheries). These enhancement facilities are carefully sited to minimize impacts on wild stocks⁹ and enhanced chum are harvested only on observable surpluses in terminal fisheries.

Processing

Fish and seafood processing is an integral part of the fisheries and aquaculture sector and has been since inception of the industry. In BC, 219 companies operate 238

⁸ For example, some like prawns and crab and to some extent salmon, are effort-based

⁹ The majority of salmon enhancement is on recreations species of coho and Chinook

facilities processing fish and shellfish from either the capture and the aquaculture sectors—only one or two process both on any scale. Fish processing is a focus of economic activity in many coastal communities and several plants are owned or operated by First Nations bands and communities. Processors take these raw inputs and producing a range of value added products (fresh, frozen, canned and smoked products) for domestic and export markets. In 2010, BC produced 472 distinct species-product seafood combinations.

Table 1: Major companies Involved in Production and Harvest of Fish and Shellfish in BC*

| Name | Species | Description |
|--|-----------------|--|
| Marine Harvest Canada www.marineharvestcanada.com | Atlantic salmon | Marine Harvest Canada is BC's largest producer of farmed salmon and operates about half of the industry's salmon farms. Marine Harvest, the parent company is Norway based and has salmon farming operations in Norway, Chile, Canada, Ireland, the Faeroe Islands and Scotland. |
| Cermaq Canada www.mainstream-group.com/portal/wps/wcm/connect/msca-content-en/mainstream-canada | Atlantic salmon | Cermaq Canada is BC's second largest producer of farmed salmon, accounting for roughly a quarter of all production. The Norwegian-owned Cermaq Group has salmon farming operations in Norway, Chile, and Canada. |
| Grieg Seafood http://www.griegseafood.no/english.aspx?pagelid=20 | Atlantic salmon | Grieg Seafood BC Ltd. holds 21 farm licenses, has its own hatchery in Gold River, and owns a small processing plant on BC's Sunshine Coast, in Egmont. |
| Creative Salmon Company Ltd. www.creativesalmon.com | Chinook salmon | Based in Tofino, BC, Creative Salmon is North America's only major producer of indigenous Pacific Chinook (King) salmon. Creative Salmon is a fully integrated company, operating a hatchery and proprietary broodstock program. Fish produced are certified organic. |
| Island Scallops www.islandscallops.com/ | scallops | Island Scallops Ltd (ISL) was established in 1989 and is currently engaged in the hatchery production, farming, processing, and marketing of marine species. ISL is a technology-driven company with extensive marine expertise, and has developed proprietary hatchery technology for several species including the unique Pacific scallop. ISL farms the Pacific scallop at several sites along the coast of Vancouver Island. With over 500 ha (1200 acres) of scallop farm tenures, the company currently holds more than 16% of all shellfish culture area in British Columbia. |
| Fanny Bay Oysters www.fannybayoysters.com/ | oysters | Fanny Bay Oysters is a Canadian company farming shellfish on the coastline of British Columbia. Our shellfish products include fresh and IQF shucked Pacific oysters, live, banquet and IQF Pacific oysters and live and IQF Manila clams. |

| | | |
|---|---|--|
| Mac's Oysters Ltd www.macsoysters.com | oysters and clams | Mac's Oysters Ltd. is an integrated shellfish farm, processor and exporter that is owned and managed by the original farmers, the McClellan family. Mac's is recognized as a pioneer in oyster and clam aquaculture on Canada's Pacific Coast. |
| The Lax Kw'alaams Nation | trout and Skeena River sockeye | Based in Port Simpson, the band operates a recently refurbished seafood processing plant; it has become an economic engine for the Lax Kw'alaams First Nation. The fish-processing plant has become one of the leading canned and frozen food producers on the coast |
| N'usi Seafood | shrimp and crab | |
| Canadian Fishing Co www.canfisco.com/ | salmon, roe and ground fish | A fully integrated fishery including fishing, processing, and marketing of seafood products. |

*See Appendix 3 for a more complete listing of companies

Recreational Fisheries

BC's recreational fisheries support a wide range of businesses and economic activities ranging from transportation and lodging, to sale or rental of fishing supplies and services. The success of these industries depends on the returns of wild salmon, rainbow trout, and prehistoric white sturgeon to local rivers and the health of freshwater stocks in BC's freshwater lakes and rivers.

Stock assessment performed by fisheries biologist and enhancement activities carried out in hatcheries across the province are critical to the sector, helping to conserve native species and stocks to maintain a healthy level of sport fishing. To the extent to which fish are bred and reared in hatcheries, the sector also benefits from BC assets associated with broodstock development, fish health, and feed production and supply.

Industry Support

Industry Associations

The interests of companies operating within the sector are supported by a number of industry associations (Table 2). These bodies provide a range of functions, primarily to represent the interests of association members regionally, nationally and sometimes internationally, and to provide information about their industries to interested parties and the public at large. These organizations provide a means for the industry or private sector operators to 'speak with one voice', but also to provide a forum for members to meet and exchange information (e.g. Aquaculture Association of Canada), or to

consolidate activities of members towards a single goal (i.e. conservation of wild stocks).

Table 2: Industry Associations Operating in BC

| Association | Website | Subsector |
|--|--|------------------------|
| Aboriginal Aquaculture Association | www.aboriginalaquaculture.com | Aquaculture |
| Aquaculture Association of Canada | www.aquacultureassociation.ca | Aquaculture |
| BC Salmon Farmers Association | www.salmonfarmers.org | Aquaculture |
| BC Salmon Marketing Council | www.bcsalmon.ca | Fisheries |
| BC Seafood Alliance | www.bcseafoodalliance.com | Fisheries |
| BC Shellfish Growers Association | www.bcsfga.ca | Aquaculture |
| BC Tuna Fishermen's Association | http://bctfa.com/new/ http://bctfa.com/new/ | Fisheries Fisheries |
| Canadian Highly Migratory Species Foundation | www.canadianalbacoretuna.com | Fisheries |
| Canadian Aquaculture Industry Alliance (CAIA) | www.aquaculture.ca | Aquaculture |
| Canadian Council of Professional Fish Harvesters | www.ccpfh-ccpp.org | Fisheries |
| Canadian Ground fish Research & Conservation Society | www.cgrcs.com | Fisheries |
| Canadian Pacific Sardine Association | www.bcsardines.com | Fisheries |
| Canadian Sablefish Association | www.canadiansablefish.com | Fisheries |
| Fisheries Council of Canada | www.fisheriescouncil.ca | Fisheries |
| Pacific Organic Seafood Association | www.pacificorganicseafood.com | Aquaculture |
| www.phmana.org | www.phmana.org | Fisheries |
| Pacific Salmon Foundation | www.psf.ca | Fisheries |
| Pacific Urchin Harvesters Association | www.puha.org | Fisheries |
| Underwater Harvesters Association | www.geoduck.org | Fisheries |
| The World Aquaculture Society | www.was.org | Aquaculture |

Breeding Services and Products

The sector has driven development of a range of bio-based expertise and assets to support sustainable production and harvesting of fish including genotyping and broodstock development services, cryopreservation of sperm and egg preservation and sterilization technologies. With their basis in breeding, or the production of offspring,

these companies all incorporate significant expertise based in genetics, or biology/physiology.

TRI-GEN Fish Improvement has been providing consulting services in the areas of research, development and genetic improvement for aquaculture broodstocks since 1988. TRI-GEN is currently involved in genetic improvement programs for Atlantic, Chinook and coho salmon as well continued development of near infrared (NIR) technology for carcass trait measurements on live fish.

More recently, Canada Cryogenetics Services (a division of Cryogenetics AS in Norway) has established a base in Vancouver Island. Canada Cryogenetics Services offers services and technology for cryopreservation and storage of fish milt, providing a means for preservation of genetic diversity in wild species and managing genetic material within the breeding programs in commercial aquaculture

The application of chemical or pressure treatments to produce sterile or all female stocks is now well developed and is used in the management of threatened native stocks. These technologies have found routine application for management of restocking of sport fishing lakes.

See Appendix 4 for a list of Companies supplying breeding and other bio-based products and services to the sector.

Fish Health Services and Products

The culturing of fish and shellfish in hatcheries, net pens, and recirculation aquaculture systems, like any other food production system around the world, has necessitated the development of significant infrastructure to understand, prevent, diagnose and manage disease. Significant expertise has been developed within companies growing fish/shellfish, as well as within federal and provincial departments regulating the sector or operating hatcheries to support stock enhancement. Significant expertise and assets have been developed in the form of specialized organizations or through the attraction of multinational companies to BC.

The Provincial Fish Health laboratory is operated by the Freshwater Fisheries Society of BC (FFSBC). The Fish Health Unit plays an integral role in the Society by maintaining year round diagnostic assessments on all hatchery-reared fish to ensure that all fish health standards established by federal and provincial regulatory agencies are met. This ensures a high-quality hatchery fish, and protects the aquatic ecosystem and wild fish populations from exposure to disease pathogens originating from hatchery

fish. The laboratory also performs diagnostics on samples from wild stocks submitted by FLNRO and MOE biologists and other stakeholders.

The Fish Health Unit constantly maintains 5 cell lines to conduct virology assays. Two of these lines are salmonid, and the other 3 lines are white sturgeon cell lines, making the Fish Health Unit unique in British Columbia. These cell lines are used in monitoring the ongoing health of salmonids and sturgeon, meeting regulation requests for the FFSSBC's fish culture stocking programs, and conservation culture programs for white sturgeon. In addition to virology, the facility supports necropsy, serology, bacteriology, tissue culture and PCR laboratories.

Based in Campbell River, in the heart of the aquaculture industry, BC Centre for Aquatic Health Sciences (CAHS) is a non-for-profit organization established in 2009 with a mandate to provide research and diagnostic services to production fish/shellfish as well as wild fish. Employing veterinarians, molecular biologists and fish health technicians, CAHS provides a range of fish health services focusing on epidemiology, welfare, stress, diagnostics, and training.

With its BC headquarters in Nanaimo, Syndel is a global company that produces and supplies quality aquaculture health care products including; induced spawning products, anesthetics, disinfectants, parasiticides, fungicides, vaccines, transportation and handling products to the sector. With close relationships with BC's companies and researchers, Syndel specializes in cost-effective aquatic animal health solutions for reproduction, disease prevention and treatment, diagnostics, nutrition and contract research to support the BC sector.

Novartis, and the Norwegian owned company, Europharma, supplies or distribute vaccines and fish health products to BC and all other major markets for salmon production.

See Appendix 4 for a list of Companies supplying fish health and other bio-based products and services to the sector.

Feed Companies

Like perhaps no other industry, the production and supply of fish feed is inextricably entwined with BC's fisheries and aquaculture sector. Fish feed is a critical component in the rearing of cultured fish, and with its traditional base in fishmeal, feed production relies on the outputs of capture fisheries operations. Not surprisingly, BC is home to several large companies producing and supplying fish feed and has developed considerable capacity in the research and production of sustainable fish feeds (e.g. use

alternatives to fish meal, fish response to alternate feeds and pigment supplements)

All major feed companies operating in BC are international in nature (EWOS Canada, Skretting, Taplow Feeds) and export a significant amount of feed. The companies maintain close ties with the sector and are responsive to sector needs, supplying mainly salmon and trout diets but also produce feed for other species. Taplow Feeds, a smaller privately held feed company has been a world leader in the development of organic aquaculture and was the first fish feed mill in North America to attain certification for the production of certified organic fish feeds.

See Appendix 4 for a list of Companies supplying feed and other bio-based products and services to the sector.

Science Assets

Research

BC boasts a significant breadth and depth of researchers across its 25 publically funded higher education institutions, attesting to the importance of the fisheries and aquaculture sector to BC. Within these institutions significant expertise can be found in the areas of fish physiology, stock assessment, fish health, ecosystem interactions, shellfish and fish culture, and genomics, and around some of these areas major research centers have been established (Table 3). In addition, some of these centers maintain strong linkages with government and other organizations working in the space. For instance, the BC Ministry of Environment (MoE), the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) and the Freshwater Fisheries Society of BC (FFSBC) have research offices at UBC. These offices house one FLNRO staff, four MOE staff and four FFSBC research staff including one post-doc.

Table 3: Major Research Centers in BC

| Institution | Description |
|---|---|
| BC Centre for Aquatic Health Sciences, Campbell River | Advances understanding of BC’s aquatic resources and supports their sustainable growth and development by addressing aquatic animal health in both wild and farmed species, food safety and welfare issues. |
| Center for Aquaculture and Environmental Research (CAER) | A specialized center for aquaculture and coastal research conducting focused research programs that integrate ecosystem and conservation with sustainable aquaculture practices for growing aquatic species of global importance. |
| The Centre for Aquatic Biotechnology Regulatory Research (CABRR) | A national Centre of Expertise within Fisheries and Oceans Canada (DFO) created to conduct research in support of the risk |

| | |
|---|---|
| | assessment and regulation of fish with novel traits, including genetically engineered fish. |
| Centre for Shellfish Research | Facilitates the research and development to support BC's shellfish aquaculture industry, offering an integrated approach to research, innovation, training and technology transfer. |
| International Centre for Sturgeon Studies | Research focused on conservation and development of the white sturgeon. |
| Cultus Lake Salmon Research Laboratory | Research on fresh water species and the Cultus lake sockeye. |
| Bamfield Marine Sciences Centre | Bamfield Marine Sciences Centre is a world-class teaching and research facility located on the outer west coast of Vancouver Island, Canada. BMSC is owned and operated by the non-profit Western Canadian Universities Marine Sciences Society whose BC based members include UVIC, SFU, UBC, and VIU. |
| UBC Zoology | UBC's Zoology Department is home to some of the best conservation biologists in the world. The Department operates a new state of the art Marine/Freshwater Aquatic Facilities and supports the R&D activities of a core group of fish physiology researchers working in UBC's Zoology Department and UBC's Fisheries Centre (below). |
| UBC Forestry | UBC Faculty of Forestry is home to a leading Canadian research group that specializes in using Biotelemetry to address wild salmon conservation issues. |
| UBC Food and Land Systems | UBC Faculty of Land and Food Systems is home to two research Chairs whose focus is fish and includes aquaculture |
| UBC Fisheries Centre | Promotes multidisciplinary study of aquatic ecosystems and broad-based collaboration with maritime communities, government, NGOs and other partners. The Center benefits from UBC's Marine/Freshwater Aquatic Facilities housed in UBC's Department of Zoology. |
| School of Resource & Environmental Management (REM) at SFU | REM provides an opportunity for interdisciplinary research and education on natural resource and environmental issues of local, national, and international interest. |
| SAFE Division at SFU | Research on the incubation, rearing, migration, and feeding behavior of salmonids, and the health and carrying capacity of the habitat on which they depend. |
| Vancouver Aquarium Marine Science | Focused on the conservation of aquatic life through display, communication, public programming and education, research and direct action. |

Genome Canada and Genome BC in particular have catalyzed development of considerable genomic capacity and expertise in the province (Table 4) including development of microarray and sequence tools for salmon. (See Appendix 2 for a list of projects funded). Other organizations (e.g. DFO Pacific Biological Station) have also established considerable genomic platforms to support their operations.

Table 4: BC-Based 'Omics Infrastructure

| Facility | Platforms |
|---|--|
| Genome BC Microarray Platform and Gene Array Facility (Prostate Centre, Vancouver General Hospital) | Microarrays |
| Michael Smith Genome Sciences Centre, BC Cancer Agency (BCCA) www.bcgsc.ca | Sequencing, mapping, gene expression and bioinformatics facilities |
| UBiC (the UBC Bioinformatics Centre) www.bioinformatics.ubc.ca | Bioinformatics |
| UVic- Genome BC proteomics Centre | Proteomics |
| UBC Wine Center | Microarrays |
| DFO Pacific Biological Station, Nanaimo | Microarrays, Genotyping |

British Columbia also supports twelve Research Chairs with expertise relevant to the sector across five of the provinces 17 colleges and universities: University of Victoria, Vancouver Island University, Simon Fraser University, the University of British Columbia and North Island College.

Outside BC's higher education system, the Department of Fisheries and Ocean employs almost 100 research scientists working in areas from aquatic animal health, to fish population science, aquatic ecosystem science, aquaculture, aquatic health, aquatic invasive species, species at risk, climate change and oceanography. The Province, responsible for fish in BC's rivers, also employs a number of highly skilled fisheries biologists and fish researchers.

See Appendix 5 for a more complete list of BC researchers.

Education & Training

In addition to the research expertise contained within BC's higher education institutes, several organizations have developed specific programs to train students for employment in the sector.

The University of Northern British Columbia (UNBC), located in Prince George with over 1,600 lakes and rivers nearby, provides a number of programs to support BC's natural resource management including undergraduate degrees in Outdoor Recreation and

Conservation (BSc, Major and Honors), Wildlife and Fisheries (BSc, major and honors), and the Social Dimensions of Natural Resources Management (BSc, minor).

On Vancouver Island, in the heart of BC's aquaculture and fisheries operations, Vancouver Island University offers a Bachelor of Science Degree in Fisheries and Aquaculture and one and two year diploma programs. The programs provide a unique blend of practical field experience and academic skills required for careers in fish and invertebrate culture, fish habitat & stock assessment, fisheries enhancement, conservation & management and research.

At University of British Columbia, the Centre for Aquaculture and Environmental Research (CAER) is an internationally recognized research and education facility dedicated to environmental protection and sustainable aquaculture. CAER is a collaborative effort between UBC and Department of Fisheries and Oceans Canada.

In Courtney, BC, Excel Career College offers an Aquaculture Technician Diploma Program. This 25-week program provides classroom and practicum training in fish husbandry and hatchery operation and related activities and prepares graduates for work in the aquaculture and fisheries sector.

Further north on Vancouver Island, North Island College, has also established an Aquaculture Tech Training Program in collaboration with the Industry as well as received a national grant for an Industry Research Chair (held by Steve Cross).

Infrastructure Assets

Stock Assessment Assets

With 81 distinct fish species and subspecies in BC's fresh water¹⁰ and 30 fish, shellfish and plants from the marine environment, BC has amassed significant expertise in stock assessment so as to monitor restocking programs, monitor stocking recovery and aquatic ecosystems, and to set harvest quotas and catch limits. In particular, significant expertise is housed within BC's Ministries of Environment and Forest, Natural Resource Operations, and the Department of Fisheries and Ocean who manages fish in rivers and lakes and saltwater fishery resources respectively. Pacific salmon, occupying both salt and freshwater at different life stages, are the responsibility of Fisheries and Oceans Canada.

¹⁰ <http://www.env.gov.bc.ca/wld/fishhabitats/native.html>

DFO and the province each employ fish biologists who collect data on fish stock through a number of quantitative and qualitative means including fish surveys, creels, and visual inspections. Additional expertise in stock assessment in one form or another is also maintained within aquaculture companies and among consulting companies and community and First Nation groups. Aquaculture companies typically collect information on traits of interest (e.g. size, flesh quality etc.) and incorporate this information into their breeding index and overarching breeding program. First Nation groups typically use this information to monitor conservation and ecosystem change.

Hatchery Assets

Hatcheries provide an enclosed environment to support production and cultivation of large numbers of fish under controlled condition safe from predators and environmental pressures normally occurring in nature. Hatcheries are used for commercial fish production and also to supplement the natural numbers of threatened or endangered species in lakes and rivers, and are thus a critical component of BC's fisheries and aquaculture sector.

Most aquaculture companies operate their own hatchery facilities. These hatcheries provide facilities for rearing and spawning of broodstock, egg fertilization and hatching and rearing of juvenile until transfer to grow out sites.

Hatcheries are also a key instrument in federal and provincial efforts to sustain native populations or to provide harvest opportunities in capture, recreational and Aboriginal fisheries.

Since 2003, the provincial trout-stocking program has been the responsibility of the Freshwater Fisheries Society of BC (FFSBC). The FFSBC operates five provincial hatcheries, producing 6.4 million trout, char and kokanee salmon for stocking into over 800 lakes and streams across BC. These fish originated from 50 separate fish stocks and seven distinct species. These hatcheries pioneered the practice of using triploidy into restocking initiatives. Since 1998, the Kootenay Trout Hatchery complex near Fort Steele has also been rearing white sturgeon eggs to yearling-age for conservation purposes. Each year sturgeon produced from this hatchery is stocked into the Columbia and Upper Columbia rivers and Kootenay River tributaries. In the spring of 2014 the Nechako Sturgeon Conservation Centre will open in Vanderhoof, BC. Located across the river from the only known spawning site for Nechako white sturgeon, the facility will hatch and release up to 12,000 juvenile sturgeon into the river each year – all part of an effort to rebuild the population and restore the ability of sturgeon to spawn successfully in their natural habitat.

Through its Salmonid Enhancement Program (SEP), the Department of Fisheries and Oceans operates eighteen major hatchery facilities and spawning channels in BC. These hatcheries produce anadromous salmon species like coho, Chinook, chum, pink and sockeye salmon along with steelhead, and cutthroat trout. Much of this work is done with community-based groups to keep in tune with local needs through Community Economic Development Hatcheries, and volunteer-run facilities.

Additionally, a number of other community or First Nation groups operate hatcheries across BC to produce fish for conservation, protection, restoration, and enhancement of indigenous (anadromous and resident) fisheries. Omega Pacific is one such group, and has been working to advance culture of Pacific salmon (Chinook) since 1980. Omega has focused on optimizing rearing methods to ensure high ocean survival and through biotechnology is able to produce smolt populations that consistently achieve 96% survival after 22 months in an ocean environment. Omega Pacific works with both the enhancement and commercial aquaculture sectors to develop the best possible high survival juvenile.

Coho salmon, Atlantic salmon, rainbow trout, white sturgeon and crayfish are also grown, with ongoing freshwater broodstock program for these species.

See Appendix 6 for a list of Provincial, Federal and Community/non-commercial hatcheries in BC.

OPPORTUNITIES

BC's bio-based assets (business, infrastructural and scientific) that have developed about BC's bountiful natural aquatic resources provide innumerable opportunities to improve the sustainability and productivity of the sector. Genomics tools and technologies may be used to:

- Increase our understanding and management of the population structure of wild fish stocks
- Improve our understanding of fish/shellfish response to stress and environmental changes (e.g. oceans with higher acidity/ lower pH levels)
- Study interactions between fish and their environment
- Improve salmon enhancement programs through the use of marker assisted selection to select for fish better able to adapt to their environment
- Improve product quality of aquaculture stocks through marker assisted breeding
- Develop improved diagnostics, treatments or vaccines to improve fish health management

- Understand and optimization fish culture in RAS (recirculation aquaculture systems)
- Develop more sustainable fish feeds
- Shorten production times through the study and optimization of grow out conditions
- Improve our understanding of fish/environment interactions
- Develop new species for culture
- Address questions regarding risk and uncertainty in the sector
- Support evidence based policies to improve sector productivity and sustainability

Application of genomics in these areas will speed the delivery of innovations and associated economic and social benefits to the First Nation and other citizens, municipalities, businesses and government BC.

Appendix 1: Major funders of Research, Development and Commercialization in the Fisheries & Aquaculture sector in BC

| Program Name | Website | Program Description |
|---|--|--|
| Canada Research Chairs | www.chairs-chaires.gc.ca | The Canada Research Chairs program stands at the center of a national strategy to make Canada one of the world's top countries in research and development. The Canada Research Chairs program invests \$300 million per year to attract and retain some of the world's most accomplished and promising minds. |
| Coast Opportunities Funds | www.coastfunds.ca | The Economic Development Fund comprises \$58 million to support eligible First Nation-led sustainable businesses and community-based employment opportunities in the Project Area, consistent with goals of conservation. |
| Department of Fisheries and Oceans (DFO)- Aquaculture Collaborative Research and Development Program (ACRDP) | www.dfo-mpo.gc.ca | DFO-ACRDP is a Department of Fisheries and Oceans (DFO) initiative to increase the level of collaborative research and development activity between the aquaculture industry and the department, and in some instances with other funding partners. ACRDP is an industry-driven program that teams industry with DFO researchers to support regulatory and fish health-related research. |
| Fish 2.0 | www.fish20.org | Fish 2.0 is a business competition that connects sustainable fisheries and aquaculture businesses with potential investors. |
| Future of Fish | www.futureoffish.org | Future of Fish (FoF) is a nonprofit accelerator for entrepreneurs launching market-based initiatives that drive sustainability, efficiency, and traceability in the seafood supply chain. |
| Genome BC User Partnership Program (UPP) | www.genomebc.ca | UPP is designed to directly address the challenges defined by users in BC's key sectors including: forestry, fisheries, agriculture, environment, bioenergy, mining and human health. |
| Genome Canada Genomic Application Partnership Program (GAPP) | www.genomecanada.ca | Promote the application and commercialization of genomics-derived solutions to address key sector challenges or opportunities facing Users - User "pull". |

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|---|--|--|
| Growing Forward 2 (GF2) | www.agr.gc.ca | GF2 is a \$3 billion dollar investment by federal, provincial and territorial (FPT) governments and the foundation for government agricultural programs and services over the next five years. GF2 programs will focus on innovation, competitiveness and market development to ensure Canadian producers and processors have the tools and resources they need to continue to innovate and capitalize on emerging market opportunities. |
| MITACs | www.mitacs.ca | Through support for unique research and training programs, Mitacs is developing the next generation of innovators with vital scientific and business skills. |
| National Research Council (NRC)- Industrial Research Assistance Program (IRAP) | www.nrc-cnrc.gc.ca | NRC-IRAP provides funding to qualified firms and their innovative research and development projects. |
| National Science and Engineering Research Council (NSERC) | www.nserc-crsng.gc.ca | The agency supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in post secondary research projects. |
| Pew Charitable Trusts | www.pewtrusts.org | Pew Foundation funds environmental-based research with a focus on habitat protection and species conservation |
| Tides Canada-Salmon Aquaculture Innovation Fund | www.tidescanada.org | Established the Salmon Aquaculture Innovation Fund focused on advancing aquaculture solutions that protect wild salmon and the marine environment. |

Appendix 2: Genome BC Investments in Fisheries & Aquaculture Genomics

| Project Title | Dates | Primary Investigators | Area | Purpose of the Research | Potential Application of the Research |
|--|-----------------------|--|---------------|---|---|
| 1. Genomics Research on Atlantic Salmon Project (GRASP) | 2001-10-01/2005-12-31 | Willie Davidson, Ben Koop | Fish research | Develop four new tools (linkage/physical maps and microarray resources) to improve understanding of salmon genomic and salmon biology. | Improve management of wild and farmed salmonids. |
| 2. Consortium for Genomic Research on All Salmonids Project (cGRASP) | 2006-01-01/2010-03-31 | Ben Koop, Willie Davidson, Stig Omholt | Fish research | Expand genomic resources (physical mapping and ESTs) for Atlantic salmon and rainbow trout, extend resources to brook char, northern pike and smelt and begin to apply tools in aquaculture/fisheries sector. | Address questions of economic and social importance to aquaculture, conservation and the environment in BC. |
| 3. Genomic Tools for Fisheries Management (FishMan Omics) | 2008-07-01/2012-06-30 | Kristi Miller-Saunders | Fisheries | Understand the stressors that salmon are facing as they migrate between freshwater and saltwater environments that could negatively impact productivity | Improved management of salmonids in various conditions. |
| 4. Genomics in Lice and Salmon (GiLS) | 2008-10-01/2012-06-30 | Willie Davidson, Simon Jones, Ben Koop, Grant Murray | Aquaculture | Understand at a genetic level the host-pathogen response during Pacific and Atlantic salmon genetic exposure to salmon lice, <i>Lepeophtheirus salmonis</i> , | Improved management (prevention and treatment) of potential infections. |

| | | | | | |
|---|-----------------------|---|----------------|--|---|
| 5. Sablefish Genomics | 2009-01-01/2010-03-31 | Ben Koop | Fisheries | Development of genetic resources for sablefish. | Improved identification, conservation and management of wild stocks, and broodstock selection in aquaculture. |
| 6. Development of a Health Assessment Tool for Marine Mussels (Myt-OME) | 2009-01-01/2011-06-30 | Helen Gurney-Smith, Stewart Johnson | Environment | To combine genomics and ecological areas of research to significantly contribute towards assessments of shellfish health, with different environmental stressors, for use in both the environmental and aquaculture sectors. | Support work in understanding and ranking systems of environmental stressors of shellfish. |
| 7. International Cooperation Project to Sequence the Atlantic Salmon Genome (ICSASG) | 2009-10-29/2013-10-31 | Willie Davidson, Patricia Iturra, Inge Jonassen, Steve (Steven) Jones, Ben Koop, Sigbjorn Lien, Alejandro Maass, Stig Omholt, Rodrigo Vidal | Basic research | Sequence and annotate the genome of the atlantic salmon. | Various applications to support productivity and sustainability of farmed and wild salmonids. |
| 8. Population transcriptomics - harnessing next-generation sequencing technologies for adaptive genetic marker discovery to inform studies in ecology, evolution and conservation | 2010-10-01/2012-06-30 | Michael Russello | Fisheries | Identification of markers for adaptive genetic changes in kokanee stocks | Improved management of freshwater salmon in BC. |
| 9. Inventory and Assessment of Health Risk of Microbes in BC | 2012-05-01/2013-06-30 | Kristi Miller-Saunders, Brian Riddell | Fisheries | Development of a novel multiplex panel to assess prevalence of microbes in salmon populations. | Improved management of BC's wild salmon fisheries. |

| | | | | | |
|--|-----------------------|-------------------------------------|-------------|---|---|
| 10. Salmon Anaemia Virus Epidemic Reduction Strategy (SAVERS) | 2013-01-14-06-30 | Andrew Bennet | Aquaculture | Develop and test chemotherapeutic agents to combat ISAV. | Improved understanding of influenza salmon anaemia virus. |
| 11. Implementation of mussel genomics into wastewater management (H2OME) | 2013-04-01/2013-09-30 | Helen Gurney-Smith, Stewart Johnson | Environment | To secure Intellectual Property (IP) protection of the marine mussel oligonucleotide microarray called MytOME, developed under a previous Genome BC collaboration, to facilitate product commercialization and collaboration. | IP and know how ready to be developed into commercial test for environmental assessment of marine waters. |

Appendix 3: Major Companies Producing or Harvesting Fish and Shellfish in BC

| Name | Address | website | species | Description |
|---|--|---|-----------------|---|
| AgriMarine Inc | Middle Bay, Campbell River, 4405 Island Highway Campbell River, B.C. Canada, V9H 1G2 T: 250-286-6465 F: 250-286-6481 | http://www.agrimarine.com | Salmon | Canadian-based AgriMarine uses proprietary solid-walled floating tanks to farm salmon in closed containment in freshwater bodies or in marine environments. AgriMarine's clean technology systems are currently being used to produce environmentally sustainable Pacific salmon in the Company's freshwater farm in China. |
| Ahousaht First Nation w/ Cermaq Canada | Clayoquot Sound, British Columbia | www.ahousaht.ca | Atlantic salmon | The Ahousaht Hwiih and Community is partnering with Cermaq Canada leadership and staff to establish a sustainable finfish aquaculture business in Ahousaht Hahoulthee. This business strives to meet or exceed existing environmental standards; be recognized globally as a progressive, innovative Aboriginal /Industry partnership that seeks mutual long term social, economic, cultural and spiritual benefits for both parties; and will consider the needs and interest of future generations. |
| BC Kelp | BC KELP PO Box 274 Prince Rupert, British Columbia Canada V8J 3P3 Mailing address: Tel: 1 (250) 622-7085 | www.bckelp.com | Kelp | BC KELP is a small family business which produces a premium quality wild and sustainable sea product. In small batches the Kelp is selectively hand harvested for outstanding quality. |
| Below Level Oyster Company | Box 74 Mansons's Landing, BC V0P 1K0 | | Oysters | |

| | | | | |
|-------------------------------------|--|--|-----------------|---|
| Canadian Benthic Ltd | 94 S Bamfield Rd, Bamfield, BC V0R 1B0 | | Scallops | |
| Canadian Kelp Resources Ltd. | Canadian Kelp Resources Port Desire Bamfield, B.C., Canada V0R 1B0 Email: contact@canadiankelp.com | http://www.canadiankelp.com | Kelp | A family owned and operated company, dedicated to the development and promotion of quality kelp products and services in the context of good ecological and humanitarian practices. Our products consist of sea vegetables and raw kelp material for pharmaceutical and cosmetic products, and kelp seed for kelp farmers. Our services consist of consulting on kelp farming, kelp product development and processing, and environmental assessment and bio-remediation. |
| Cermaq Canada | #203 - 919 Island Highway Campbell River, BC V9W 2C2 T: 250-286-0022 F: 250-286-0042 | www.mainstreamcanada.com | Atlantic salmon | Cermaq Canada is BC's second largest producer of farmed salmon, accounting for roughly a quarter of all production. The Norwegian-owned Cermaq Group has salmon farming operations in Norway, Chile, and Canada. |
| Creative Salmon Company Ltd. | PO Box 265 612 Campbell Street Tofino, BC V0R 2Z0 T: 250-725-2884 F: 250-725-2885 | www.creativesalmon.com | Chinook salmon | Based in Tofino, BC, Creative Salmon is North America's only major producer of indigenous Pacific Chinook (King) salmon. Creative Salmon is a fully integrated company, operating a hatchery and proprietary broodstock program. Fish produced are certified organic. |
| Evening Cove Oysters Ltd | 1360 Stewart Ave, Nanaimo, BC V9S 4E1 | | Oysters | |
| Fanny Bay Oysters | 8260 S Island Hwy, Fanny Bay, BC V0R 1W0 T: (250) 335-0125 F: (250) 335 1211 | www.fannybayoysters.com/ | Oysters | Fanny Bay Oysters is a Canadian company farming shellfish on the coastline of British Columbia. Our shellfish products include fresh and IQF shucked Pacific oysters, live, banquet and IQF Pacific oysters and live and IQF Manila clams. |

| | | | | |
|---------------------------------|--|---|---|--|
| Golden Eagle Aquaculture | Agassiz, BC | | Coho salmon | Golden Eagle Aquaculture is a fully integrated land-based (Recirculation Aquaculture System) operation producing coho salmon. |
| Grieg Seafood | 106 - 1180 Ironwood Street Campbell River, BC V9W 5P7 T: 250-286-0838 F: 250-286-1883 | www.grieg.ca | Atlantic salmon, coho | Grieg Seafood BC Ltd. holds 21 farm licenses, has its own hatchery in Gold River, and owns a small processing plant on BC's Sunshine Coast, in Egmont. |
| N'usi seafood | | | Shrimp and crab | The Heiltsuk operate a community-owned fish processing plant in Bella Bella in central Campbell Island. The plant processes shrimp and crab and plans to expand to salmon, sea cucumbers, sea urchins and manila clams. |
| Island Scallops | 5552 W Island Hwy Nanaimo H, BC V9K 2E7 (250) 757-9811 | www.islandscallops.com/ | Scallops | Island Scallops Ltd (ISL) was established in 1989 and is currently engaged in the hatchery production, farming, processing, and marketing of marine species. ISL is a technology-driven company with extensive marine expertise, and has developed proprietary hatchery technology for several species including the unique Pacific scallop and sablefish (black cod). ISL farms the Pacific scallop at several sites along the coast of Vancouver Island. With over 500 ha (1200 acres) of scallop farm tenures, the Company currently holds more than 16% of all shellfish culture area in British Columbia. |
| Kitasoo Aquafarms | Klemtu, British Columbia | http://www.kitasoo.org/fisheries/index-fisheries.html | Atlantic salmon | Kitasoo Aquafarms operated a production salmon farm near Klemtu from 1989 to 1994. Since 1998, Kitasoo Aquafarms has partnered with Marine Harvest Canada for the purposes of salmon farming. Kitasoo Aquafarms currently holds 4 salmon farm tenures and is currently developing 2 additional tenures as well as research on potential shellfish farming sites in the Kitasoo traditional territory. |
| Kyuquot SEAfoods Ltd | 2541 Conrad Rd., Courtnay BC, V9N 9N8 | | 11 species of fish, shellfish and marine plants | |

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|---------------------------------|--|---|---|---|
| Little Wing Oysters Ltd | 2192 101 Hwy, Powell River, BC | | Oysters | |
| Mac's Oysters Ltd | 414 Emerton Road Fanny Bay, British Columbia Canada V0R 1W0 | http://www.macs-oysters.com | Oysters and clams | Mac's Oysters Ltd. is an integrated shellfish farm, processor and exporter that is owned and managed by the original farmers, the McLellan family. Mac's is recognized as a pioneer in oyster and clam aquaculture on Canada's Pacific Coast. |
| The Lax Kw'alaams Nation | | | Trout and Skeena River sockeye | Based in Port Simpson, the band operates a recently refurbished seafood processing plant has become an economic engine for the Lax Kw'alaams First Nation. The fish-processing plant has become one of the leading canned and frozen food producers on the coast |
| Marine Harvest Canada | #124 - 1334 Island Highway Campbell River, BC V9W 8C9 T: 250-850-3276 F: 250-850-3275 | www.marineharvestcanada.com | Atlantic salmon | Marine Harvest Canada is BC's largest producer of farmed salmon and operates about half of the industry's salmon farms. Marine Harvest, the parent company is Norway based and has operations in Norway, Chile, Canada, Ireland, the Faeroe Islands and Scotland. |
| Namgis Nation | Namgis First Nation 49 Atli Street, Alert Bay P.O. Box 210, Alert Bay, B.C. V0N 1A0 Tel: 250-974-5556 Toll Free: 888- 962-6447 Fax: 250-974- 5900 | http://www.namgis.bc.ca/CCP/Pages/default.aspx | Atlantic salmon | The 'Namgis Closed Containment Project is growing out Atlantic salmon to 3 to 5 kg in a land-based, biosecure, closed containment recirculating aquaculture system (RAS). The first fish entered the facility on March 18, 2013. |

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|-----------------------------------|---|---|--------------------------------|---|
| North Pacific Kelp Product | North Pacific Kelp Product 1201 Oceanview Drive, PO Box 545 Queen Charlotte, BC V0T1S0 Haida Gwaii - Canada | http://www.northpacifickelp.com | Kelp | Hand harvested kelp, dried at room temperature in specially designed facilities. |
| Odyssey Shellfish Ltd | 7400 Island Hwy, Bowser, BC V0R 9G0 | | Oysters | |
| Omega Pacific | Omega Pacific Hatchery Carol Schmitt or Bruce Kenny Ph. 250-731-5043 email: camp9@lincsat.com PO Box 9 Port Alberni, BC Canada V9Y7M6 | http://www.omegapacific.ca | Chinook salmon | With more than thirty consecutive years of spawning and growing Chinook salmon, Omega has discovered optimum rearing methods to ensure high ocean survival. Omega Pacific's advancements in Bio-Technology have enabled the culture of smolt populations which consistently achieve 96% survival after 22 months in an ocean environment. |
| Pentlatch Seafoods | 3320 Comox Road, Courtenay, BC V9N 3P8 T: (250) 339 4545 | http://komogway.com | Clams and oysters (Komo Gway) | Pentlatch Seafoods Ltd. is a company wholly owned and operated by the K'ómoks First Nation on Vancouver Island, British Columbia, Canada and named in honour of the house of Pentlatch. Pentlatch Seafoods grows premium quality oysters and clams in the heart of Canada's Shellfish Capital – the Comox Valley within the traditional territory of the K'ómoks First Nation |
| SableFish Canada | Sable Fish Canada Ltd. 3335 Walkers Hook Road, Salt Spring Island, British Columbia, V8K 1N7 | http://kyuquotsond.com | Sablefish | Producing sablefish. |

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|---|--|---|---------------------------------------|--|
| Stellar Bay Shellfish | 7400 W Island Hwy Bowser, BC V0R 1G0 T:(250) 757-9304 | http://www.stellarbay.ca | Oysters, clams, mussels | Operating from two family run farms, Sawmill Bay Shellfish produces oysters, clams, mussels and scallops reared in glacier-fed waters off Read Island. |
| Target Marine Products Ltd. | 7333 Sechelt Inlet Road Sechelt, BC V0N 3A4 T: 604-885-4688 F: 604-885-7949 | http://www.northerndivine.com | Caviar, sturgeon meat | Target Marine is a wholly BC owned Aquaculture Enterprise that has developed and now maintains sustainable land-based recirculation systems to raise the 'Mighty Fraser River' white sturgeon. |
| Taste of BC | Taste of BC Aquafarms Inc, 930 Jameson Road, Naniamo, BC V6R 6W8 | www.freshbcsalmon.com | Steelhead | A model farm producing steelhead in a RAS system. |
| Taylor Shellfish Farms | 701 Broad Spit Rd, Quilcene, WA | | Oyster seed, oyster & other shellfish | Hatchery supplying oyster seed |
| We Wai Kai Seafood Corp | PO Box 220, Quathiaski Cove, BC V0P 1N0 | | Scallops | |
| West Coast Fish Culture (Lois Lake) Ltd. | C13, Dickson Road Powell River, BC V8A 5C1 T: 604-487-9200 F: 604-487-1036 | http://www.westcoastfishculture.ca | Stillwater steelhead | West Coast Fish Culture (Lois Lake) Ltd. farms Stillwater steelhead in Lois Lake, British Columbia. Fish are raised on sustainable feed, without antibiotics. |
| Yellow Island Aquaculture Ltd | Yellow Island Aquaculture Ltd. Box 340, Heriot Bay, BC V0P 1H0 | http://www.yellowislandaquaculture.com | Chinook salmon | Yellow Island Aquaculture Ltd. (YIAL) is a small, family owned, organic salmon hatchery and farm located on Quadra Island, just east of Campbell River on Vancouver Island, British Columbia. Since our start in 1985, YIAL remains the oldest, continuously-owned Pacific salmon farm in B.C. Our specialty products are fresh whole, fresh filleted, hot |

smoked, and candied Chinook salmon. We also provide production eggs and smolts for other aquaculture operations who wish to obtain animals from an organic source.

Appendix 4: Companies Supplying Bio-Based Products or Services to the Sector

| | Name | species | Description |
|---|--|---|--|
| Breeding Services & Products | TRI-GEN Fish Improvement | Atlantic, Chinook and coho salmon | TRI-GEN Fish Improvement has been providing consulting services in the areas of research, development and genetic improvement for aquaculture broodstocks since 1988. TRI-GEN is currently involved in genetic improvement programs for Atlantic, Chinook and coho salmon as well continued development of NIR technology for carcass trait measurements on live fish. |
| Breeding Services & Products | Canada Cryogenetics Services www.cryogenetics.com | Finfish | Cryogenetics Canada serves aquaculture customers and fish stock conservation programs on the Pacific as well as the Atlantic coast with milt stripping, cryopreservation, milt storage and milt distribution. |
| Breeding Services & Products | Pacific Omega www.omegapacific.ca | Producers of Pacific Salmon & trout - ova, fry & smolts | Production of Pacific salmon & trout fry and ova for enhancement purposes. |
| Feed | EWOS www.ewos.com/wps/wcm/connect/ewos-content-canada/ewos-canada | Atlantic and Pacific Salmon, trout, bass, sturgeon, yellowtail, sea bream, flounder, rockfish and cobia | EWOS Canada Limited is a manufacturer of high quality fish feed diets that are formulated to meet the nutritional needs of each stage of the salmonid lifecycle. |
| Feed | Taplow Feeds www.taplow.com | Atlantic salmon, yellow tail, pond, trout, Chinook salmon | Taplow Feeds owns and operates a manufacturing facility in Chilliwack, British Columbia. The Company has state-of-the-art, technologically advanced equipment with which to manufacture high quality extruded fish feed and pet foods. Strict Quality Assurance and Control Systems are in place to facilitate our exports throughout World Markets. Taplow Feeds produces organic fish feeds and is inspected by the Canadian Food Inspection Agency. |

| | | | |
|-----------------------------|---|--|--|
| Feed | Skretting www.skretting.ca | Hatchery / larval and weaning diets | Skretting (formerly Moore-Clark) is Canada's largest aquaculture feeds producer and leads the market with innovative feeds and feeding expertise. The company supplies mainly salmon and trout diets but also produces other fish feeds. Our substantial international resources and expertise are a guarantee of the highest quality standards throughout the food chain. |
| Feed | Piscine Energetics www.mysis.com/piscineenergetics.html | Ornamental aquaculture, aquarium species | Piscine Energetics Inc., headquartered in British Columbia, Canada has been revolutionizing the ornamental aquaculture and aquarium industry through innovation in aquatic nutrition. Piscine Energetics MYSIS SHRIMP (PE MYSIS) is a nutritionally complete fish food harvested from the pristine glacial lakes of Canada. |
| Fish Health Services | Aquametrix Research | All | Aquametrix Research Ltd., a private company specializing in marine environmental assessment and aquaculture research/development. |
| Fish Health Services | BC Centre for Aquaculture Health Sciences www.caHS-bc.ca | All | BC CAHS exists to improve the health of aquatic animals and ecosystems, by developing applied scientific knowledge. CAHS offers a range of fish health and husbandry support services to the aquaculture industry. |
| Fish Health Services | Europharma www.europharma-ca.com | All | Europharma is a specialized distributor of vaccines and fish health products in all major markets for salmon production. The Norwegian owned company funds a number of R&D projects and host seminars to contribute to the progress of salmon farming. Europharma is the worldwide supplier of SuperSmolt®. |
| Fish Health Services | Provincial Fish Health Laboratory | All | Run by the Freshwater Fisheries Society of BC (FFSBC), the Provincial Fish Health lab diagnoses many of the disease issues in wild stocks (FLNRO and MOE biologists + stakeholders submit samples). The lab also performs all of the fish health services for the FFSBC . The lab facility supports several labs including a necropsy, serology, virology, PCR, and a tissue culture lab. The Fish Health Unit can perform bacteriology isolation and basic identification of some common fish bacterial pathogens. PCR is used for the amplification and confirmation of certain fish pathogens, and virology is used for the detection of salmonid and sturgeon viruses. |
| Fish Health Services | Syndel www.syndel.com | All | Syndel is the world leader in aquatic animal reproduction. Syndel produces and markets quality aquaculture health care products including; induced spawning products, anesthetics, disinfectants, parasiticides, fungicides, vaccines, transportation and handling products. |

Appendix 5: BC Researchers and Areas of Expertise/Interest

(note a list of DFO scientists can be found here: DFO scientists <http://www.meds-sdmm.dfo-mpo.gc.ca/sdb-bds/listings-liste.do?d-3680070-o=2&d-3680070-p=1&d-3680070-s=1&lang=eng>)

| Organization | Name | Expertise/Interests |
|------------------------------------|--------------------|--|
| BC Institute of Technology | Angelo, Mark | River's Institute |
| BC Institute of Technology | Ashley, Ken | Fisheries Restoration, Aquatic Ecology |
| Center for Aquatic Health Science | Marshall, Wyth | Aquatic Animal Health |
| Center for Aquatic Health Science | Saksida, Sonja | Aquatic Animal Health |
| Center for Aquatic Health Science | Siah,Ahmed | Aquatic Animal Health |
| Department of Fisheries and Oceans | Abbott, Cathryn | Aquatic Animal Health, Aquatic Invasive Species, Biotechnology/ Genomics, Biodiversity Science |
| Department of Fisheries and Oceans | Beamish, Richard | Aquatic Habitat / Aquatic Environmental Science, Ocean Climate |
| Department of Fisheries and Oceans | Bower, Susan | Aquatic Animal Health |
| Department of Fisheries and Oceans | Bradford, Mike | Aquaculture, Aquatic Animal Health, Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | Brown, Robin | Aquatic Animal Health, Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Ecosystem effects of fishing, Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Brown, Tom | Aquatic Habitat / Aquatic Environmental Science, Fish Population Science |
| Department of Fisheries and Oceans | Candy, John | Biotechnology/ Genomics, Biodiversity Science, Fish Population Science |
| Department of Fisheries and Oceans | Carmack, Eddy | Ocean Climate |
| Department of Fisheries and Oceans | Chandler, Peter | Physical Oceanography |
| Department of Fisheries and Oceans | Cherniawsky, Josef | Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Christian, Jim | Biological Oceanography, Ocean Climate |
| Department of Fisheries and Oceans | Brown, Laura | |
| Department of Fisheries and Oceans | Clarke, Craig | Aquaculture, Aquatic Habitat / Aquatic Environmental Science |

| | | |
|---|-------------------------|---|
| Department of Fisheries and Oceans | Cooke, Karina | Biological Oceanography |
| Department of Fisheries and Oceans | Crawford, Bill | Physical Oceanography |
| Department of Fisheries and Oceans | Crewe, Norm | Physical Oceanography |
| Department of Fisheries and Oceans | Cummins, Patrick | Hydrography, Physical Oceanography |
| Department of Fisheries and Oceans | Curtis, Janelle | Aquatic Habitat / Aquatic Environmental Science, Ecosystem effects of fishing, Fish Population Science, Species at Risk |
| Department of Fisheries and Oceans | Dangerfield, Neil | Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Denman, Kenneth | Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Devlin, Robert | Engineering Research Scientist |
| Department of Fisheries and Oceans | Dunham (Epelbaum), Anya | Aquaculture, Aquatic Ecosystems Science, Aquatic Invasive Species |
| Department of Fisheries and Oceans | Duprey, Nicholas | Aquaculture, Ecosystem effects of fishing, Fish Population Science, Marine Mammal |
| Department of Fisheries and Oceans | Edwards, Andrew | Aquatic Ecosystems Science, Biological Oceanography, Fish Population Science, Marine Mammal, Physical Oceanography, Species at Risk |
| Department of Fisheries and Oceans | Foreman, Mike | Physical Oceanography |
| Department of Fisheries and Oceans | Forrest, Robyn | Aquatic Ecosystems Science, Ecosystem effects of fishing, Fish Population Science |
| Department of Fisheries and Oceans | Forster, Ian | Aquaculture, Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | Fraser, Tamara | Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Freeland, Howard | Physical Oceanography |
| Department of Fisheries and Oceans | Fu, Caihong | Aquatic Ecosystems Science, Biodiversity Science, Ecosystem effects of fishing, Fish Population Science, Ocean Climate |
| Department of Fisheries and Oceans | Galbraith, Moira | Aquatic Animal Health, Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | Garver, Kyle | Aquaculture, Aquatic Animal Health, Biotechnology/ Genomics |
| Department of Fisheries and Oceans | Gordos, Kristian | Aquaculture, Biotechnology/ Genomics, Fish Population Science |
| Department of Fisheries and Oceans | Gower, Jim | Physical Oceanography |
| Department of Fisheries and Oceans | Grandin, Chris | Fish Population Science |
| Department of Fisheries and Oceans | Haigh, Rowan | Aquatic Ecosystems Science, Fish Population Science, Species at Risk |
| Department of Fisheries and Oceans | Hannah, Charles | Physical Oceanography |
| Department of Fisheries and Oceans | Hare, Rob | Hydrography |

| | | |
|------------------------------------|-----------------------------|--|
| Department of Fisheries and Oceans | Herunter, Herb | Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | <u>Higgs, Dave</u> | Aquatic Animal Health |
| Department of Fisheries and Oceans | Holloway, Greg | Hydrography, Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Holmes, John | Aquatic Ecosystems Science, Biological Oceanography, Fish Population Science |
| Department of Fisheries and Oceans | Holt, Carrie | Aquatic Ecosystems Science, Biodiversity Science, Fish Population Science, Ocean Climate |
| Department of Fisheries and Oceans | Hume, Jeremy | Aquaculture, Aquatic Animal Health, Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Ianson, Debby | Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Ikonomou, Michael | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Physical Oceanography |
| Department of Fisheries and Oceans | Jensen, John | Aquaculture, Aquatic Animal Health |
| Department of Fisheries and Oceans | Johannessen, Sophia | Aquatic Habitat / Aquatic Environmental Science, Ocean Climate, Chemical Oceanography |
| Department of Fisheries and Oceans | Johnson, Keith | Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Johnson, Stewart | Aquaculture, Aquatic Animal Health, Biotechnology/ Genomics |
| Department of Fisheries and Oceans | Jones, Simon | Aquaculture, Aquatic Animal Health, Biotechnology/ Genomics |
| Department of Fisheries and Oceans | <u>Kieser, Dorothee</u> | Aquatic Animal Health |
| Department of Fisheries and Oceans | King, Jacquelynne | Aquatic Ecosystems Science, Fish Population Science, Ocean Climate |
| Department of Fisheries and Oceans | Kreiberg, Henrik | Aquaculture, Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Kruzynski (RETIRED), George | Aquatic Animal Health, Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | Lam, Cordia | Fish Population Science |
| Department of Fisheries and Oceans | Lange, Krista | Aquatic Habitat / Aquatic Environmental Science, Biological Oceanography, Ocean Climate |
| Department of Fisheries and Oceans | Leus, Dan | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Ecosystem effects of fishing, Fish Population Science |
| Department of Fisheries and Oceans | Loseto, Lisa | Aquatic Ecosystems Science, Marine Mammal |
| Department of Fisheries and Oceans | MacConnachie, Sean | Species at Risk |
| Department of Fisheries and Oceans | Macdonald, Robie | Aquatic Ecosystems Science, Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | MacDonald, Steve | Aquatic Habitat / Aquatic Environmental Science, Limnology / Freshwater ecology |

| | | |
|---|-------------------------|--|
| Department of Fisheries and Oceans | Maclsaac, Erland | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Limnology / Freshwater ecology |
| Department of Fisheries and Oceans | Mackas, Dave | Aquatic Ecosystems Science, Biological Oceanography |
| Department of Fisheries and Oceans | MacLellan, Steve | Limnology / Freshwater ecology |
| Department of Fisheries and Oceans | Malange, Kelly | Limnology / Freshwater ecology |
| Department of Fisheries and Oceans | Masson, Diane | Physical Oceanography |
| Department of Fisheries and Oceans | McFarlane, Sandy | Aquatic Ecosystems Science, Fish Population Science, Ocean Climate |
| Department of Fisheries and Oceans | McLaughlin, Fiona | Physical Oceanography |
| Department of Fisheries and Oceans | Melling, Humfrey | Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Miller-Saunders, Kristi | Biotechnology/ Genomics, Fish Population Science |
| Department of Fisheries and Oceans | Miller, Lisa | Ocean Climate |
| Department of Fisheries and Oceans | Moore, Douglas | Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | O'Brien, Mary | Physical Oceanography |
| Department of Fisheries and Oceans | Patten, Bruce | Fish Population Science |
| Department of Fisheries and Oceans | Patterson, David | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Limnology / Freshwater ecology |
| Department of Fisheries and Oceans | Pearce, Christopher | Aquaculture, Aquatic Habitat / Aquatic Environmental Science, Aquatic Invasive Species |
| Department of Fisheries and Oceans | Pena, Angelica | Biological Oceanography |
| Department of Fisheries and Oceans | Richardson, Wendy | Physical Oceanography |
| Department of Fisheries and Oceans | Romaine, Steve | Biological Oceanography, Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Selbie, Daniel | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Limnology / Freshwater ecology, Species at Risk |
| Department of Fisheries and Oceans | Shortreed, Ken | Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Sinclair, Alan | Fish Population Science |
| Department of Fisheries and Oceans | Sowden, Terry | Aquatic Ecosystems Science |
| Department of Fisheries and Oceans | Steiner, Nadja | Biological Oceanography, Ocean Climate, Physical Oceanography, Chemical Oceanography |
| Department of Fisheries and Oceans | Stewart, Hannah L. | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science |

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|---|--------------------|--|
| Department of Fisheries and Oceans | Surry, Maria | Biotechnology/ Genomics, Fish Population Science |
| Department of Fisheries and Oceans | Thomson, Richard | Physical Oceanography |
| Department of Fisheries and Oceans | Timothy, David | Physical Oceanography |
| Department of Fisheries and Oceans | Traxler, Garth | Aquaculture, Aquatic Animal Health |
| Department of Fisheries and Oceans | White , Linda | Physical Oceanography |
| Department of Fisheries and Oceans | Whitney, Frank | Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Whyte, Ian | Aquaculture, Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science |
| Department of Fisheries and Oceans | Withler, Ruth | Biotechnology/ Genomics, Fish Population Science |
| Department of Fisheries and Oceans | Yelland, Douglas | Aquatic Ecosystems Science, Aquatic Habitat / Aquatic Environmental Science, Biological Oceanography, Ocean Climate, Physical Oceanography |
| Department of Fisheries and Oceans | Ross, Peter | Aquatic Animal Health, Aquatic Habitat / Aquatic Environmental Science, Marine Mammal, Species at Risk |
| Freshwater Fisheries Society of BC | Powell, Jim | Fish physiology and adaptive management strategies of fish culture |
| Freshwater Fisheries Society of BC | Williamson, Cory | Fish, Wildlife Habitat management |
| Freshwater Fisheries Society of BC | Godin, Theresa | Triopoy, Recreational Fisheries |
| Freshwater Fisheries Society of BC | Northrup,Sara | Molecular mechanisms related to performance (currently focused on pH tolerance) and in-lake behavior |
| Ministry of Environment | McAdam, Steve | Fish Biologist, Sturgeon |
| Ministry of Environment (UBC) | Van Poorten, Brett | Conservation Science |
| North Island College | Cross, Stephen | Sustainable Aquaculture |
| Simon Fraser University | Kennedy, Chris J. | Environmental Toxicology, Environmental and Evolutionary Physiology |
| Simon Fraser University | Bendell, Leah | Sustainable Shellfish Aquaculture Initiative |
| Simon Fraser University | Breden, Felix | Population Genetics, Immunogenetics and Sexual Selection |
| Simon Fraser University | Cooper, Andy | Quantitative marine ecology, Fisheries management |
| Simon Fraser University | Cox, Sean | Aquatic Conservation and Management, Human impacts on aquatic ecosystems |
| Simon Fraser University | Davidson, Willie | Molecular Biology & Biochemistry |
| Simon Fraser University | Dulvy, Nicholas | Marine Biodiversity and Conservation |

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|---|------------------------------|--|
| Simon Fraser University | Flamarique, Inigo Novales | Euroanatomy and physiology of fish visual pathways |
| Simon Fraser University | Reynolds, John | Salmon Ecosystems |
| The University of British Columbia | Brauer, Colin | Zoology |
| The University of British Columbia | Cheung, William | Fishing & climate change Impacts, Marine ecosystem goods and services |
| The University of British Columbia | Christensen, Villy | Ecosystem Modeling and Management |
| The University of British Columbia | Close, David | Fisheries Centre |
| The University of British Columbia | Farrell, Tony | Fish physiology—stress response |
| The University of British Columbia | Hinch, Scott | Pacific salmon ecology & conservation laboratory |
| The University of British Columbia | McAllister, Murdoch | Fisheries Assessment |
| The University of British Columbia | McKinley, Scott | Biotelemetry, environmental physiology, fish monitoring techniques, fish handling and anaesthetics, animal performance, fish activity/health, biotelemetry data analysis |
| The University of British Columbia | Pauly, Daniel | Fisheries, Marine Ecosystem Policy |
| The University of British Columbia | Pitcher, Tony | Policy & Ecosystem Restoration in Fisheries |
| The University of British Columbia | Richards, Jeff | Comparative physiology |
| The University of British Columbia | Milsom, Bill | Physiological basis of biodiversity in vertebrates |
| The University of British Columbia | Russello, Michael | Ecology and Evolutionary Biology |
| The University of British Columbia | Schluter, Dolph | Ecology and evolution |
| The University of British Columbia | Schulte, Patricia | Physiology, Genomics, Population |
| The University of British Columbia | Shadwick, Robert | Physiology, Locomotion/Skeletal Systems and Structures of marine organisms. |
| The University of British Columbia | Sumaila, Rashid | Fisheries Economics Research |
| The University of British Columbia | Taylor, Eric | Evolution and conservation of fishes |
| The University of British Columbia | Trites, Andrew | Marine Mammal Research |
| The University of British Columbia | Vincent, Amanda | Fundamental and applied field and laboratory research related to seahorses, pipefish and pegasid fish. |
| The University of British Columbia | Walters, Carl | Quantitative Modeling of Fisheries Resources |
| The University of British Columbia | Yun, Sang-Seon | Fisheries Centre |

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|---|-----------------------------|---|
| The University of British Columbia | Otto, Sally | Population genetics and evolutionary biology |
| University of Northern BC | Booth, Annie | Environmental and Natural Resources Policy (Domestic and International); Environmental Philosophy and Ethics; Native American/First Nations Worldviews; Women and Environments; Sustainable Development and Communities; Community Based Resource Management; Environmental Education |
| University of Northern BC | Costello, Allen | Management and Conservation of Native Fishes |
| University of Northern BC | Shrimpton, Mark | Physiology, Environmental Change |
| University of Victoria | Anholt, Bradley | Experimental ecology |
| University of Victoria | Juanes, Francis | Marine fishes, life history, conservation genetics, predator-prey relationships, soundscapes and sound production, conservation of marine ecosystems. |
| University of Victoria | Juniper, Kim | Marine ecosystems and global change |
| University of Victoria | Koop, Ben | Biology |
| University of Victoria | Mazumder, Asit | Ecosystem and Watershed Ecology of Freshwater and Marine Ecosystems |
| University of Victoria | Dower, John | Fisheries Oceanography and Plankton Ecology |
| University of Victoria | Baum, Julia | Ecology and conservation of marine populations and ecosystems |
| University of Victoria | Sutherland, Ben | Host-parasite interaction |
| Vancouver Aquarium | Marliave, Jeffrey Burton | Marine Science |
| Vancouver Island University | Barker, Duane | Fish Health Parasitology, Marine Ecologist |
| Vancouver Island University | Burns, Theresa | Centre for Coastal Health |
| Vancouver Island University | Crawford, Greg | International Centre for Sturgeon Studies |
| Vancouver Island University | Dawson-Coates, Jennifer | Fisheries & Aquaculture |
| Vancouver Island University | Dejager, Tim | Centre for Coastal Health |
| Vancouver Island University | Dudas, Sarah | Ecosystem interactions, Shellfish population dynamics, Invertebrate larval dispersal, Marine non-indigenous species, Conservation |
| Vancouver Island University | Duff, Stefanie | Invertebrate ecologist |
| Vancouver Island University | Edmondson, Gordon | Sturgeon |
| Vancouver Island University | Foote, Chris | Fisheries Ecologist |
| Vancouver Island University | Furnell, Don | Fisheries & Aquaculture |

| | | |
|------------------------------------|---------------------|--|
| Vancouver Island University | Gurney-Smith, Helen | Marine Invertebrates, Stress, Disease, Nutrition |
| Vancouver Island University | Iwasawa, Stefan | Integration between human, animal and environmental health |
| Vancouver Island University | Kingzett, Brian | Centre for Shellfish research |
| Vancouver Island University | Mielke, Max | Centre for Shellfish research |
| Vancouver Island University | Murray, Grant | Coastal Resource Management |
| Vancouver Island University | Noyon, Mark | Fisheries & Aquaculture |
| Vancouver Island University | Pennell, Bill | Shellfish Research |
| Vancouver Island University | Stephen, Craig | Risk assessment and management for fish and wildlife, Emerging infectious diseases, global health, health surveillance and intelligence, and public health |
| Vancouver Island University | Stitt, Tyler | Centre for Coastal Health |
| Vancouver Island University | Thomson, Catherine | Shellfish Research |
| Vancouver Island University | Tillapaugh, Don | Shellfish and Sturgeon |

Appendix 6: Government and Community Hatcheries in BC

(CEDP, Community Economic Development Hatcheries, see <http://www.pac.dfo-mpo.gc.ca/sep-pmvs/projects-projets/cedp-pdec/index-eng.html> for more information; DFO, Department of Fisheries and Oceans Canada, see <http://www.pac.dfo-mpo.gc.ca/sep-pmvs/hatcheries-ecloseries-eng.html> ; Provincial hatcheries, see <http://www.gofishbc.com>)

| Type | Name | Species | Description |
|------|-------------------------|---|--|
| CEDP | Cowichan River Hatchery | Cowichan Chinook | The Cowichan River Hatchery project, located near Duncan on Vancouver Island, was initiated in 1978 as a partnership between Cowichan Tribes and Fisheries and Ocean Canada to enhance the Cowichan and Koksilah River salmon stocks, obtain stock information, increase fish production, provide employment, contribute to the local economy and improve relations between the partners. |
| CEDP | Deadman River Project | Coho and habitat selection | The Deadman project is located on the Deadman River, a tributary of the Thompson River, 5 miles west of Savona, BC. The facility is on Skeetchestn First Nation land and is operated by the Skeetchestn Band. |
| CEDP | Dunn Creek Hatchery | Coho | The Dunn Creek Hatchery is situated on a 4.73 hectare Provincial Crown leased property at the north end of Dunn Lake. Located 32.5 km on Dunn Lake Road north of Barriere, B.C. |
| CEDP | Fort Babine Hatchery | Chinook and coho historically now mostly habitat monitoring | The Fort Babine Hatchery Project is located on the upper Babine River across from the community of Fort Babine and is approximately 120 kms northwest of the Town of Smithers. |
| CEDP | Hartley Bay Hatchery | Coho | The Hartley Bay Salmon Hatchery is located on the Gabion River in the First Nations reservation known on maps as Hartley Bay, called Txalgiu. Hartley Bay, the home community of the Gitga'at (People of the Cane) First Nation, lies about 90 miles southeast of Prince Rupert and 50 miles southwest of Kitimat, at the confluence of Grenville and Douglas Channels. The hatchery is owned and operated by the Hartley Bay Band Council. |
| CEDP | Kincolith Hatchery | Chinook and chum | The Kincolith Hatchery, located at the mouth of the Nass River, is owned by the Nisga'a and operated by the Nisga'a Lisims Government. Initiated in 1978, intentions were to rebuild Kincolith Chinook to historic levels, provide survival, migration and fishery contribution information on Kincolith coho for domestic and international management decisions, and provide increased production of Kincolith coho for the sport, capture and Aboriginal fisheries. |
| CEDP | Klemtu Project | Chum and coho | The Klemtu project is operated by the Kitasoo Band Council and is located at Klemtu, on Swindle Island at Trout Bay. This project was initiated in 1980 to create a commercial fishery, and provide training, employment, food fish, economic benefit, and aboriginal involvement. Currently at this site are a small hatchery facility, an enumeration fence, and an ocean net pen. |

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| CEDP | MacLean Bay Hatchery | Coho, chinook, chum and pink | The Sechelt First Nation operates the Maclean Bay Hatchery located in Sechelt Inlet, approximately 8 km from the town of Sechelt. The facility opened in 1978 under the DFO Salmon Enhancement Program Economic Development Partnership Program. |
| CEDP | McLoughlin Hatchery | Sockeye and chum | The project was initiated with the Heiltsuk Indian Band in 1977 to provide a capture fishery, training, employment, food fish, economic benefit, and encourage native involvement through project implementation, operation and annual planning exercises. The project is located on Campbell Island near Bella Bella, approximately 90 km west of Bella Coola (I.F.#1) (Latitude 52.13824, Longitude, -128.15156). The site is owned by the Heiltsuk Indian Band. |
| CEDP | Namgis Project | Sockeye and chum | The Namgis First Nation project is located near the mouth of the lower Nimpkish River on the northeast coast of Vancouver Island, near Alert Bay. |
| CEDP | Nanaimo River Hatchery | Chinook, chum, coho, and pink | The Nanaimo River project, located on the Nanaimo River south of Nanaimo, was initiated in 1978 to maximize benefits to the local fishers and restore Nanaimo River chum, coho, and Chinook stocks. |
| CEDP | Powell River Project | Chinook, coho | The Powell River project, located on Lang Creek near Powell River on the Sunshine Coast, was initiated in 1983 to rebuild Lang Creek summer coho and enhance other local streams for coho. |
| CEDP | Quatse River Hatchery | Salmon populations | The Quatse Salmon Stewardship Centre is just minutes from the airport, ferry, and downtown Port Hardy. We are located at 8400 Byng Road, next to the Quatse River Regional Park and Campground. |
| CEDP | San Juan Project | Chinook, coho | This project, which is located four miles upstream of the estuary on the San Juan River on Vancouver Island, was initiated in 1980 to enhance chum stocks. |
| CEDP | Seymour Hatchery | Coho, chum, pink, Chinook, and steelhead | The project is located in North Vancouver, on the Seymour River, in the Lower Seymour Conservation Reserve, immediately below the Seymour Falls Dam. |
| CEDP | Sliammon Project | Stocks in the Sliammon River, Theodosia River and Okeover Creek Systems | The Sliammon Project, located on the Sliammon River north of the city of Powell River, was initiated between Fisheries and Oceans and the Sliammon First Nation in 1977. |
| CEDP | Thornton Creek Hatchery | Chinook, coho, chum | Est 1976 located on the West Coast of Vancouver Island, on the North side of Ucluelet Harbour - 10km from the town of Ucluelet. |
| CEDP | Tla-o-qui-aht Project | Kennedy River Chinook and Staghorn coho | The Tla-o-qui-aht Project is owned by the Tla-o-qui-aht First Nations. It is located on the West Coast of Vancouver Island near Tofino, and was initiated in 1984 to address enhancement of severely depleted Kennedy River Chinook. |

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| CEDP | Yakoun River Hatchery | Yakoun River Chinook and coho | Located at Marie Lake on Graham Island, Haida Gwaii was established in 1978 as a partnership between the Old Massett Village Council and Fisheries and Oceans Canada to rebuild the declining Yakoun River Chinook stock as well as enhance Yakoun River coho salmon. |
| DFO | Big Qualicum Hatchery | Pacific Salmon and steelhead trout | Big Qualicum employs a number of natural and artificial enhancement techniques to increase populations of Pacific salmon and steelhead trout. It was the first of the modern enhancement projects to be undertaken in this province and has provided a model for other developments. Research and assessment of this facility have increased the scientific data available on salmonid behaviour, life cycle and habitat requirements. And not to be forgotten is the annual landed value of over \$10 million to the capture and sport fisheries. The hatchery also provides an important source of fish for the native food-fish program and countless hours of enjoyment for the recreational fisherman. |
| DFO | Capilano River Hatchery | Coho, Chinook and steelhead | Capilano River Regional Park, North Vancouver, British Columbia, Canada |
| DFO | Chehalis River Hatchery | Coho, Chinook, chum salmon and cutthroat trout | Near Harrison Mills in the Lower Mainland - British Columbia. Hatchery is fed by gravity from the Chehalis River (riverbank fixed-screen intake- supplies 25,000 to 50,000 lpm (15-30 cfs) of river water depending on water demand). Hatchery facilities include an aeration tower, hatchery laboratory, concrete raceways and holding channels, fish brailer, lifer and transfer equipment, spawning equipment and sludge lagoon. |
| DFO | Chilliwack River Hatchery | Chinook, coho, chum, and steelhead | The Chilliwack River Hatchery was built on an old side channel of the Chilliwack River under the Salmonid Enhancement Program (SEP). Up to 6 million salmon smolts, of five salmon species including two Chinook stocks, coho, chum, and steelhead are produced annually for the capture, sport and First Nations fresh-water and marine fisheries. |
| DFO | Conuma River Hatchery | Conuma River: chum, Chinook and coho Tlupana River: Chum, Chinook Canton River: chum Sucwoa River: chum and Chinook Gold River: Chinook Burman River: Chinook | The Conuma Enhancement Facility was built in 1978 with the goal of major enhancement of wild chum salmon stocks in the area and minor enhancement of wild coho, Chinook and steelhead stocks in the Conuma River to offset any incidental catch in the capture fisheries. The present egg targets for the Conuma Enhancement Facility are 2,950,000 Chinook, 5,400,000 chum, and 150,000 coho, which include approximately 2,450,000 Chinook and 1,500,000 chum to be seapen-reared. In all of these facilities, enhanced fish are released as juveniles to mature naturally in the ocean environment. |

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| DFO | Fulton River Spawning Channel | | |
| DFO | Inch Creek Hatchery | Coho, Chinook, chum, steelhead | Located near Mission, British Columbia, Canada, the Inch Creek Hatchery uses modern fish culture techniques to produce coho salmon, Chinook salmon, chum salmon, and steelhead trout for a number of local tributaries to the Fraser River. The hatchery currently produces 600,000 coho smolts from Inch Creek, Norrish Creek and Stave River. In partnership with community-run hatcheries about 150,000 coho are also raised for the Nicomekl and Serpentine Rivers in Surrey. In addition the facility produces 200,000 Chinook fry from the Stave River and 20,000 from Maria Slough; 20,000 steelhead smolts for the Stave River; and 1,000,000 chum fry from Inch Creek. |
| DFO | Kitimat River Hatchery | Coho, Chinook, chum, steelhead, and cutthroat | <p>The Kitimat River Fish Hatchery was first started in 1977 as a pilot project. It was located across from the Eurocan Pulp and Paper mill. At that time it consisted of an Atco trailer containing a few troughs. The hatchery only released 50,000 – 150,000 fish. The Hatchery was started because of decreased salmon stocks from historical levels, particularly in the Chinook. Overfishing, habitat degradation, industrial logging, etc. caused the decreased stocks.</p> <p>The Government of Canada granted the Kitimat Hatchery with 10 million dollars to build the facility as it is today. Construction was completed in 1983, and now 11 million fish are released each year. The hatchery five different species of salmonids are raised, the chum, Chinook, coho, cutthroat, and steelhead.</p> |
| DFO | Little Qualicum Hatchery | | |
| DFO | Nadina River Spawning Channel | | Houston |
| DFO | Nitinat River Hatchery | Chum, Chinook, coho and steelhead | Nitinat River Hatchery is Canada's largest salmon hatchery, and produces chum, Chinook and coho salmon, and also some steelhead. The hatchery annually performs the largest chum salmon egg take in all of Canada, with a total of over 40 million eggs being taken. The facility is a major contributor to the capture chum fishery. Over 350 thousand coho are produced each year, as well as approximately ten thousand steelhead. The facility is also a major producer of Chinook, the annual release of which has grown to over six million smolts. This has resulted in a thriving sport fishery inside Nitinat Lake and also in surrounding fishing locations on the west coast of Vancouver Island. |
| DFO | Pinkut Creek Spawning Channel | | |

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| DFO | Puntledge River Hatchery | Chinook, pink, coho, and chum | "The Puntledge River Hatchery was constructed to save these Chinook from extinction and to boost other species to healthy levels. The facility was designed to produce 100,000 adult chum salmon, 15,000 summer Chinook, 60,000 fall Chinook, 60,000 coho and 5,200 winter steelhead. Some pinks are being incubated as well." |
| DFO | Quinsam River Hatchery | Pink, coho, Chinook, steelhead, cutthroat | The Quinsam Hatchery has been in operation since 1974. Prior to this date the numbers of adult fish returning to spawn were 4,000 coho, 4,000 Chinook and 30,000 pink Salmon per year. Hatchery returns have boosted these runs to 30,000 coho, 15,000 Chinook and 10,000 pink Salmon. This hatchery has played a vital role in restoring natural spawning runs to the Campbell/Quinsam Rivers as well as assisting production of other systems such as the Puntledge and Oyster rivers. |
| DFO | Robertson Creek Hatchery | Adult & juvenile coho, Chinook, steelhead & Chinook fry | The Robertson Creek project began as a spawning channel in 1959 designed to introduce pink Salmon into the Somass River system. The facility has undergone several expansions since that time and now produces 8 million Chinook smolts, 1 million coho smolts and 180,000 steelhead smolts each year. The resulting adult salmon production is 150,000 Chinook, 100,000 coho and 10,000 steelhead each year. |
| DFO | Rosewall Hatchery | Endangered Chinook and sockeye stocks | Rosewall Creek Hatchery was developed in the mid- to late-60s as a research facility operated by the Department of Fisheries and Oceans' Science Branch. Recently, the site has been committed to small projects and rehabilitation of endangered salmon stocks. Rosewall is also home to the Fanny Bay Salmonid Enhancement Society, a group of volunteers committed to restoration of the Baynes Sound area. |
| DFO | Snootli Creek Hatchery | Coho, chum, Chinook, sockeye, pinks (in the Atnarko spawning channel) | Built in 1978, with an initial capacity of 10 million eggs, this Japanese-style hatchery was designed to increase adult chum salmon returns to the Bella Coola River and its tributaries by 160,000 fish annually. Expansion over the last 20 years has increased Snootli Hatchery's capacity to 8,000,000 chum, 3,000,000 Chinook, 500,000 coho, and 1,000,000 sockeye. In addition, the hatchery is responsible for maintaining a pink salmon spawning channel on the Atnarko River, inside Tweedsmuir Provincial Park. |
| DFO | Spius Creek Hatchery | Chinook and coho | Modern fish culture techniques are used to produce coho and Chinook Salmon. The hatchery produces Chinook salmon (for the Nicola River, Salmon River, Coldwater River, Deadman River, and Spius Creek), coho salmon (Coldwater River, Salmon River, Eagle River, Deadman River, Bridge River, and Spius Creek). Hatchery also provides a sport fishery for one month a year in the Thompson River for returning Nicola River Chinook adults. Produces Chinook and coho salmon for the salt-water sport and capture fisheries. The hatchery also provides information to fisheries management and research. Interior Chinook and coho stocks tagged at this facility provide fisheries management with information on fish migration and ocean survivals, and exploitation rates. In co-operation with Chehalis River Hatchery incubates Harrison River and Chehalis River Chinook. Produces Chinook and coho for the Fraser River, Thompson River, and Nicola River Indian food fishery. |

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| DFO | Tenderfoot Creek Hatchery | Chinook, coho, chum and pink | Tenderfoot Creek Hatchery produces 1.6 million Chinook smolts, 300,000 coho smolts and 100,000 chum fry each year. Up to 3 million pink salmon and 100,000 steelhead trout are added to the production on some years, depending upon escapement levels and fishery requirements. |
| DFO | Weaver Creek Spawning Channel | Sockeye, Chum and Pink Salmon | Salmon enhancement has a long history in British Columbia, originating at Weaver Creek in 1885. In the fall of that year, eggs obtained from Sockeye Salmon were first transplanted to other streams in the province. Following decline in Sockeye stocks in the 1960s a spawning channel was built beside Weaver Creek (1965), the hatchery. The run of Sockeye today is more than 200 times the size of the run produced from Weaver Creek alone prior to 1965. |
| Provincial | Summerland Trout Hatchery | Rainbow trout and Brook charr | The Summerland Trout Hatchery (established 1928) is the oldest continuously running trout hatchery in BC. The hatchery stocks fish into approximately 260 lakes annually into the south central regions of B.C. (Thompson-Nicola, Okanagan and West Kootenay). The Summerland Trout Hatchery also rears fish that are then transferred to the Clearwater Trout Hatchery to be stocked in the Cariboo and Northern B.C. Lakes. A second off-site hatchery located in Skaha provides additional rearing capacity for catchable rainbow trout. |
| Provincial | Clearwater Trout Hatchery | Rainbow Trout, Eastern Brook trout and kokanee salmon | The hatchery stocks fish into approximately 330 lakes annually in all regions of BC except Vancouver Island. Most fish stocking occurs in the Interior and the Northern lakes in BC. Over three million fish are released each year. The Clearwater Trout Hatchery is one of two hatcheries (along with Kootenay Trout Hatchery) that stock kokanee salmon in British Columbia. Clearwater trout hatchery also raises Moberley Lake, Lake Trout in an attempt to recover this culturally important species |
| Provincial | Fraser Valley Trout Hatchery | Rainbow Trout (native and catchable), Anadromous Coastal cutthroat trout and steelhead trout | The Fraser Valley Trout Hatchery stocks over 860,000 fish into over 150 lakes and streams throughout BC. |
| Provincial | Kootenay Trout Hatchery | Rainbow Trout, Westslope cutthroat trout, Eastern Brook trout and white sturgeon and kokanee | <p>The Kootenay Trout Hatchery went into production in 1965 and is responsible for stocking 130 to 150 lakes in the east and west Kootenay regions, as well as some lakes in the Thompson-Nicola and Okanagan regions. The hatchery provides fish to the Clearwater Trout Hatchery and Prince George holding facility for central and northern stockings in the province.</p> <p>Most recently the hatchery has become a key component in white sturgeon recovery initiatives for both the trans-</p> |

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| | | | boundary Kootenay River population (in 1998) and the upper Columbia River population (in 2001). The Kootenay hatchery has facilities to accommodate adult holding, spawning, and juvenile rearing. |
| Provincial | Vancouver Island Trout Hatchery | Rainbow trout, Anadromous and Coastal cutthroat trout | The hatchery stocks approximately 350,000 fish into 75 lakes, streams, and rivers on Vancouver Island and the surrounding islands in Region 1 (Vancouver Island.) |
| Other | Omega Pacific | Pacific salmon & trout - ova, fry & smolts | A private company, Omega Pacific has been dedicated to advancements in Pacific salmon culture since 1980. With more than thirty consecutive years of spawning and growing Chinook salmon, Omega has discovered optimum rearing methods to ensure high ocean survival. Omega Pacific's advancements in Bio-Technology have enabled the culture of smolt populations which consistently achieve 96% survival after 22 months in an ocean environment. |
| Other | Okanagan Nation Alliance | Sockeye | March 2014 opening |

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