Reference Document: Salmon Farming in British Columbia

*Updated January 2015*
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Introduction

Seafood is a healthy food choice. As the number of people in the world grows, the need for seafood will increase. As demand increases, it is important that we find ways to supplement the supply of wild caught fish to relieve pressure on wild fish populations and to ensure fish does not become overfished or unaffordable.

Salmon farmers in British Columbia (B.C.) are in a unique position to help meet this growing market for a nutritious and affordable fish protein. The coast of B.C. offers significant opportunities to raise salmon, which are proven to be a very efficient animal to farm, and relieve the mounting strain on wild fisheries. Increased supply of fish, made possible by farming, will keep prices within reach for families.

With over seven billion people now living on earth, the ocean is becoming more important than ever for providing food. A clean environment is critical to successful fish farming so farmers make it a priority to protect the area that represents both their home and their livelihood.

About this Document

This document was originally produced by the BC Salmon Farmers Association and presented to the CBS show 60 Minutes on December 5, 2013.

In the summer of 2013, Marine Harvest Canada – a member company of the BC Salmon Farmers Association (BCSFA) – was invited by 60 Minutes producer Peter Klein to participate in a story about salmon farming in B.C. A full day interview was provided on October 10, 2013. As a supplement to the interview, BCSFA staff compiled this resource document to provide a summary of topics discussed, and to provide a resource for viewers seeking further information and data on current salmon farming practices in British Columbia.

The 60 Minutes segment about B.C.’s farm-raised salmon aired on May 11, 2014. “Saving the wild salmon” can be viewed at http://www.cbsnews.com/news/saving-wild-salmon/.

This document is an updated version of that provided to the producers of 60 Minutes. It is publicly available at www.salmonfarmers.ca.
Salmon Farming in British Columbia

Lifecycle of a Farm-Raised Salmon

It takes about three years to grow a salmon to market size. The salmon eggs hatch in land-based, freshwater hatcheries and the tiny salmon begin to feed from a yolk-sac. After the yolk sac is consumed, they will continue to be raised in freshwater tanks. Farmers follow the natural lifecycle of a salmon: moving them from freshwater to saltwater within a year of hatching. They continue to be fed and cared for at ocean farms for about two years. When they reach market size of ten to twelve pounds, salmon are processed and packaged – fresh, on ice – and shipped to market within 48 hours. Some salmon are set aside and grown for another year as broodstock to provide a source of eggs for the next generation.

Atlantic Salmon in the Pacific

Many attempts have been made over the past 100 years to introduce Atlantic salmon in various water bodies throughout the Pacific Northwest. These attempts weren’t made by salmon farmers, but by sport fishing interests. None of these introductions were successful. In fact, all purposeful attempts by Canadian and U.S. governments and interest groups to colonize Atlantic salmon in the Pacific Northwest have failed because Atlantic salmon are poor colonizers outside their natural range.

- A report on the risk of Atlantic salmon colonization found: “The combined evidence strongly supports current scientific opinion that the risk of Atlantic salmon colonization in British Columbia from domesticated, farmed escapees is low — if not extremely so.” (Ginetz, 2002, p.3): [http://www.salmonfarmers.org/sites/default/files/research-resources/risk_of Colonization_r.m.j_ginetz.pdf](http://www.salmonfarmers.org/sites/default/files/research-resources/risk_of Colonization_r.m.j_ginetz.pdf)
- In the early days of salmon farming in B.C., Atlantic salmon eggs were imported under strict protocols. These protocols were important for preventing disease transfer. Subsequently, farm companies developed their own broodstock and hatcheries to reduce the need to import eggs. Atlantic salmon egg imports to B.C. are publicly reported. The information,
Farm Siting Criteria

Siting criteria for farms are comprehensive. Farms are located in areas that maximize the use of energy (strong currents) while at the same time minimizing potential negative impacts. Information on siting criteria can be found here:


Location and Number of Operating Sites

In B.C., approximately 70 farms are in operation at one time and have a very small footprint. All the active farm sites together would fit inside New York's Central Park.

- Each year, the BC Salmon Farmers publicly report which sites are active from March to June: [http://www.salmonfarmers.org/sites/default/files/all_companies_2014-07_out_migration_sites.pdf](http://www.salmonfarmers.org/sites/default/files/all_companies_2014-07_out_migration_sites.pdf)

Benefits of Eating Salmon

Nutritional Profile of B.C. farm-raised salmon

British Columbia farm-raised salmon (Chinook, Coho and Atlantic) is a healthy seafood choice.

- Nutritional health benefits of salmon are very clear: [http://www.salmonfarmers.org/sites/default/files/research-resources/nutritional_benefits.pdf](http://www.salmonfarmers.org/sites/default/files/research-resources/nutritional_benefits.pdf)
United States Government Dietary Guidelines

Salmon (wild and farm-raised) is recommended by North American health authorities as an important part of our diet.

- Dietary Guidelines for Americans (2010): “Moderate evidence shows that consumption of about 8 ounces per week of a variety of seafood, which provide an average consumption of 250 mg per day of EPA and DHA, is associated with reduced cardiac deaths among individuals with and without pre-existing cardiovascular disease. Thus, this recommendation contributes to the prevention of heart disease. Seafood varieties that are commonly consumed in the United States that are higher in EPA and DHA and lower in mercury include salmon...” [http://www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf](http://www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf) (p 39)

- Marine Harvest’s Annual Report confirms that Marine Harvest’s salmon are a rich source of Omega 3s (EPA/DHA), providing 1.7g/100g. One or two servings a week of Marine Harvest Atlantic farm-raised salmon provides the recommended levels of Omega 3 intake (250mg+ per day).

Salmon Feed

Feed Ingredients

Salmon feed ingredients are designed to meet the nutritional requirements of farm-raised salmon.

- The science-based diet continues to evolve to address the availability and sustainability of raw ingredients.

- By formulating diets that are nutritionally dense and meet the specific needs of salmon, more of the feed’s ingredients go towards the animal’s growth and, consequently, less is released as waste.

- Salmon feed contains no added hormones or steroids.

- Reducing raw marine ingredients (fishmeal and fish oil) is paramount to ensuring the sustainable growth of global aquaculture, and B.C. salmon farmers are leading the way in using alternative proteins and oil ingredients: [http://www.skretting.ca/Internet/SkrettingCanada/webInternet.nsf/wprId/508FA5EAF6EE717B88257A100076BBCB!OpenDocument](http://www.skretting.ca/Internet/SkrettingCanada/webInternet.nsf/wprId/508FA5EAF6EE717B88257A100076BBCB!OpenDocument)

Carotenoids and the Colour of Salmon

Wild and farm-raised salmon require carotenoids for healthy growth and reproduction. In the wild, salmon get these nutrients from the seafood they eat. For farm-raised salmon, carotenoids - astaxanthin and/or canthaxanthin - are included in the feed to ensure the salmon are receiving all of their nutritional requirements. A byproduct of these healthy carotenoids is a change in the
pigmentation of the flesh – which occurs in both wild and farm-raised salmon: [http://www.fisheries.noaa.gov/aquaculture/homepage_stories/10myths.html](http://www.fisheries.noaa.gov/aquaculture/homepage_stories/10myths.html)

**Feed Conversion Ratios**

Farm-raised salmon are amongst the most efficient users of feed; converting feed to “meat” at less than 1.2 : 1.0 (meaning 1.2 kg of feed produces 1.0 kg of salmon). This efficiency is because salmon are cold blooded (conserve energy) and because they are neutrally buoyant in the water so they don’t require large bones to support themselves. Salmon farmers have also become much more skilled at feeding their salmon – using technology such as underwater cameras to ensure all of the feed is consumed.

- More information on how salmon feed conversion compares to other proteins can be found here: [http://www.bcsalmonfacts.ca/#!/fact/eaters](http://www.bcsalmonfacts.ca/#!/fact/eaters)

**Fish In, Fish Out**

To replicate the diet of wild salmon, fishmeal and fish oil are included in the feed given to salmon raised on farms. The amount of meal and oil that goes into that feed, and how much salmon is produced is known as the “Fish In: Fish Out” ratio. Because the diet fed to MHC salmon is low in fish meal and oil, MHC’s farm-raised Atlantic salmon are *net producers* of fish protein.

- Though twenty years ago, a farm-raised salmon’s diet may have included up to 50% fishmeal and fish oil, today it represents only a small part of the diet. Current salmon feed formulations contain less than 18% fishmeal and oil. North American fish feed companies (that also supply feed to salmon hatcheries and salmon ranchers in the US and Canada) source fishmeal and oil from responsible fisheries: [http://www.skrettingguidelines.com/common/fb/view.aspx?assetid=1179&publicid=03147c85-f3c7-4774-a418-0aeace4ccf655](http://www.skrettingguidelines.com/common/fb/view.aspx?assetid=1179&publicid=03147c85-f3c7-4774-a418-0aeace4ccf655)

- According to the Global Aquaculture Alliance Best Aquaculture Practices salmon farm standard ([http://www.gaalliance.org/cmsAdmin/uploads/BAP-SalmonF-611S.pdf](http://www.gaalliance.org/cmsAdmin/uploads/BAP-SalmonF-611S.pdf)), “*BAP-certified salmon producers shall obtain fish in: fish out ratios below 2.0. By 2016, they shall obtain ratios below 1.5.*” However, B.C. salmon farmers are already there. Marine Harvest Canada currently meet the 2016 standards – Fish In : Fish Out ratios are less than 1:1 and as feed manufacturers continue to improve their diets, and as farmers continue to find ways to improve farming practices, that ratio will continue to decline.

- Fishmeal and oil are also used for direct human consumption and in feeds for other animals such as poultry, pork, and companion animals (pets).
PCBs and Other Contaminants

British Columbia farm-raised salmon (Chinook, Coho and Atlantic) are low in PCBs, dioxins, mercury and other unwanted contaminants.

- Because a salmon is a fast growing fish, there is little accumulation of unwanted contaminants such as mercury:

  “Metal concentrations in farmed and wild salmon from British Columbia, Canada, were relatively low and below human health consumption guidelines. Methylmercury in all salmon samples (range, 0.03-0.1 microg/g wet wt) were below the 0.5 microg/g guideline set by Health Canada. Negligible differences in metal concentrations were observed between the various species of farmed and wild salmon. Our findings indicate farmed and wild British Columbia salmon remain a safe source of Omega-3 highly unsaturated fatty acid intake for cardioprotective and, possibly, other health benefits.”


- Levels of PCBs found in all species of salmon are about 1% of Canada and U.S. health authority risk guidelines: “The level of PCBs in farmed salmon is 200 times less than the US FDA and Canadian CFIA legal limit of 2000 ppb in edible fish products.”

  SOURCE: http://www.salmonfarmers.org/sites/default/files/research-resources/Nutritional value of British Columbia Farmed Salmon MHC.pdf

- The levels of PCBs in Atlantic salmon is less than other foods, such as eggs and salted butter:

  ![PCB levels in foods](http://www.aquaculture.ca/files/health-salmon.php)
Fish Health

British Columbia farm-raised salmon are very healthy and average better than 90 percent survival on the farm.

- “The total mortality rate has been relatively stable across years and has ranged from 9-13%... “: www.farmfreshsalmon.org/sites/default/files/Project5A-Report.pdf (pg. 7)
- Fish health, which includes a mandatory Health Management Plan, is outlined in Sections 5, 6, 7, 8, in the Condition of License: http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/docs/licence-cond-permis-mar-eng.pdf
- Fisheries and Oceans Canada provides public fish health data about B.C. salmon farms: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/health-sante/index-eng.html

Fish Vaccines

Effective vaccines that have been developed in the past decade protect farm-raised salmon from most naturally occurring marine fish diseases.

- Effective vaccines have helped protect farm-raised salmon from naturally occurring fish health challenges: http://marineharvest.com/globalassets/canada/pdf/salmon-vaccines.pdf

Antibiotics are rarely used at B.C. salmon farms and, if required, can only be administered through the supervision of a veterinarian.

- Antibiotic use has declined over the last two decades:

Viruses

Viruses are the most abundant organisms on the planet. It is estimated there are more than a million viruses in every drop of surface seawater. Most viruses are not harmful to fish, although some are. Animals and humans host many viruses, but this does not necessarily mean a disease is present. All fish viruses present in B.C. farm-raised salmon are naturally occurring in the Pacific Ocean none pose a risk to human health.

Piscine Reovirus

Piscine reovirus (PRV) is known to occur in both wild and farm-raised fish in the North Pacific (predates salmon farming) and is not known to cause disease.


Infectious Salmon Anemia

Infectious Salmon Anemia (ISA) has never been confirmed in the North Pacific despite thousands of wild, hatchery and farm-raised fish being tested.

- Statement about ISA and ISAv testing: [http://www.salmonfarmers.org/sites/default/files/hot-topics/isa_0.pdf](http://www.salmonfarmers.org/sites/default/files/hot-topics/isa_0.pdf)

Atlantic Veterinary College audit results

A lab that reported positive preliminary test results for ISAv in the North Pacific - from samples that were always negative after confirmatory tests - failed several quality audits performed by the World Organization for Animal Health (OIE). As a result of these failed audits, the Atlantic Veterinary College (AVC) was removed as an IOE reference laboratory for ISAv in May 2013.

- “Conclusions of the audit were unfavourable and showed that a series of weaknesses in the system have a direct impact on the quality of diagnoses conducted by the OIE Reference Laboratory at AVC.” The AVC audit is publicly posted here: [http://www.oie.int/fileadmin/Home/eng/International_Standard_Setting/docs/pdf/Aquatic_Commission/Evaluation_OIE_Ref_Lab_ISA_website.pdf](http://www.oie.int/fileadmin/Home/eng/International_Standard_Setting/docs/pdf/Aquatic_Commission/Evaluation_OIE_Ref_Lab_ISA_website.pdf)
Sea Lice

Sea lice are a naturally occurring external marine parasite and are not a risk to human health. However, farm-raised salmon may be a source of sea lice to small, juvenile wild salmon.

B.C. salmon farmers have been recognized for their proactive management of the sea lice concern. This management ensures sea lice from farm-raised salmon are not a threat to out-migrating juvenile wild salmon:

- “Adapting the management of parasites on farmed salmon according to migrations of wild salmon may therefore provide a precautionary approach to conserving wild salmon populations in salmon farming regions.” Rogers et al. (2013): http://bamp.ca/images/2013%20Rogers%20et%20al%20-%20journal.pone.0060096.pdf
- “The survival of the pink salmon cohort was not statistically different from a reference region without salmon farms.” Morton et al. (2010): http://icesjms.oxfordjournals.org/content/68/1/144.abstract
- Salmon farmers also continue to research potential risk and new management techniques: www.bamp.ca
- Sea lice management and monitoring results are publicly reported here: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/lice-pou-eng.html

Use of Emamectin Benzoate (SLICE®)

Emamectin benzoate (product name SLICE®) has been used in British Columbia since 1999 and is an effective tool to control sea lice. SLICE® is only authorized for use under the professional guidance of a licensed veterinarian. It is milled directly into the feed and used sparingly to ensure sea lice levels on farm-raised salmon remain low and are not a threat to out-migrating juvenile wild salmon.

- SLICE® use (2000-2012):

- Marine Harvest Canada continues to research and implement alternative controls for sea lice such as vaccines and non-medicinal controls including hydrogen peroxide treatments, as well as the use of natural sea lice predators such as the Pacific lumpsucker.

Impacts of Salmon Farming

Benthic Impact Management

Farmers must follow strict guidelines to minimize benthic (ocean bottom) impact. This is important for environmental sustainability and also for the farm-raised fish – healthy fish come from healthy oceans.

- Benthic monitoring results are publicly reported here: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/benth-eng.html

Fish Escapes

Escapement of farm-raised salmon is now rare in British Columbia due to a number of improvements made by the industry including better staff training, investment in state of the art infrastructure (cages, anchors, netting), strict regulation of net strength, and improved husbandry and handling techniques.

- Escape Prevention through Maintenance of Cage and Net Integrity is included in the Condition of License: http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/docs/licence-cond-permis-mar-eng.pdf (Appendix VIII)
- All escaped fish from aquaculture facilities are publicly reported here: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/escape-evasion-eng.html
- Escaped Atlantic salmon have never colonized rivers in the Pacific Northwest. The risk of colonization of Atlantic salmon is extremely low, as described by Ginetz in his 2002 report: “The combined evidence strongly supports current scientific opinion that the risk of Atlantic salmon colonization in British Columbia from domesticated, farmed escapees is low — if not extremely so.” http://www.salmonfarmers.org/sites/default/files/research-resources/risk_of_colonization_r.m.j._ginetz.pdf
Carbon Footprint

Farm-raised salmon maintains a relatively low carbon footprint compared to other terrestrial food animals. B.C. salmon farmers have participated in numerous “Life-cycle analysis” studies, and adhere to ISO 14001 certification programs to continue to reduce carbon footprint.  

Potential Negative Impact on Wild Salmon

While all types of farming has an impact on the environment, B.C. salmon farmers recognize their responsibility to minimize negative effects on the surrounding environment – which includes wild salmon and all marine life.


Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River

In its Final Report, the Cohen Commission – a recent, comprehensive third party review of all factors that may have affected the survival of the 2009 return of Fraser River sockeye salmon – highlighted ocean conditions and lack of food as “primary factors”:

- “I am also satisfied that marine conditions in both the Strait of Georgia and Queen Charlotte Sound in 2007 were likely to be the primary factors responsible for the poor returns in 2009. Abnormally high freshwater discharge, warmer-than-usual sea surface temperatures, strong winds, and lower-than-normal salinity may have resulted in abnormally low phytoplankton and nitrate concentrations that could have led to poor zooplankton (food for sockeye) production.” (Final Report, Volume 3, p. 59)

Specific to salmon farming, Justice Bruce Cohen concluded, after hearing from expert witnesses including veterinarians and fish virologists, that:

- “Data presented during this inquiry did not show that salmon farms were having a significant negative impact on Fraser River sockeye. However...the statistical power of the database (containing fish health data from 2004 to 2010) was too low to rule out significant negative impact. I accept the evidence of Dr. Korman and Dr. Dill that scientists need another 10 years of regulatory data (until at least mid-2020) before they can more confidently identify any relationships that may exist.” (Final Report, Volume 3, p. 24).

The full Cohen report can be found here: http://farmfreshsalmon.org/cohen-commission-0

British Columbia salmon farmers have publicly supported these conclusions and additional recommendations included in the Final Report.
Pacific Salmon Catch

While Pacific salmon returns to North America are highly variable from year to year, the overall catch of salmon has increased over the past few decades to record highs. The following graph is from the Pacific Salmon Status and Abundance Trends 2012 Update by Irvine et al.:

North American commercial catch of Pacific salmon by species from 1925 to 2011 in millions of fish

Marine Mammal Interactions

As with all agriculture and capture fisheries, salmon farmers must deal with predators that may harm or consume their fish. B.C. salmon farmers have developed non-lethal ways to deter seals and sea lions from attacking their stocks. Lethal interactions are now rare and, if they do happen, are reported to regulating authorities.

- Any lethal interactions are posted publicly at: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/mar_mamm-eng.html
- As well, a Marine Mammal Conflict Mitigation Management Plan is included in the Condition of License (Appendix XI) http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/docs/licence-cond-permis-mar-eng.pdf
- At Marine Harvest Canada, lethal measures against predators are a last resort and only used when all available avenues have been exhausted.
Other Salmon Aquaculture

Alaskan Salmon Ranching

Aquaculture – commonly referred to as *ocean ranching* – began in Alaska in the 1970s in response to “record low wild-stock runs”. Today, cultured salmon are a very important part of the Alaska salmon fishery and represent a large percent of the annual catch of Alaska salmon. Cultured salmon are also very important to other fisheries around the world including Japan and Russia. [http://www.lib.noaa.gov/retrievedsites/japan/aquaculture/proceedings/report30/heard.htm](http://www.lib.noaa.gov/retrievedsites/japan/aquaculture/proceedings/report30/heard.htm)

![Annual North American hatchery releases of Pacific salmon by Alaska, Canada and southern United States from 1971 to 2011 in millions of fish.](image)


Recirculating Aquaculture Systems

Marine Harvest Canada grows salmon in land-based recirculating aquaculture systems (RAS) for one third of the fish’s lifecycle. If viable for market sized production, land-based salmon farms may provide an opportunity for regions located away from the coast to produce fresh fish year round. B.C. Salmon Farmers Association members are assisting and supplying local research and development projects designed to test the viability of growing salmon and other fishes to market size in land-based farms.

Genetically Engineered Salmon

Marine Harvest, British Columbia salmon farmers, Canadian fish farmers, and the International Salmon Farmers Association do not support growing genetically engineered salmon for human consumption.

- Our statement regarding genetically engineered salmon can be found here: http://www.aquaculture.ca/files/article-2010-09-10.php

Transparency

British Columbia salmon farmers take pride in being transparent about industry practices and operational data. Information on the industry can be found at www.salmonfarmers.org and www.bcsalmonfacts.ca. This information is supplemented by public reporting through our government regulators: http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/index-eng.html

Certification

British Columbia’s salmon farmers recognize the value and importance of third-party certification to provide confidence for consumers on the health, safety and sustainability of our products. These certifications compliment the stringent government regulations that direct our industry.

- All Atlantic salmon farmers in B.C. are certified to the Global Aquaculture Alliance’s Best Aquaculture Practices (BAP) 3 star program. The BAP Standards Oversight Committee for development of the Salmon Farms standard included the following conservation organizations: Monterey Bay Aquarium, Marine Conservation Society, Aquarium of the Pacific, and New England Aquarium: http://www.gaalliance.org/bap/
- All Atlantic salmon farmers in B.C. are committed to the Global Salmon Initiative (GSI), launched in August 2013. This initiative is focused on “making significant progress towards fully realizing a shared goal of providing a highly sustainable source of healthy protein to feed a growing population, while minimizing our environmental footprint, and continuing to improve our social contribution.” http://www.globalsalmoninitiative.org/about-us/
- One commitment of GSI is a goal for all members to achieve Aquaculture Stewardship Council standards by 2020. http://www.globalsalmoninitiative.org/areas-of-focus/standards/
Aquarium Endorsement of B.C. Farm-raised Salmon

Like third-party certifications, aquarium endorsements assist consumers in purchasing sustainable seafood.

- The Aquarium of the Pacific (California) and its nonprofit seafood advisory program (*Seafood for the Future*) recognizes Marine Harvest Canada as a responsible supplier. The aquarium’s comprehensive report can be found here: [http://www.aquariumofpacific.org/news/story/aquarium_provides_update_on_farmed_salmon](http://www.aquariumofpacific.org/news/story/aquarium_provides_update_on_farmed_salmon)

First Nation Involvement

British Columbia salmon farmers strive to bring benefit to the communities where they operate. More than fifteen resource development agreements and service contracts are currently in place with B.C. Coastal First Nations, and First Nation peoples make up twenty percent of the workforce in the B.C. salmon farming industry.

Additional Material