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An Impetus for Innovation

This is the BC Salmon Farmers Association’s second annual Sustainability Progress Report. The information within this report speaks to the desire from our members for transparency, and their drive to continue building a strong and progressive industry that is rooted in sustainable practices – environmentally, economically, and socially.

The salmon farming industry in B.C. has improved significantly over the past thirty years by adopting new technology and creating an impetus for innovation. Like in any developing sector, there have been issues that needed attention. All of the issues have not yet been solved, but the resolve and commitment to get there are genuine. With collaboration and communication from operating communities, First Nations, science, government and academia, progress will continue.

Jeremy Dunn,
Executive Director,
BC Salmon Farmers Association

Advancing Commitments

As Chair of the BC Salmon Farmers Association’s independent Science Advisory Council I am encouraged to see that the efforts B.C. salmon farmers make to their operations and the industry are, as a whole, more sustainable. I believe sharing the information in these reports is crucial to help British Columbians understand the issues that affect this sector and our ocean environment.

The industry continues to advance its commitments to marine research through initiatives such as the Marine Environmental Research Program – providing funding support worth $1.5-million until 2020 for research approved by the independent Science Advisory Council, which addresses priorities that further our understanding on the marine environment.

I look forward to seeing the industry progress further in years to come.

Dr. Don Noakes,
BCSFA Science Advisory Council Chair
Dean of Science and Technology,
Vancouver Island University
Values
As an Association, we value transparency, integrity and being proactive in our dealings with our members, the public and other stakeholders in the marine environment.

Vision
Our farmers set world-class standards for responsible fish farming, enabling British Columbia to be a major supplier of healthy seafood.

The Facts
- B.C. salmon farms are operated in seven distinct regions of coastal B.C.
- There are 109 licensed salmon farms along B.C.’s coast, with around 60 of these sites operational at any given time.
- In 2015, B.C. farmers harvested over 76,000 MT of salmon – more than 364 million portions feeding people in a record 11 countries. Farm-raised salmon is B.C.’s highest valued agricultural export.
- B.C. accounts for 61% of Canada’s annual harvest of farm-raised salmon.
- Every salmon farm in B.C. is certified by an audited third-party environmental program. Today 100% of the farms raising Atlantic salmon are certified to the Global Aquaculture Alliance’s Best Aquaculture Practices standard, and B.C. is home to North America’s only producer of certified Organic Chinook salmon. Farmers raising Atlantic salmon have committed to be 100% certified by the Aquaculture Stewardship Council salmon standard by 2020.
Third party certifications are a means of validating that products and services meet comprehensive food safety, environment and social standards. In Canada, these independent verifications provide added assurance of responsible seafood farming practices in a country with some of the world’s toughest and well-enforced regulatory frameworks for aquaculture.

Every salmon farm in British Columbia holds at least one third party certification or recommendation. Certifications vary by company, but most include stringent third-party audits and public disclosure of audit findings.

### Atlantic Salmon
#### CERMAQ CANADA
- Global Aquaculture Alliance – Four-Star Best Aquaculture Practices
- Aquaculture Stewardship Council (5 farms)
- Aboriginal Principles for Sustainable Aquaculture
- Occupational Safety Standard of Excellence
- ISO 9001, ISO 22000, OHSAS 18001, ISO 14001

#### GRIEG SEAFOOD B.C.
- Global Aquaculture Alliance – Three Star Best Aquaculture Practices
- Aquarium of the Pacific’s ‘Seafood for the Future’ responsible sourcing programme

#### MARINE HARVEST CANADA
- Global Aquaculture Alliance – Four-Star Best Aquaculture Practices
- Aquaculture Stewardship Council (4 farms)
- Aquarium of the Pacific’s ‘Seafood for the Future’ responsible sourcing programme
- Occupational Safety Standard of Excellence

### Chinook Salmon
#### CREATIVE SALMON
- Canadian Organic Aquaculture Standard

### Coho Salmon
#### GOLDEN EAGLE AQUACULTURE
- Ocean Wise – Vancouver Aquarium

### Steelhead Salmon
#### WEST COAST FISH CULTURE
- Aquarium of the Pacific’s ‘Seafood for the Future’ responsible sourcing programme

#### LOIS LAKE STEELHEAD
- Ocean Wise – Vancouver Aquarium

### Sablefish
#### GOLDEN EAGLE SABLEFISH
- Ocean Wise – Vancouver Aquarium

### Aquafeeds
#### CARGILL AQUA NUTRITION CANADA/EWOS FEEDS
- Global Aquaculture Alliance – Best Aquaculture Practices
- GLOBALG.A.P.
- ISO 9001, ISO 22000, OHSAS 18001, ISO 14001
- Canadian Organic Aquaculture Standard
- Occupational Safety Standard of Excellence

#### SKRETTING
- Global Aquaculture Alliance – Best Aquaculture Practices
- GLOBALG.A.P.
- ISO 9001
- Canadian Organic Aquaculture Standard
- HACCP Feed Assure

#### TAPLOW FEEDS
- Canadian Organic Aquaculture Standard
The 2016 Sustainability Progress Report builds upon the information provided in the first report published in 2015, and has been updated with relevant information up to May of 2016.

This report focuses on three key pillars of sustainability, detailing the salmon farming industry’s commitments and giving examples of how salmon farmers are progressing on their pathway of constant improvement.

Pillars of Sustainability

Sustainable: “Meeting the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987)

1) ENVIRONMENTAL SUSTAINABILITY
Considering the responsible stewardship and health of the environment, our fish, and the wild species with which we share the marine ecosystem.

2) ECONOMIC SUSTAINABILITY
Considering how we make a positive contribution to our economy - locally, regionally, and nationally.

3) SOCIAL SUSTAINABILITY
Considering our community development and involvement, social responsibility, and transparency.
Environmental Sustainability

Considering the responsible stewardship and health of the environment, our fish, and the wild species that share the marine ecosystem.

Commitments

B.C. salmon farmers commit:

1. To hold the well-being of our fish at the utmost importance, ensuring maximum survival throughout the production cycle.

2. For those utilizing antibiotics: To continue to reduce the amount used to treat infections in our farm-raised salmon, until innovations in fish health management replace its need altogether.

3. To continue practicing extreme diligence in containment management – with the continued goals of zero escapes and minimizing interactions with predators.

4. To implement the most modern mitigation strategies for sea lice and embrace an integrated pest management approach. Farmers are committed to ongoing transparency in sea lice monitoring, reporting, and mitigative actions.

5. To further develop a comprehensive sea lice monitoring program on wild salmon, in the vicinity of salmon farms around Vancouver Island.

6. To continue the drive to reduce dependency on wild fish resources for salmon feed, and to continue efforts to ensure reputable, traceable sources.

7. To minimize the use of copper-based anti-foulants.

8. To increase engagement in research to better understand wild Pacific salmon, and endeavouring to contribute as much relevant information as possible to these studies.

9. To meet the requirements of ‘Gold Standard’ environmental certification programs by 2020, including a goal of meeting the Aquaculture Stewardship Council (ASC) certification for all farms raising Atlantic salmon.

10. For those growing Atlantic salmon: To continue our commitment to the Global Salmon Initiative (GSI) – launched in August 2013. This initiative brings global aquaculture companies together to work to minimize the industry’s environmental footprint, and continue to improve social contribution.
Ocean Monitoring
B.C. salmon farmers strive towards staying on the cutting edge of ocean monitoring technologies and actively participating in sharing information on oceanographic conditions where farms exist, for the purpose of generating knowledge on changing conditions.

Changing Climate
Warmer water temperatures and ocean acidification can influence the structure of marine ecosystems, species ranges and distributions, the spread of invasive species such as harmful algae, as well as the prevalence of pathogens and their vectors (ISAC, 2016).

• Extremes are becoming the new normal in the marine coastal environment and something that marine resource users, including B.C. salmon farmers, need to be aware of and respond to in their operations.
• Conditions in the marine environment have an immense influence upon the health of farmed fish, and are therefore carefully monitored.
• All B.C. salmon farmers conduct some degree of daily water monitoring. Measurements include temperature, dissolved oxygen, salinity, and monitoring for harmful algae and phytoplankton.
2015 AT A GLANCE

• In 2014, an unusually warm mass of water known as “the blob” was situated off the west coast of North America (OWSC, 2016) and persisted for almost two years. By January 2015, the warm water moved to the B.C. coast, which likely affected wild and farmed species in the region (DFO, 2016a).

• Global temperature records have been broken for each month since October 2015, exhibiting unseasonably warm ocean temperatures (Silberg, 2016; DFO, 2016a).

• Rapid and early melt of snowpack resulted in critically low stream flows much earlier in the year than usual (MFLNR, 2016).

• Unique algal bloom patterns and algal species composition were evident (DFO, 2016a), as were the changes in salinity and dissolved oxygen availability in numerous coastal areas.
Water Temperatures & Salinity in Coastal B.C. Regions

Water temperature (°C) and salinity (practical salinity unit) collected by B.C. salmon farmers since 2005 have been compiled from one site in each of the four coastal regions (Clayoquot Sound, Klemtu, Broughton Archipelago, and Sechelt Inlet). The monthly average (dark blue dashed line) is an indication of what conditions have

Clayoquot Sound - Dawley Pass

Klemtu - Kid Bay

Interpreting the data

Data values that lie outside of the standard deviation suggest an unusually high or low value was observed for that month in 2015. Seasonal trends in water temperature are obvious, with peak values occurring during the summer months. Multiple oceanographic factors influence salinity patterns, but the amount of variability in the values is interesting.

• Each facility has unique characteristics in terms of temperature and salinity values.

• At all sites, 2015 temperature values were higher than average, with the greatest differences observed from January to June.

• All sites observed water temperatures ≥1.5°C above average for some months, with farms in Clayoquot Sound, Klemtu, and Sechelt Inlet having recorded water temperatures ≥2°C above average.
been like over approximately the past decade at each site (e.g. a short-term baseline). The purple dots represent an average value for each month in 2015 relative to one standard deviation (green vertical lines). Measurements at all sites except Clayoquot Sound are from 5m depth; Clayoquot Sound measurements are taken at 6m depth.

### Broughton Archipelago - Burdwood

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature (°C)</th>
<th>2015</th>
<th>Avg 2005-2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>34</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>Feb</td>
<td>32</td>
<td></td>
<td>30</td>
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<tr>
<td>Mar</td>
<td>30</td>
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<td>28</td>
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<tr>
<td>Apr</td>
<td>28</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>May</td>
<td>26</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Jun</td>
<td>24</td>
<td></td>
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</tr>
<tr>
<td>Jul</td>
<td>22</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Aug</td>
<td>20</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

### Sechelt Inlet - Salten

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature (°C)</th>
<th>2015</th>
<th>Avg 2005-2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>34</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>Feb</td>
<td>32</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Mar</td>
<td>30</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Apr</td>
<td>28</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>May</td>
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<td></td>
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<td>Jun</td>
<td>24</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Jul</td>
<td>22</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Aug</td>
<td>20</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

- **Salinity values at all facilities in 2015 fell within the range of variability for most months.** Lower than average values in April and May for some sites may be linked to the rapid and early melt of snowpack.
- **Higher than average salinities were evident in July and August in Clayoquot Sound, Broughton Archipelago, and Sechelt Inlet.**

### Survival of Stock

B.C. salmon farmers closely monitor the health of their stock through world leading fish health management practices. Today an average of 90% of salmon survive from entry into the marine environment through to harvest.
Fish Health Management

B.C. salmon farmers are passionate about the health of their fish. They apply the best standards and fish husbandry practices, use preventative vaccinations, diagnostic testing and regular fish health examinations by trained fish health professionals and licensed veterinarians.

Vaccines

Vaccines are an integral part of fish health management. B.C. salmon farming companies utilize vaccines to protect fish against common bacterial and viral pathogens that occur naturally in the Pacific marine environment, such as Infectious Hematopoietic Necrosis (IHN). These pathogens are not harmful to humans but do pose a threat to the health of salmon.

• By vaccinating fish and preventing pathogen outbreaks in farm-raised salmon, the risk of disease transmission between farm-raised and wild salmon is minimized.
• Since more effective vaccines have come into use, antibiotic use has decreased dramatically over the past two decades.
• Farm-raised salmon are currently vaccinated to protect against: Furunculosis, Vibriosis, Coldwater Vibriosis, Bacterial Kidney Disease (BKD), Enteric Red Mouth, and IHN.
• The two bacterial diseases of B.C., for which vaccine research is underway, are Yellow Mouth (Tenacibaculum) and Salmonoid Rickettsial Septicaemia (SRS). The development of vaccines help to minimize the current need for antibiotics in B.C., as has been the case in Norway (see graph on page 13).

Antibiotics

Antibiotics are an important part of animal and human welfare. In aquaculture, antibiotics are only available through prescription by a licensed veterinarian, for the purpose of managing bacterial illnesses in fish if they arise.

British Columbia’s aquaculture industry continually strives to set a high standard for antibiotic reporting. The B.C. Ministry of Agriculture is the only reporting body in Canada that provides a formal report on antibiotic use in provincial agricultural industries (Grant et al., 2014 and Radke, 2014), and Fisheries and Oceans Canada specifically generated public reports on antibiotic usage in B.C.’s aquaculture industry.

• Antibiotic use is not permitted for farm-raised salmon sold under the certified organic standard.
• Salmon that are treated are not sent to market until they have passed a mandatory waiting period to ensure any residues are below the allowable limit. This is tested regularly to ensure food-safety, and is closely regulated by Health Canada and monitored by the Canadian Food Inspection Agency.
• Salmon farmers manage the health of fish stocks responsibly, with as little antibiotic use as possible – working towards the elimination of its use in the future. The goal is to avoid microbial resistance and environmental residues.
• Through advancements in fish health management and improved vaccines, antibiotic use over the past two decades has declined substantially.
In 2015, the B.C. salmon farming industry experienced an increase of SRS infections in larger fish, which require higher volumes of antibiotics to treat than do smaller fish. Unique marine conditions in 2015 were likely contributing factors to the increased incidence of SRS. As a result, an increase in antibiotic use was required in 2015. This is not the first time farmers have had to treat for SRS in B.C., and the disease appears to affect salmon more during periods of warm ocean conditions.

SRS is a disease of fish that is caused by the bacterium *Piscirickettsia salmonis*. It affects multiple species including both Pacific and Atlantic salmon. This is a variant that is unique to the North Pacific Ocean, and it is suspected that a reservoir for the bacteria exists in the marine environment, in non-salmon fishes and shellfish (Brocklebank et al., 1993 and Rosas and Enriquez, 2014). The infection is managed using antibiotics.

Globally, salmon farmers are working to use less antibiotics. In B.C., the frequency of antibiotic use on salmon farms has declined year over year. On average, B.C. farms treated their fish with antibiotics 1.4 times per production cycle in 2015 (over the span of approximately 2 years) (GSI, 2016).

The majority of treatments in B.C. are for Yellow Mouth, which occurs in salmon during the first few months of entry into the ocean. These are populations of small fish, which require relatively small doses of medicine.

**Global Comparison:**

**FREQUENCY OF ANTIBIOTIC TREATMENTS OF FARM-RAISED SALMON**
(antibiotic treatment/production cycle)

**Comparison of B.C. farm-raised salmon production with antibiotic use**

<table>
<thead>
<tr>
<th>Country</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia</td>
<td>1.55</td>
<td>1.40</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.76</td>
<td>0.31</td>
</tr>
<tr>
<td>Faroe Islands</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Norway</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Chile</td>
<td>2.59</td>
<td>2.30</td>
</tr>
<tr>
<td>Australia</td>
<td>0.06</td>
<td>0.14</td>
</tr>
</tbody>
</table>

(DFO, 2016b)
**Sea Lice Management**

Sea lice occur naturally in the marine environment around the world. Juvenile salmon (wild and farm-raised) arrive at sea free of sea lice. Sea lice have evolved to attach to migrating salmon as they travel through the ocean. They thrive in warm and salty conditions, consistent with the marine environmental conditions experienced in many areas in 2015. Minimizing sea lice on farm-raised salmon helps to reduce the numbers of sea lice wild salmon are exposed to as they migrate through an area.

**Average number of sea lice per farm-raised salmon**

*January 2006 to December 2015*

<table>
<thead>
<tr>
<th>Adult Females (<em>L. salmonis</em>)</th>
<th>Motiles (<em>L. salmonis</em>)</th>
<th>Management Response Threshold</th>
<th>March-June Out Migration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Average number of salmon louse (*L. salmonis*) life stages (motiles and females) counted per B.C. farm-raised Atlantic salmon compared with the regulatory threshold (3 motiles per fish) for management response (from March 1 to June 30). Seasonal peaks in sea lice prevalence are linked to annual wild salmon returns. (DFO, 2016c)

**Key**

**Motiles:** All free-moving life stages of *Lepeophtheirus salmonis* (salmon louse), including females.

**Females:** All adult female lice, with/without egg strings, of *Lepeophtheirus salmonis*.

**Chalimus:** Attached early stages of species of *Lepeophtheirus* and *Caligus*. (Note: for early life stages, the differentiation between species of *Lepeophtheirus* requires molecular techniques, and the differentiation between chalimus stages of the most common copepods on Atlantic salmon, *Lepeophtheirus salmonis* and *Caligus clemensi*, is not practical during cage-side inspections. In other words, and for practical reasons, chalimus counts represent all lice species that may be present at the time.

**Caligus:** All motile life stages of *Caligus clemensi* found.

**Management Response Threshold:** Fisheries and Oceans Canada requires that sea lice management action be initiated (harvest or treatment) when motile counts are over 3. (DFO, 2016c).
Sea lice and cultured salmon

B.C. salmon farmers are transparent in sharing information concerning sea lice on farm-raised salmon and management actions taken to reduce sea lice numbers. Atlantic salmon farming companies regularly post updates on sea lice counts on their websites.

B.C. salmon farmers employ a number of techniques to manage sea lice on farm-raised salmon. These measures include decreasing the number of cultured fish on farms through harvest, and the use of the therapeutants SLICE® and Paramove 50®.

In 2015, therapeutant use in B.C. farm-raised salmon averaged 1.4 treatments per production cycle. The average quantity of in-feed therapeutant used to treat sea lice on B.C. salmon farms in 2015 was 0.25g of active ingredient per tonne of salmon produced, a reduction from 0.35g per tonne in 2014 (GSI, 2016). Research on alternative, non-medicinal treatment methods is being driven through a global industry effort.

Sea lice and wild fish

Wild fish are natural carriers of sea lice. B.C. salmon farmers are proactive and interested in knowing the status of sea lice conditions on wild salmon in areas where they farm. This is important in forecasting any mitigative measures or actions that might be needed to ensure that farm-raised salmon are not further contributing to the sea lice numbers on wild fish.

B.C. salmon farmers have established wild salmon sea lice monitoring programs in all farming regions of the province – working collaboratively with researchers in academia and the government.

- Broughton Archipelago (2010 – current)
- Discovery Islands (current)
- Klemtu (2015 – current)
- Nootka Sound (2004 – current)
- Port Hardy (2011 – current)
- Quatsino Sound (2015 – current)
- Sechelt Inlet (current)
Salmon farming in B.C. has evolved since its beginnings over 30 years ago. Improved technology has led to advances such as higher quality, more sustainable fish food, automated feeding and surveillance systems, improved containment structures, and effective fish health innovations. B.C. salmon farmers continue to be progressive in exploring new technology to increase production efficiencies and sustainability.

**Feeding Our Fish**

**MARINE INGREDIENT INCLUSION RATES**

Over the past several years, the suppliers of feed for B.C. farm-raised salmon have taken great strides to reduce the amount of fishmeal and fish oils in their aquafeeds, while maintaining nutritional value and increasing traceability to their marine ingredients. On average, current salmon feeds contain less than 15% fishmeal and fish oil.

Salmon Feed: Average % of fishmeal & fish oil used by B.C. salmon feed producers (2008-2015)

Feed companies have steadily decreased the amount of fishmeal and fish oil in their feeds, thereby reducing impacts on marine resources.
Feed Conversion Ratio

kg of feed needed to increase animal's weight by 1 kg

- B.C. farm-raised salmon are highly efficient in utilizing feed for growth. Salmon farmers closely monitor their use of feed to ensure efficiency.
- B.C. farm-raised salmon's noteworthy feed conversion ratio of 1.2 has decreased dramatically from previous decades.
- The assessed quantity of wild pelagic fish that is needed to produce the fishmeal and fish oil required to raise one unit of farmed salmon is known as the Forage Fish Dependency Ratio (FFDR). In B.C., the average FFDR has decreased since 2013, and is well below the standards set by the Aquaculture Stewardship Council (ASC, 2016), indicating a continuing shift away from reliance upon wild marine resources in feed.

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>ASC Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishmeal</td>
<td>0.83</td>
<td>0.69</td>
<td>0.65</td>
<td>&lt;1.35</td>
</tr>
<tr>
<td>Fish oil</td>
<td>2.52</td>
<td>2.07</td>
<td>2.07</td>
<td>&lt;2.95</td>
</tr>
</tbody>
</table>

Average Forage Fish Dependency Ratio (FFDR) for fishmeal and fish oil in B.C. (GSI, 2016)
TRACEABILITY AND QUALITY ASSURANCE

Traceability is important to sustainability. It is important to know where a product comes from, and be able to trace it back through its history to ensure food safety, quality of ingredients, handling, and processing methods used.

• Feed companies use modern machinery and advanced technology to assure feed quality (Taplow Feeds, 2016a).
• Feed companies servicing the B.C. salmon farming industry have very comprehensive traceability programs. The programs in place allow for the complete visibility and control from the raw material supply chain, through all phases of production, to the customer’s facilities.
• Information can be accessed quickly to trace and recall any product or material in any position of the supply chain. Evidence of traceability can be provided through a third party chain of custody (Cargill Aqua Nutrition, 2016; Skretting, 2016a; Taplow Feeds, 2016b).

LOCAL SOURCING

Raw materials sourced for salmon feeds are chosen based on quality, safety and digestibility. Companies strive to use ingredient sources that are as local as possible.

• 75% of sourced raw material comes from within Canada and the United States.
• An effort to incorporate fish trimmings into feed is made where possible. This recycles valuable marine derived nutrients and reduces dependence upon wild sources of marine ingredients.

Breakdown of raw material sourcing by B.C. salmon feed producers.

- British Columbia 38%
- The Rest of the World 25%
- Canada (outside BC) 27%
- United States 10%
It is important to know where a product comes from, and be able to trace it back through its history...

INNOVATIVE RESEARCH – REPLACING FISHMEAL

A major driver of research for the two largest feed companies in B.C. is in seeking to further reduce reliance on marine raw materials.

• Earlier this year, Cargill Aqua Nutrition announced they are making a significant investment in Calysta, a company that has developed FeedKind™ protein – a non-animal, non-vegetable replacement for fishmeal. FeedKind™ protein begins with bacteria that are cultured and consume methane. The process produces a high protein feed ingredient that is functionally and compositionally equivalent to fishmeal (Calysta, 2016).

• Skretting recently announced the development of MicroBalance™ FLX – making them the first to market with a fishmeal free feed formulation, while still delivering equal performance in terms of fish growth and health. This line of products has been made possible through progressive and extensive research. It means that Skretting can be increasingly flexible with raw material inclusions, enabling the available responsibly sourced fishmeal resource to go much further than in the past, and thereby increasing the sustainability credentials of salmon production globally (Skretting, 2016b).

* Where marine ingredients are used, fishery by-products are preferred as a sustainable choice. No salmon meal and oil is used.

1 Proportions of feed components are approximate. Each feed company uses a proprietary blend of ingredients.
Fish welfare, worker safety and environmental consciousness are top priorities for B.C. salmon farmers. They use the best technology available to grow the healthiest fish possible, while minimizing their environmental footprint.

**FRESHWATER TECHNOLOGY**
The early life stages of salmon (e.g. fry and parr) begin in freshwater hatcheries. Major investments have been made toward recirculating aquaculture system (RAS) technology to optimize production and improve environmental performance (Grieg Seafood, 2016a). RAS recirculates 98% of water, and reduces the consumption of water resources, thus making it a sustainable method for producing high quality smolts.

**MARINE TECHNOLOGY**
In place of copper-based anti-foulants, Remote Operated Net Cleaners (RONCs) use high-pressure water and scrubbing discs to safely clean nets (Marine Harvest, 2016a). Advanced feeding systems with underwater cameras allow salmon farmers to see conditions above and below the surface of the net pen, and feed fish electronically (Creative Salmon, 2016).

Secondary nets that are placed outside of the primary containment net discourage marine mammal interactions. These nets also act as a secondary containment area, in the unlikely event that a farm fish escapes the primary containment net.

**WORKER SAFETY**
Satellite-based worker safety monitoring and communication technology is in use at some farms in remote areas. This technology lets workers send and receive messages instantly, including for emergencies such as tsunami warnings, and sends a notification if a worker is inactive for more than a few minutes due to a potential injury (Cermaq, 2016a). Lone worker policies ensure that provincial workplace legislation is adhered to.
Escapes and Predator Management

ESCAPES

- B.C. salmon farmers have a zero tolerance policy with respect to escapes and are diligent at reporting and responding to escapes of farm-raised salmon, effectively and efficiently.

- Salmon farmers work towards ensuring 100% containment of their stocks at all times, despite challenges from weather events and predator interactions with infrastructure.

- In 2015, three salmon (two Atlantic and one Chinook) were lost in three separate incidents.

- The most up to date reporting on escapes can be found on the public reporting website of Fisheries and Oceans Canada.

MARINE MAMMALS

- The animals most commonly interacting with salmon farm sites in B.C. include Pacific harbour seals, Steller sea lions, California sea lions, and river otters.

- Harbour seals exist in healthy populations on the west coast of Canada. The rate of growth in B.C., approximately 11% per year in the 1970’s and 1980’s has slowed or stabilized, suggesting that populations are approaching or attaining carrying capacity (DFO, 2010).

- Steller sea lions are listed as a species of Special Concern in western Canada (COSEWIC, 2013). Overall abundance is estimated to have increased by about 215% over the last 25 years – about a 3.1% increase annually (Pitcher et al., 2007).

- California sea lion populations have been growing steadily and the current growth rate of the population, from south-western Canada to southern Mexico, is approximately 5% per year (NMFS, 2011).

MARINE MAMMAL MORTALITIES ON SALMON FARMS (2011-2015)

Marine mammal mortalities have remained low on B.C. salmon farms, despite growth in seal and sea lion populations, indicating that methods and infrastructure in place to reduce interactions are extremely effective. (DFO, 2016d).
Since marine mammals are common in the waters around fish farms, salmon farmers make it an important priority to find non-lethal and passive ways of reducing marine mammal interactions on fish farms.

**Marine Environmental Research Program**

An understanding of the dynamics between farm-raised salmon, wild salmon and the ocean environment is fundamental to conducting sustainable finfish aquaculture in B.C. In 2014, salmon farmers in B.C. responded to a growing need for more research on these dynamics and fish health related topics.

In order to further the industry’s research initiatives, the BC Salmon Farmers Association developed the Marine Environmental Research Program – committing $1.5 million to fund competitive research programs between 2015 and 2020 that address one or more of the four key research priorities:

1. Understanding endemic pathogens in wild and farm-raised salmon and their transfer mechanisms.
2. Understanding Pacific salmon migration and the factors that affect migration – sockeye, Chinook, coho, pink, and chum.
3. Understanding the interactions between salmon farms and the environment and investigating potential impacts while developing mitigations as appropriate.
4. Creating an improved and more accessible fish health data and reporting system.

Companies have made investments in employee training, site setup procedures and infrastructure, in order to reduce interactions and keep marine mammals away from farm-raised populations.
In order to gain a better understanding of the marine environment and B.C.’s wild marine species, particularly wild salmon stocks, research is conducted in partnership with government, academic and independent research institutions. By building new partnerships, the Association also endeavors to seek external research funding to leverage these funds to the greatest potential.

As of 2016, MERP funds have been granted to six projects, three of which are outlined below. Details of all the projects can be found at bcsalmonfarmers.ca on the Research and Innovation page.

**Acoustic Tags and Analyses: Use of acoustic tagging methods to study juvenile salmon within the Strait of Georgia and Johnstone Strait (2015 – 2019)**

**Priority Met:** Understanding pacific salmon migration – sockeye, coho, Chinook

**Collaborating Organizations:** Pacific Salmon Foundation, University of British Columbia, Kintama Research Services, Canada’s Ocean Tracking Network, and Fisheries and Oceans Canada.

- Use of acoustic tagging technology to track juvenile salmon along their migration from freshwater to the open ocean, with a focus on sockeye salmon from Chilko Lake through the Strait of Georgia, Discovery Islands, and Johnstone Strait.

**Use of hydro-acoustic methods to assess the migration timing and distribution of juvenile salmon in Discovery Islands and Johnstone Strait (2015-2019)**

**Priority Met:** Understanding pacific salmon migration – sockeye, coho, Chinook

![Collaborating Organization: Fisheries and Oceans Canada](image)

- Use of hydro-acoustics to monitor fish abundance, behaviour and distribution for extended and continuous periods of time. DFO is deploying hydro-acoustic equipment (multi-frequency autonomous echo sounders) on moorings to monitor juvenile salmon migratory behaviour in the Discovery Islands and Johnstone Strait.

**An examination of the potential use of perch to clean sea lice infested Atlantic salmon (2016 – 2017)**

**Priority Met:** Understanding pathogen transfer from farm-raised to wild salmon and from wild to farm-raised salmon

**Collaborating Organizations:**
- Vancouver Aquarium Marine Science Centre
- Marine Harvest Canada
- Fisheries and Oceans Canada
- SeaPact
- B.C. Centre for Aquatic Health Sciences

- This project will be exploring the effectiveness of a local B.C. fish species to “clean” sea lice from cultured Atlantic salmon. This research is the first of its kind in B.C., and results are expected to determine if kelp perch or pile perch are effective in picking sea lice from salmon – a proven non-medicinal method for managing sea lice in cultured salmon.
SCIENCE ADVISORY COUNCIL

Funding decisions for received proposals are made by an external body, the BCSFA Science Advisory Council. The Council reviews proposals and provides oversight on the use of dedicated funds for studies in the Marine Environmental Research Program.

Membership for the Council spans academia, conservation organizations, government and industry to ensure an inclusive, collaborative effort in funding decisions that also meet research priorities.

In addition to the Science Advisory Council, all proposed research goes through a third party peer-review process for scientific integrity.

WORKSHOP SERIES – COLLABORATIONS ON THE COAST

The BCSFA holds annual workshops each February to bring together organizations researching areas that fit within the priorities of the Association.

Additional research priorities have been carefully identified by the B.C. salmon farming industry (2015-2020):

1. Capacity building – B.C. salmon farmers seek to acquire the supporting infrastructure (e.g. laboratory space, tank space, and equipment) and expertise needed to address relevant fish health issues.

2. Forecasting potentially harmful phytoplankton events and related dissolved oxygen changes in farming regions.

3. Develop a better understanding of how the manipulation of biomass on sites can be used to effectively manage disease and make improvements to the farm’s localized environmental footprint, with consideration of changing climate.

4. To characterize, better understand, and develop mitigation measures for fish health issues primarily related to climate change.
Economic Sustainability

Considering how we make a positive contribution to our economy – locally, regionally, and nationally.

Contributions to the Economy

The operations of the farm-raised salmon industry impact the B.C. economy through expenditures on goods and services (such as feed, equipment, transportation, and veterinary services), the employment of staff, and the generation of tax revenues for local, provincial, and federal governments.

- Operations of the farm-raised salmon industry contribute over $400 million in GDP and over $60 million in tax revenues for federal, provincial and municipal governments (MNP, 2015).

- Approximately 40% of B.C. salmon farmers’ contributions to the GDP, employment and tax revenues are attributable to activities that occur on north Vancouver Island, while 35% are estimated to be attributable to activities that occur on the Lower Mainland. The remaining 25% are attributable to activities between the remainder of Vancouver Island and the Central Coast of B.C. (MNP, 2015).
Coastal Employment

B.C. salmon farming companies are committed to hiring and retaining a strong employee base in B.C.’s coastal communities, with jobs paying approximately 30% more than the median employment income in B.C. Member companies of the BCSFA strive to maintain a diverse workforce that supports local economic growth (MNP, 2015).

- The total number of jobs generated as a result of salmon farming in B.C. is 4,997 (2,362 direct, 1,926 indirect, 689 induced) (MNP, 2015).
- Salmon farmers and supporting businesses are typically located in rural coastal areas where unemployment has traditionally been higher than the provincial average.
- In 2014, B.C.’s salmon farming workforce consisted of approximately 30-35% female and 65-70% male employees.

Salmon farming companies run a number of courses, including those on cross-cultural knowledge of B.C.’s First Nations, and training programs that provide employees with opportunities to increase their knowledge base, and also help them advance their careers. Some jobs that companies offer include farm and hatchery site operations, fish health management, marketing, processing, administration, human resource management, and regulatory affairs.

First Nations Partnerships

B.C. salmon farmers have engaged in 20 economic and social partnerships with coastal First Nations. Approximately 78% of B.C.’s annual production of farm-raised salmon is harvested from areas covered by agreements with First Nations (AAA, 2015). Partnership agreements include formal protocols between First Nations and companies farming in their traditional territories, and creating on-going, open dialogues on practices.

The Aboriginal Aquaculture Association of B.C. has developed the Aboriginal Principles for Sustainable Aquaculture. This certification provides a standard for salmon farming companies and First Nations based on a structured framework that ensures First Nations values, expectations, and interests guide the sustainable management of aquaculture operations.

Salmon farming companies make an effort to enhance quality of life in First Nations communities through sponsorships for sports, scholarships, and cultural, educational, and elder activities.
Exports

B.C. salmon farmers set a new record for exports in 2015, and are on track to set new records in 2016 as well. The numbers for 2015 reveal an emerging appetite for farm-raised salmon in China, with exports from British Columbia more than doubling over the previous peak in 2012. China is now B.C.’s second most important export market next to the United States, which has historically been the sector’s primary export market, and remains so today.

- New record exports to China: 1,250mT (a value of $9.2M CAD) – an increase of volume of 140% from the previous high in 2012.
- New record exports to the United States: 52,150mT (a value of $404.9M CAD) – a 2% increase in volume from the previous record in 2012, but a 40% increase in export value from the previous high in 2012.

In 2015, trade with Asia was up 38% over the previous record in 2013, with B.C. exporting fresh farm-raised salmon for the first time to South Korea. Preliminary data from Statistics Canada (January to May 2016) indicates an increase in demand for B.C. farm-raised salmon in Asian markets.

- Exports to South Korea are up 10-fold over 2015 numbers, with over 29,000 kg exported so far this year.
- Exports to Japan are on pace to double in 2016, with farmers already reaching 97% of the total export volume for 2015.
- Exports to Taiwan for 2016 have already exceeded the 2015 total.
Social Sustainability

Considering our community outreach and involvement, social responsibility and transparency.

Commitments

- Supporting local activities at the grass roots level, fostering a sense of belonging and community.
- Fostering First Nations partnerships, where possible – B.C. salmon farmers commit to growing coastal economies and social sustainability by creating lasting, equitable partnerships with First Nations.
- Continuing to be open and transparent about operations in communities.

Community Engagement

Developing social sustainability through enhancing the well-being of a community is a key goal of salmon farming companies in B.C., because coastal communities are the foundation of our operations. Programs that have benefitted from the donations of salmon farming companies in B.C. vary widely, including service groups, to sports teams, social programs, conservation and fish habitat restoration groups, and wild salmon enhancement programs. Examples of some of the programs can be found in the left side bar.

Community Contributions by B.C. Salmon Farmers (2015)

- Donations to 350+ organizations & charities
- $600,000+
- 23,000+lbs of salmon

CHARITABLE BBQ’S

Over the past five summers, Marine Harvest Canada’s charitable salmon barbeque trailer has traveled to various locations on northern Vancouver Island – raising money for local charities. To date, the program has raised $106,000.

TOWN RECREATIONAL PROGRAMS FOR SPECIAL NEEDS

Grieg Seafood B.C. annually provides support to the City of Campbell River’s specialized recreation program for teens, adults and families with special needs. These programs include sewing, social events, cooking classes, and outdoor activities.

ROYAL CANADIAN LEGION’S ANNUAL FISHING DERBY

Creative Salmon annually donates salmon and support staff for the Tofino Royal Canadian Legion’s annual family fishing derby and BBQ – a popular community event and fundraiser for the Legion in Creative Salmon’s operating community.
References


References (cont’d)


Our Membership

The BC Salmon Farmers Association (BCSFA) has 48 members, representing a range of salmon farmers, suppliers, partners and supporters from around British Columbia and beyond. For contact information see bcsalmonfarmers.ca/members/

Ahousaht First Nation
Akva Group
Aqua-Pak & Noboco
Aqua Pharma INC
Aquatrans Distributors
Badinotti Net Services Canada Ltd.
Biomark
Brown’s Bay Packing Company
Brunswick Jetters Ltd.
Campbell River Netloft Ltd
Canada Cryogenetics Services
Cargill Aqua Nutrition Canada/EWOS Feeds
Cermaq Canada Ltd.
Comox Valley Economic Development Society
CPI Pumps & Irrigation
Creative Salmon
Cummins Power Generation
District of Port Hardy
DIVESAFE International
Dynamic Systems Analysis
Elanco Canada Limited
Europharma
Excel Career College
Flying Fresh Air Freight
Gemini Marine Services Ltd.
Golden Eagle Aquaculture Inc.
Grieg Seafood BC Ltd.
Hardy Buoys
Kitasoo Aquafarms
Lions Gate Fisheries Ltd.
Marine Harvest Canada
Merck Animal Health
NexGen Hearing Industrial
Ocean Quality North America
Omega Pacific Hatchery Ltd.
Pentair Aquatic Eco-Systems Inc.
Poseidon Oceans Systems Ltd.
Realtime Aquaculture
Saltstream Engineering Ltd.
Sea Roamer Marine Services
Skretting North America
Syndel Laboratories
Talpox Feeds
Tlatlasikwala First Nation
TRI-GEN Fish Improvement Ltd.
West Coast Fishculture (Lois Lake) Ltd.
West Coast Reduction Ltd.
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