2020
New Brunswick Annual Sea Lice Management Report

Prepared by the Atlantic Canada Fish Farmers Association (ACFFA)

Data for this report is generated from the Fish-iTrends Decision Support System. Fish-iTrends is the data collection system developed by the Atlantic Veterinary College (AVC) at the University of Prince Edward Island for use by the Atlantic Canada salmon farming industry. This system is maintained by the AVC who acts as a third-party monitor of data submissions by salmon farmers. Provincial fish health personnel have ongoing access to this data; AVC and/or regulators perform third party audits of the salmon farm lice counts to verify accuracy in reporting.

To further support this system and ensure data accuracy, the AVC developed a sea lice monitoring certification program for farm technicians. Training helps to ensure accurate counts are based on the Sea Lice Monitoring Program, a requirement under the New Brunswick Aquaculture Act and General Regulations and the Integrated Pest Management Plan for Sea Lice.

ACRONYMS

ABMA	Aquaculture Bay Management Area
EDRs	Emergency Drug Releases
NBDAAF	New Brunswick Department of Agriculture, Aquaculture and Fisheries
DFO	Department of Fisheries and Oceans
PMRA	Pest Management Regulatory Agency
VDD	Veterinary Drugs Directorate

EXECUTIVE SUMMARY

The three-year Aquaculture Bay Management Area System (ABMA) implemented in New Brunswick (See map in Appendix A) not only supports improved environmental management but it has also provided the basis to improve fish health management practices, including sea lice management. Principles within the ABMA system include:

- Mandatory fallowing of production sites and the bay management area to help break pathogen lifecycles as well as the life cycle of sea lice;
- Single year class stocking at each farm site and within each management area; preventing older farmed salmon, which may have already been exposed to pathogens / parasites in the marine environment, from transferring it to incoming smolts.

In 2020, salmon farming companies continued to develop a sea lice management and treatment strategy in each Bay Management Area, that included product rotations and synchronized treatment strategies. Like all farmers, they relied on the professional advice of veterinarians who have access to approved products for use when animals are infected by a pathogen or threatened by parasites. All in feed sea lice treatments were authorized through a veterinarian's prescription and all treatments were reported to federal and provincial regulators.

Water temperatures continued to be an important factor in the management of sea lice impacts on fish farmers in the Bay of Fundy. As shown in Figure 1, water temperatures in 2020 in southwest New Brunswick were warmer overall than other years and winter tempertatures did not go as low

as others years which did not aid in sea lice declines during that winter period. Water temperatures for the Bay of Fundy averaged 12.6 in August and 12.8°C in September 2020 and once again temperatures reamined above 10°C through to the end of November. December averaged above 8°C.

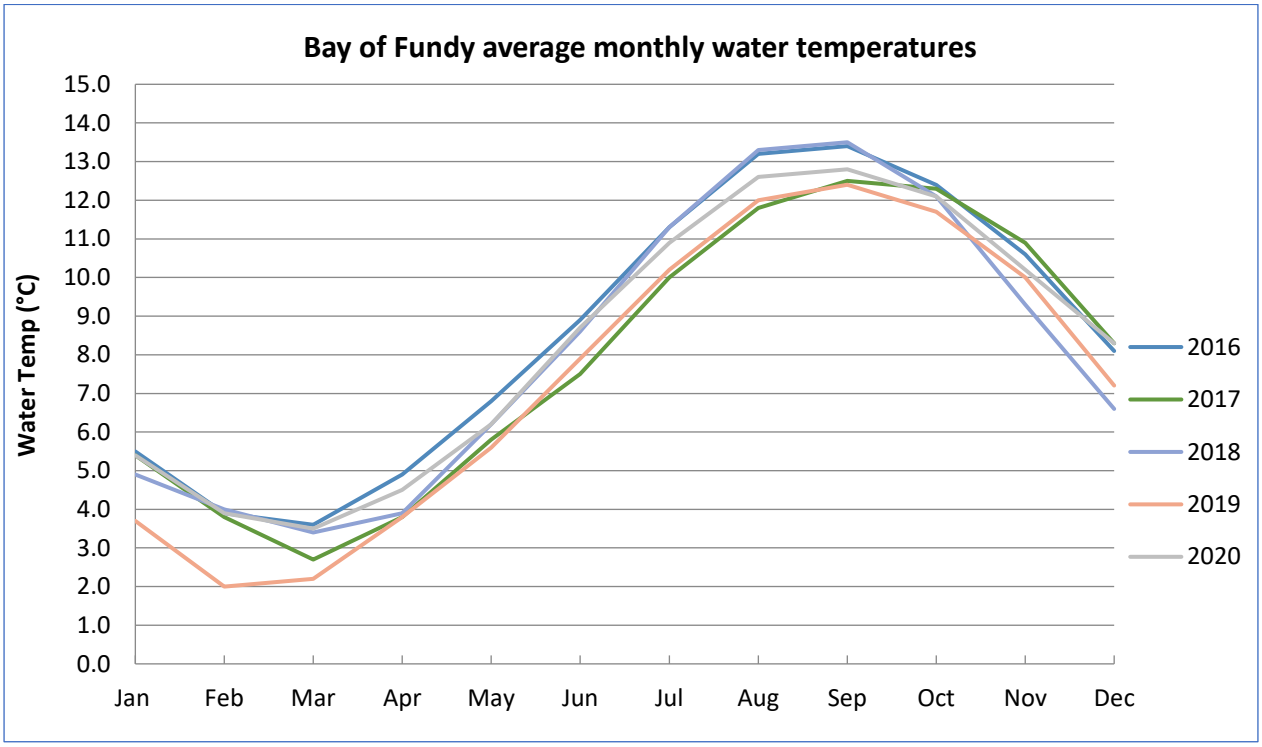


Figure 1: Average monthly water temperatures for 2016-2020

This report on sea lice management is based on the 2020 data obtained through individual farm reporting and data analysis of the sea lice counts within the specific ABMAs. The data represents the average sea lice count for adult female lice, which are indisputably the most critical life stage to control and the life stage generally reported by other jurisdictions.

BACKGROUND

Sea lice are naturally occurring parasites that feed on the skin and mucous of both wild and farmed salmon. The salmon sea louse cannot live in the fresh water of our hatcheries - therefore all smolts are free of sea lice before they enter the net pens. However, since sea lice can pass through the netting of the pens, farmed salmon may become infected with the sea lice in the surrounding water. Since this parasite cannot be eliminated from the marine environment, salmon farmers have developed management practices that reduce the likelihood of infection[1].

These practices include:

- Selecting new farm sites with good flushing and water current
- Production sites are emptied of all farmed fish for periods of time (fallowed).

[1] http://www.aquaculture.ca/files/species-salmon.php

- Only farmed salmon from a single yearclass are present at each farm site – this prevents older farmed salmon (who may have received the parasite from the wild salmon) from transferring them to incoming smolts
- Employing bay management systems where hydrographic conditions reduce the possibility of year-class carry-over

Increasing ocean temperatures over prolonged periods of time and later in the year are having an impact on the number of sea lice in the Southwestern New Brunswick by reducing the number of weeks to reach the female adult stage by 60% (Figure 2).

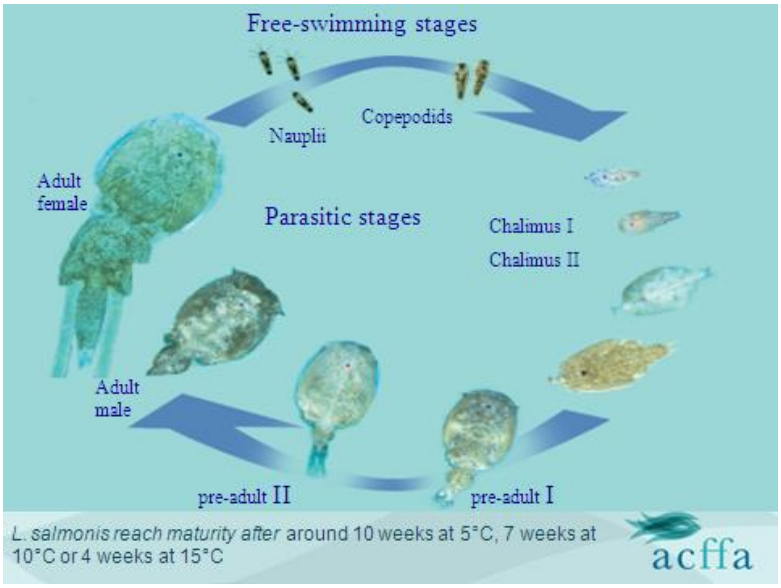


Figure 2: Maturity stages of L. salmonis

Therefore, salmon farmers continued to invest in the development of proactive management practices to reduce the likelihood and severity of infestations. All farmed salmon enter the marine environment disease and parasite free. However, because sea lice travel on wild fish, ocean currents and even in zooplankton, they can move freely between both wild and farmed fish.

In 2000, salmon farmers around the world acquired access to an anti-parasitic therepeutant, emamectin benzoate – the active ingredient in SLICE®. This was the only product available for use in Canada until 2009.

In 2008, New Brunswick farmers observed a reduced efficacy to SLICE®. It was then that the New Brunswick salmon farming industry worked with federal and provincial governments, scientists and the National Fish Health Working Group to research and evaluate effective alternative options for controlling sea lice and promoting overall fish health management. The European aquaculture industry has had access to a variety of sea lice management tools for over a decade. Recognizing this, the Atlantic Canada salmon farming industry collaborated internationally, and continues to do so, for evaluation and research of new sea lice management opportunities. The objective is to find new tools that will augment and/or replace management practices already in place.

Efforts by salmon farmers to make real and lasting progress to support integrated pest management has been challenging. In part due to the fact that fundamental to any integrated pest management plan (IPMP) is access to a variety of treatment options. In the past, there have been challenges in getting timely authorizations and/or permits to support the evaluation or use of products under alternative delivery methods.

Canada is the only jurisdiction that requires separate approvals from companies producing the active ingredients in treatment products used in commercial sea lice treatment products. Canada still does not have access to the same products that have been used in other jurisdictions for years. Not all products are appropriate for all life stages of lice. Furthermore, addressing sea lice impacts is further complicated by environmental conditions such as high winds, salinity and water temperature.

Studies have shown that young pink salmon mount an effective immune response to sea lice infection[2]. This immune response causes the lice to be shed from the salmon –protecting the young salmon from illness or death due to sea lice infection. Feed formulations have been developed, many using natural ingredients that may inhibit sea lice from attaching to farmed salmon or boost the salmon's immune system. Immunostimulants include items like Vitamin E, β glucans from yeast, and plant extrats. Anti-attachment feeds may use glucosinolates that are biologically active compounds found in the Brassicaceae family of plants, including broccoli, cabbage, cauliflower, rapeseed, mustard, and horseradish, which if ingested by vertebrates, exert health-promoting effects due to their antioxidant and detoxifying properties.

These feeds are being used in Norway and in the EU. It is of consumer interest to note that while humans can consume these feed ingredients and fish that have been fed these ingredients that are being imported for sale in Canada, they are not permitted for direct use in Canada. After nearly a decade, the Canadian Food Inspection Agency has not amended their list of approved ingredients for infeed products.

In addition to issues affecting access to treatment options or functional feeds, records maintained by salmon farmers show that marine water temperatures in New Brunswick continue to increase. We began to see a trend of increases by 2 degrees centigrade above historical levels in 2009. . We continue to see these high water temperatures maintained for longer periods and on average later in the year than we have seen in the past.

HIstorically, sea lice populations on salmon farms can be very low January through to June. To ensure that low sea lice abundance is maintained, strategic spring treatments begin in April / May where required. This minimizes the risk and ensures that any wild salmon leaving rivers are not exposed to sea lice from salmon farms. When water temperatures cool, farmers will again do a strategic final treatment in late fall to reduce lice abundance prior to winter. The timing of treatments thoughout the year is determined on an as needed basis.

CURRENT MEDICINAL SEA LICE TREATMENT OPTIONS

An Overview of International Options

There are a range of compounds available internationally for sea lice management. These include:

1. Avermectins: SLICE®, Ivermectin
2. Chitin Inhibitors: Calicide, IMVIXA
3. Organophosphates: Salmosan
4. Pyrethroids: AlphaMax, Excis
5. Hydrogen Peroxide: Interox Paramove 50, Aquaparox 50

These products have been available for many years in other jurisdictions including Norway, the UK and Chile. Extensive international research is available to provide data to support Canadian risk assessments through Health Canada for Emergency Drug Releases (EDRs) or Emergency

[2] http://www.aquaculture.ca/files/species-salmon.php

Registrations (ERs) pending local monitoring and surveillance data collection to complete full registrations of the products.

An Overview of Canadian Options

All registered in-feed products listed below are only available through a prescription by a veterinarian. The Veterinary Drugs Directorate (VDD) evaluates and monitors the safety, quality and effectiveness, sets standards and promotes the prudent use of veterinary drugs administered to food-producing and companion animals. The Pest Management Regulaotry Agency (PMRA) preforms a similar role for topical / bath pesticde treatment products. Use of all products is reported to both federal and provincial regulators.

1. Salmosan®

Salmosan® was previously registered and administered on New Brunswick farms in the 1990s but the registration lapsed when SLICE® was introduced. The Province received an ER for Salmosan® in November 2009. This permit was subject to scientific monitoring, where sediment and water quality testing has shown little to no impact as a result of Salmosan® treatments (More information can be found at www.atlanticfishfarmers.com)

Prior to full registration of Salmosan®, yearly applications for access to this product were submitted to PMRA. Full product registration of Salmosan® with PMRA occurred in September 2017.

2. Interox Paramove®50 / AQUAPAROX 50

Hydrogen peroxide products are benign in the environment, degrading quickly to water and oxygen. Approval for use of Interox Paramove®50 through an ER was received June 11, 2010 and the first application occurred on June 26, 2010.

Like Salmosan®, new ER applications for use were submitted annually. Full product registration of Interox Paramove®50 with PMRA occurred in March 2015. Another hydrogen peroxide product, Aquaparox 50 was registered in September 2016.

3. Avermectin

Avermectins such as SLICE® and Ivermectin may be used as an in-feed sea lice treatment, under a veterinary prescription. Both products are approved under VDD,[3] though the use of Ivermectin is via Extra Label Drug Use decision.

4. Calicide®

Calicide® is an in-feed treatment approved by VDD. Because Calicide® affects only early life stages of sea lice, administration timing is essential; it is also most effective when used in conjunction with bath treatments that affect later stages of sea lice. Use by the industry was limited and as a result, producers have chosen not to maintain a supply of this product in Atlantic Canada.

5. IMVIXA

Licenced in other countries, IMVIXA is an in-feed treatment given to smolt while in freshwater hatcheries, prior to salt water transfer. It cannot be used in the marine evnironment. It is not currently availabel in Canada.

[3] http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/hpfb-dgpsa/vdd-dmv/index-eng.php

CURRENT ALTERNATIVE SEA LICE TREATMENT OPTIONS

Non-therapeutant Control Strategies

Use of non-chemical control strategies for controlling on-farm sea lice such as cleaner fish, and / or hydro-licers, flushers and warm water systems, have been increasing each year. In 2020 most sea lice treatments were accomplished through mechanical removal. The use of these non-chemical control strategies does not necessarily remove the need for therapeutant options as many of these alternatives involve physical handling of the fish so less stressful options may be required at high and low water temperatures. There are currently seven units available for in operation in New Brunswick with more to be added.

RESEARCH AND ALTERNATIVE SEA LICE MANAGEMENT OPTIONS

The ACFFA has played an active role on behalf of our industry working with researchers from government, academia, private institutions, and with industry at the regional, national and international level. Collaborative and coordinated research to support effective sea lice management has commonly focused on five key areas:

1. **Regulatory Research**
   - To support the evaluation, licensing and use of new treatment options
2. **Environmental Dynamics**
   - To provide necessary answers regarding potential risk to the marine environment and non-target species as a result of sea lice management activities
3. **Management Practices**
   - To support improved on-farm sea lice management practices
4. **Novel Treatments / Green Technology**
   - Evaluation of non- chemical management options in addition to new technology to reduce the potential environmental impact of sea lice management and improve sea lice management performance
5. **Modelling**
   - Collecting and using data to evaluate the effectiveness of sea lice management activities and/or to provide information on means of improving the effectiveness of new or current technologies

Industry continues to make significant financial and human resource investments to support research critical to improving knowledge and understanding of sea lice dynamics and management.

The ACFFA regularly publishes proceedings from workshops at http://www.atlanticfishfarmers.com/research-program-project-reports.html. Results from all collaborative research is publicly shared through workshops, communication with stakeholder groups at a variety of meetings, as well as industry and agency websites. Interim research data from private and academic research is often available at these workshops and published as part of workshop proceedings.

Some examples that we can report from this research program include:

- ✓ The Fish-iTrends Decision Support System continues to provide an online data management system that records all sea lice population data; these data are verified by a third-party audit and are being used to evaluate the effectiveness of sea lice management;
- ✓ Well boats and tarpaulins were introduced to ensure all sea lice bath treatments are performed in closed systems, significantly reducing potential environmental impact and the quantity of products required for effective sea lice treatments

- ✓ Hydrological surveys to determine possible refinements to the current Aquaculture Bay Management Areas.
- ✓ Implementation and adjustment of alterative lice removal technologies (e.g., warm water)
- ✓ Evaluation on the use of cunner and lump fish as a sea lice cleaner fish;
- ✓ Evaultion of new sea lice treatment products and vaccines

NON-TARGET SPECIES

Wild salmon populations in Atlantic Canada fluctuate in a similar manner in areas with and without salmon farms. Sea lice populations on salmon farms during the out-migration period are very low and pose little risk to wild smolt. There has been a range of field research and scientific monitoring conducted on all sea lice bath treatment products both in Canada and in other jurisdictions.

There have been no significant changes in the landings for the traditional fishing sector since 2007[4] while lobster landings have steadily increased since 1999[5]. To view fishery data visit http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm

SEA LICE MANAGEMENT ON FARMED SALMON 2020

Salmon farming companies continue to prepare a coordinated sea lice management and treatment strategy that includes controlling lice numbers in each Bay Management Area, product rotations and synchronized treatments. This strategy is communicated to traditional fishing groups annually.

In 2020, Avermectins were used in-feed with smolt and treatments of Salmosan® and Aquaparox 50 were used in closed treatment systems. The majority of sea lice treatments in 2020 were completed with warm water, flusher and or hydro-licer equipped vessels.

As shown in Figure 3, warm water temperatures experienced during the 2019 winter kept sea lice numbers higher than usual on most farms however temperatures were too low to treat until the end middle of April. The traditional strategic spring treatment began at the end of April using warm water, hydro-licer or Aquaparox 50.

It was early July 2020 when the water temperatures increased above 10 degrees Celsius and once the temperature did increase it again held for an extended period, into late November, contributing to prolonged presence of sea lice populations through December.

In 2020, on a per 100m cage basis, only 22.7% of treatments for sea lice used either salmosan or hydrogen peroxide.

[4] ftp://ftp.fao.org/FI/STAT/summary/a1a.pdf
[5] http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/lobster-homard-eng.htm

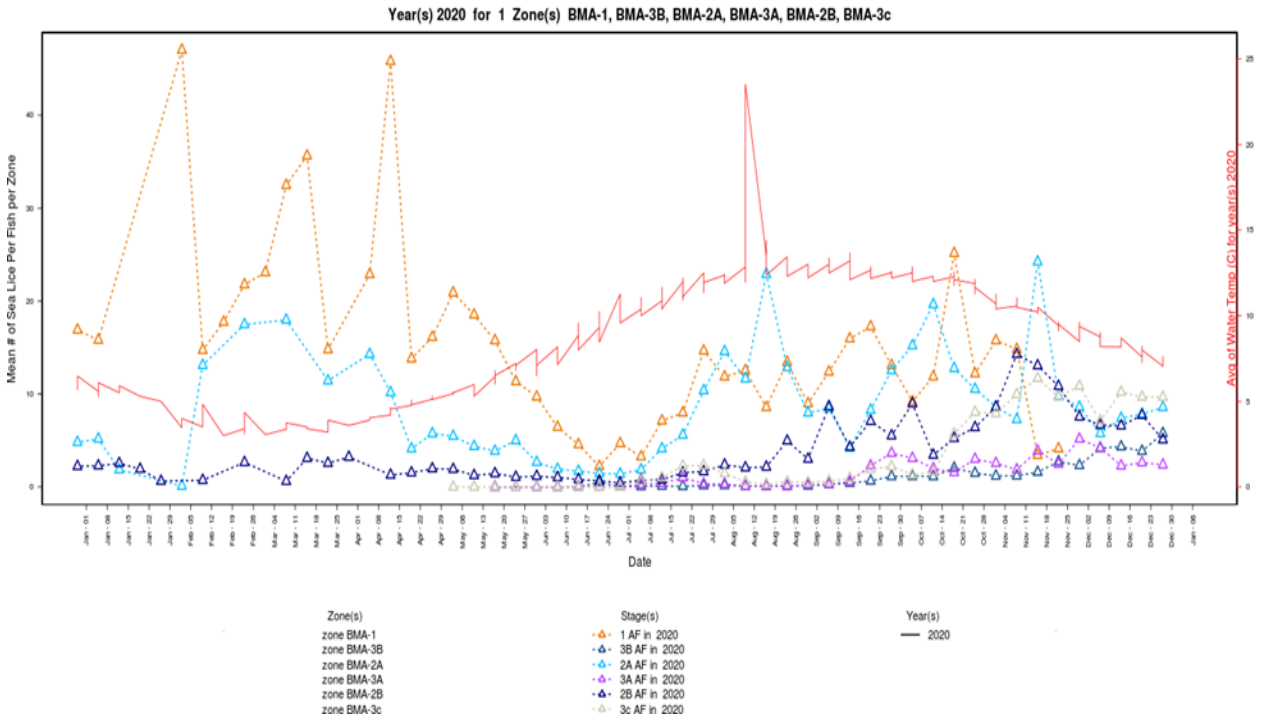


Figure 3: Average adult female Lepeoptherius salmonis sea lice per BMA and average water temperature for 2020

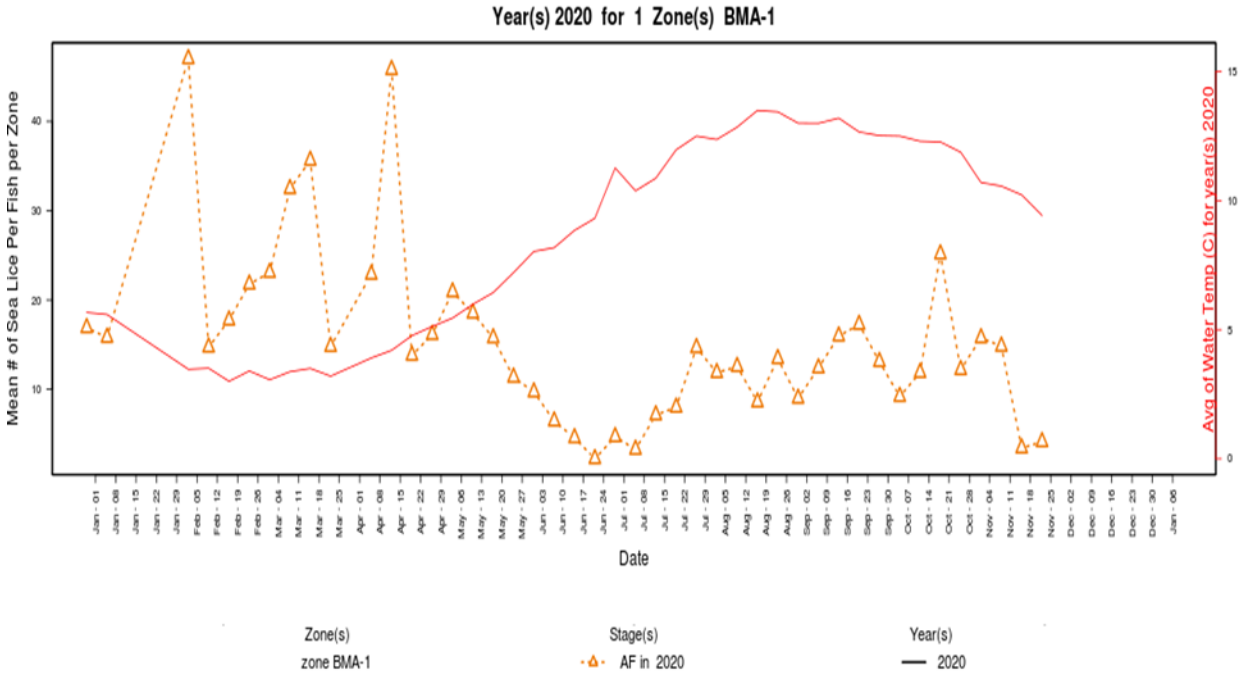
2020 ANALYSIS BY BAY MANAGEMENT AREA

The following data charts are generated from the Fish-iTrends data base system developed in 2009 through collaboration with the Atlantic Veterinary College at the University of PEI. Fish-iTrends supports sea lice management for the Atlantic salmon farming industry.

Charts for each Bay Management Area contain the average count, by month, for adult female *Lepeoptherius salmonis* sea lice and the average water temperaure. These lice are considered the most critical to the management of sea lice populations within a salmon farm. Information specific to the management area is provided below.

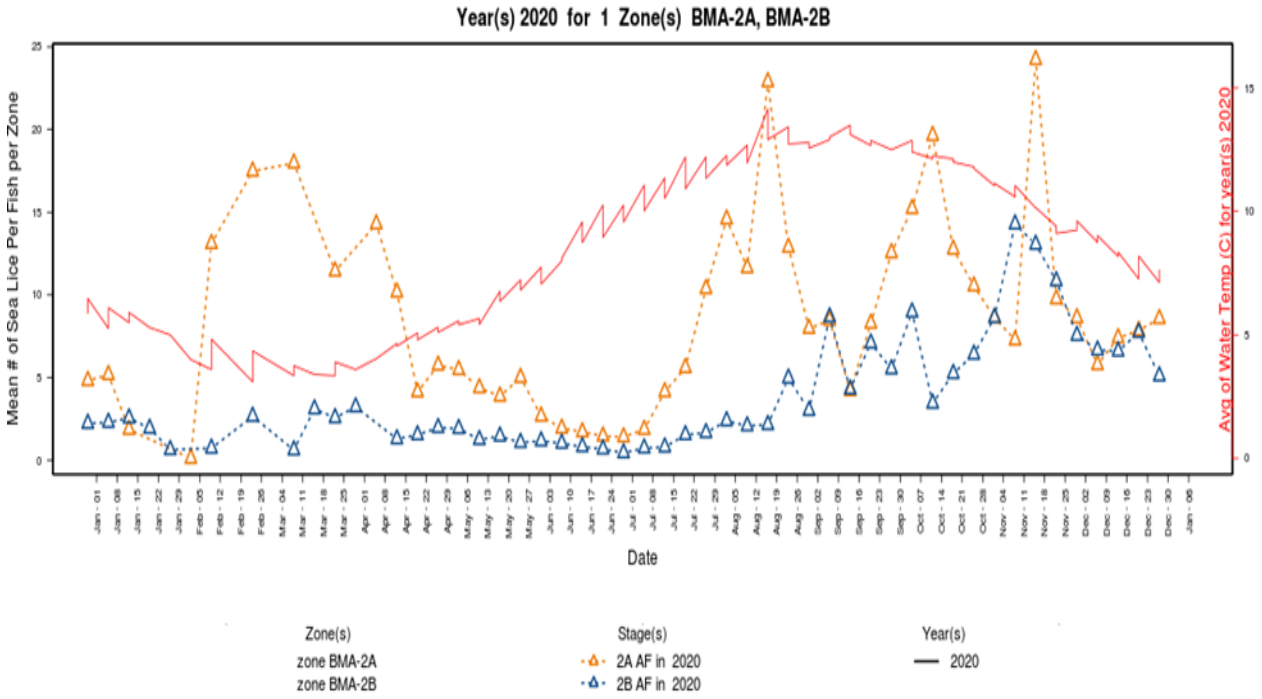
Note the Y-axis scale (numbers of lice) varies from one graph to another.

BMA 1 – 2020 Analysis

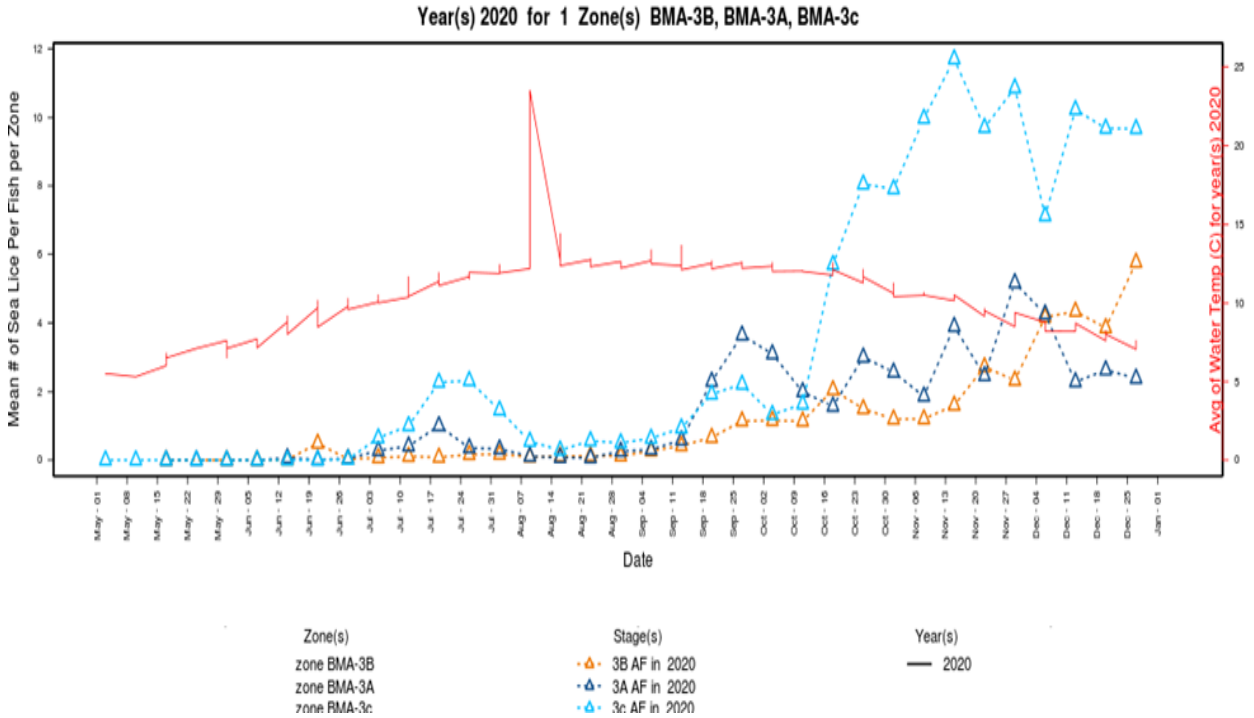


BMA 1 was stocked in 2018 so sites were being harvested. Treatments in April / May were with hydrogen peroxide product. All subsequent treatments (4) were with Salmosan.

BMA 2a, 2b – 2020 Analysis



BMA 2a and 2b were stocked in 2019. Treatments started in early April with hydrogen peroxide product. After mid May subsequent treatments (15) to early October were with Salmosan. Hydrogen peroxide was used again for three treatments in December.



BMA 3a, 3b and 3c were stocked with smolt in Spring 2020. Bath treatments (15) with hydrogen peroxide product or Salmosan occurred in July, September, October and December in 3c and one in 3a. Infeeds are primarily used with smolt. There were no bath treatments in 3b.

2015- 2020 TREND ANALYSIS

The following graph provides data on the mean number of adult female sea lice in New Brunswick since 2015.

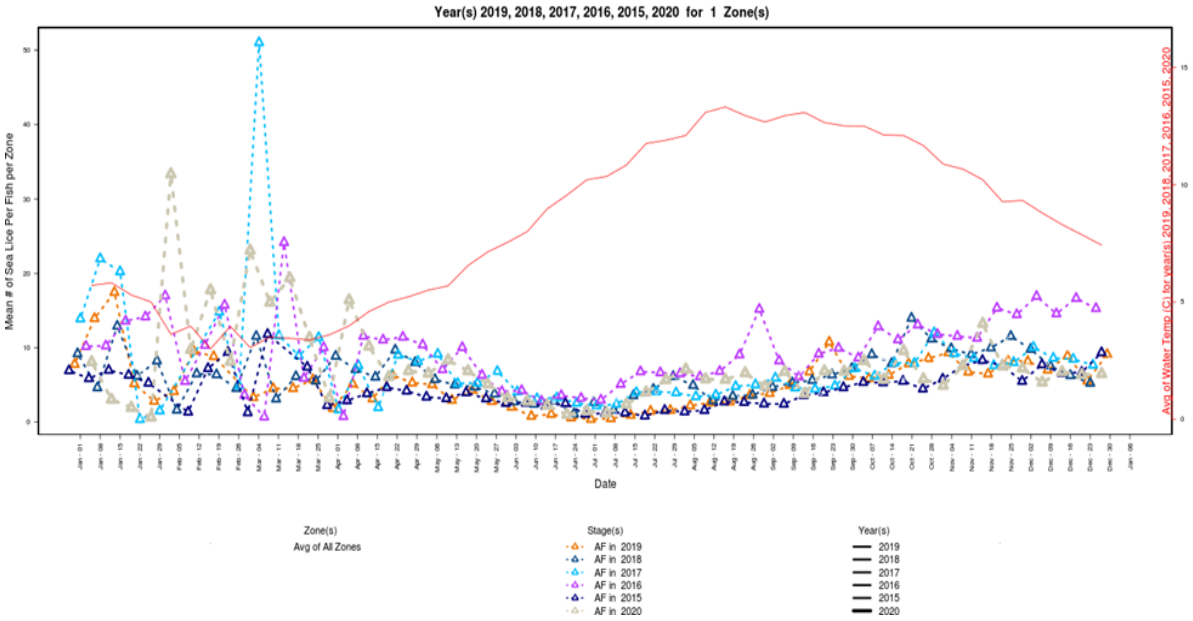


Figure 4: Average number of adult female *Lepeoptherius salmonis* sea lice per BMA from 2015-2020

SUMMARY AND RECOMMENDATIONS

This report shows the industry has been effective overall in mitigating the impacts of sea lice populuations, uncontrollable climate change effects (e.g., prolonged warm waters), continue to make this challenging. There is a recognized ongoing need to access more proactive tools to ensure the industry can continue to have a minimal environmental footprint.

These tools can only be developed through continued research that supports the development of more non-chemical management options such as the use of cleaner fish, warm water showers and sea lice retention filters. Research and monitoring is also critical to the approvals of new sea lice medicines and vaccines.

Additionally, sea lice inhibitors in new feed formulations and vaccines offer great promise but require regulatory changes to access new feed ingredients. While the use of medicines and therapeutants is not necessarily the first or only option evaluated to treat for sea lice, access to a range of products available and approved for use in other countries that are exported to Canadian consumers, must also be supported domestically.

The access to a more full suite of tools would alter the graphs and ensure fewer and smaller peaks in lice number by having access to a variety of products with less ecological impacts. Incorporated in an operational integrated pest management plan, this would increase production with fewer fish losses which would relate to increased socio-economic benefits in coastal communities through the Atlantic region.

As a final point, the ACFFA will continue to promote new research and the adoption of a Minor Use Minor Species program for fish health and feed products. We are hopeful that a new federal regulatory and policy framework for aquaculture will be more effective to enable the salmon farming industry to adopt new research, technology and other innovations in a timelier manner.

This is not only critical to fish health management but also to our communities and consumers who rely on Canada's salmon farming industry, to remain viable and competitive.

APPENDIX A

Aquaculture Bay Management Areas of New Brunswick