2016
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 Canadian salmon farming industry. This system is maintained by the AVC who has acted as a third-party monitor of data submissions by salmon farmers. Provincial fish health personnel have ongoing access to this data; AVC 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 ACFFA supported the AVC in the development of a sea lice monitoring certification program for farm technicians. This ensures 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 and support breaking 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, from transferring it to incoming smolts.

In 2016 salmon farming companies continued to develop a coordinated sea lice management and treatment strategy that included maintaining lice thresholds in each Bay Management Area, product rotations and synchronized treatment strategies. Like all farmers, they rely 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. Sea lice treatments are authorized through a veterinarian's prescription. All treatments are reported to federal and provincial regulators.

Water temperatures and salinity play 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 2016 in southwest New Brunswick rose through the summer and remained unseasonably high all through December. These temperatures held for an extended period contributing to increased lice populations. The

industry continued to witness higher water temperature trends with the average water temperatures in this area in December 2016 over 8 degrees Celsius.

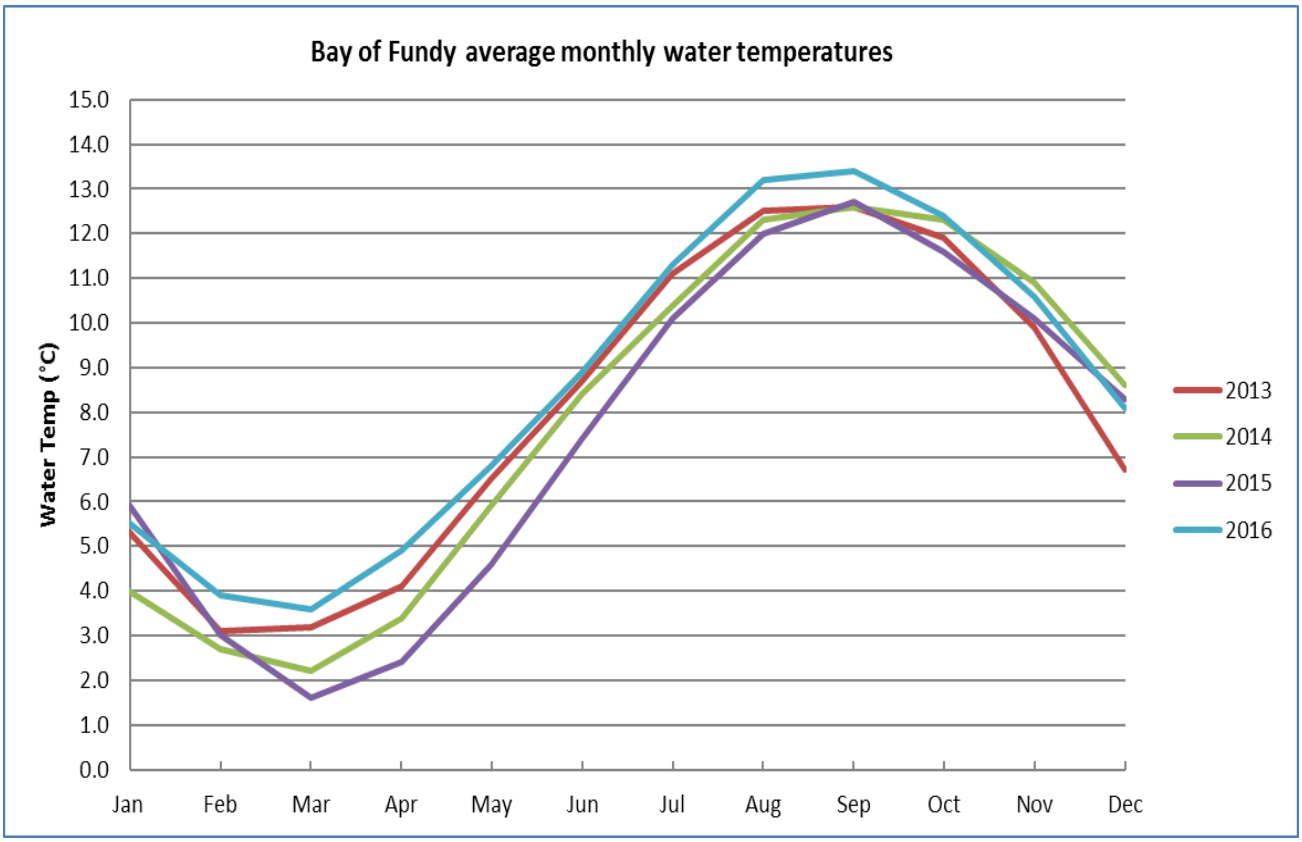


Figure 1*: Average monthly water temperatures for 2013-2016*

This report on sea lice management for 2016 is based on the 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 carried by wild salmon or other fish in the surrounding water. Since this parasite cannot be eliminated from wild salmon, salmon farmers have developed management practices that reduce the likelihood of infection[1].

These practices include:

- Selecting farm sites with good flushing and water current
- Production sites are emptied of all farmed fish for periods of time (fallowed). Without a host, the sea lice population declines

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

- Only farmed salmon from a single year are present at each farm site – this prevents older farmed salmon (who may have received the parasite from the wild salmon) from transferring it to incoming smolts
- Employing bay management systems where hydrographic conditions severely reduce the possibility of year-class carry-over
- The effectiveness of these management practices is supported by many scientific studies that suggest that salmon farms have little impact on the sea lice levels that naturally occur on wild salmon.

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 maturity weeks to reach the female adult stage by 60% (Figure 2).

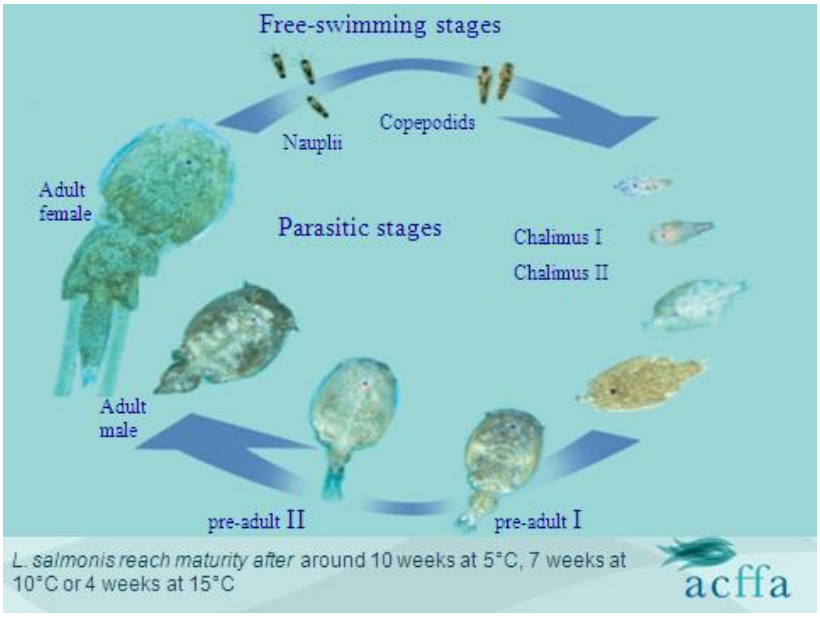


Figure 2: Maturity stages of *L. salmonis*

Therefore, salmon farmers have 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 chemo-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 difficult. 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 up to a decade. 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 and factors such salinity and water temperature.

Scientific 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 – and thereby protects the young salmon from illness or death due to sea lice infection. Feed formulations have been developed, many using natural ingredients that can inhibit sea lice from attaching to farmed salmon or boost the salmon's immune system. These feeds are being used in Norway and in the EU. It is of consumer interest to note that while humans can consume some of these feed ingredients and fish that have been fed these ingredients are being imported for sale in Canada, they are not permitted for direct use in Canada. Yet, after nearly six years, the Canadian Food Inspection Agency has not amended their list of approved ingredients for feed products.

In addition to issues affecting access to treatment options or functional feeds, records maintained by salmon farmers show that water temperatures in New Brunswick waters continue to increase. We began to see a trend of increases by 2 degrees centigrade above historical levels in 2009; this trend continued in 2010, in 2012, 2014 and again in 2015. We are seeing these record high water temperatures maintained for longer periods and later in the year than we have seen in the past.

Traditionally, sea lice populations on salmon farms can be very low January through to June and to ensure that low sea lice abundance is maintained, strategic spring treatments begin in April / May where required using Interox Paramove®50 (hydrogen peroxide). This ensures that any wild salmon leaving rivers are not at risk due to sea lice from salmon farms. Farmers are able to maintain stable low lice populations throughout the summer allowing the number of gravid females to increase marginally only on those farms to be harvested. When water temperatures cool, farmers will again do a strategic final treatment to reduce lice prior to winter.

CURRENT 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
3. Organophosphates: Salmosan
4. Pyrethroids: AlphaMax, Excis
5. Hydrogen Peroxide: Interox Paramove 50

These products have been available for many years in other jurisdictions including Norway, the UK and Chile. In the USA, Maine has used Excis, Avermectins and Interox Paramove 50 under an Investigational New Animal Drug (INAD) permitting process. Extensive international research is available to provide data to support Canadian risk assessments through Health Canada, in support of Emergency Drug Releases (EDRs) or Emergency Registrations (ERs) pending local monitoring and surveillance data collection to support full registrations of the products. Local scientific

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

research and monitoring and surveillance are being carried out to support Canadian product registrations. However, scientific permits, EDRs and/or ERs must be granted to enable this field work to be conducted.

An Overview of Canadian Options

Health Canadas' Pest Management Regulatory Agency (PMRA)[3], responsible for authorizing the use of bath treatment products through an Emergency Registration, only does so for periods of up to one year. This process must be repeated annually pending full registration of the product in Canada – which requires scientific research and monitoring to support the application. It can take several years for a pharmaceutical company to gain full license approvals for their products in Canada.

All products, listed below, are only available through a prescription by a veterinarian. Use of all these products is reported to both federal and provincial regulators.

1. Salmosan®

Salmosan® was previously registered and administered on New Brunswick farms in the 1990s and the registration lapsed when SLICE® was introduced. The Province received an ER for Salmosan® in November 2009. This permit was subject to scientific monitoring, and this 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)

An ER permitting the use of Salmosan® through well boat treatments was granted in August 2010. However in 2010, PMRA imposed a limit of 2800 grams per day of Salmosan®; allowing the treatment of approximately two net pens per day, depending on cage size, at a farm site. This restriction meant that on-farm sea lice could not be quickly eliminated and additional treatments were required. This product use restriction was eventually changed to limit the number of treatments completed per day but to avoid the risk of tolerance developing, the farming industry avoided product use in 2011 and again in 2012. The ER approval granted for product use June 2013 to June 2014 was again changed to reflect data provided by the ACFFA and the Province removing the limit on the number of cages that can be treated per day. The current (2016-2017) restriction for tarp treatments is on the number of net pens that can be treated simultaneously on one site. For well boat treatments, a maximum of three net pens can be completed per day per farm.

Pending full license approval of Salmosan®, yearly applications for access to this product must be submitted to PMRA. Due to the timing of the approval (November 4, 2010) and conditions that had to be met prior to use, many salmon farms did not have sea lice treatment product available for several weeks at a time when water temperatures remained high and new generations of sea lice were developing. This resulted in a significant increase in sea lice populations and impact to farm fish health that was beyond the control of the salmon farmer and is another example of where regulatory bottle-necks impact IPMP for sea lice.

Full product registration of Salmosan® is in progress with PMRA and was expected to be complete in 2016. However, the process has been delayed and a 2017 completion is now anticipated.

2. Interox Paramove®50

Interox Paramove®50 is a hydrogen peroxide product, benign in the environment, degrading quickly to water and oxygen. Approval for use of this product through an ER was received June 11, 2010 and the first application occurred on June 26, 2010. By that time water temperatures in the area with the highest sea lice counts were already 14 + degrees – well above the recommended high of 12 degrees.

[3] http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php

Like Salmosan®, new applications for use were submitted annually. Over time, the salmon farming industry has developed protocols to enable the use of this product with minimal negative impact to our farm stock using a lower dose and at temperatures above 12 degrees, but this also means reduced efficacy.

Full product registration of Interox Paramove®50 with PMRA occurred in March 2015.

3. Avermectins

Avermectins such as SLICE® and Ivermectin **MAY** be used as an in-feed sea lice treatment under a veterinary prescription, licensed through Health Canada's Veterinary Drug Directorate[4]. 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.

4. Calicide®

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

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 resources investment since 2010 to support research critical to improving knowledge and understanding of sea lice dynamics and management.

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

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 DFO websites. Interim research data from private and academic research is often available at these workshops and published as part of workshop proceedings.

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

- ✓ The Fish-iTrends Decision Support System operated by the University of Prince Edward Island, 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;
- ✓ A certification program has been established for sea lice monitors to ensure accurate sea lice data are reported from farm sites; and
- ✓ Well boats and tarpaulins have been 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

Local research is continuing. Projects underway include:

- ✓ Evaluation on the use of cunner and lump fish as a sea lice cleaner fish;
- ✓ Implementation and adjustment of alterative lice removal technologies (e.g., freshwater and laser); and
- ✓ Ongoing hydrological surveys to determine possible refinements to the current Aquaculture Bay Management Areas.

NON-TARGET SPECIES

Wild salmon populations in Atlantic Canada fluctuate in a similar manner in areas both 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. Data from the St. George fishway monitoring reports issued each fall indicate most returning fish have no sea lice, with rare reports of more than five sea lice per fish http://www.asf.ca/main.html.

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.

Federal and provincial researchers have reported the data from research conducted by Fisheries and Oceans Canada and the NB Department of Agriculture Aquaculture and Fisheries publicly. Data was shared with fishery and conservation organizations at a variety of meetings attended by the ACFFA, by DFO and by NBDAAF and are available on the ACFFA website: www.atlanticfishfarmers.com.

There have been no significant changes in the landings for the traditional fishing sector since 2007[5] while lobster landings have steadily increased since 1999[6].
To view fishery data visit http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm

[5] ftp://ftp.fao.org/FI/STAT/summary/a1a.pdf

[6] http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/lobster-homard-eng.htm

SEA LICE MANAGEMENT ON FARMED SALMON 2016

In 2016, Avermectins were used in-feed with Salmosan® and Interox Paramove®50 used in closed treatment systems.

Full registration evaluation of Salmosan® continues with Health Canada's Pest Management Regulatory Agency. Full registration for this product is expected in 2017 but will be available through the current Emergency Registration approval until June 21, 2017.

Salmon farming companies continue to prepare a coordinated sea lice management and treatment strategy that includes maintaining lice thresholds in each Bay Management Area, product rotations and synchronized treatments. This strategy is communicated to traditional fishing groups and a meeting was held to provide details on an area-by-area basis.

With the extended warm water temperatures experienced in 2016 sea lice bath treatments continued until the end of January. As shown in Figure 3, low water temperatures experienced after this time kept sea lice numbers relatively low on most farms until mid-April leading into the traditional strategic spring treatment using Interox Paramove®50.

Although it was mid- July 2016 before the water temperatures increased above 10 degrees Celsius, once temperatures did increase, they again held for an extended period contributing to sea lice populations into late December.

Interox was used for early lice control but Salmosan® in full tarps began to be used on some farms in mid-May and its use continued into the Fall and early Winter due to the unseasonably high water temperatures.

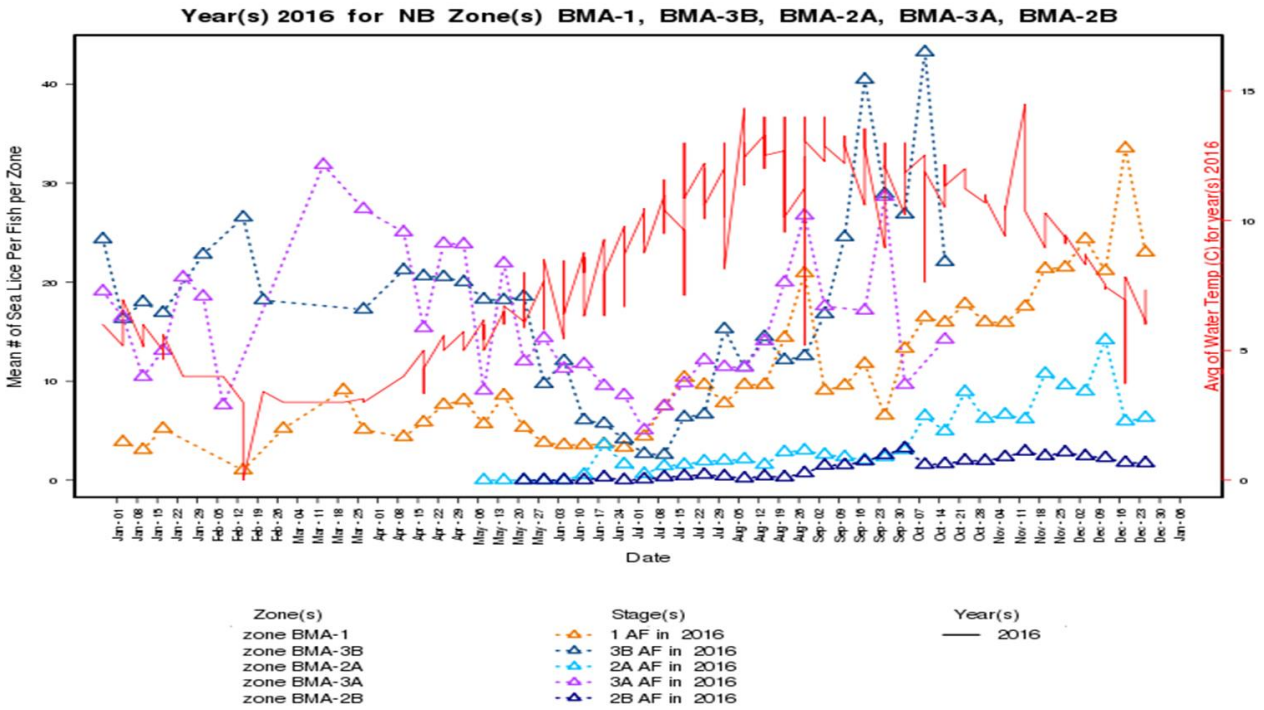


Figure 3: Average adult female *Lepeoptherius salmonis* sea lice per BMA and average water temperature for 2016

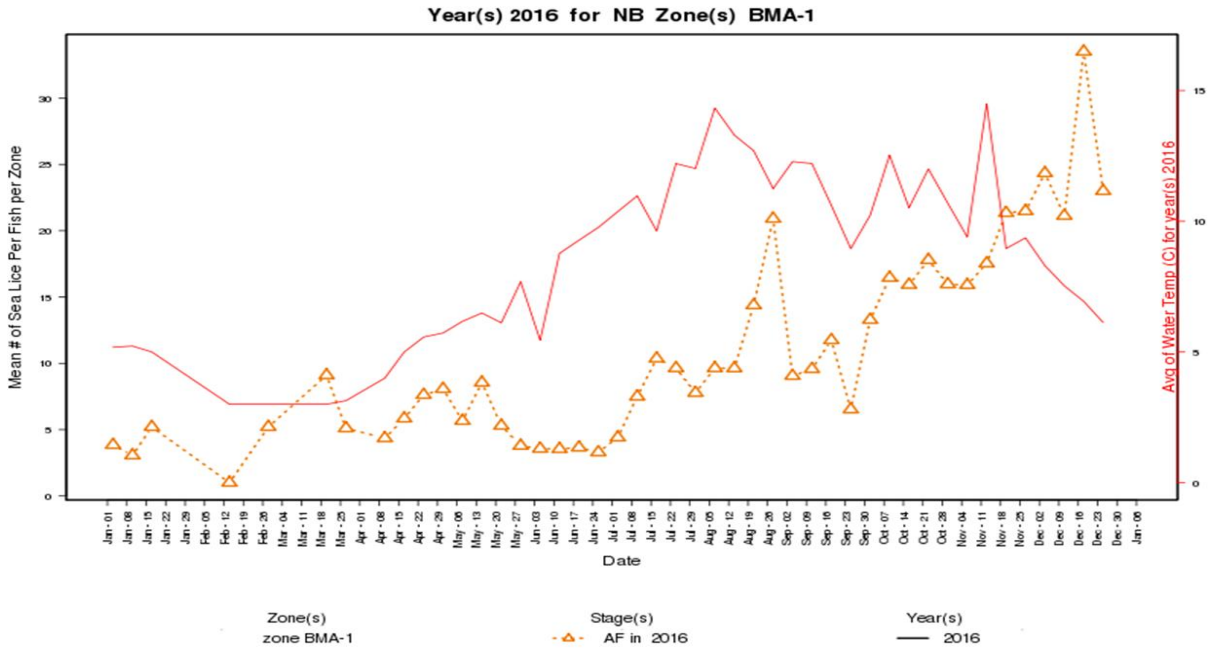
2016 ANALYSIS BY BAY MANAGEMENT AREA

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 by the Atlantic salmon farming industry.

Charts for each Bay Management Area contain the average count, by month, for adult female *Lepeoptherius* salmonis sea lice. 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.

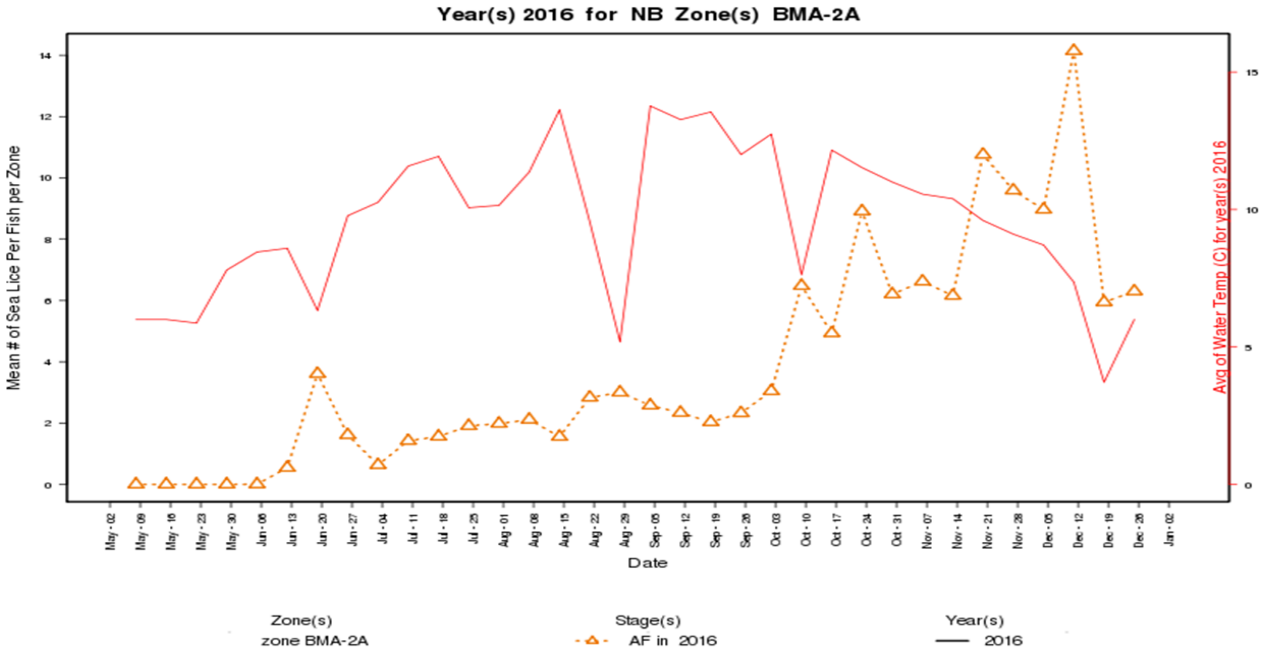
Note that the Y-axis scale (numbers of lice) varies from one graph to another.

BMA 1 - 2016 Analysis



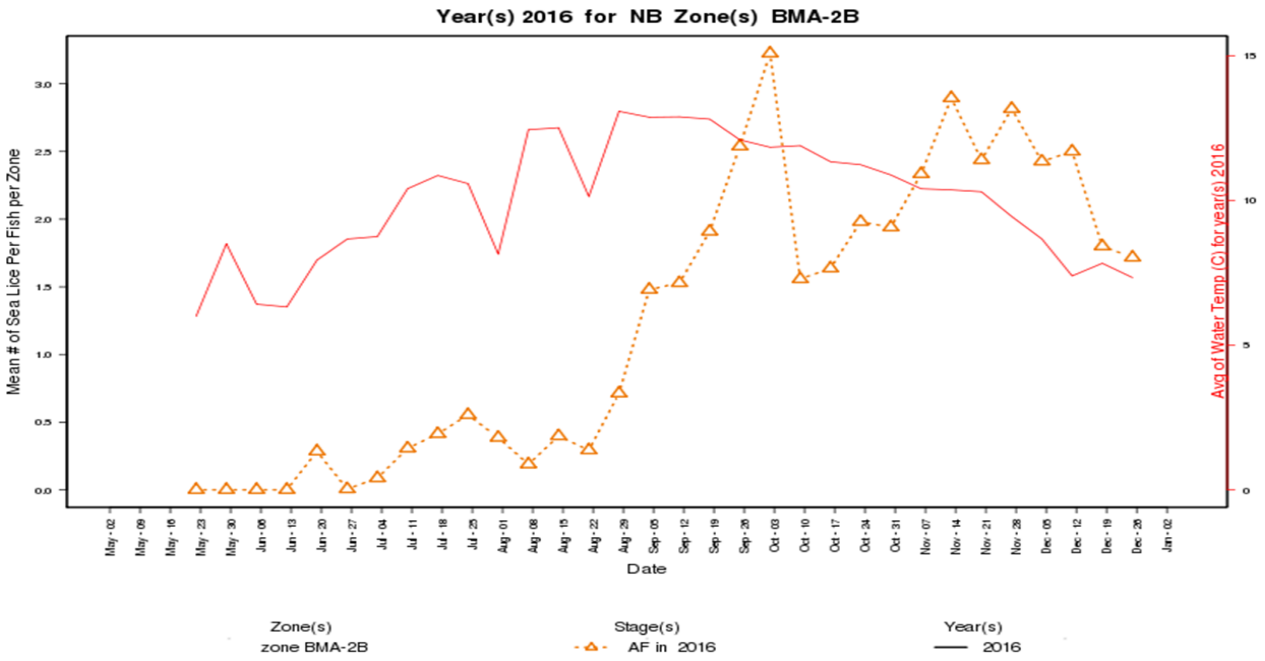
2016 *–Second year salmon with harvesting of spring stocked sites. Sea lice bath treatments started in late April and continued to the end of December. Interox and Salmosan were both used.*

BMA 2A - 2016 Analysis



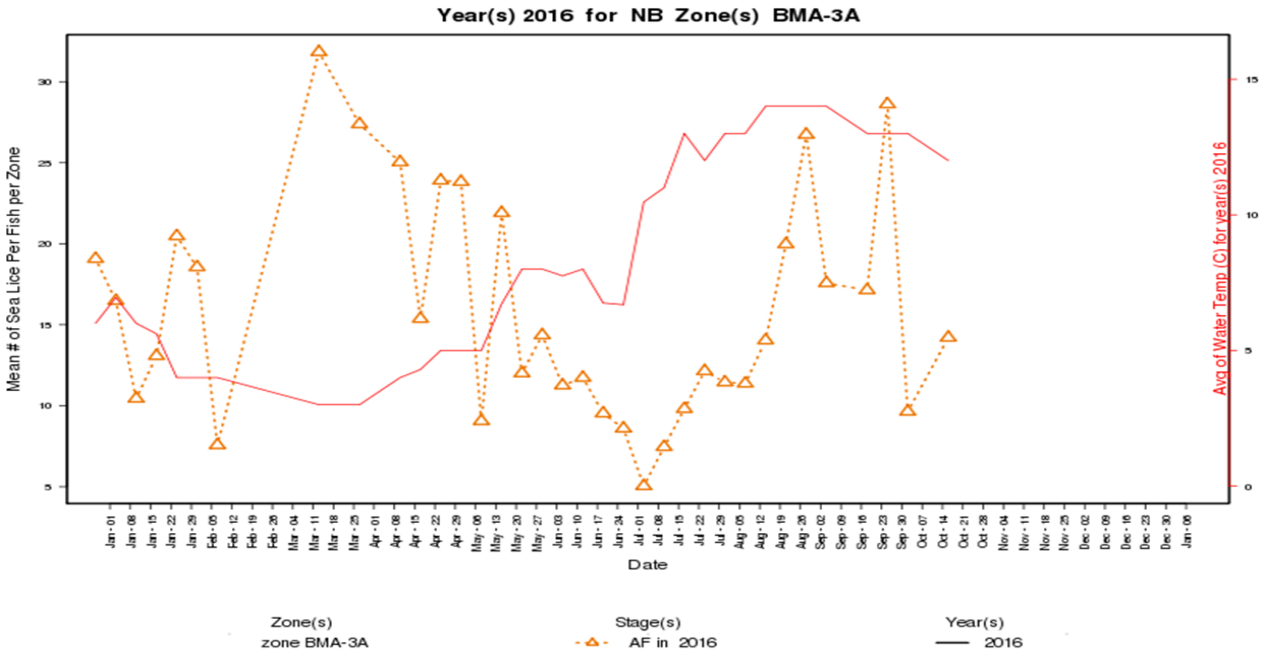
2016 – Stocking of smolts began in mid- April 2016. *Initial sea lice treatments were through in-feed products with bath treatments starting in mid-June. Bath treatments continued to end of December using primarily Salmosan.*

BMA 2B - 2016 Analysis



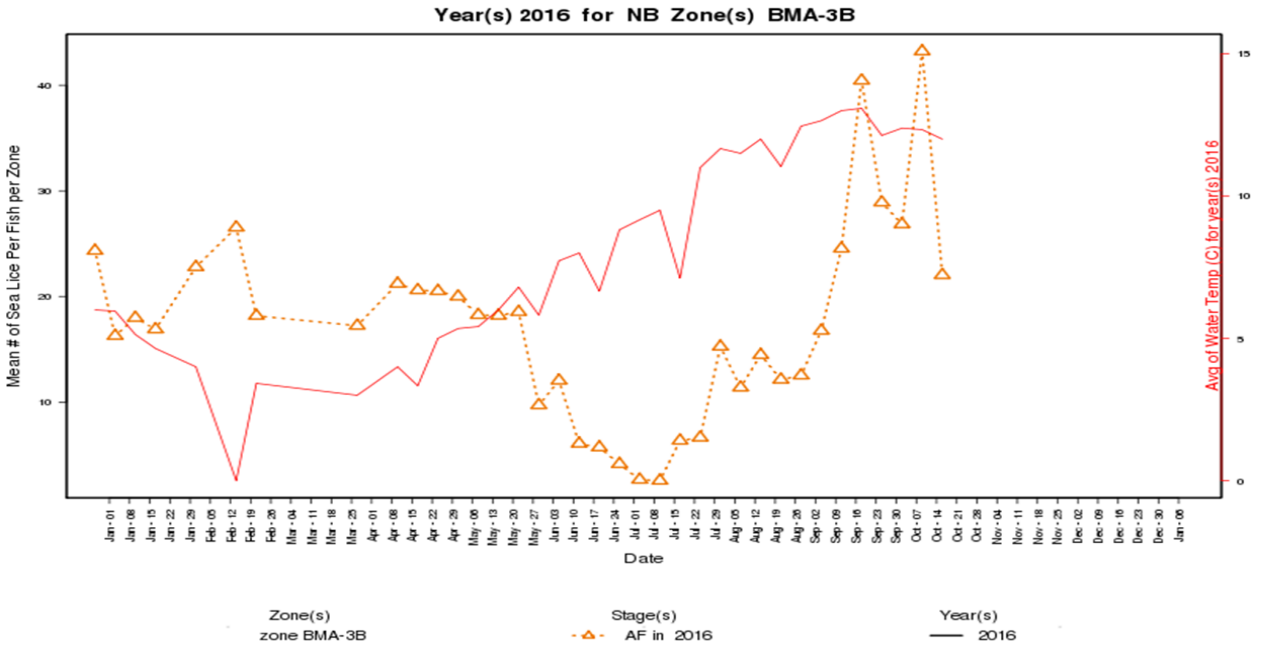
2016– Stocking of smolts began in mid- April 2016. *Initial sea lice treatments were through in-feed products. Two bath treatment occurred in October, one with Salmosan and one with Interox*

BMA 3A - 2016 Analysis



2016 *– These fish were stocked in 2014 so harvesting on the few remaining sites continued into October. Spring bath treatments started in April and were completed in September, using primarily Salmosan.*

BMA 3B - 2016Analysis



2016 *– These fish were stocked in 2014 so harvesting on the few remaining sites continued into October. Spring bath treatments started at the end of May and were completed in September, all using Salmosan.*

2010- 2016 TEMPERATURE TREND ANALYSIS

The following graph provides data on the mean number of adult female sea lice in New Brunswick since 2011.

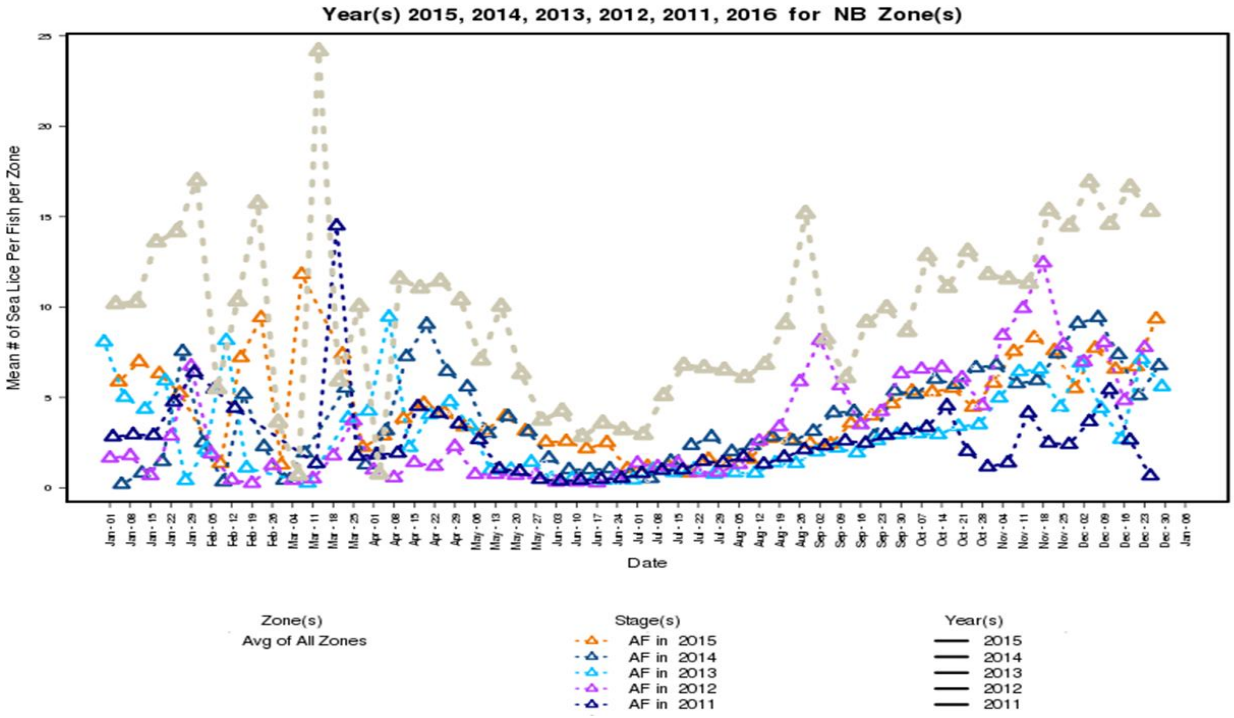


Figure 4: Average number of adult female *Lepeoptherius salmonis* sea lice per BMA from 2011-2016

SUMMARY AND RECOMMENDATIONS

There is no doubt that although this report shows the industry has been generally effective in mitigating the impacts of sea lice populuations, uncontrollable climate change effects, continue to make this increasingly challenging. There is a critical need to access more effective proactive tools to ensure the industry can continue to minimize its footprint on the environment.

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

Additionally, sea lice inhibitors in new feed formulations offer great promise but require regulatory changes to access new feed ingredients. While the use of medicines and therapeutants is a last resort action, 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 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 which is a key component of an Aquaculture Act in Canada, now being framed under the leadership of the Minister of Fisheries and Oceans in collaboration with the provincial regulatory agencies. We are hopeful that Canada's 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, consumers ensuring Canada's salmon farming industry and our individual companies remain competitive.

APPENDIX A

Aquaculture Bay Management Areas of New Brunswick