

# Sea Lice Management Strategy 2007/2008

## Background

The Ministry of Agriculture and Lands regularly reviews the provincial Sea Lice Management Strategy (The Strategy). It is considered a living document and the review process follows a Ministry approach of continuous evidence-based improvement as substantive new information comes to light.

Research funded by Pacific Salmon Forum and numerous years of lice abundance data on farmed salmon collected and reported by British Columbia Salmon Farmers Association (BCSFA, validated through the provincial Sea Lice Monitoring and Audit Program), has increased our understanding of interactions between aquaculture and the ecosystem in which it functions.

The Ministry's objectives and the proposed amendments are provided in this strategy which outlines aspects of common concern related to sea lice, the ecosystem and the protection of salmon, wild and farmed.

In general, six fundamental observations have guided the 2007/2008 approach to sea lice management in BC:

1. Monitoring and reporting compliance by industry remains high. Further, industry continues to work cooperatively with the Ministry in terms of mitigating potential effects and elevating our knowledge.
2. The abundance of sea lice on farmed salmon has remained low and has continued to trend downward since 2005.
3. There is no evidence of substantial recruitment (from within the farm) onto farmed salmon for 6 to 7 months following medication of the farmed fish, despite a drug withdrawal period of weeks.
4. The strategic use of in-feed emamectin benzoate<sup>1</sup> is, on average, used fewer than two times per finfish grow out cycle in BC, and there has been a steady decline in the drug's overall annual use since 2005.
5. Predictive mathematical models suggest *an association* between the presence of sea lice in wild and farmed salmon yet, to date, *a cause and effect* relationship between the abundance of lice on farmed fish and the abundance on out-migrating wild fry remains under investigation.
6. The effect of Pacific Ocean sea lice on salmon in BC is minimal compared to the consistent severe damage caused by Atlantic Ocean sea lice in farms of the

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<sup>1</sup> Information on emamectin benzoate can be found at the following web location <http://www.cahs-bc.ca/SliceFactSheetMar2007.pdf.pdf> and at [http://www.al.gov.bc.ca/ahc/fish\\_health/sealice.htm](http://www.al.gov.bc.ca/ahc/fish_health/sealice.htm)

Atlantic Ocean. Recent genetic research by Yazawa et al. (2008<sup>2</sup>) shows that the Pacific *L. salmonis* louse is genetically distinct from the Atlantic Ocean louse and the Pacific louse has evolved independently for a number of million years. These data are suggestive (though not conclusive) of an Atlantic Ocean origin of Pacific sea lice. This is a pivotal discovery in that the independent evolutionary history may explain the marked differences in louse virulence and pathology in salmon of the Atlantic Ocean regions compared to farmed and wild salmon in British Columbia.

Mandatory sea lice monitoring and reporting has occurred and will continue on Atlantic salmon farms in 2007/2008. All salmon farming companies have a Fish Health Management Plan (FHMP) as a condition of licence. Inclusion of the sea lice management strategy into the FHMP marked a conscious policy decision to move towards integrated pest management for on-farm sea lice control in BC, and enhanced the reporting requirements of the FHMP.

The on-farm lice assessment is based on internationally accepted protocols for sea lice monitoring. Lice monitoring conducted on Atlantic salmon farms provides information for assessment of the integrated pest management approach. The program generates information to assess: trends in lice abundance; the management of sea lice on farmed salmon; and the association with Fisheries and Oceans Canada (DFO) data on wild stock measurements as these data become available.

Industry will be required to continue monthly monitoring and reporting of lice abundance on Atlantic salmon farms within coastal sub-zones. Currently, industry reports its findings to a third-party private database and the Ministry is encouraging industry to adopt and implement a farm-by-farm web-based reporting structure as is practiced by some BC producers. The occurrence of sea lice on farmed and wild salmon is natural and an elevated transparency of these local data is likely to be embraced by all observers.

Lice abundance information from the salmon farms is evaluated along with environmental information to support integrated area management of farmed fish lice populations during wild stock out-migration (i.e. March 01 to July 01).

The BC Pacific Salmon Forum and the Fish Health Management Advisory Committee, along with veterinarians responsible for the management of aquaculture stocks, will continue to work together to evaluate the information collected and the effectiveness of the control measures taken. Members of these groups also cooperate with representatives of DFO to integrate wild fish information as it becomes available. DFO continues its research into sea lice on wild fish populations of the BC coast.

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<sup>2</sup> Yazawa et al.: [Mar Biotechnol \(NY\)](#). 2008 Nov-Dec;10(6):741-9. [Epub 2008 Jun 24](#).

## Monitoring and Reporting by Industry

All Atlantic salmon producers must monitor sea lice abundance a minimum of once each month. During any time of the year, if the average motile lice levels reach three (3) lice per fish an action must be taken. Lice management actions may include:

- Monitoring more frequently (i.e. increase farm counts to twice per month);
- Harvest the most affected fish to reduce the abundance of lice at the farm;
- Therapeutic management of the lice infestation; or
- Applying other farm husbandry techniques to reduce the abundance of lice.

However, from March 01 to July 01 (i.e. the spring out-migration period of juvenile salmon) producers and veterinarians accept that action options become focused toward: therapeutic management or the harvest / removal of the affected fish (i.e. with the objective to reduce the abundance of lice at the farm with practical urgency). This may occur by selecting some cages for medication and other non-medicated cages for immediate harvest.

The industry's lice count data are aggregated to the coastal sub-zone level and are provided to government monthly for display on the BCMAL [Fish Health website](#).

## Monitoring and Audit by BCMAL

The Animal Health Branch of BCMAL conducts numerous sea lice audits of salmon farms. On a quarterly basis the provincial database randomly selects 25% of the active farms for audit, and 50% of the active farms during the wild smolt out-migration period (Q2). During calendar quarter two (Q2), the BCMAL audits occur in addition to routine monitoring by the farm personnel and do not substitute the requirement of the farm to conduct its own abundance count. In other words, in April, May and June 50% of the active farms assess their fish for lice twice each month; once on their own and once with BCMAL personnel.

The objective of the FHMPs and the provincial audit program is to validate the estimates of lice abundance on farmed fish in the sub-zones and to verify the accuracy of lice assessments conducted by farming personnel. The assessments performed by provincial biologists serve as a sub-sample validation of the industry data.

There are two circumstances in which the monitoring program is modified to suit specific conditions:

1) BCMAL does not currently require Pacific salmon producers to routinely count and report lice abundance on farmed Pacific salmon. Initial monitoring and audit assessments in 2003 and 2004 corroborated scientific information that farmed Pacific salmon harbour very few lice (see [Fish Health Report 2003-2005](#)); however, producers continue to observe the Pacific salmon for sea lice during opportune handling events and those observations must be available for review to BCMAL fish health staff upon request.

2) The Sechelt area, coastal sub-zone 3.1, is also currently and conditionally exempt from routine lice monitoring and reporting. Historically, the Atlantic salmon raised in this region harboured so few lice (see Fish Health Reports 2003-2005 and [2006](#)) that the handling of fish alone was deemed more harmful than useful. Consequently, in 2006 this area was granted a reprieve from routine sea lice counts. Rather, a requirement of 'opportunity counts' (eg. during weight sampling or sorting) remains in place. Audit assessments by BCMAL biologists continue as part of the random farm selection procedure. The routine monitoring requirement of farms in this sub-zone is continually reviewed. It is this type of continual consideration of sea lice data from wild and farmed fish stocks that can lead to intermittent refinement of the lice control strategies in various coastal sub-zones.

Further detail of the provincial audit and monitoring procedure is included below as [Appendix 1](#).

## Comparison of Action Levels in Other Countries

The BC policy of more conservative action levels is precautionary; the principle followed when management is evidence-based and gaps in knowledge require further investigation. In comparing lice management standards with other countries, BC has more stringent action levels than most other farming areas. In addition, the monitoring and reporting of sea lice by BC farmers is stipulated within the company's FHMP; in other words, it is a mandatory condition of licence.

Country	Time of Year	Trigger Level	Action
Norway (2008)	Dec 1 – Jul 1	0.5 adult females; 3 motile lice	Treatment required
Scotland		No trigger level known	Area Management
Ireland	Mar 1 – May 1	0.3 - 0.5 egg-producing (gravid) adult females per fish	Treatment required
	May 1 – Mar 1	2 egg-producing (gravid) adult female lice per fish	
Chile		No trigger level known	
BC Canada	Mar 1- Jul 1	3 motile lice per fish*	Treatment / Harvest
	Jul 1 – Mar 1		Elevate monitoring, treatment or harvest

\* An analysis of BCMAL data (Quarter 2 of 2006, 2007, 2008) indicates that an abundance of zero to three motile lice per fish includes (on average) fewer than 0.25 gravid females per fish in that same season, March to July.

## Information Sharing Between Companies

It is common for discussions of sea lice management to occur between companies sharing the same sub-zone or bay area. Where multiple companies are found within a defined area, management actions, particularly treatments, are often coordinated to achieve maximum efficacy and to reduce any potential risk of lice recruitment from adjacent farms. The companies that have farms in the Broughton region work together to ensure that sea lice management actions are coordinated as much as possible.

## Research Activities 2007 - 2008

Attempts to address unanswered questions and concerns about possible relationships between lice and wild fry populations in BC are largely represented in the numerous research projects listed below. This ongoing work involves various stakeholder groups – some independent of one another, and others working in collaboration. The BC Pacific Salmon Forum (PSF) 2007-2008 annual report and a more recent 2008 PSF update workshop reflect the following lice-related projects / papers that influence the Ministry's 2008 Strategy:

### PSF 2007-2008 Annual Report:

1. ***Marine monitoring of juvenile pink and chum salmon and sea lice in the Broughton and Knight Inlet.***
2. ***Behavioural interactions of sea lice, three-spine sticklebacks and juvenile pink salmon.***
3. ***Estimating sea lice transmission from farm to wild juvenile salmon.***
4. ***Abundance of planktonic sea lice in Knight Inlet and Tribune Channel.***
5. ***Equipment development to determine the vertical distribution of *L. salmonis* planktonic larvae.***
6. ***Effects of sea lice on the physiology and health of pink salmon.***
7. ***Survival and predation experiments.***
8. ***Pink and chum population dynamics in the Broughton.***
9. ***Discovery Passage planktonic monitoring and juvenile salmon assessment 2007.***

### Recent scientific publications:

10. ***Experimental infections with *Lepeophtheirus salmonis* (Krøyer) on threespine sticklebacks, *Gasterosteus aculeatus* L., and juvenile Pacific salmon, *Oncorhynchus* spp - S. Jones et al., 2006***
11. ***Evaluation of sea lice abundance levels on farmed Atlantic salmon (*Salmo salar* L.) located in the Broughton Archipelago of British Columbia from 2003 to 2005 – S. Saksida et al., 2007.***
12. ***Differences in *Lepeophtheirus salmonis* abundance levels on Atlantic salmon farms in the Broughton Archipelago, British Columbia, Canada – S. Saksida et al., 2007.***
13. ***Declining wild salmon populations in relation to parasites from farm salmon – M. Krkosek et al., 2007***

14. **Perspectives on pink salmon and sea lice: scientific evidence fails to support the extinction hypothesis** – S. Jones and K. Brooks, 2008
15. **The effect of sea lice infestation on the salinity preference and energetic expenditure of juvenile pink salmon (*Oncorhynchus gorbuscha*)** - S. Webster et al., 2007.
16. **Differential rejection of salmon lice by pink and chum salmon: disease consequences and expression of proinflammatory genes** – S. Jones et al., 2007
17. **Early development of resistance to the salmon louse, *L. salmonis*, in juvenile pink salmon** – S. Jones et al., 2008
18. **Influence of reduced feed ration on *L. salmonis* infestation and inflammatory gene expression in juvenile pink salmon**– S. Jones et al., 2008
19. **A strategy for improved pest control on Irish salmon farms** – Ireland DAFF, 2008
20. **EST and mitochondrial DNA sequences support a Pacific form of salmon Louse, *Lepeophtheirus salmonis*** – R. Yazawa et al., 2008.

#### PSF updated presentations, 2008:

21. **Evaluation of levels of sea lice on farmed Atlantic salmon and wild juvenile salmon in the Broughton Archipelago from 2004-2006** – W. Wosniok and A. Donald
22. **Marine monitoring of juvenile salmon and sea lice in the Broughton, and sea lice identification and lethal thresholds of *L. salmonis*** – B. Hargreaves and S. Jones
23. **Abundance of planktonic sea lice in Knight Inlet/Tribune Channel** - D. Mackas and M. Galbraith
24. **The vertical distribution of *L. salmonis* planktonic larvae** – A. Lewis, C. DiBacco and S. Tang
25. **Sources and processes of winter infections of sea lice on farmed salmon** – R. Beamish
26. **Assessment of fish health in out-migrating juvenile pink salmon** – G. Marty and S. Saksida
27. **Effects of sea lice on the physiology and health of pink salmon** - C. Brauner, L. Nendrick, M. Sackville, M. Gardner and A. Farrell
28. **Pink and chum population dynamics in the Broughton** – P. Van Will and B. Riddell
29. **Kitasoo juvenile salmon sea lice analysis 2005-2008** – L. Greba and S. Saksida
30. **Marine monitoring of sea lice on wild juvenile salmonids in Clayoquot Sound** – K. Beach
31. **Environmental Fate and Potential Biological Effects of Emamectin Benzoate - A Laboratory and Field Based Study** – M. Ikonomou
32. **Sea Lice management, transmission and wild salmon survival** – M. Krkosek
33. **Modeling – What have we learned and what do these things mean?**

The Ministry now has several years of assessment data in addition to the results of studies conducted by researchers investigating sea lice biology. All offer deeper awareness of potential interactions between sea lice, farmed salmon and wild salmon populations in BC.

It has always been accepted that Atlantic salmon in other countries and regions are continually challenged by disease directly attributable to sea lice of the Atlantic Ocean and it is important to consider the experience of other countries regarding sea lice. It is equally important to understand the unique population dynamics of British Columbia. BC has numerous species of wild salmon populations relative to other countries and the genetics of Pacific Ocean sea lice are different than Atlantic Ocean lice.

## Summary

- Mandatory monitoring and management of sea lice on fish farms has occurred and will continue in 2007/2008.
- Current assessment protocols are appropriate, yet BCMAL and farming companies are responsible to watch for, and correct if necessary, any 'protocol drift' that may arise on individual farms.
- BCMAL continues to audit farms in 2007/2008 with a target period for increased monitoring during the wild smolt out-migration period, March 01 to July 01.
- The action level remains: an average abundance of 3 motile lice stages per fish throughout the year. However, the management action taken during the wild smolt out-migration period, March to July, is different than the remaining quarters.
- The management option of '*harvest or remove fish populations*' must abide by the intent to reduce the abundance of lice at the farm with practical urgency (i.e. weeks), rather than over a protracted length of time (i.e. months).
- The Ministry strongly urges industry to adopt and implement a farm-by-farm, web-based, monthly reporting structure for its corporate sea lice abundance data.

## Appendix 1 - Excerpts from the 2007 Fish Health Report

### 4.5.1 Analysis of Sea Lice Audit Data: Atlantic Salmon Farms

Active farms that satisfy the criteria for sea lice audit were identified and randomly selected for audit. Table 17 summarizes the audit activity of 2007. It is common that one or two farm visits are cancelled each quarter as a result of bad weather, environmental conditions such as low dissolved oxygen or plankton bloom, or due to equipment or staffing restrictions. The table below reflects four audit cancellations.

<b>Table 17: 2007 Total farms selected, total farms audited and numbers of live fish assessed (per quarter)</b>					
	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Annual</b>
<b># farms selected</b>	11	26	11	13	61
<b># farms visited</b>	11	25	9	12	57
<b># fish counted</b>	640	1,480	540	720	3,380

Analysis of the 57 lice-counting comparisons made in 2007 found no significant difference between counts performed by BCMAL personnel and designated farm staff at the farm-level for the *Lepeophtheirus* motile or female stages, or the *Caligus* motiles ( $p > 0.05$ ). This agreement between paired count results (of the mean abundance of lice counted, on different fish, from the same pen) provides confidence in the technical proficiency of the farm personnel generating the count data as reported by the farms.

This on-farm, split-sample, lice-counting procedure and the examination of records represents a compliance audit. The results of the joint count serve as that farm's monthly count and the results are recorded as the audit "snapshot" of the farm. These assessments are included as part of the audit data for the sub-zone that quarter and are used for 'within sub-zone' analysis and the sub-sample validation test (see Figures 18 to 24 below).

Tables 18a/b and Figures 16a/b show the aggregated results of the BCMAL average abundance of sea lice on Atlantic salmon farms for all sub-zones in 2007. In general, the lice abundance on farmed Atlantic salmon was the lowest level seen since the inception of BC's monitoring and audit programs. In quarter four (Q4), elevations of motile and female lice occurred without corresponding increases of the chalimus (i.e. early) life stage. This is evident in both first and second year class fish (see Tables 18a/b). This observation supports the premise that wild fish returning in the late summer are the most likely source of motile lice rather than mature lice being generated from younger lice stages on farms.

To further increase the confidence in the data reported by industry, data from the audited farms within each sub-zone were examined for ‘within farm’ (farm-level) and ‘within sub-zone’ variation together. This is an important test for the auditing function because it best models the industry situation: collection of information from different farms, with different personnel, occurring on different days, with different ages of fish exposed to lice, etc. All statistical analyses were completed using Microsoft Statistix 8.

Our analyses found no significant difference between counts performed by government personnel and farm personnel at the sub-zone level, for all but a few cases. Farm staff did have higher counts for two cases of *Caligus* and BCMAL staff had higher counts in one case. Related to that, the *Caligus* motile stages tend to detach from fish during the handling and anaesthetic bath, more so than *Lepeophtheirus*. In each case where counts differed, *Caligus* were recovered from the anaesthetic totes and counts were added to the audit total.

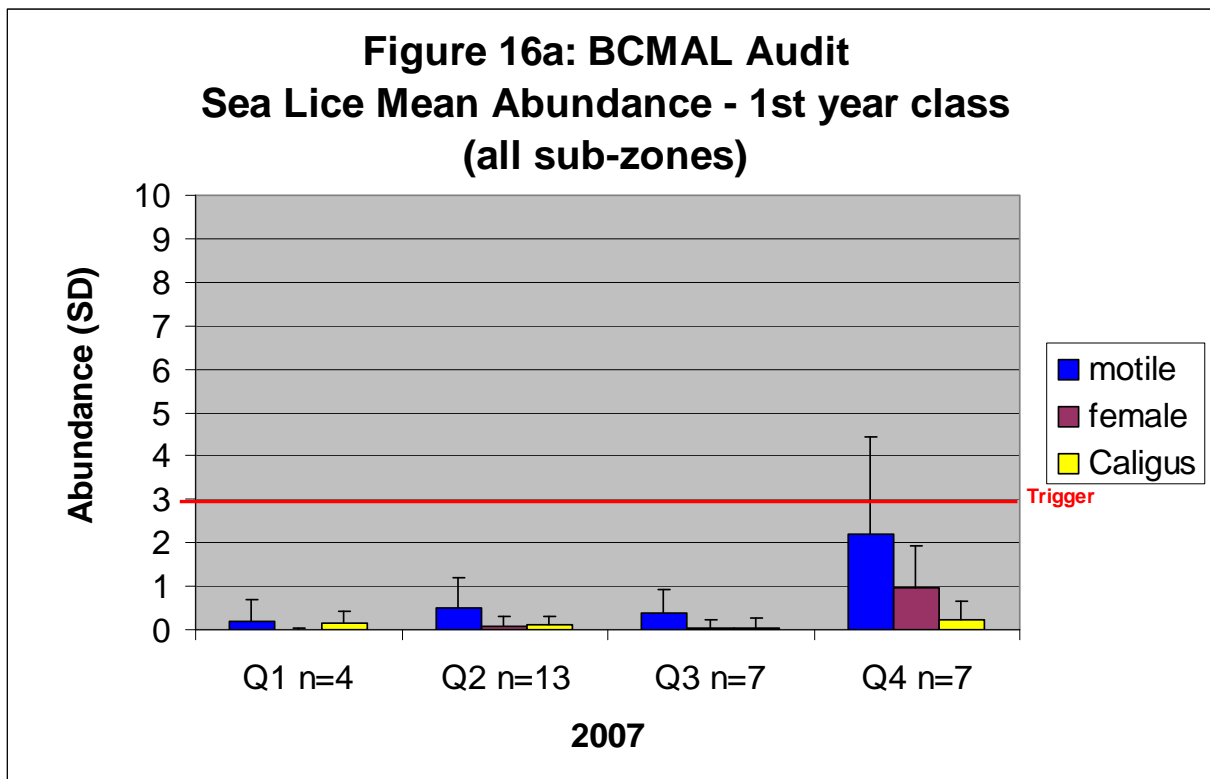
In conclusion, lice detection and identification by industry in 2007 was found to tolerate statistical scrutiny, both at the farm- and the sub-zone levels, which provides confidence in the industry-reported lice abundance.

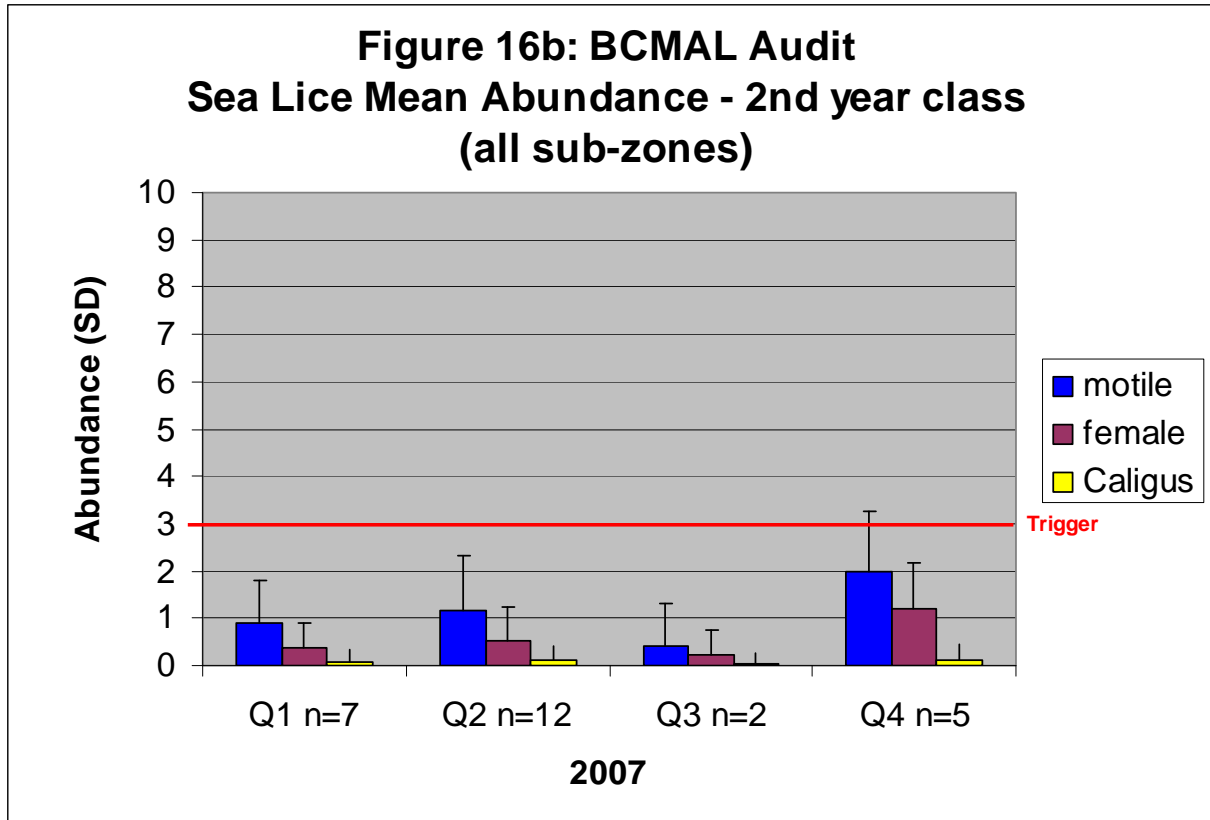
<b>Table 18a.</b> Mean abundance of motile, female <i>L. salmonis</i> , chalimus sea lice and motile <i>Caligus clemensi</i> during Atlantic salmon farm audits in 2007 (per quarter) – 1 <sup>st</sup> year class*				
<b>2007 Mean Abundance</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>
Number of Farms Audited (n)	4	13	7	7
Motile	0.19	0.51	0.39	2.21
Standard Deviation (SD)	0.505	0.684	0.533	2.235
Female	0.01	0.07	0.05	0.96
SD	0.046	0.224	0.183	0.994
Chalimus	1.60	0.37	0.72	0.44
SD	1.824	0.861	1.543	1.346
Caligus Motile	0.16	0.10	0.05	0.23
SD	0.251	0.216	0.223	0.429

\* Tables of comparable audit data reflecting separate year classes of Atlantic salmon can be found in its Appendix 7.11.

**Table 18b.** Mean abundance of motile, female *L. salmonis*, chalimus sea lice and motile *Caligus clemensi* during Atlantic salmon farm audits in 2007 (per quarter) – 2<sup>nd</sup> year class

2007 Mean Abundance	Q1	Q2	Q3	Q4
Number of Farms Audited (n)	7	12	2	5
Motile	0.90	1.15	0.43	1.98
Standard Deviation (SD)	0.894	1.185	0.904	1.273
Female	0.36	0.51	0.22	1.21
SD	0.530	0.716	0.535	0.976
Chalimus	0.54	0.72	0.13	0.09
SD	1.394	2.847	0.365	0.482
Caligus Motile	0.07	0.10	0.03	0.13
SD	0.270	0.303	0.220	0.327



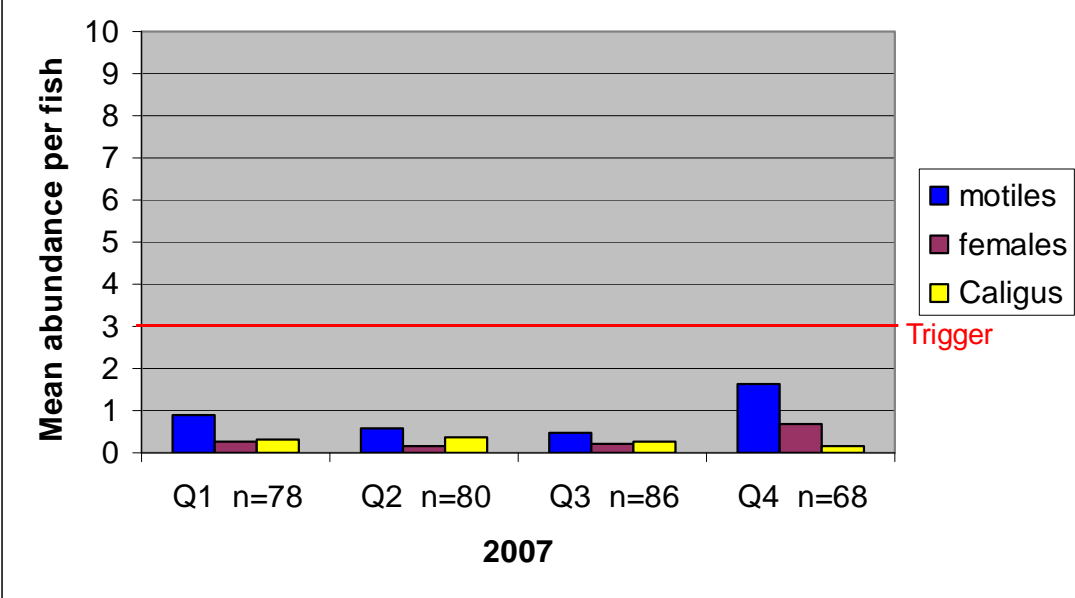


With regard to farmed Pacific salmon, initial monitoring assessments in 2004 corroborated scientific reports that farmed Pacific salmon harbour very few lice (see [Fish Health Report 2003-2005](#)). As a result, BCMAL no longer requires Pacific salmon producers to routinely count and report lice abundance; however, producers continue to visually monitor the salmon for sea lice at opportune time such as: during routine carcass assessments, weight sampling events or at times when lice have historically been documented (i.e. at harvest or during brood sorts in the autumn). This information must be available for audit review to BCMAL fish health staff upon request.

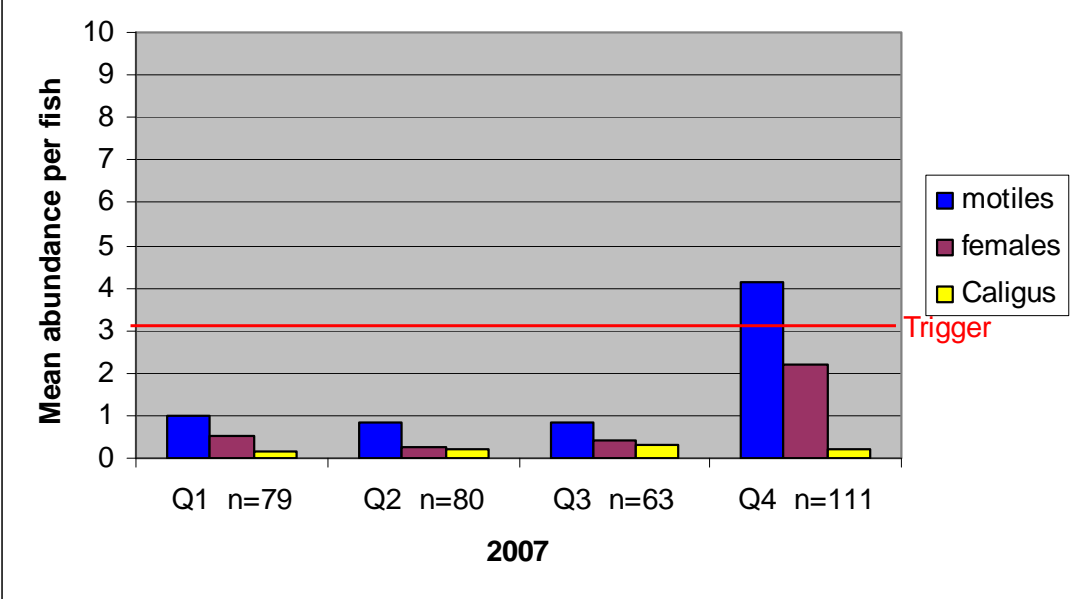
#### 4.5.2 Evaluation and Audit Comparison to Industry Lice Reports

The 2007 BCSFA average abundance of sea lice on Atlantic salmon (in all zones combined, by year class) is shown below in Figures 17a and b. The overall average remains well below three lice per fish with the exception of autumn. The 'n' value in each quarter reflects the number of lice assessments conducted by industry; over 600 counts and approximately 38,000 fish in total. The monthly sub-zone tables and bar charts submitted by BCSFA to BCMAL are included below.

**Figure 17a: BCSFA Sea Lice Averages on Atlantic salmon - 1st Year Class (all sub-zones)**



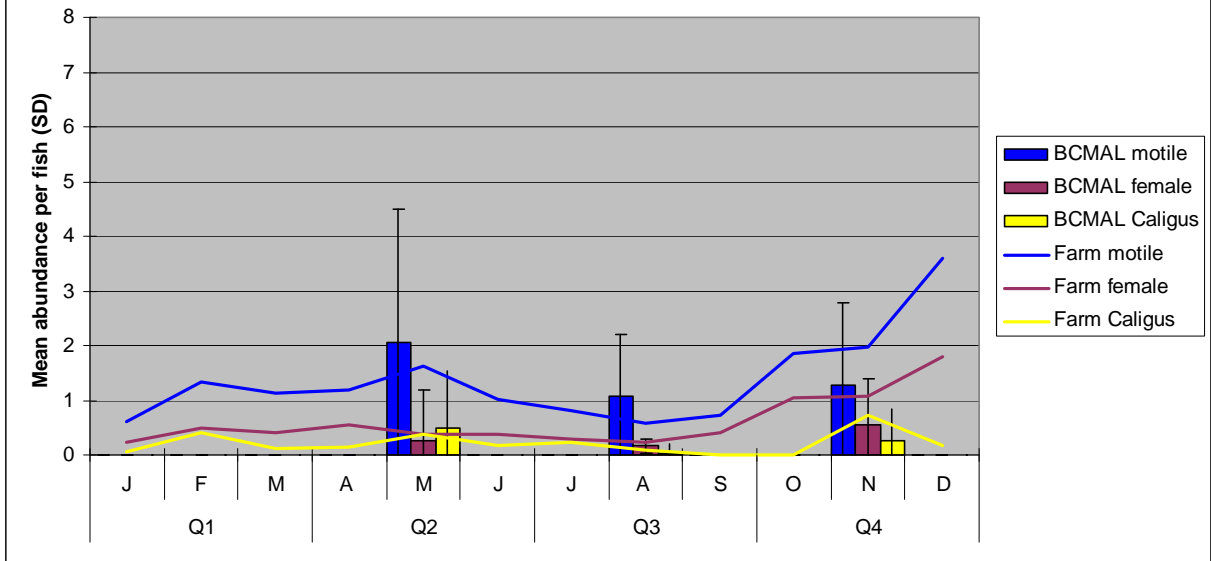
**Figure 17b: BCSFA Sea Lice Averages on Atlantic salmon - 2nd Year Class (all sub-zones)**



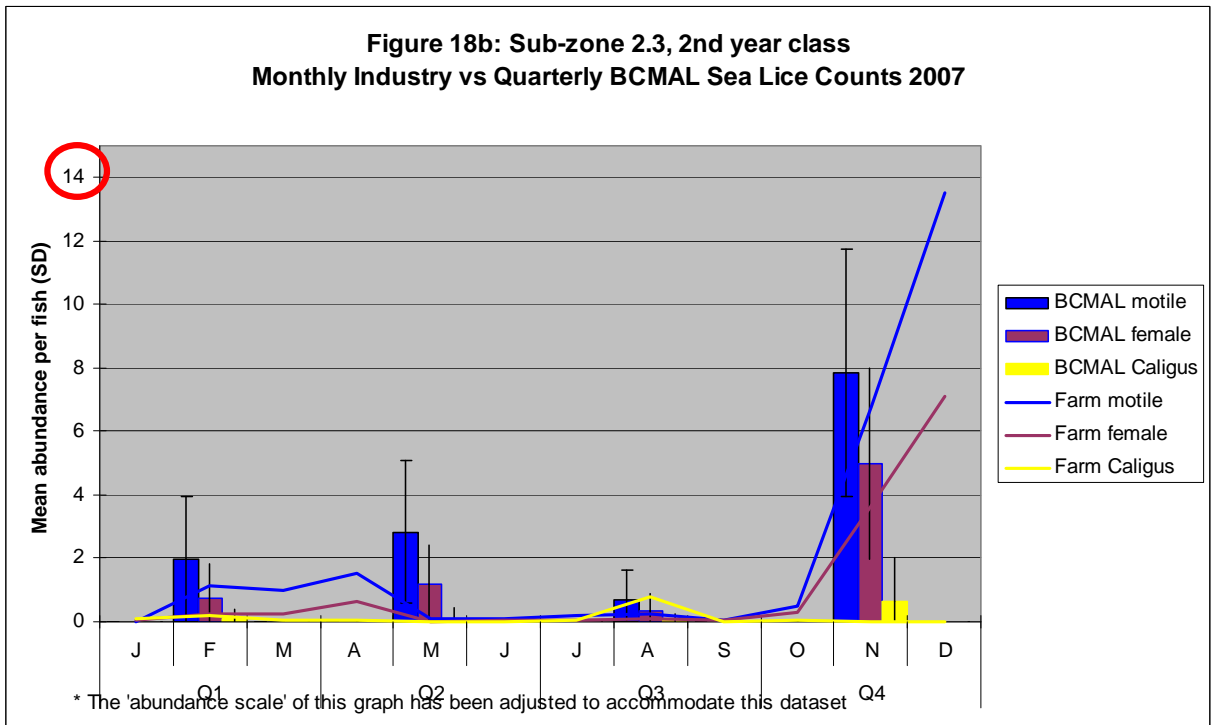
BCMAL sea lice audit data is collected each quarter on days that the farm has already scheduled for lice counts. Audit data contributes to the monthly and twice-monthly data collected by industry. As such, the BCMAL data is a sub-set of the farm-reported data and therefore is not an independent estimate of sea lice abundance. We must refer to these “snapshot” comparisons of farm and sub-zone data as “sub-sample validation” which is a useful tool to evaluate confidence in the data collected and submitted by industry.

Below, Figures 18a to 24b, are BCMAL estimates (bars) overlying monthly average lice abundance (lines) submitted by industry. In the graphs, BCMAL audit data are placed mid-quarter; however, in reality, the sampling date may have occurred any time within that quarter. Despite this variation in ‘time of data collection’ (and the difficulty in generating a good estimate of lice abundance due to the ‘within pen’, ‘between pen’, and ‘between farms within a sub-zone’ variance), the BCMAL sub-sampling validation shows acceptable agreement with the abundance reported by industry. In the few cases where the audit data does not fall in agreement with the more frequent and representative industry counts (i.e. the best estimate of lice abundance on farmed fish), in each case the industry reported higher sea lice abundance.

**Figure 18a: Sub-zone 2.3, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

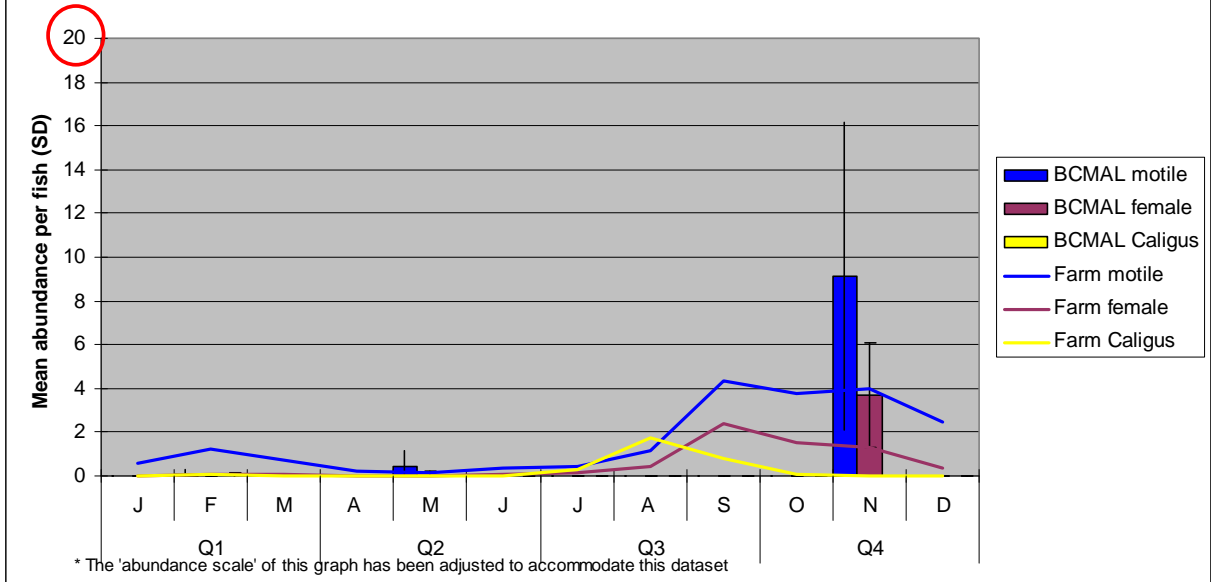


**Figure 18b: Sub-zone 2.3, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

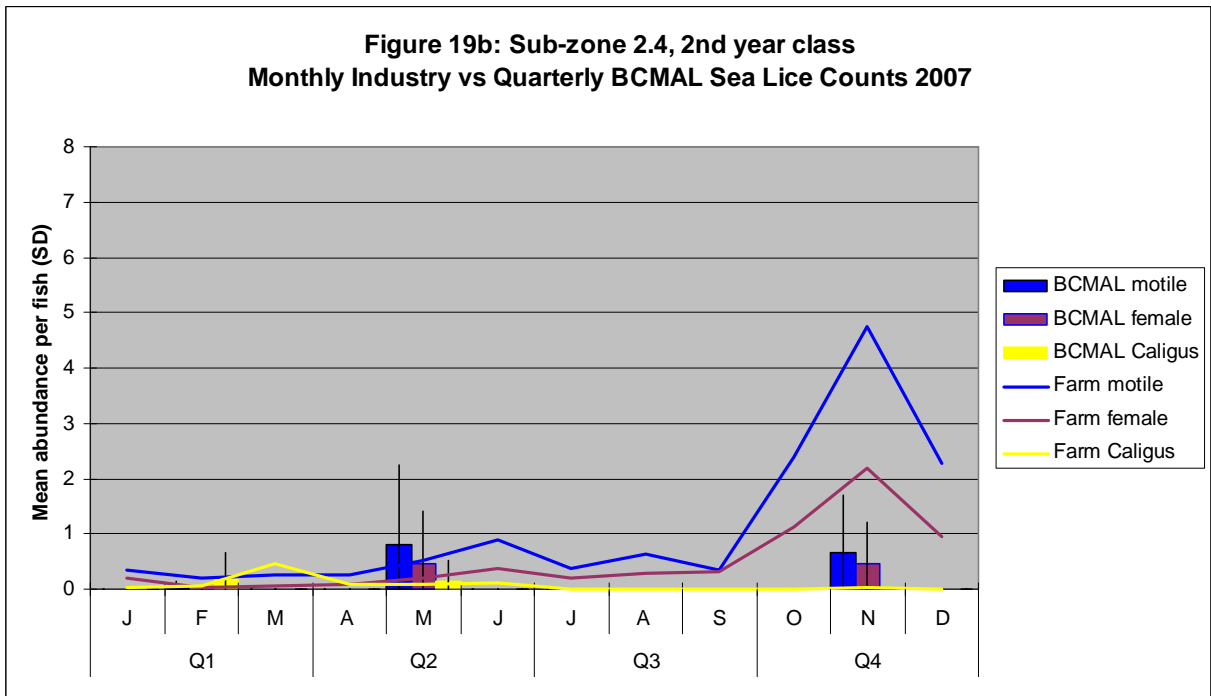


NB. Quarter 4 lice abundance in sub-zone 2.3, although exceeding the trigger level of three (3) motile lice per fish, was monitored and managed accordingly. The abundance was reduced effectively by January 2008.

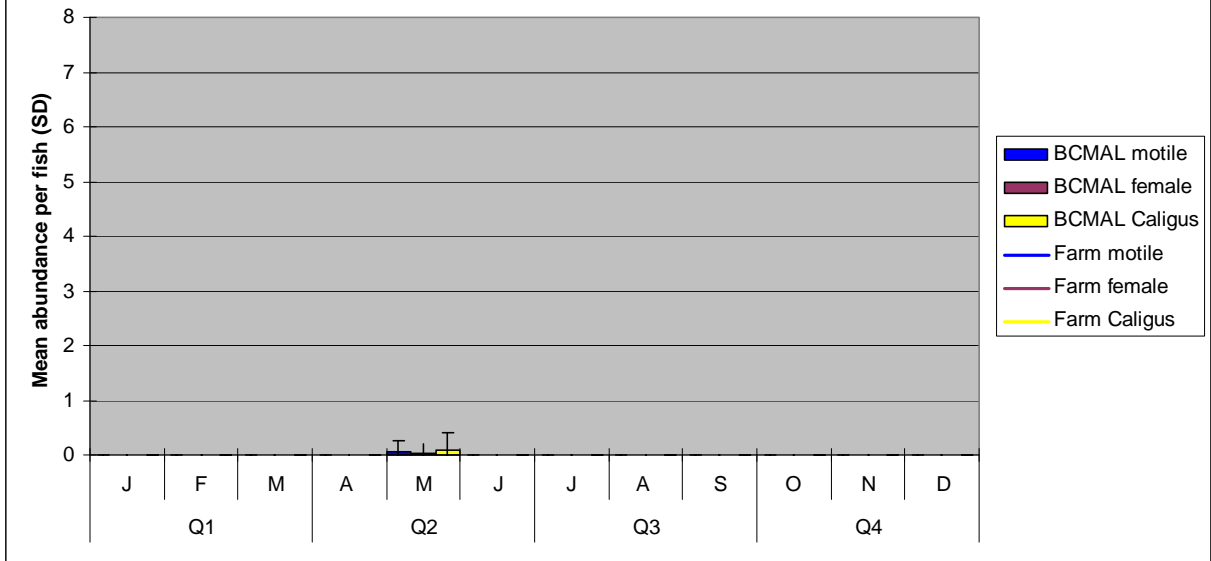
**Figure 19a: Sub-zone 2.4, 1st year class**  
**Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007 \***



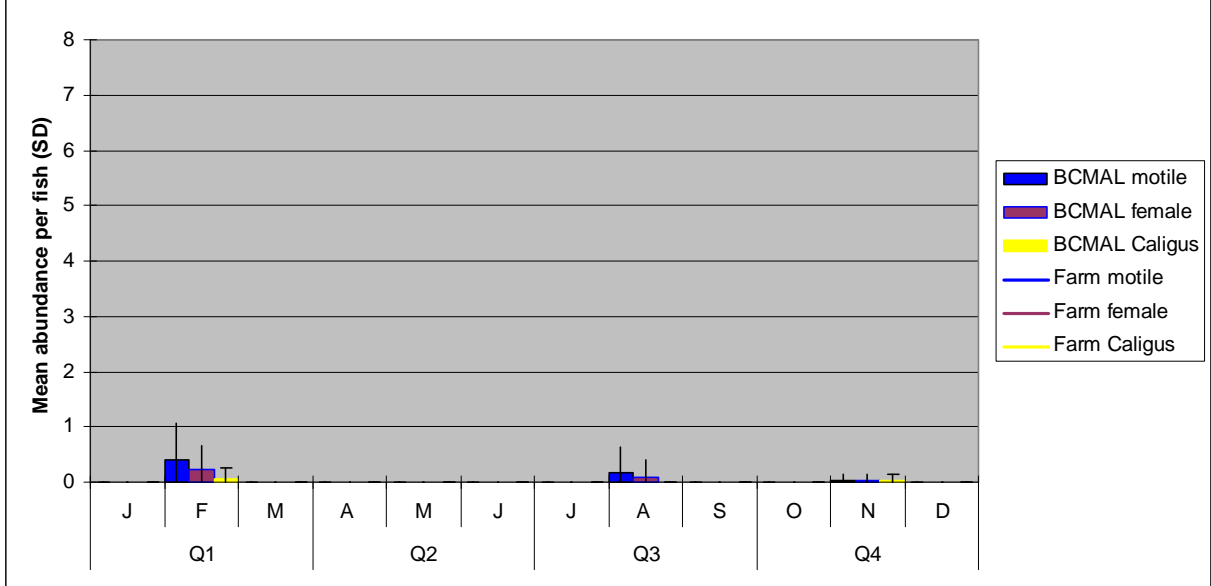
**Figure 19b: Sub-zone 2.4, 2nd year class**  
**Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**



**Figure 20a: Sub-zone 3.1, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

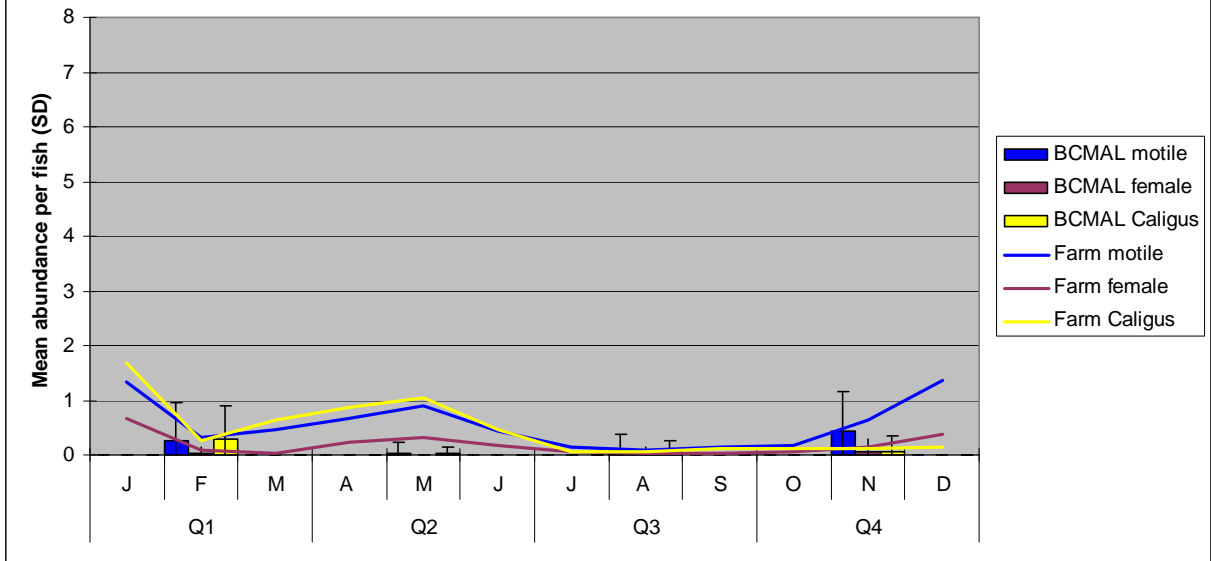


**Figure 20b: Sub-zone 3.1, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

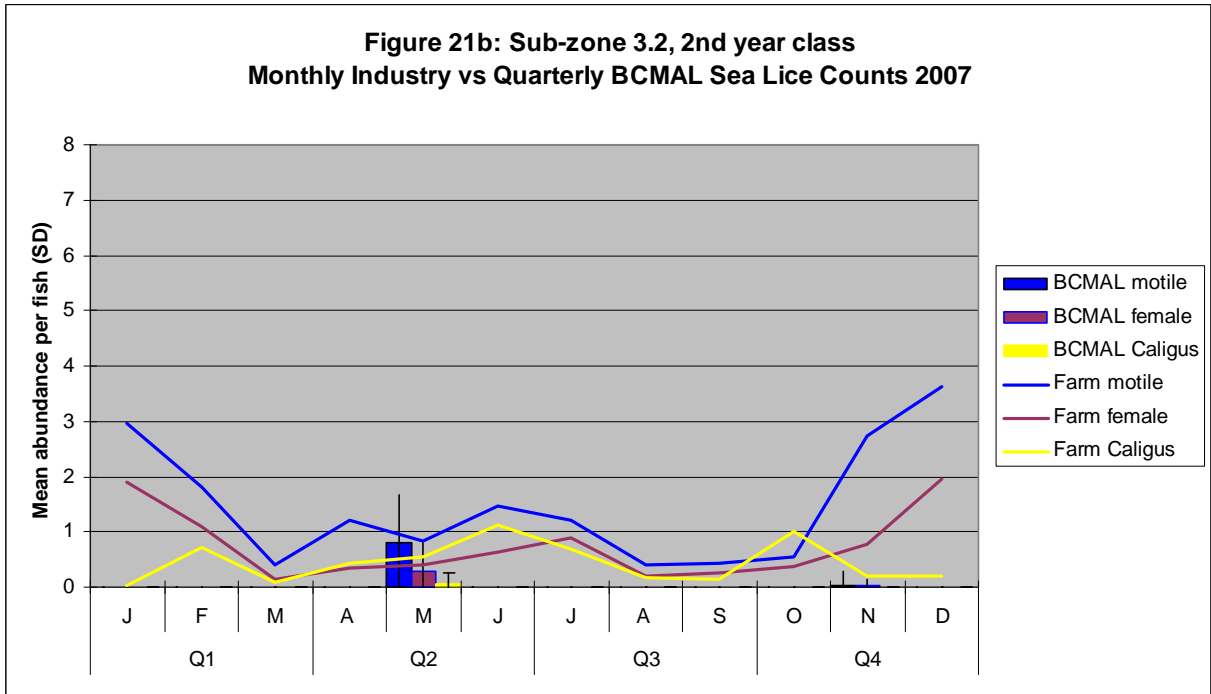


NB. Farms operating in sub-zone 3.1 are currently exempt from routine monitoring and reporting sea lice abundance due to the historically very low abundance on the Atlantic salmon. The stress & handling of fish was deemed an excessive risk relative to the value of the data generated. BCMAL however continues to assess the Atlantic salmon as per its audit selection procedure.

**Figure 21a: Sub-zone 3.2, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

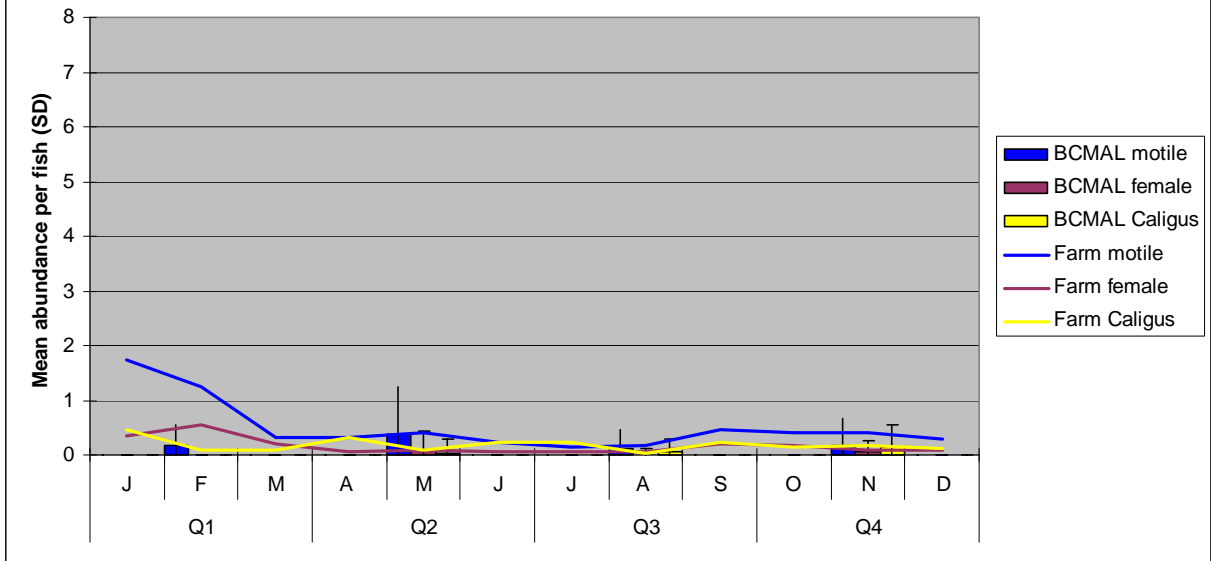


**Figure 21b: Sub-zone 3.2, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

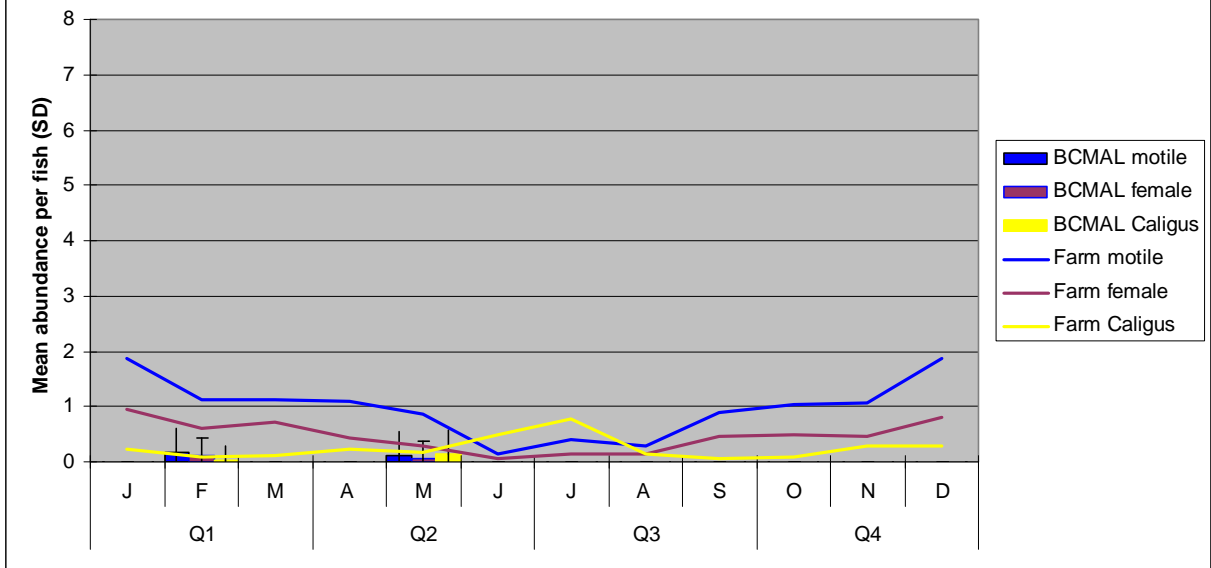


NB. Farm monitoring and audit procedures continue to identify a presence of *Caligus* lice species in sub-zone 3.2. *Caligus* species are common on non-salmonid fishes. Their presence in 2007 is attributable to wild herring and pilchard populations near salmon farms. *Caligus* lice are ubiquitous and recording their abundance on farmed fish will enable trend analysis.

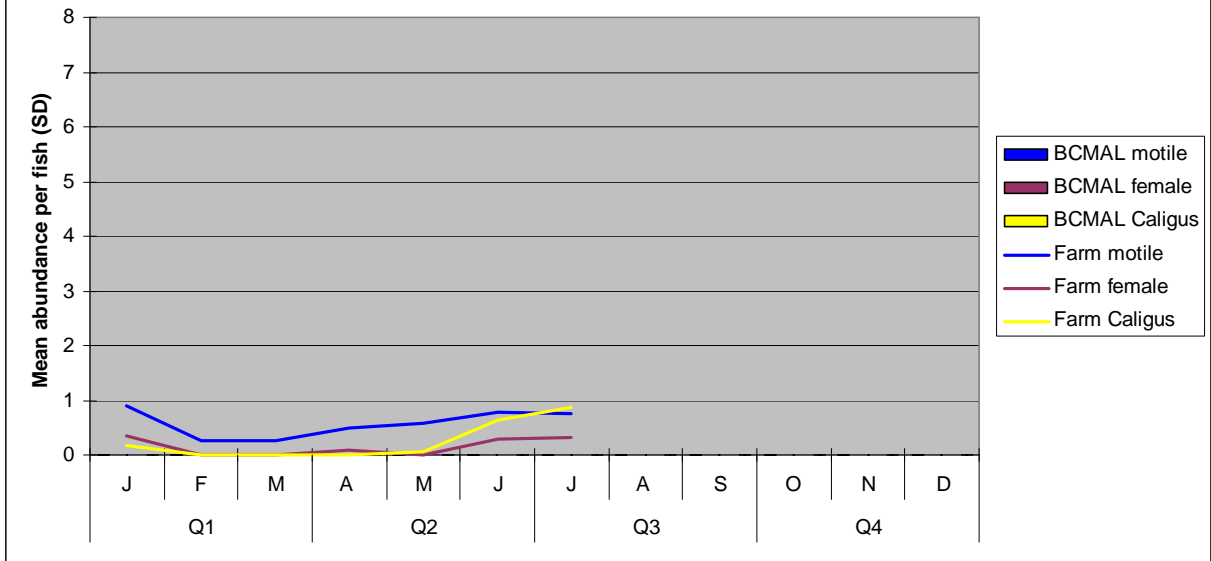
**Figure 22a: Sub-zone 3.3, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**



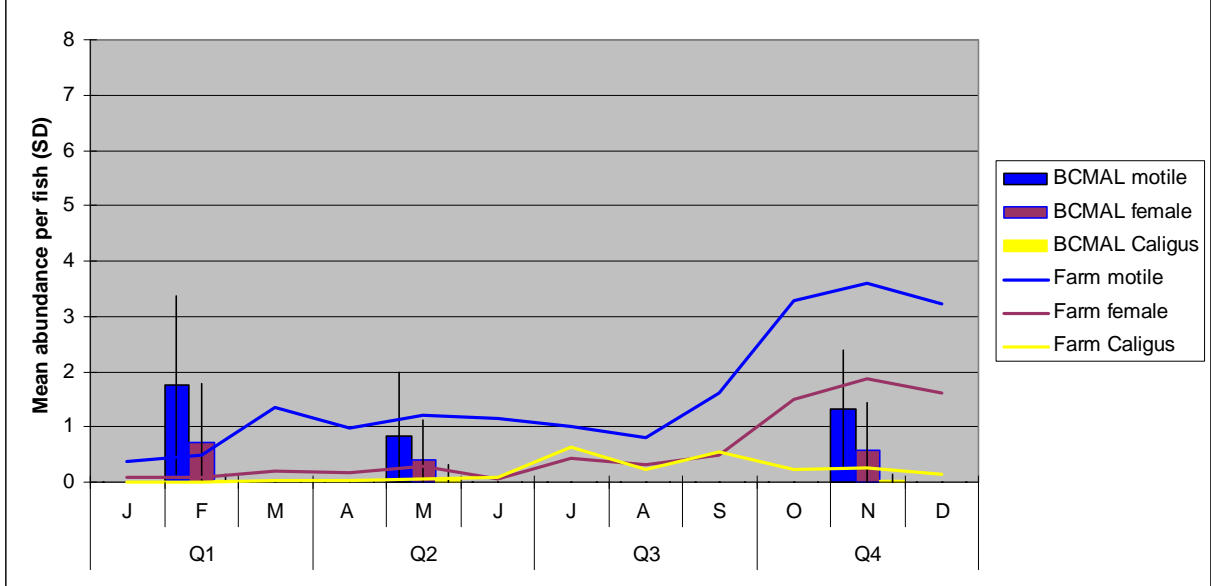
**Figure 22b: Sub-zone 3.3, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**



**Figure 23a: Sub-zone 3.4, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

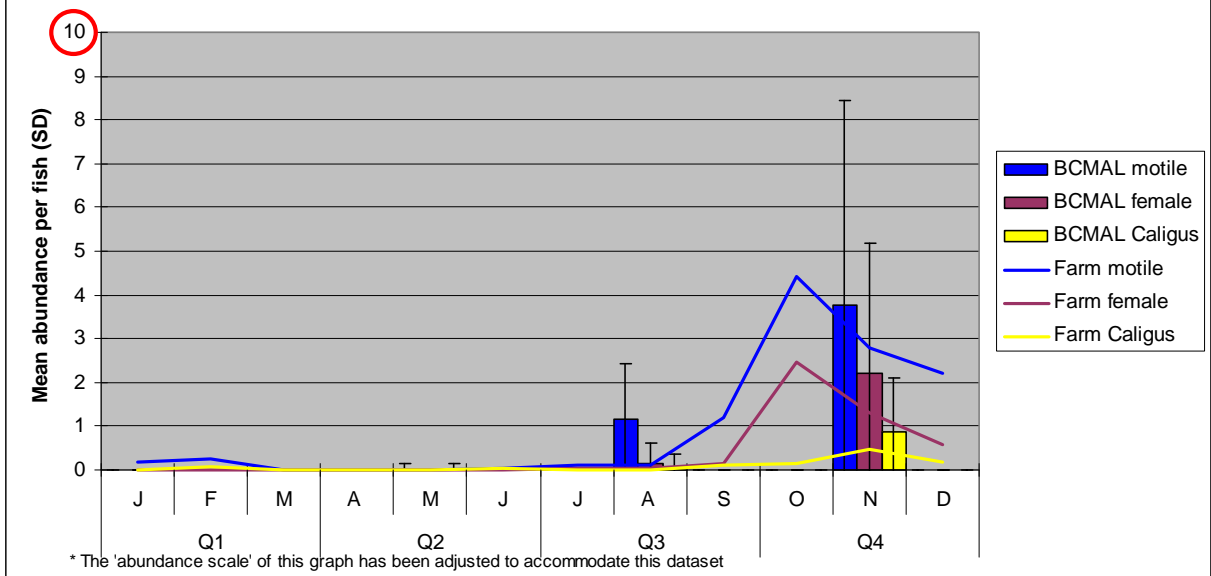


**Figure 23b: Sub-zone 3.4, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**

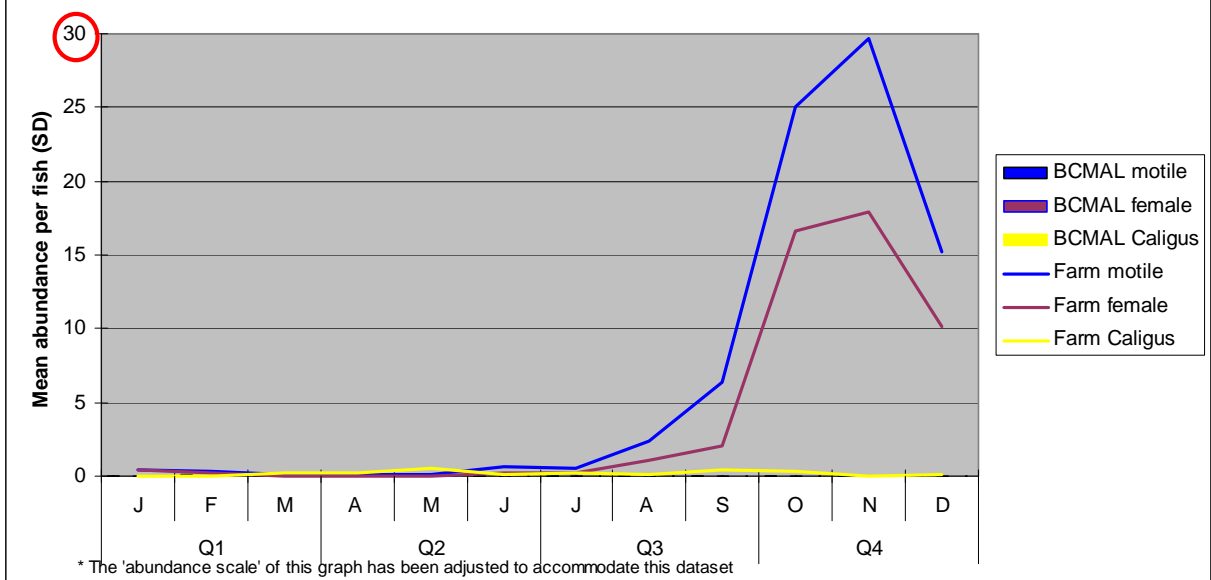


NB. In Figure 23a the populations of 1<sup>st</sup> year class fish in sub-zone 3.4 were moved or re-classified as 2<sup>nd</sup> year class fish in July 2007, marking the end of monitoring and reporting from aquaculturists in sub-zone 3.4 for the remainder of the year.

**Figure 24a: Sub-zone 3.5, 1st year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007**



**Figure 24b: Sub-zone 3.5, 2nd year class  
Monthly Industry vs Quarterly BCMAL Sea Lice Counts 2007 \***



NB. Audit counts were performed in quarter 1; the mean abundance was 0.017 motile per fish at that time (see Appendix 7.11, Table 7.11.7). The marked rise in abundance of sea lice in sub-zone 3.5 in quarter 3 is an annual seasonal phenomenon. Environmental factors and producers manage the abundance accordingly each autumn and winter.

## 4.6 Synopsis of Industry Sea Lice Results - 2007

The following information is a brief review of the temporal and spatial occurrence of lice on farms by way of BCMAL audits and the examination of industry sea lice reports submitted to the Ministry in 2007.

### Summary:

- **Abundance of lice in 2007 during the out-migration period of wild fry (March to July) was well below the trigger level of 3 motile lice per fish in all sub-zones.** In most cases the lice abundance on the salmon farms in late 2006 had declined or been managed to fewer than 2 motile lice per fish by February 2007 and abundance of motile lice remained low for at least six months. In other words, no obvious recruitment of lice populations arose from within the farms between February and August 2007.
- **The trigger level of three motile lice per fish continues to be a conservative monitoring and management objective.** Sea lice are natural marine parasites of fish in all regions. There is no indication in the sentinel Atlantic salmon population of ill health even when afflicted by relatively high numbers of lice observed each autumn.
- **Lice levels vary between year classes.** The overall abundance of lice on juvenile Atlantic salmon is lower in their first year of sea water compared to 2nd year fish (adults).
- **Lice levels can vary significantly between areas.** Data collected by industry on a farm-by-farm basis and submitted to government clearly shows that there are areas where lice abundance has consistently been very low for years. Sub-zone 3.1 (Sechelt) has not had its lice abundance approach the trigger point since monitoring began whereas other areas experience increases in lice levels each autumn. With the exception of the autumn months, in 2007 most sub-zones had lice counts that averaged fewer than 1.5 motile lice per fish.
- **Abundance of lice varies naturally from year to year.** Sea lice data have been collected consistently over a four year period (2004 -2007 inclusive) using a standardised protocol and reporting structure. Annual comparisons interest some people but direct comparisons are difficult because the location of 'active' and reporting farms changes from year-to-year. Annual fluctuation in average lice abundance in all sub-zones is to be expected.
- **Sea lice are naturally occurring parasites of wild fish.** Data collected from wild stocks shows that returning adult salmon can carry high numbers of sea lice. Undoubtedly this is a natural life cycle of this parasite on its native fish hosts.
- **Marine conditions can affect the occurrence and abundance of lice on farms.** Information on environmental conditions and the impact on lice survival and reproduction is well documented. Two key factors are temperature and salinity. In general, elevated water temperature and greater salinity tends to favour the survival and reproduction rate of sea lice. The following authors have published relevant works speaking to the environmental factors and biology/behaviour of *Lepeophtheirus salmonis*: Heuch et al., 2000; Revie et al., 2002; Tucker et al., 2000; Jones et al., 2006, 2007, 2008; Webster et al., 2007; Krkosek, 2007; Brooks and Jones, 2007; Yazawa et al., 2008.

#### **4.7 Sea Lice Abundance on Farmed Atlantic Salmon in the Broughton Archipelago**

The ongoing analysis of spatial and temporal variations in sea lice abundance on farmed salmon and out-migrating wild juvenile salmon in the Broughton Archipelago (as conducted in parallel by DFO, BCMAL, industry and environmental non-government organisations (ENGOS)) will provide critical information required to further our knowledge of the region and of sea lice behaviour. Determining the degree of association will be a key step to assessing whether there is a causal link between sea lice found on farmed salmon and those found on wild juvenile salmon in the Broughton Archipelago. The Pacific Salmon Forum Final Report is a useful resource explaining current projects and results to date.

The average abundance of motile sea lice on both 1<sup>st</sup> and 2<sup>nd</sup> year class Atlantic salmon raised in the Broughton area were well below trigger levels throughout the year including the period of wild salmon out-migration season. Figures 22a/b and corresponding Tables 7.11.5 and 7.12.5 in the appendices reflect lice counts pertaining to sub-zone 3.3.

##### **In 2007:**

- Juvenile Atlantic salmon (1<sup>st</sup> year class fish) had an average abundance of less than 0.5 motile lice per fish from March 2007 through December 2007.
- Larger 2<sup>nd</sup> year class fish had an abundance of less than 1.2 from February 2007 to November.
- Two species of lice were most common on farmed salmon: *Lepeophtheirus salmonis*, (*L. salmonis*) and *Caligus clemensi* (*C. clemensi*).
- The predictable seasonal pattern of increased abundance of motile lice in the autumn began in September; the abundance increased to 1 louse per adult fish and subsequently to 1.9 lice in November 2007. This pattern was not evident in juvenile farmed salmon.

## Sea Lice Therapeutic Management:

Currently only one product is available for controlling sea lice in British Columbia: emamectin benzoate, otherwise known as SLICE®. The therapeutic remains in its final stages of the federal review and approval process under the authority of Health Canada. As such, it has yet to receive a license and label. The product is available by the Emergency Drug Release (EDR) program. Emamectin benzoate is an efficacious product for sea lice management and, following treatment in BC, lice abundance on farms typically remains low for 5 months.

As illustrated in Figure 26, the anti-lice treatments have declined since 2005. This coincides with a general decline in sea lice abundance on farmed fish over the same corresponding period. Initially, from 2000 to 2003, harvest-sized Atlantic salmon would generally not have been medicated with SLICE® because the presence of sea lice on these fish does not result in ill health, and the medication would interfere with harvest flexibility. Between 2003 and 2005, and upon the implementation of the provincial Sea Lice Management Strategy, the prescription use of SLICE® increased primarily because the larger fish were medicated in late winter to minimise any potential effect their lice may have on wild fish fry during the spring out-migration. By 2006 and 2007, reduced lice loads and pre-spring harvests help to explain the reduced use of the anti-lice medication.

Figure 26:

