Proposals to replace ASC Salmon PTI indicators 5.2.5 and 5.2.6

Executive Summary

In order to reduce the potential for environmental impact of medicinal products targeting sea lice, ASC has sought to develop indicators of industry use of medicines, which allow recognition of better and worse performers and can be used as a metric which allows producers to rationally reduce the use of medicines in sea louse management and thereby reduce potential for environmental impact and improve the sustainability of aquaculture.

The current ASC Salmon Standard incorporates a Parasiticide Treatment Index (PTI) that sought to measure the use of medicinal products employed to control sea lice infection levels over a production cycle. This PTI comprised the product of four measures: a therapeutant factor reflecting the product used and incorporating nominal toxicity, dose and environmental persistence weighting, a treatment factor reflecting the method of treatment application, a resistance factor relating to the potential impact of repeated use of products upon development of sea louse drug resistance and a sensitive time factor reflecting the seasonal presence / sensitivity of key organisms, such as lobsters or migrating salmonids, in the environment of the treating farm. Application of a globally applied threshold PTI value for ASC certification of farms was intended to act as a driver for reduction of the use of medicinal products in control of sea lice and, coupled with defined values for maximum acceptable sea louse loads, to serve as a mechanism for reducing sea louse numbers on farms and minimising potential for environmental impact, including effects on wild salmonid populations.

Following implementation of the PTI, an independent analysis of farm PTI scores and sea lice infection data across the initial years of implementation of the ASC Salmon Standard revealed a number of shortcomings of the PTI as originally conceived. Most importantly, from the perspective of ASC, salmon producers, NGOs and other stakeholders, use of the PTI failed to drive down the use of medicines in sea louse control, failed to help reduce sea lice numbers on farms and failed to slow the development of drug resistance in sea lice populations. As a consequence, following a wider consultation exercise regarding proposed amendments to the PTI, a technical working group comprising the ASC, academia, industry and NGOs, drawn from across the major jurisdictions, was assembled to formulate an alternative approach.

The proposed replacement measure, termed the Weighted Number of Medicinal Treatments (WNMT), is supported by stringent additional requirements for rotation of medicines and for farms to employ an increasing range of non-medicinal management, monitoring and treatment approaches as part of a state-of-the-art integrated pest management (IPM) strategy. By this means the new measure seeks to more actively address the global driving down of medicinal treatment use, farm lice numbers and parasite drug resistance development. This in turn will serve to reduce the potential for adverse environmental impact. The WNMT is defined as the total number of occasions a medicinal product was used over the full production cycle, with partial treatments being counted as a proportion of the total farm cages treated, e.g. 1 treated out of 10 scores 0.1. The proposed new measure specifically recognises that one of the main factors driving the rate of development of drug resistance in treated sea lice populations, regardless of product employed, is the frequency of treatment with any given class of medicinal product. Hence, the proposed amended Salmon Standard requires farms both to reduce the frequency of treatment below defined thresholds and to specifically rotate the classes of medicines used, allowing only two successive treatments with the same class of treatment product, in order to help break the cycle of resistance development.

The amended Salmon Standard requires producers to meet a maximum allowable WMNT or Entry Gate (EG), generated through robust analysis of the most recent available regional datasets, that permits entry into the certification process. Unlike the preceding PTI threshold, which comprised a single global value, the value of the Entry Gate is specified by region, in recognition of key regional differences in ecosystems, drug availability / efficacy, epidemiology and legislation, including differences between lice species, wild host reservoirs and environmental variables. Such regional thresholds, defined so as to allow only the best performing farms in a given region to enter the certification process, ensure that improvements in performance are driven universally, rather than solely within regions for which a single selected global threshold is within reach. Once admitted to the certification process, however, farms would nevertheless have to demonstrate continued reduction of treatment frequency towards a lower fixed Global Target (GT), set at a level consistent with the top 20% of producers globally. According to these new criteria, site treatment frequencies (= WMNT) >EG would not be certified, sites >GT and ≤EG would be certified but need to show time-bound improvement against an IPM progress ladder and sites ≤GT would be certified with no additional conditions. By insisting on the increased use of non-medicinal IPM elements, once the certification process has been entered, this new approach should both encourage producers to reduce use of medicines globally and act to drive the development of improved non-medicinal tools and technologies. It is intended that the initial regional and global thresholds selected will be periodically updated (downwards) to reflect regional and global improvements, such revision being supported by the extensive monitoring and transparent reporting requirements implemented alongside the new criteria.

A number of changes have been made, with respect to the earlier PTI approach, in addition to the use of regional thresholds, mandatory IPM requirements and product rotation, which are considered to be justified as follows:

- Removal of toxicity from the new measures. This follows from 1) The move to an approach that treats all medicinal products with equal precaution 2) recognition of the extensive consideration of toxicity and persistence data already required for initial licensing of medicines for use against sea lice, as occurs for all veterinary medicines 3) the lack of applicable knowledge concerning e.g. effects on aquatic organisms in situ, relevant toxic doses, fate in the marine environment, impacts of environmental / biological variables 4) existence of mandatory legislative strictures / medicine availability or efficacy. Together these factors were considered to prevent weighting according to nominal toxicity from being productive as a rational measure to reduce use of medicines or protect the environment.
- Removal of treatment mode. As with toxicity, all treatment modes (e.g. bath, in-feed, well-boat) will now be considered equal, providing more consistent and appropriately precautionary regulation of treatment as a whole.
- Removal of sensitive periods from new measure. The amended ASC Salmon Standard will use regional lice load regulations or an ASC maximum limit, whichever is lower. Since regional regulations already take into account migrating salmonids by reducing allowable lice loads during sensitive periods, this no longer needs to be included in the new standard. Similarly, toxicity to lobsters is already tested during licensing of medicinal products and the licensed treatment doses and regimes already take this into account.
- Inclusion of “partial” treatments. In order to maintain control of sea lice effectively, it is often necessary for producers to treat only one or a limited number of pens on a site. By not treating all pens / lice on a site, this should help reduce the rate of development of resistance by leaving more susceptible lice in the local population and also reduces discharge of medicinal products to the environment.

While ASC and the technical working group recognise that no single measure or set of requirements can provide a complete solution, it is considered that the proposed amendments provide the best approach, given current knowledge, to protection of the environment while ensuring the progressive evolution and sustainability of sea louse control in salmon aquaculture.

1a) Summary of the PTI paper published on 5th Nov 2015[1]

ASC initiated the Salmon Standard Operational Review in March 2015 and produced a paper on the subject of parasiticide use in November of the same year. Based on the feedback received it was deemed necessary to establish a working group and in May 2016 one was set up. The mandate of the group was to advise on the PTI proposals, incorporating stakeholder feedback and to develop options for replacing the PTI requirements within the Salmon standard. The existing indicators in the Salmon Standard are available in the Annex for reference.

The analysis shows that there are significant differences between the PTI scores attainable within salmon producing regions, and that those differences are largely due to ecological and environmental features rather than management.

The single reference bar of 13, whilst it may be achievable by the top 20% of sites in some countries and some regions within countries, the gap between the requirement score and the mean and maximum of what is currently found in all countries except perhaps Canada suggests that there is a serious risk of the bar being beyond the reach of the bulk of farms even with improved management. Environmental conditions plus national regulations play a significantly much higher role in determining treatment frequency than farm management options. The real problem with the PTI single requirement is shown by how far the mean and the mode of PTI distribution within the countries are from this requirement (Table 1). The intent is to encourage the farms to improve their management so they can eventually match the top 20%, but given the very significant contribution of external factors over company factors in the variance of PTI scores the extent which management can achieve this, at least by pharmaceutical mean, is probably limited in the regional context. The single reference point raises the strong possibility of screening for compliant locality than compliant management. The compliance with the PTI should be a challenge to certification not a barrier.

PTI is therefore a single measure for a complex and variable problem, and there are a number of possible amendments, which could be made to improve its effectiveness in measuring the impact of parasiticides upon the wider environment. These include:

1. Need for a proportional adjustment when a partial treatment is employed
2. There is no indication of amount of bioactive compound added to the water
3. The unproven factor of 4.5 for 'lobster' is ecosystem partial and involves double counting.
4. The requirements of national regulations on target lice levels in response to local conditions are not consistent with the uniform requirement of Indicator 3.1.7, which tends to be counteractive to the PTI score. A more ecosystem related view of these requirements should be adopted.

The fixed requirement for the PTI of 13 or less does not recognise the predominant influence of different ecological conditions. As a measure to drive best practice management is unknown, but the analysis suggests this is unlikely given that environmental and location factors drive the observed variance in PTI scores. The results suggest the ASC has four possible options to improve the requirements in the salmon standard to better direct industry innovation to achieve the objectives intended from the standard.

The options suggested in the paper were

1. To maintain the present bar at 13 but adjust the calculation to account for single-cage treatments and eliminate the double counting regarding crustaceans toxicity

[1] https://www.asc-aqua.org/what-we-do/our-standards/development-and-review/operational-review-salmon-pangasius-tilapia-standards/

2. To set a fixed bar with a progressive improvement element once an entry gate score is achieved. This would require operational improvements to meet the regional limits in terms of percentage decrease in PTI over the previous two cycles or the cumulative mean as reported to ASC until a value can be derived based on evidence
3. Reformulate PTI to calculate Parasiticide Load, with a progressive improvement element*
4. In addition to the option above also develop a requirement related to the *frequency of paraciticide use* and combine this with a reformulated Parasiticide Load on a progressive and cumulative mean improvement basis*

** In these options the degree of improvement possible due solely to management may have to be refined through time as these need to be calibrated. This would be done by compiling the recorded improvements in the ASC database for review in the light of experience.*

1b) Summary of stakeholder comments received on the PTI paper published by ASC

Nine organisations submitted comments on the proposals for amending the PTI requirements within the salmon standard. Whilst there was general consensus that the PTI requirements needed reviewing, stakeholders called for further research as more information would be necessary to fully consider the impacts of parasiticides and how to assess these.

The option which received the most general support was Policy Option 4, although there were requests for more information on the rationale for this option to ensure that this was a well-informed proposal. Overall, the proposal for region-specific requirements was not supported, due to insufficient information to justify the need for this, and because of the risks involved when using such an approach. Additionally, proposals for developing a ‘frequency of use’ requirement and phased improvements were not supported by stakeholders at the time of publishing. It has been agreed that a working group will be initiated from May 2016 to discuss this further.

Example of comments (for all, see comments file):

General:

“The Parasiticide Treatment Index (PTI) was developed by the SAD (Salmon Aquaculture Dialogue) to be a novel, quantitative means to measure multiple impacts of parasiticde use including toxicity, impact on non-target organisms, and risk of resistance. Although the PTI presents a good first step in assessing complex concerns around parasiticide use, like most new indicators there is opportunity to refine the methodology as more information becomes available over time. The SAD explicitly notes this opportunity for refinement on page 48 stating “the data collected from this requirement will also help the SAD set more measurable requirements in the future”. The discussion paper presented in the Operational Review is a first step in this process, however, the review of data is incomplete, the scope of research is narrow, and the final recommendations are, as a result, poorly conceived and do not appear to meet the short or long term goals of the ASC.”

“They [the papers referenced in the document] should be accessible through either or both of these means.”

“ - Number of treatments per generation should be the main target to reduce
• Rotation between different groups of actives – not more than two treatment with the same group of active per production cycle (generation)
• Products belonging to the same group/mode of action are equal from a resistance point of view and switching between such products has no rationale.

• The allowable number of treatments per generation should be defined in each production region – reduction of 15 % per generation down to an acceptable level – four per generation?
• Current Toxicity factors evaluated, use wider scale and include hydrogen peroxide with a low number The Parasiticide Load should be related to biomass produced/fish harvested in the same period"

Measuring Frequency:

"While the BC Ministry of Agriculture supports reformulating the PTI we do not support a frequency of use requirement nor phased improvements." "Frequency is not as important as total amount released." In a consideration of frequency as a meaningful measure we would like to suggest that instead of frequency being considered a unitary event, a more graded measure should be used whereby the treatment should be expressed as a percentage of the pens treated at one time. "

"This option (4) seems to be a preferred and simple way to determining the risk of selecting resistance." "One might define one treatment as 1. The calculation might be done by counting the total number of treated cages and dividing it by the total number of active (stocked cages) cages at the same site and at the same point of time."

Regional limits vs global:

"The BC Ministry of Agriculture supports a comprehensive review of lice triggers and supports the concept of regionally appropriate lice triggers be developed for the salmon standard."

"While we acknowledge that "sea lice infestation has many regional characteristics and variability," our overarching concern is that the region-specific thresholds proposed for indicator 3.1.7 may be set primarily to help ensure that a majority of farms in each region can meet the threshold, possibly at the expense of increasing risk of harm to wild salmonids."

"We have significant concerns about the suggested shift to applying a regional lens to Principle 5.2 "Therapeutant Treatments". If this principle were to shift towards geographic specific thresholds, it automatically removes the ability to measure impact across regions and overlooks the reality that some geographic locations have an inherently lower environmental risk when it comes to salmon farming."

"We are concerned about the use of country/region specific requirements."

"Rationale for updating limits of PTI scores to reflect regional variations not justified."

Parasiticide load:

"need to measure the amount of chemical used per tonne or area and take into account the toxicty and persistence of the chemical itself while also including some measure of frequency as an indicator of potential resistance."

1c) The PTI working group

The working group establishment was facilitated by the ASC secretariat with direction from the TAG. Members were recruited from the NGO (2+2 from ASC), Industry (3) and Academic (2) sectors based on their technical knowledge of sea lice in salmon and use of treatments. A consultant was also hired to help chair meetings and with the development of the proposals.

Members: Piers Hart (WWF UK), Sharon DeDominicis (Marine Harvest, Canada), Crawford Revie (University of Prince Edward Island), James Bron (University of Stirling), Paolo Jorquera (Blumar), Gordon Ritchie (Marine Harvest), John Werring (David Suzuki Foundation), Chris Ninnes (ASC), Ian Payne (Independent Consultant), Iain Pollard (ASC).

Three in-person meetings where held; one in May 2016, one during the sea lice conference in Sept 2016 and the final meeting in March 2017. Additionally, telephone meetings where held on; 19th Oct 2016, 3rd Nov 2016, 18th Nov 2016, 2nd Dec 2016, Sept 8th 2017.

The working group was set with the task of drafting proposals for replacing the PTI indicators based on the paper and stakeholder consultation.

1d) How the group ended up with the proposed indicators

The working group meetings discussed at length the options for revising the ASC requirements for parasiticide use. The challenge faced was the same faced by the Salmon Dialogue in that constructing a requirement can become very complicated very quickly. There was also a tendency at meetings to circle back to an equation similar in construction to the PTI. The group thus had to be innovative and disciplined in finding a simple and effective solution that would ensure that "significant" negative environmental impacts and resistance associated with parasiticide use are avoided, whilst promoting best practices, ensuring transparency and applying metric limits.

The group initially looked at exploring what option 4 might look like. There was mixed stakeholder support for this but generally this was seen as the preferred option. However, a number of difficulties with using Parasiticide Load (PL) to measure performance kept coming up; 1) it does not take in to account the health of fish and efficacy; 2) it is outside the control of the farm; and 3) the quantity of active ingredient varies by medicine. Also, in order to treat a stock it may be necessary to repeat doses as determined by a veterinarian.

In reality, the PL will also be unpredictable, highly variable, to large extent uncontrollable by the farmer and will be a poor proxy for potential environmental impact. Measurement of marine life in the vicinity of the cage to really find out if there is an impact would be better, however it can be extremely difficult to disentangle the effects of drug residues from the effects of benthic feed deposition. Finally the group concluded that what we really want is to reduce the number of treatments over time.

Regarding the environmental impact of Parasiticide use, it was recognised that although some research exists, the evidence of impact is largely inconclusive. If this information were available, we would be able to prevent impacts where these are identified. Therefore direct monitoring of environmental impact will give assurances about what we're doing and could push the use of medicinal products downwards.

These types of assessments can be physical or can be modelled using software. The Scottish Environment Protection Agency (SEPA) and academic institutions in Chile and elsewhere have carried out studies to determine the presence of medicinal product residues within and outside the farm and evaluate environmental impact. Results are extremely variable and are dependent on chemotherpeutant identity and mode of treatment such that study results are highly variable, with impacts being found in some cases and no trace of the medicinal product found in others. Hence environmental monitoring of impact was seen by some as a requirement to supplement the metric limits.

It is also important to promote non-medicine treatments and use best practice management to reduce lice. These methods may have less impact on other marine life and encouragement of innovation is a key part of the ASC programme. Integrated Pest Management (IPM) for sea lice has long been recognized as being highly important for effective and robust sea lice management.

IPM is based upon proven techniques and approaches to terrestrial parasite management for agriculture systems. The strategy generally involves coordinated application of a diverse range of available management practices, with surveillance, communication and cooperation between operators within a defined area. Management approaches employed should give consideration to the interests of producers, society and the environment. Since IPM serves to reduce dependence upon medicinal treatments and thereby slow development of parasite drug resistance, it is a strategy that ASC intends to promote hence the certification requirement to progress in IPM.

Given the variability of PL as a measure and the ability of farms to more extensively implement IPM, the treatment frequency, in terms of weighted number of treatments, was seen as the best measure of performance and will allow fish health professionals to use more diverse management tools as appropriate for a given context. In line with the above discussion credit can be provided for non-medicinal treatments as part of IPM and a threshold placed on the number of successive repeated treatments using the same chemotherapeutants class in order to further reduce the risk of resistance.

There was significant discussion around setting regional metrics that took account of ecological differences, including consideration of whether these should be set by country or by ecosystem, or whether a global limit was necessary and more appropriate. This was not resolved with consensus. As a result, the ASC proposed that it is necessary to set regional limits because of the differences in global best practices and to drive improvement in all regions. For instance, setting a global limit would make it too easy for some to meet the conditions and too hard for others. Where it is too easy there will be no incentive to improve and where it is too hard, farms will not join the programme and be committed to the time-bound improvements. There needs to be a level that is achievable (by best practice) in all regions and that will drive improvements for all.

The working group also found that the fluctuation in the number of treatments over a cycle creates a need for some flexibility over a limit. So the concept of creating an entry gate was explored, which would allow farms to enter into the programme as long as they met a minimal entry gate level. This was included in the original PTI paper as an option and did not receive much support from stakeholders. Nevertheless, the group saw that an entry gate would bring most environmental benefits whilst excluding the worst performers.

With incentives for continued improvement, it would be expected that the number of treatments would fall over time towards a lower "Global Target". The limit for the entry gate could be set at a level such that the top percentage of farms in a given region would be able to meet the entry gate.

Once the global target limit is reached, a farm does not need to go further, but between the entry gate and global target there needs to be continuous improvement, with the aim of achieving the greatest progress where possible. The requirements should take into account special circumstances / events which are a reality of production.

To set the entry gate and global target levels, a dataset provided from GSI was used (the paper is provided separately). The global target was proposed to be set at the level reached by the top 20% of global producers. The entry gate level was proposed to be set at a level reached by the top 66% or 50% of producers in a given region (data was evaluated to determine the values as shown in the section 1e below). This will bring more people into the process who would be committed to identified, time-bound improvements in order to remain certified. This is a suggestion for the consultation and feedback is sought on these values.

1e) Scientific basis for improvement of parasiticide treatment indicator

The initial metric for indicating the use of parasiticides to treat for sea lice infestation is the Parasiticide Treatment Index (PTI). The main driver of the PTI is the frequency of treatment over a complete production cycle but it has six other modifying multiplication factors including toxicity against Daphnia, resistance and method of treatment. Each modifying factors is subject to its own assumptions and approximations. The PTI is therefore a complex, compound dimensionless indicator. It is a completely novel metric which tries to combine all the complexities of sea lice treatment into a single metric for which there was no previous data set. The SAD set the global requirement at 13 but as it came into use as the salmon standard went operational in 2013, questions arose over how the metric was actually performing and how sensitive it was to change, particularly to improved management.

An independent analysis, summarised in the PTI Report (ASC November 2014), was carried out on a data set collected in a uniform template from producers across the major salmon producing regions which concluded that there were significant differences (p=0.01) in the frequency of PTI scores across the regions which reflected the rather different lice problems faced given that the regions vary in lice species, host species, oceanic conditions and in supporting ecosystems. Moreover, analysis of variance indicated that major driver of PTI scores were these environmental conditions whilst the impacts of management, whilst significant, were much less. The scores also varied from year to year in a way more consistent with the intensity of lice attack which in turn tends to be related to seasonal conditions.

The report suggested a range of options to ASC for modifying the PTI and its requirements but also suggested the possibility of simply using frequency of treatments or the parasiticide load, being the weight of active ingredient put into the water equivalent to the antibiotic load employed within the same principle (P5). The ASC, whilst recognising that the PTI was a valuable start, finally concluded that the rather simpler indicators were more practical and put out two options for consultation:

- The parasiticide load
- The parasiticde load plus frequency of treatment

The use of science based metrics implies the use of the best available scientific data against which to calibrate them. To set requirements in an informed fashion needs a representative data set upon which to base that calibration.

However, the requirements need to take into account the regional differences whilst at the same time arrive at a global standard. To allow for this a two tier system was devised. The first requirement, termed the Entry Gate (EG), is related to the regional situations to allow the farms to enter the improvement process and then there would be a Global Target (GT) for which there is a time-bound plan by which those at the EG to approach by an assessed process of continuous improvement.

Data sources and methods

The collection of an homogenous data set in 2014 created a valid data array against which ASC could judge PTI performance following the analysis in the original PTI Report. It also, however, enabled a view of the pattern of Weighted Number of Medicinal Treatments (WNMT) in the different countries to be produced which provides a platform for a frequency based indicator can be developed.

A total of N=582 farm-years were used (representing a total of just under 3,500 total treatment events). Some 90% of the data came from the years 2009-2013 with a further 8% of 'undefined' year - most likely also one of these years. These data provided a view of the distribution of treatment frequencies across producer countries with the exception of countries such as Australia and New Zealand where the sea lice problem is not an issue due to prevailing ecological conditions and parasiticides are not needed. This data set has been shared with all members of the TWG to allow scrutiny and further analysis.

Since the study reported in 2014 the data set could be a little dated but it does represent equivalent data collected simultaneously across the regions. Other available data sets are more piece meal since they each tend to be regional in focus and not necessarily collected under the same conditions. Never he less, one of the research colleagues on the TWG has been able to analyse some more recent data from regional data sets from British Colombia, Ireland and Norway and produced substantially similar view of frequency distributions.

Entry Gate (EG) and Global Target (GT) thresholds

The mean and median (50 percentile) of the samples from each country are given in Table 1 as taken from the initial data set. Eastern Canada was not part of the original survey but to be comprehensive a data set from the *Fish-i-Trends* system the University of Prince Edward Island run on behalf of East Coast producers was used to produce the equivalent statistics.

Country	Number of Observations	Mean WNMTs	Median 50 percentile	66 percentile	Proposed Entry Gate WNMT
Atlantic Canada			8	8	8
Pacific Canada	61	1.2	1	2	GT*
Chile	80	10	9	12	11
Faeroes	35	5.8	6	8	8
Ireland	13	6.2	3	7	7
Norway	312	5.0	5	6	6
Scotland	84	9.2	9	11	9

Table 1. Frequency statistics of number of treatments per cycle per country.
**GT is Global Target = 4*

Global Target

In arriving at a Global Target for the indicator the question is, what is a treatment frequency below which continuous progress cannot be predictably expected given year to year fluctuations? Taking this into consideration the TWG suggested that the Global Target should be 4 treatments per cycle. This progressive approach towards the target will be driven to a significant extent by the implementation of an IPM strategy. To estimate what percentage of farms might achieve this target it was considered that British Colombia values be omitted from the data since these are unrealistically low. This is because these data are based on the historic 'SLICE only' model (as only SLICE was approved during this period) which was agreed as not a long-term sustainable approach and does not represent the best IPM strategy. Without the BC data, a GT treatment frequency of 4 includes 28% of farm records.

Entry Gate

The Entry Gate is that frequency the producer must achieve to enter the improvement process which leads towards the GT. A view of the frequency distributions is available (PTI Report 20014) along with the basic characteristics of those distributions (Table 1). The differences in these distributions are a function of the different ecological conditions in each region so. To allow for these significant differences the entry point must be relative and not an unrealistic set value. This lead the TWG to consider a percentage of farms that would be likely to meet this and thereby enter the improvement process. An estimate of this is given by the percentile 'break points' in the distributions, hence the median is the break point where 50% of the farms are at or below that value (Table 1).

In considering what would be the most appropriate percentile the value of 66% suggested. The ASC was inclined to be more inclusive because, being committed globally to progressive improvement of standards, it was important to drive improvements through IPM, amongst other management options, towards the Global Target by farms showing a commitment to improvement. The 66 percentile values for WNMTs are given in Table 1.

In the main, these are the values used for the EG however, the estimate for Ireland in Table 1 is based only on 13 records and therefore in arriving at a more representative recommendation, further data from Marine Board of Ireland was consulted. The value for Chile was slightly reduced because the Chilean data was regarded as lacking representative data from Area XII in the extreme south where lice incidence was lower. Regarding Scotland, the number of 11 was considered excessively high when compared to the rest of the North Atlantic regions and was also much higher than has been reported in a number of historical studies (e.g. Revie et al 2010[2], Murray 2016[3]). Consequently, in the light of this historic data, the number was reduced by 2 so that it was more in line with the other surveys (Table 1).

Progress requirements

Implementing an IPM plan is a measure that allows progress towards the final goal. However, it is necessary to measure progress in that direction. Predictably reducing frequency from year to year is very difficult due to year to year fluctuations in the environmental conditions and intensity of lice infestations. Essentially this can only be demonstrated as a trend or against some form of rolling average. To show such a trend requires at least four or five data points which would amount to two three year cycles. Hence the requirement to reduce the WNMT by 25% can only meaningfully be demonstrated from a sufficient time series of records which realistically after the first two cycles have been completed (6 years) in time for the second re-certification audit. Thereafter further assessment can be in preparation for each recertification audit since after the first period there will always be six years of records.

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[2] Revie, C. W. et al (2010). Assessing topical treatment interventions on Scottish salmon farms using a sea lice (Lepeophtheirus salmonis) population model. Aquaculture 306: 191-198

[3] Murray A.G. (2016). Increased frequency and changed methods in the treatment of sea lice (Lepeophtheirus salmonis) in Scottish salmon farms 2005-2011. Pest Management Science 72:322-6. Epub 2015 Mar 16

Annex: Relevant Sections of the ASC Salmon Standard as related to PTI

Indicator	Requirement
5.2.5 Maximum farm level cumulative parasiticide treatment index (PTI) score as calculated according to the formula in Appendix VII	PTI score ≤ 13
5.2.6 For farms with a cumulative PTI ≥ 6 in the most recent production cycle, demonstration that parasiticide load* is at least 15% less that of the average of the two previous production cycles	Yes, within five years of the publication of the ASC Salmon Standard

*Parasiticide load = Sum (kg of fish treated x PTI). Reduction in load required regardless of whether production increases on the site. Farms that consolidate production across multiple sites within an ABM can calculate reduction based on the combined parasiticide load of the consolidated sites.

Rationale for PTI:

"The purpose of the PTI in requirement 5.2.5 is to place a cap on the number of treatments of parasiticides, while taking into account differences in risk associated with each treatment option (the parasiticide), the treatment method and treatment timing (both in term of repeated use of a single parasiticide during a given period of time and the time or year with regard to risk to wild species). In essence, it addresses the frequency of use of the therapeutant on certified farms and key risk factors related to its use. The PTI does not directly address the issue of total amount of parasiticide used in an area because it does not factor in the size of the farm or the amount of fish being treated, and it does not address use on neighboring farms that are not certified.

Since environmental risk from parasiticides is closely linked to total release of active therapeutant into the environment, the SAD requires that, within five years of the publication of the requirement, farms with a cumulative PTI greater than six demonstrate a reduction over time of the parasiticide load from treatments on the farm. Parasiticide load is calculated by multiplying the PTI scores for each parasiticide treatment by the weight of the fish treated. This requirement is consistent with industry efforts to reduce both frequency and amount of parasiticide used, as well as with initiatives to develop treatment methods that do not release active parasiticides into the environment. To encourage thinking about cumulative use across a broader area, tracking of total use of parasiticides is required under the ABM."

Appendix VII: Parasiticide Treatment Index

The PTI is a function of four components as outlined below: therapeutant used, treatment method used, timing of treatment with regard to wild species that are at greatest risk from parasiticides, and the consecutive use of therapeutants that increases risk of resistance developing.

PTI is calculated as follows:
The PTI for any individual treatment is calculated as:
PTIi= [(therapeutant factor)*(treatment factor)*(resistance factor)*(sensitive time factor)]
The farm level PTI over the production cycle is the sum of individual PTIs from each treatment.
Farm level PTI= Σ (PTI1 …..PTIx)

Component 1: Therapeutant factor (for the therapeutant used)
Factor per therapeutant is given in the following table. Therapeutant factor = (Toxicity Factor)*(Persistence Factor)*(Dosage Factor) based on the following rankings:
0 to 2 - toxicity to the environment (based on toxicity data for the indicator species of daphnia)

0 to 3 - persistence in the environment (based on publicly available data)
1 to 3 - typical dosage per unit of fish treated (based on relative data for the substances used within their main group and oral vs. bath treatment)

Parasiticide	Commercial Name	Treatment Mechanism	Toxicity Factor	Daphnia LC50 (µg/l)	Persistence Factor	Dosage Factor	Therapeutant Factor
Diflubenzuron	Releeze	Oral	1	Ranked as teflubenzuron	3	3	9
Teflubenzuron	Ektobann vet. /Calcide	Oral	1	2.8 µg/l	3	3	9
Cypermethrin	Betamax vet.	Bath	2	0.3 µg/l: high concern	2	1	4
Deltamethrin	Alpha max	Bath	2	0.56 µg/l: high concern	3	1	6
Azamethiphos	Salmosan	Bath	2	0.67 µg/l: high concern	1	3	6
Emamectin benzoate	Slice vet.	Oral	2	0.56 µg/l: high concern	2	1	4
Hydrogen Peroxide		Bath	0	Daphnia magna 7700 µg/l	0	3	0

Component 2: Treatment factor (for the method of treatment used)
Treatment methods were assigned weights taking into account risk of that method to the environment in terms of release of chemical to the environment and the degree to which the method allows greater precision in dosing.
- Bath treatment with an open skirt – factor 1 (default)
- In-feed treatment – factor 0.8
- Bath treatment in a closed waterbody (wellboat or tarpaulin) – factor 0.8
- Treatment with no active chemical released into environment*– factor 0.2

*For example, a treatment in a production system where water is not released into the natural environment, or a bath treatment in a wellboat where the chemical is denatured and rendered inactive prior to release to the environment.

Component 3: Resistance factor (for repeat uses of the same therapeutant)
In order to reduce risk of development of resistance of sea lice to treatments, the PTI incorporates a factor for the repeated use of the same treatment.
Default resistance factor = 1
If the same therapeutant is used for more than one treatment within a period of 12 months, the resistance factor is 2 (factor of 2 is applied starting with the second treatment)

Component 4: Sensitive time factor (timing of treatment with regard to wild species)
The factor for timing of treatment with regard to wild species is intended to address concerns about use of parasiticides at times when populations of species potentially affected by the treatment are particularly sensitive. As noted in the report of the SAD Technical Working Group on Chemical Inputs, parasiticides present a greater risk to crustaceans than other species because of their modes of action. Scientific review and conversations with experts suggest that there is not a clear period that presents a greater risk at a population level for crustacean species other than lobsters. Therefore, only lobsters are addressed in this iteration of the PTI within the "sensitive timing" factor. Because there isn't a clear "riskier" period for populations of other crustaceans, the best way to address this is to reduce frequency of treatments by reducing the PTI.

- The default “sensitive timing” factor is 1.
- If the farm area (discharge area) contains lobsters, and if the species is in a time-limited phase where the population is known to be sensitive or are in a known sensitive period, the “sensitive timing” factor is 4.5. Whether lobsters are present in the farm area shall be considered in the environmental impact assessment in requirement 2.4.1, as is outlined in Appendix I-3.

Sensitive time periods for which the higher factor shall be used are:
- For American lobster on the east coasts of the US and Canada: July 1 – August 31
- For European lobster In Norway and the UK: July 1 – August 31

Example Calculation

In the example scenario below, the farm used four treatments of parasiticide over the course of the production cycle. The PTI for each treatment is calculated and then summed to determine the total PTI. None of the treatments in this scenario took place during a time denoted as especially sensitive to wild species in the area. The second treatment of emamectin benzoate is given the higher resistance factor as it, in the example below, took place within 12 months of the prior treatment of the same therapeutant.

Treatment	**Therapeutant**	**Therapeutant factor**	**Treatment factor**	**Resistance factor**	**Sensitive time**	**PTI**
1	Emamectin benzoate	4	0.8	1	1	3.2
2	Emamectin benzoate	4	0.8	2	1	6.4
3	Azamethiphos	6	0.8	1	1	4.8
4	Deltamethrin	6	0.8	1	1	4.8
Sum PTI						**19.2**

Updating PTI with new information

If new therapeutants become available for sea lice treatment, or if new treatment methods are developed, the Technical Advisory Group of the ASC may be asked to determine a therapeutant factor or treatment factor for that new parasiticide or new method, following guidelines for assignment of factors left by the SAD SC.