Monterey Bay Aquarium Seafood Watch®

Seafood Watch® Criteria for Aquaculture

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Monterey Bay Aquarium
Seafood Watch®

Seafood Watch® Criteria for Aquaculture

Public comment period – 1

Introduction

The Monterey Bay Aquarium is requesting feedback on the Seafood Watch Aquaculture Assessment Criteria during our current revision process. Before beginning this review, please familiarize yourself with all the documents available on our Standard review website.

The goal of the first public comment period is to gather expert opinion and suggestions for improvement on the current version of the Seafood Watch criteria.

Providing feedback, comments and suggestion

This document contains the current version of the Seafood Watch Aquaculture Criteria. A number of "Guidance for public comment" sections have been inserted and highlighted, and various general and specific questions have been asked throughout. Seafood Watch welcomes feedback and particularly suggestions for improvement on any aspect of the criteria from specific calculations, to the structure of individual criteria, and including the broader approach taken by Seafood Watch with respect to sustainable aquaculture. Please feel free to comment on any section of relevance to your expertise, and in general:

- Please provide solutions or suggestions for improvement wherever possible.
- Please support your feedback with references wherever possible.
- Please suggest additional experts to contact wherever possible.

Before beginning this review, please familiarize yourself the documents available on our standard review website, and with the Seafood Watch ratings and guiding principles for farm-raised seafood below.

Seafood Watch Ratings and Guiding Principles

The Seafood Watch Assessment Criteria for Aquaculture result in a Seafood Watch rating of Best Choice (green), Good Alternative (yellow), or Avoid (red). The assessment criteria are used to determine a final numerical score as well as numerical sub-scores and color ratings for each criterion. These scores are translated to a final Seafood Watch color rating according to the

methodology described in the table below. The table also describes how Seafood Watch defines[1] each of these categories. The narrative descriptions of each Seafood Watch color rating category, and the guiding principles listed below, compose the framework the criteria are based on, and should be considered when providing feedback on any aspect of the criteria.

Best Choice	Final Score >6.6[2], **and** no Red Criteria, **and** no Critical[3] scores	Wild-caught and farm-raised seafood on the "Best Choice" list are ecologically sustainable, well managed and caught or farmed in ways that cause little or no harm to habitats or other wildlife. These operations align with all of our guiding principles.
Good Alternative	Final score >3.3 and <6.6, **and** no more than one Red Criterion, **and** no Critical scores.	Wild-caught and farm-raised seafood on the "Good Alternative" list cannot be considered fully sustainable at this time. They align with most of our guiding principles, but there is either one conservation concern needing substantial improvement, or there is significant uncertainty associated with the impacts of this fishery or aquaculture operations.
Avoid	Final Score <3.3, **or** two or more Red Criteria, **or** one or more Critical scores.	Wild-caught and farm-raised seafood on the "Avoid" list are caught or farmed in ways that have a high risk of causing significant harm to the environment. They do not align with our guiding principles, and are considered unsustainable due to either a critical conservation concern, or multiple areas where improvement is needed.

Aquaculture Guiding Principles

Sustainable aquaculture farms and collective industries, by design, management and/or regulation, address the impacts of individual farms and the cumulative impacts of multiple farms at the local or regional scale by:

1. **Having robust and up-to-date information on production practices and their impacts publically available;**
   Poor data quality or availability limits the ability to understand and assess the environmental impacts of aquaculture production and subsequently for seafood purchasers to make informed choices. Robust and up-to-date information on production practices and their impacts should be publically available.
2. **Not allowing effluent discharges to exceed, or contribute to exceeding, the carrying capacity of receiving waters at the local or regional level;**
   Aquaculture farms minimize or avoid the production and discharge of wastes at the farm level in combination with an effective management or regulatory system to control the location, scale and cumulative impacts of the industry's waste discharges.
3. **Being located at sites, scales and intensities that maintain the functionality of ecologically valuable habitats;**
   The siting of aquaculture farms does not result in the loss of critical ecosystem services at the local, regional, or ecosystem level.

[1] Each criterion is scored from 1 to 10 based on sub-factor scores, as described in the document below. Criteria scoring <3.3 are considered "red" criteria.
[2] Very severe conservation concerns receive "critical" scores, which result in an Avoid recommendation.

4. **Limiting the type, frequency of use, total use, or discharge of chemicals to levels representing a low risk of impact to non-target organisms;**
   Aquaculture farms avoid the discharge of chemicals toxic to aquatic life or limit the type, frequency or total volume of use to ensure a low risk of impact to non-target organisms.
5. **Sourcing sustainable feed ingredients and converting them efficiently with net edible nutrition gains;**
   Producing feeds and their constituent ingredients has complex global ecological impacts, and the efficiency of conversion can result in net food gains or dramatic net losses of nutrients. Aquaculture operations source only sustainable feed ingredients or those of low value for human consumption (e.g. by-products of other food production), and convert them efficiently and responsibly.
6. **Preventing population-level impacts to wild species or other ecosystem-level impacts from farm escapes;**
   Aquaculture farms, by limiting escapes or the nature of escapees, prevent competition, reductions in genetic fitness, predation, habitat damage, spawning disruption, and other impacts on wild fish and ecosystems that may result from the escape of native, non-native and/or genetically distinct farmed species.
7. **Preventing population-level impacts to wild species through the amplification and retransmission, or increased virulence of pathogens or parasites;**
   Aquaculture farms pose no substantial risk of deleterious effects to wild populations through the amplification and retransmission of pathogens or parasites, or the increased virulence of naturally occurring pathogens.
8. **Using eggs, larvae, or juvenile fish produced from farm-raised broodstocks thereby avoiding the need for wild capture;**
   Aquaculture farms use eggs, larvae, or juvenile fish produced from farm-raised broodstocks thereby avoiding the need for wild capture, or where farm-raised broodstocks are not yet available, ensure that the harvest of wild broodstock does not have population-level impacts on affected species. Wild-caught juveniles may be used from passive inflow, or natural settlement.
9. **Preventing population-level impacts to predators or other species of wildlife attracted to farm sites.**
   Aquaculture operations use non-lethal exclusion devices or deterrents, prevent accidental mortality of wildlife, and use lethal control only as a last resort, thereby ensuring any mortalities do not have population-level impacts on affected species.
10. **Avoiding the potential for the accidental introduction of non-native species or pathogens during the shipment of live animals;**
    Aquaculture farms avoid the international or trans-waterbody movements of live animals, or ensure that either the source or destination of movements is biosecure in order to avoid the introduction of unintended pathogens, parasites and invasive species to the natural environment.

Seafood Watch® Criteria for Aquaculture

Public comment guidance - This section contains the standards preamble. We are not requesting specific feedback on this section, but feel free to comment on this general background information.
Comment

The Monterey Bay Aquarium is committed to inspiring conservation of the oceans. To this end, Seafood Watch®, a program of the Monterey Bay Aquarium, researches and evaluates the environmental impact of aquaculture products and shares these seafood recommendations with the public and other interested parties in several forms, including regionally specific Seafood Watch pocket guides, smartphone apps and online at www.seafoodwatch.org. Seafood Watch® defines "sustainable seafood" as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems.

This document contains the sustainability criteria by which aquaculture species and production systems are evaluated for the purpose of developing a seafood recommendation for consumers and businesses. Accompanying documents include a calculation and scoring tool and guidance document, both available online at www.seafoodwatch.org. Wild capture seafood sources are evaluated with a different set of criteria.

Aquaculture is the process of converting resources from one form to another more desirable form via aquatic animals and plants. This process offers the potential for substantial economic and social benefits but has complex ecological, social and economic costs. The long-term sustainability of aquaculture depends on a balance and synergy of these costs and benefits. Overall, maximizing the social and economic benefits of aquaculture continues to be the driver for, and focus of, both subsistence and industrial production. **These criteria focus on the environmental aspects** of aquaculture and provide a tool to assess and highlight the ecological impacts and costs, thereby helping to inform and understand the ecological sustainability of different aquaculture systems.

Scope

These criteria can be applied to all aquaculture species and production systems at all scales from individual farms to regional, national and international industries. Reference is made to 'fish' throughout for clarity, with the recognition that this term applies to all species of fish, shellfish, crustacea and aquatic plants.

Public comment guidance - The scope of the Seafood Watch criteria is important, and it is essential to note that any suggestions for improvement must be applicable to all species, all production systems and any location globally. We typically make recommendations at the country level, but we also do (and are increasingly asked to do) regional, company, or site-specific recommendations.
Comment:

General Question 1 - Given the practical challenges of assessing the sustainability of farmed

seafood, should the approach of Seafood Watch change with respect to how it assesses aquaculture at the country, region or farm level? Are there new opportunities or new ideas? Could, or should Seafood Watch take an entirely different approach to farm-raised seafood?
Comment: No – regional assessment are most useful on the consumer end of things. Farm-level assessments should be done if there are marked differences in production systems, but on the whole production practices for farm-raised seafood are fairly uniform by species/production method.

General Question 2- While the country and regional recommendations continue to be important to consumers and major buyers, should Seafood Watch revise the criteria entirely to form a more typical "checklist" type standard format that is more applicable, (and potentially auditable) at the farm level?
Comment:

Any other general feedback?
Comment:

Table of Contents

Public comment guidance – The contents page provides an opportunity to see the full list of ten criteria. These criteria are based on common impact categories associated with aquaculture within the academic literature, expert opinion, and aquaculture certification schemes. We welcome feedback on this list at the broad level of inclusion; i.e. are these the correct impact categories to be considering in an assessment of aquaculture's environmental sustainability? Assessments using these criteria are complex and time consuming, and we would also welcome feedback and suggestions for their simplification. Note that Seafood Watch does not currently intend to assess socioeconomic or human health impacts and defers to other organizations with specific expertise.

Comment:

Criterion 1 - Data

Public comment guidance.
Overview - The data criterion is intended to reward the concept of publically available high quality information. Good quality data is important to making robust Seafood Watch sustainability assessments and is greatly preferable to the alternative of applying a precautionary principle in the situations where good quality data is lacking. In reality, few aquaculture industries have good quality data publically available.

Specifics - We have currently chosen to make direct assessments using whatever data is available. The data criterion does contribute to the overall final score, but it is not currently used as an indicator of robustness or confidence for the assessment. It would be possible to apply the individual data scores to their respective criteria assessments or to the overall final score to adjust them and/or indicate the confidence or robustness of the result, however we currently do not want to change the outcome of the assessment based on good or bad data availability.

Feedback - We welcome feedback on any aspect of this criterion, and would also welcome suggestions for improvements, including an entirely different approach or structure for this criterion.

General comments:

- **We would like to see the inclusion of 'publicly available' in the descriptors of High Data Quality score (10 out of 10 for sure and perhaps even 7.5 out of 10). Transparency and publicly available data is a key leverage point of these criteria and foundational to the development of a sustainable industry (as it promotes social license).**

- **It says in the preamble above that you do not want to change the outcome of the assessment based on good or bad data availability – we believe that this position should be reconsidered in situations where data availability is very low (i.e. 2.5 or lower), such that a critically low data availability score would trigger an overall red recommendation.**

- **I still find the 'other' category in this criterion awkward – how do you assess the quality of data for a category that is not being scored? This is very arbitrary and I think could be eliminated.ai**

-

Impact, unit of sustainability and principle

- *Impact:* Poor data quality and availability limits the ability to assess and understand the impacts of aquaculture production. It also does not enable informed choices for seafood purchasers or enable businesses to be held accountable for their impacts.
- *Unit of sustainability:* The ability to make a robust sustainability assessment.
- *Principle:* Robust and up-to-date information on production practices and their impacts is available to relevant stakeholders.

Assessment scale

- Farm-level assessments – apply this criterion to the farm being assessed, or at a broader level, where relevant (e.g., national regulations or enforcement).

- Regional or national assessments – apply to regional or national statistics, or relevant impacts. Use "typical" or "average" farms within the region or country, where necessary.

Data: Factor 1.1 – Data relevance

Not all of the following data categories will be relevant to every aquaculture assessment. To begin, confirm which data categories are relevant to the aquaculture operations being assessed.

Specify in the scoring table below which of the following categories (A–J) are relevant to the assessment (Category A is always considered relevant).
For example, Category F would not be relevant for a non-fed (e.g., extensive) aquaculture system or rope-grown shellfish.

	Data Category
A	Production data – industry or farm size and production volumes, species, number and locations of farms or sites
B	Effluent – water quality testing, impact monitoring, regulatory control and enforcement
C	Habitat – farm locations, habitat types, impact assessments, history of conversion, habitat monitoring, habitat regulatory control and enforcement
D	Predator and wildlife mortality rates and population impacts
E	Chemical use – type, frequency, dose and discharge
F	Feed use – ingredients and sources, eFCR, inclusion rates of fishmeal and oil (including by-products), vegetable or crop meals and oils, land animal products and by-products
G	Escape numbers and size of animals, recapture or survival rates, international live animal movements, species and domestication status
H	Disease outbreaks, mortalities, pathogen and parasite levels and treatments, biosecurity characteristics
I	Source of farm stocks, use of wild fisheries for broodstock, larvae or juveniles
J	Other – e.g., energy use for water pumping or aeration

Data: Factor 1.2 – Data quality

A measure of the availability and quality of relevant data.

For each of the relevant categories A–J above, select the appropriate data confidence score according to the following definitions or guidelines, and fill in the scoring table below. While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Quality	Examples of Data Availability, Quality and Confidence	Score
High	▪ Independently verified, peer-reviewed research, official regulatory monitoring results or government statistics ▪ Complete, detailed, and available without averaging or aggregation ▪ Up to date within reason, and covering relevant timeframes ▪ Collected using appropriate methods (e.g., frequency of collection, number of data points, etc.) ▪ Overall, assessor confidence is high that the operation and its impacts are fully understood	10
Moderate-high	▪ Data quality does not meet the 'High' standards above but are complete and accurate in relation to this assessment ▪ Up to date within reason, and covering relevant timeframes; data gaps may be present but are non-critical ▪ Some non-critical aggregation or averaging may have taken place ▪ Data collection methods (e.g., frequency of collection, number of data points, etc.) are considered robust ▪ Overall, data are still considered to give a reliable representation of the operation(s) and/or impacts	7.5
Moderate	▪ Data may not be verified ▪ Some loss of relevant information may have occurred through data gaps, averaging or aggregation ▪ Data collection methods are questionable or unknown ▪ Data provides some useful information, but the assessor (subjectively) is uncertain whether data fully represent the farming operations	5
Low-moderate	▪ Data probably not verified ▪ Weaknesses in time frames or collection methods; data gaps or aggregation and averaging mean that critical interpretation is not possible ▪ Data provide little useful information and are not sufficient to give confidence that the operation and its impacts are well understood	2.5
Low	▪ Data are incomplete or out of date, unverified, or collection methods are inappropriate ▪ Data do not provide useful information and are not considered to represent the operation(s) and/or impacts	0

Data: Scoring table

For each relevant category, enter the data quality value in the 'Score' column.

	Data Category	Relevance Y / N	Quality 0-10	Score
A	Industry/farm statistics	Y[4]		
B	Effluent			
C	Locations/habitats			
D	Predator and wildlife			
E	Chemical use			
F	Feed			
G	Escapes, animal movements			
H	Disease			
I	Source of stock			
J	Other (e.g., energy use)			
			Total	

$$\text{Data Score} = \left(\frac{\text{Total}}{\text{Number of relevant categories A-J}} \right)$$

Final data criterion score = _____ (range 0–10)

Note: In the majority of cases, the Seafood Watch Aquaculture Criteria have been constructed so that increasing data availability leads to a more robust assessment, but is also rewarded with the potential for better scores.

Public Comment - Criterion 1 - Data Final comments and feedback
Comment:

Criterion 2 - Effluent

Public comment guidance.
Overview – The large scale production of terrestrial and aquatic animals typically produces substantial quantities of waste whose disposal may have the potential to exceed the carrying capacities of some receiving environments. Improved feeding efficiencies have reduced relative waste production and both environmental monitoring and awareness have also improved. However many aquaculture industries have also increased the scale and intensity of their total waste production. It can be argued that there are now few global examples of egregious effluent discharge practices at the farm level or collectively at the regional or zonal level, nevertheless,

[4] Industry/farm production statistics are always a relevant category.

effluent production continues to be a key aspect of industrial aquaculture production.

Specifics - The effluent criterion currently has two options for assessing the direct and potential cumulative impacts of the discharge of nutrient wastes from farms. The first is the "evidence" based option which is a straightforward assessment of the impacts in situations where there is sufficient data to robustly indicate what the impacts (if any) are. In the current criteria, this evidence-based option can only be used if the Data Criterion score for effluent is at least 7.5 out of 10. The second assessment option is a (somewhat complex) calculated estimate of the risk of impact based sequentially on the amount of waste produced by the fish, the proportion of that waste actually discharged from the farm, and the effectiveness of the farm management and/or local regulatory system in place to prevent direct or cumulative impacts from those discharges. Due the greater availability of data, nitrogen has been used as a proxy for waste production and potential impacts, even though in many circumstances phosphorous may be the dominant real-world indicator.

Feedback - We welcome feedback on the broad overview and concept of this criterion, along with suggestions to improve the specifics of how this criterion can be assessed. Currently it's complex, and we welcome suggestions for an entirely different approach or structure for this criterion.

General Comments:

Impact, unit of sustainability and principle

- *Impact:* Aquaculture species, production systems and management methods vary in the amount of waste produced per unit of production. The combined discharge of farms, groups of farms or industries contribute to local and regional nutrient loads.
- *Unit of sustainability:* The carrying or assimilative capacity of the local and regional receiving waters beyond the farm or its allowable zone of effect.
- *Principle:* Aquaculture operations minimize or avoid the production and discharge of wastes at the farm level in combination with an effective management or regulatory system to control the location, scale and cumulative impacts of the industry's waste discharges beyond the immediate vicinity of the farm.

Assessment guide

- This criterion applies to effluent effects outside the farm boundary or beyond an allowable zone of effect. Effluent impacts within the farm's boundary, immediate area or allowable zone of effect are addressed in Criterion 3 – Habitat.
- If good research or data are available, you may use either the Evidence-Based Assessment table below OR the Risk-Based Assessment (Factor 2.1 and 2.2).
- If the assessed operations do not have good effluent and/or impact data, or they cannot be easily addressed using the Evidence-Based Assessment, use Factor 2.1 and 2.2 below:

Effluent: Evidence-Based Assessment (based on good data availability and quality)

The Evidence-Based Assessment is the preferred method and should be used if good research or data are available (i.e. a Criterion 1 – Data score of 7.5 or higher for the Effluent category). To complete the Evidence-Based Assessment, consider the available data and select the most appropriate score from the examples in the table below.

While data specific to the species, geographic region, and production system under assessment is preferable, general information on effluents resulting from the production system under assessment should be considered if shown to be relevant.

In the table, 'impacts' are defined as evidence of eutrophication, low dissolved oxygen, high sulphide contents, low redox potential, algae blooms, changes in species diversity or community structure associated with excess nutrients, salination or other relevant measurements or indicators of exceeding the nutrient carrying capacity of the local or regional environment at any time over multiple production cycles, particularly including periods of peak biomass, harvest and occasional operations (e.g., pond flushing or cleaning).

Impacts "beyond the immediate vicinity of the farm or discharge point" are suggested as beyond 30 m from the farm boundary or discharge point, or beyond an Allowable Zone of Effect (AZE). Impacts within the AZE are considered in Criterion 3 – Habitats.

While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Effluent Concern	Effluent or Pollution Examples	Score
No concern	▪ The species produced is extractive, or not provided external feed or nutrient fertilization and has no other effluent or waste impacts ▪ The production system does not discharge[5] wastes, or data show all wastes are treated on site, or collected and disposed of appropriately ▪ Data show the effluent discharged is of the same quality as the influent water supply	10
Low	▪ Data show no evidence that effluent discharges cause (or contribute to cumulative) local or regional impacts	8
Low-moderate	▪ Data show no evidence that discharges cause (or contribute to cumulative) impacts beyond the immediate vicinity of the farm or discharge point[6]	6
Moderate	▪ Data show only occasional, temporary or minor[7] evidence of impacts beyond the immediate vicinity of the farm or discharge point, or contributions to cumulative local or regional impacts	4
Moderate-high	▪ Data show evidence of frequent impacts beyond the immediate vicinity of the farm or discharge point, or contributions to cumulative local or regional impacts	2
High	▪ Data show discharges consistently cause impacts beyond the immediate vicinity of the farm or discharge point, and/or	0

[5] Soluble and solid nutrient wastes – including solids such as pond sludge, filter solids, etc.
[6] Immediate vicinity – as a guide, beyond 30 m from the farm, or beyond an allowable zone of effect
[7] Occasional, temporary or minor – as a guide, exceedences of regulatory limits or other values occur in less than 10% of the measurements within a year or less than 10% of the total duration of a year, and are not considered to have any lasting impact beyond the exceedence period.

	contribute to cumulative local or regional impacts	
Critical	▪ Data show discharges from aquaculture operations lead to population declines in key indicator species beyond the immediate vicinity of the farm or discharge point, or result in mortality of protected or endangered species	C

**Note:* intermediate values (i.e., 1,3,5,7 or 9) may be used if needed.

Effluent criterion score = _____ (range 0–10)

If the assessed operation(s) cannot be addressed using these categories, or if the Criterion 1 – Data score is less than 7.5 for the Effluent category, continue to the Risk-Based Assessment and Factors 2.1 and 2.2 below:

Public comment guidance – Please provide any comments or suggestions below on the approach taken by this evidence-based assessment.

Question – if illegal effluent activities are taking place (e.g. illegal sludge dumping from ponds), should this automatically result in a red recommendation, or should evidence regarding the actual environmental impacts take precedent (if it is available)? That is, if the impacts of an illegal activity are ecologically sustainable, should we penalize the assessment score?

Comment:

- Qualifying scores 8 – C above relative to "the immediate vicinity of the farm or discharge point" suggests there is overlap in this criterion with Criterion 3. As I read it, C2 is an assessment of the environmental impact of effluents (solids and soluble) whereas C3 is an assessment of the environmental impact of actual farm siting. However, qualifying both criteria based on the AZE does not provide a clear distinction between the two criteria.

- We agree that the evidence-based assessment is likely a more robust assessment matrix (the risk-based assessment being a complex calculation with multiple assumptions built in), however we believe that the assessment of the management effectiveness included in the risk-based assessment is a critical component to the overall scoring of effluent impact (appropriate monitoring, reporting and auditing are key criteria to ensuring minimal impacts of effluent, particularly at a cumulative level). This is in-part mitigated/addressed by ensuring that the evidence-based assessment is only used when a there is a data score of 7.5 or 10, but in practice a high data-score does not equate to effective management practices. We would suggest including scaled language in all of the options above as to what minimum management requirements are for each of the tiered scores, or at the very least better qualify what 'data' needs to be available (dissolved oxygen, sulphide levels, TSS, P or N levels, etc.).

- A potential suggestion/option moving forward:

  1. Develop the management effectiveness database by country (as originally intended) based on the criteria for in F. 2.2. This will provide a general management score for

each country/region. Include an additional qualifier to each of the score categories in the evidence-based assessment that requires a minimum management effectiveness score for the region being assessed (which could be referenced in the mgmt. effect. Database now created). This could potentially allow you to remove the risk-based assessment entirely.

- As for the question posed above re illegal dumping... Illegal activity – even if it is perhaps within "ecological sustainability limits" - should **not** be condoned in these criteria!

Effluent: Risk-Based Assessment (based on poor data availability or quality)

Effluent: Factor 2.1 – Waste discharged per ton of fish

A measure of the amount of waste discharged from the farm per ton of fish produced, using nitrogen as the most data-rich proxy indicator.

Factor 2.1 is a combination of the waste produced per ton of fish (2.1a) and the proportion of that waste that is discharged from the farm, which is dictated in general by the production system (2.1b).

Factor 2.1a – Biological waste production per ton of fish
A measure of the amount of nitrogenous waste[8] produced for each ton of fish produced.

a) Protein content of feed = _____ %
b) Economic feed conversion ratio (eFCR[9]) = _____
c) Fertilizer nitrogen input per ton fish produced = _____ kg N t^{-1}
d) Protein content of harvested whole fish = _____ %
e) Protein nitrogen content factor = 0.16 (fixed value; protein is 16% nitrogen)

Nitrogen input per ton of fish produced = (a x 0.16 x b x 10) + c = _____ kg N t^{-1}

Harvested nitrogen per ton of fish produced = (d x 0.16 x 10) = _____ kg N t^{-1}

Waste N produced per ton of fish = N input - harvested N = ____ kg N t^{-1}
Factor 2.1a score = _____ kg N t^{-1}

[8] Although phosphorous wastes are also important, particularly in freshwater systems, nitrogen data is much more accessible and therefore used as an overall proxy for waste.
[9] eFCR = total feed inputs divided by total harvested fish output over the entire production cycle. It should ideally be averaged over multiple production cycles and take account of seasonal differences (e.g., wet or dry season, age of fish). If these data are not readily available, be precautionary and use the best data available.

Factor 2.1b – Production system discharge

This factor assesses how much of the waste produced by the fish is actually discharged from the farm; it acts as a multiplier value (between 0 and 1) for Factor 2.1a. A score of 1 means 100% of the waste produced is discharged; a score of zero means none of the waste is discharged (e.g., a system that assimilates, collects, treats or otherwise appropriately disposes of all wastes).

Select the basic scores and adjustments for the production system from the table below. If data are available on waste loss, waste treatment, waste collection or other aspects of the production system that reduce the loss of the nutrients, use them where possible (marked by 'X'). If no data are available, use the pre-selected values[10].

Public comment Guidance - The values in the table below are from a number of papers on nutrient dynamics in various aquaculture systems. We welcome feedback and suggestions for improvement, noting that the criteria must function across all species and all production systems globally. Please provide references where possible.
Comment:

System Characteristic	Basic Score	Adjust
Nets, cages and pens		
Open exchange net pens or cages	0.8	
Modified cages (e.g., 'diapers') – provide data on waste collection	X	
Adjustment – other – provide data		-X
Ponds		
Ponds – unknown operation, or operating as a flow-through raceway system	1.0	
Ponds – daily exchange	0.51	
Ponds – discharge once per cycle, exchange at harvest	0.34	
Zero exchange ponds over multiple cycles	0.24	
Ponds – other – provide data	X	
Adjustment – settling pond adjustment (daily use with discharged water; minimum 12 hours retention time)		-0.17
Adjustment – use of settling pond for discharged harvest water		-0.1
Adjustment – proper sludge disposal adjustment		-0.24
Adjustment – other – provide data		-X
Raceways or tanks		
Raceways, tanks – operating as flow-through	1.0	
Raceways, tanks – flow-through with solids filtration, collection and appropriate disposal	0.8	
Raceways, tanks – recirculation system, solids collection plus biofiltration treatment (or other) for soluble wastes; minimal water exchange	0.2	
Raceways, tanks – other treatment system – provide data	X	
Adjustment – inappropriate disposal of collected solid wastes		+ 0.2

[10] Based on the scientific literature for farm-level discharges.

Adjustment – other – provide data		-X
Other systems		
Provide data	X	- X
Other adjustments		
Adjustment - use of IMTA or other nutrient uptake system – provide data on N uptake		- X
Other adjustments		X

Basic (unadjusted) production system discharge score = _____
Adjustment 1 = _____ (leave blank if no adjustments)
Adjustment 2 = _____
Adjustment 3 = _____
Factor 2.1b: Discharge score = _____ (range 0-1)
Note: the final discharge score must be between 0 and 1 (i.e., between 0 and 100% of the waste produced is discharged).

Factor 2.1 score:
Waste discharged = Waste produced x Production system discharge score
Waste discharged per ton of fish = 2.1a x 2.1b = _____ kg N ton^{-1}

Public Comment Guidance - The values in the table below are a simple way of converting waste production values into a 0-10 scale. They are based on common literature values from different species and production systems.

Comment:

Discharge Description	**Value (kg N ton^{-1})**	**Score**
	0	10
Low	0.1 – 9.9	9
	10 – 19.9	8
Low-moderate	20 – 29.9	7
	30 –39.9	6
Moderate	40 – 49.9	5
	50 – 59.9	4
Moderate-high	60 – 69.9	3
	70 – 79.9	2
High	80 – 89.9	1
	> 90	0

Factor 2.1 score = _____ (range 0–10)

Effluent: Factor 2.2 – Management of farm-level and cumulative impacts

This factor is a measure of the presence and effectiveness of laws, regulations, management control measures, or eco-certification (appropriate to the scale of the industry) to limit the *total*

discharge of wastes from farms and the *cumulative* impacts of aquaculture effluent from multiple farms to within the carrying capacity of the receiving environment.

The above waste score (Factor 2.1) is on a "per ton of production" basis, and therefore does not directly measure the total amount of waste discharged from one or more farms, or the impacts of these wastes. Even aquaculture operations that produce a lot of waste per ton of production can have a minimal overall impact if the farm's size and location, or the concentration and connectivity of multiple farms are well managed or regulated. Similarly, aquaculture operations that discharge relatively small amounts of waste per ton of production could have substantial impacts if the farms are large and/or concentrated.

Assessment scale

- Farm level – apply at the farm level, if applicable farm level certification or management practices are present, otherwise apply at the regional or country level according to the relevant control measures.

- Regional or country – apply the relevant regional or national control measure (or eco-certification if applicable) to the "average" farm.

Note: It is considered unacceptable for farms, industries or countries that export farm-raised seafood to be less than fully transparent about the environmental management measures and regulations that control the way the exported seafood was produced. This includes making those measures and regulations available in the language of the importing countries.

Factor 2.2a – Intent and content of effluent regulations and management measures

Using the relevant FAO National Aquaculture Legislation Overview (NALO) country factsheet, answer the following questions on effluent regulations. If the relevant country factsheet is not available, search the FAO's FAOLEX legislative database.

NALO - http://www.fao.org/fishery/collection/nalo/en
FAOLEX - http://faolex.fao.org/faolex/index.htm

An additional search should be made (or contact initiated with relevant country experts) to check for recent legislation enacted since the last update of these databases.

For third party certified farms or other independently verified standards, it is acceptable to answer the questions relating to the relevant standards and inspection/audit process where these are considered to be more robust than the regulatory (or other) system.

Note: "Control measures" refers to policies, legislation or regulations, and/or independently verified management measures, codes of practice, Best Management Practices or certification schemes that have the appropriate language[11] and authority for enactment. The next factor (2.2b) assesses the enactment and enforcement of such measures.

Public comment Guidance – Up to date information on aquaculture regulations is typically

[11] Appropriate language – avoidance of 'should', 'minimize', etc.

challenging to find, and the structure and scoring of this section provides only a rough estimate of the risk of cumulative effluent impacts. We welcome feedback and suggestions for improvement on how the criteria can assess the potential cumulative impacts at the water-body or zonal level.

Comment:

- We would like to see standardized scores for management effectiveness by region/country. In nearly all circumstances aquaculture management (where it exists) is carried out at a regional or country level, meaning that these scores should be consistent across reports, however that is not always the case. In the current scoring tool on F2.2 and F3.2 it reads "*it is our intention to hire a contractor with environmental or marine law experience to build a database of management effectiveness scores across a variety of countries".* We understand that it has been challenging to do this, but would suggest that this be a high priority moving forward.
- It may be worth adding qualifying language as to what effluent regulations should be addressing (i.e. a minimum standard that effluent regulations cover monitoring and reporting of redox potential or sulphide levels, dissolved oxygen, phosphorous or nitrogen (depending on environment), etc.)

Scoring answers: Yes = 1; Mostly = 0.75; Moderately = 0.5; Partly = 0.25; No = 0

Questions	Score
1 – Are effluent regulations or control measures present that are designed for or are applicable to aquaculture[12]?	
2 – Are the control measures applied according to site-specific conditions and/or do they lead to site-specific effluent, biomass or other discharge limits?	
3 – Do the control measures address or relate to the cumulative impacts of multiple farms?	
4 – Are the limits considered scientifically robust and set according to the ecological status of the receiving water body?	
5 – Do the control measures cover or prescribe monitoring of all aspects of the production cycle including peak biomass, harvest, sludge disposal, cleaning, etc?	
Total = (0–5)	

Factor 2.2a score = _____ (0–5)

Factor 2.2b – Enforcement of effluent regulations and management measures

The most comprehensive regulations or management measures are worthless without effective enactment and enforcement, yet these aspects are typically difficult to assess. Contact enforcement agencies and in-country NGO, academic or industry experts to answer the following questions.

[12] Designed for or applicable to aquaculture – as opposed to regulations designed for fisheries, agriculture or other activities or industries that are poorly related to the needs of aquaculture regulation. Aquaculture certification standards should receive a 'yes' score.

If the assessed operation's third-party certification is the most relevant example of good management, then apply the questions to the inspection/auditing and certification process.

Scoring answers: Yes = 1; Mostly = 0.75; Partly = 0.5; Slightly = 0.25; No = 0

Questions	Score
1 – Are the enforcement organizations and/or resources identifiable and contactable and appropriate to the scale of the industry?	
2 – Do monitoring data or other available information demonstrate active enforcement of the control measures?	
3 – Does enforcement cover the entire production cycle (i.e., are peak discharges such as peak biomass, harvest, sludge disposal and cleaning included)?	
4 – Does enforcement demonstrably result in compliance with set limits?	
5 – Is there evidence of robust penalties for infringements?	
Total = (0–5)	

Factor 2.2b score = _____ (0–5)
Factor 2.2 score = (2.2a x 2.2b) / 2.5

Factor 2.2 effluent management score = _____ (range 0–10)

Final effluent criterion score
Although reducing waste produced per ton of production is important, the total or cumulative amount of waste produced by the farms and the industry is typically more important.

The effectiveness and enforcement of the management regime is most relevant to controlling farm size, total waste discharge and cumulative industry impact. The scoring matrix below therefore favors a low waste discharge per ton of production, but also values the effectiveness of management to control cumulative impacts.

Select the final effluent score from the table using the waste discharge (Factor 2.1) and management (Factor 2.2) scores.

Public comment Guidance – This final score selection table has been constructed to set a final score based on the combination of waste discharged and the effectiveness of the management or regulatory scheme to prevent cumulative impact. For example if the production is highly polluting but the management is good, then there should still be no impact. Similarly, if there is little waste discharged, it doesn't matter if the management or regulations are weak. Red/yellow and yellow/green scoring boundaries run as curved diagonals between 3 and 4, and 6 and 7 respectively. We welcome feedback and suggestions for improvement.

Comment:

		Management score (Factor 2.2)										
		10	**< 10**	**< 9**	**< 8**	**< 7**	**< 6**	**< 5**	**< 4**	**< 3**	**< 2**	**< 1**
Waste discharge score (Factor 2.1)	**10**	10	10	10	10	10	10	10	10	10	10	10
	9	10	10	9	9	9	8	8	7	7	7	6
	8	10	9	9	8	8	7	7	6	6	5	5
	7	10	9	8	7	7	6	6	5	5	4	4
	6	10	9	8	7	6	6	5	5	5	4	3
	5	10	8	7	6	6	5	5	5	4	4	3
	4	10	8	7	6	5	5	4	4	4	3	2
	3	10	8	7	6	5	4	4	4	3	2	1
	2	10	7	6	5	4	4	3	3	2	1	0
	1	10	7	6	4	3	3	2	2	1	0	0
	0	10	6	5	3	2	2	1	1	0	0	0

Final effluent criterion score = _____ (range 0–10) (Zero score = critical)

Public Comment Criterion 2 – Effluent – General comments or final feedback
Comment:

Criterion 3 – Habitat

Public comment guidance.
Overview – The habitat impacts of some types of aquaculture, particularly shrimp and salmon farming, have previously been widely criticized; however it can now be argued that in these cases, ongoing mangrove destruction in shrimp farming has largely ceased and improved siting and monitoring have reduced the concern of large scale habitat impacts from net pen aquaculture. In the case of mangrove or other wetland destruction that generally happened more than ten years ago, the simple passage of time means that it is increasingly controversial to penalize farmers today for the now "historic" construction of their farms. Nevertheless it is also clear that in many cases there would be a net gain in ecosystem services if those farm areas were converted back to mangroves and wetlands. While the ongoing conversion of high value habitats for aquaculture has largely been eliminated, the ongoing desire to greatly increase global aquaculture production of all species in all production systems is likely to continue to compromise alternative ecosystem services.

It can also be argued that the current dominance of terrestrial crop and animal ingredients in aquaculture feeds also means that the substantial terrestrial habitat impacts of their production must be considered.

Specifics – The criterion structure has two parts; the first assesses the habitat impacts at the level of a "typical" farm, and the second assesses the effectiveness of the management or regulatory system to manage the cumulative impacts of multiple farms at the regional or ecosystem level. Currently, "historic" impacts are considered to be pre-1999 based on a growing awareness of ecosystem services and specific events such as the Ramsar Treaty.

Feedback – Methods to quantify habitat value, habitat functionality, ecosystem services and the impacts on them from the wide variety of aquaculture production systems remain poorly developed. The complication of ongoing verses "historic" habitat impacts is also significant in terms of trying to assess the sustainability of seafood currently available on the market. We welcome feedback and suggestions for improvement (and simplification) on any aspect of this criterion, and also welcome suggestions for an entirely different approach or structure. We would also welcome feedback and suggestions on the assessment of habitat impacts of terrestrial feed ingredients.

Comment:

- Habitat impacts of terrestrial feed ingredients is addressed to some degree in F5.3 – further weighting that factor might be one way to further address this. Thinking of this practically, it would be near impossible to get the resolution of data for a feed formulation needed to assess the habitat impacts of different terrestrial feed ingredients.
- It could be made more clear in the pre-amble that this criterion is meant to assess the environmental impact of siting aquaculture operations on the physical environment (to further differentiate from C2; see comments in C2)
- Overall, we feel like the approach taken to assess this criterion is appropriate, but greater weighting could be placed on the management factor (F 3.2). See comment box below.

Impact, unit of sustainability and principle

- *Impact:* Aquaculture farms can be located in a wide variety of aquatic and terrestrial habitat types and have greatly varying levels of impact to both pristine and previously modified habitats as well as to the critical "ecosystem services" they provide.
- *Unit of sustainability:* The ability to maintain the critical ecosystem services relevant to the habitat type.
- *Principle:* Aquaculture operations are located at sites, scales and intensities that cumulatively maintain the functionality of ecologically valuable habitats.

Habitat: Factor 3.1 – Habitat conversion and function

A categorical measure of habitat impact taking account of the ongoing functionality of affected habitats and the historic or ongoing nature of the habitat conversion for aquaculture.

This factor is based on the following definitions:

- Maintaining functionality – aquaculture has not caused the loss of any critical ecosystem services.
- Loss of functionality – aquaculture has caused 'major' habitat impacts, defined as the loss of one or more critical ecosystem services.
- Critical ecosystem services are those that:
    - society depends on or values;
    - are undergoing (or are vulnerable to) rapid change;
    - have no technological or off-site substitutes (see Rationale for more information).

Assessment guide:

Step 1

- Determine the appropriate habitat type for the farm, farms, region or industry being assessed. Use "average" habitat types where necessary, or split the assessment into different recommendations if habitat types lead to different scores and overall ranks.

Step 2

- Determine if key ecosystem services continue to function, and the degree of functionality remaining.
    - If all critical ecosystem services are maintained, the habitat is considered to be "maintaining full functionality".
    - If all critical ecosystem services are maintained to some degree, the habitat is considered to be "maintaining functionality" and the score will depend on the degree of impact.
    - If any critical ecosystem service has been lost, the habitat is considered to have lost functionality.
- If the habitats are considered to be maintaining functionality, then use Table 1 and the examples in the Appendix to determine the appropriate score.
- If the habitat is considered to have lost functionality, go to Step 3.

Step 3

- If the habitats are considered to have lost functionality, then consider the scores in Table 2 along with the timeframe of historic and/or ongoing habitat loss
- Use the habitat values in Table 3 where necessary.

For additional guidance, consider the examples in the Appendix.

Habitat: Table 1 – Maintaining habitat functionality

Habitat Functionality	Impact on Habitat Functionality	Score
Maintaining functionality	Maintaining full functionality	10
	Minimal impacts	9
	Minor-moderate impacts	8
	Moderate impacts	7
Loss of functionality	Major impacts	Go to Table 2

Habitat: Table 2 – Loss of habitat functionality

Timeframe of Habitat Loss	Habitat Value	Score
Historic, > 10 years	Low	6

Historic, > 10 years	Moderate	5
Historic, > 10 years	High	4
< 10 years or ongoing loss	Low	3
< 10 years or ongoing loss	Moderate	2
< 10 years	High	1
Ongoing Loss of Habitat Functionality	High	0

Habitat: Table 3 – Habitat value

High	Moderate	Low
Coastal intertidal Coastal/terrestrial shoreline Estuaries Tidal wetlands and forests Freshwater wetlands Coral reefs Seagrass/algae beds Freshwater lakes Rivers and streams Tropical broadleaf and mixed forests	Coastal inshore sub-tidal[13] Riparian land and floodplains Temperate broadleaf and mixed forests	Open ocean/offshore[14] Coniferous forests Grasslands, savanna and shrublands Desert and dry shrublands

Factor 3.1 score = _____ (range 0–10)

Habitat: Factor 3.2 – Farm siting management effectiveness

Public comment Guidance – Similar to the effluent regulation section, up-to-date information on aquaculture regulations is typically challenging to find, and the structure and scoring of this section provides only a rough estimate of the risk of cumulative effluent impacts. We welcome feedback and suggestions for improvement on any aspect of this criterion.

Comment:

- Suggestion to include 'or expansion of existing sites' to Q1 in F3.2a
- Suggestion to change the focus of Q3 in F3.2a to require that the industry's ongoing and future expansion is based on/guided by zonal area management plans (be they marine use plans, land use plans, or coastal zone plans). The reason for this is that in practice very few countries have a set a limit to aquaculture industry expansion – it continues to be assessed on a case-by-case basis. Requiring zonal planning should be one of the end-goals for this type of assessment as it would lead to a more robust set of guidelines for industry expansion.
- Q2 and Q3 in F3.2b are more relevant to management effectiveness as opposed to

[13] Inshore sub-tidal = approximately from zero to three nautical miles from the main coastline.
[14] Open ocean/offshore = greater than three nautical miles offshore.

enforcement and speak a bit to the previous comment made – suggestion to wrap these two questions into one and move it to section F3.2a

The above habitat conversion factor relates to a specific farm or to the 'typical' or 'average' farm in a region or country. Ecosystem impacts are driven largely by the cumulative impact of multiple farms in a location, habitat type, region or a country. This factor (3.2) is a measure of the presence and effectiveness of regulatory or management controls appropriate to the scale of the industry, and therefore a measure of confidence that the cumulative impacts of farms sited in the habitats declared in Factor 3.1 above are at appropriate spatial scales.

Using the relevant FAO National Aquaculture Legislation Overview (NALO) country factsheet, answer the following questions on siting and habitat regulations. If the relevant country sheet is not available, search the FAO's FAOLEX legislative database.

NALO - http://www.fao.org/fishery/collection/nalo/en
FAOLEX - http://faolex.fao.org/faolex/index.htm

An additional search should be made (or contact initiated with relevant country experts) to check for any recent legislation enacted since these databases were last updated.

For third party certified farms or other independently verified standards, it is acceptable to answer the questions relating to the relevant standards and inspection/audit process where these are considered to be more robust than the regulatory (or other) system at controlling impacts from multiple farms (considering that these farms may not themselves be certified).

Note: "Control measures" relates to policies, legislation or regulations, and/or independently verified management measures, codes of practice, Best Management Practices or certification schemes that have the appropriate language[15] and authority for enactment. The next factor (3.2b) assesses the enactment or enforcement of such measures.

Factor 3.2a – Regulatory or management effectiveness
Scoring answers: Yes = 1; Mostly = 0.75; Partly = 0.5; Slightly = 0.25; No = 0

Questions	Score
1 – Is the farm location, siting and/or licensing process based on ecological principles, including an Environmental Impact Assessment requirement for new sites?	
2 – Is the industry's total size and concentration based on its cumulative impacts and the maintenance of ecosystem function?	
3 – Is the industry's ongoing and future expansion limited to an appropriate scale and/or to appropriate locations, and thereby preventing the future loss of ecosystem services?	

[15] Designed for, or applicable to aquaculture – as opposed to regulations designed for fisheries, agriculture or other activities or industries that are poorly related to the needs of aquaculture regulation. Aquaculture certification standards would be scored as 'yes'. Appropriate language – avoidance of 'should', 'minimize', etc.

4 - Are high-value habitats being avoided for aquaculture siting? (i.e., avoidance of areas critical to vulnerable wild populations; effective zoning, or compliance with international agreements such as the Ramsar treaty)	
5 - Do control measures include requirements for the restoration of important or critical habitats or ecosystem services?	
Total = (0–5)	

Factor 3.2a score = _____ (range 0–5)

Factor 3.2b – Siting regulatory or management enforcement

Scoring answers: Yes = 1; Mostly = 0.75; Partly = 0.5; Slightly = 0.25; No = 0

Questions	Score
1 – Are enforcement organizations or individuals identifiable and contactable, and are they appropriate to the scale of the industry?	
2 – Does the farm siting or permitting process function according to the zoning or other ecosystem-based management plans articulated in the control measures?	
3 – Does the farm siting or permitting process take account of other farms and their cumulative impacts?	
4 – Is the enforcement process transparent – e.g., public availability of farm locations and sizes, EIA reports, zoning plans, etc?	
5 – Is there evidence that the restrictions or limits defined in the control measures are being achieved (see example[16])?	
Total = (0–5)	

Factor 3.2b score = _____ (range 0–5)

Factor 3.2 Siting management score = (3.2a x 3.2b) / 2.5 = _____ (range 0–10)

Final habitat criterion score = (2 x Factor 3.1) + Factor 3.2) / 3
Habitat criterion score = _____ (Range 0–10) (Zero score = critical)

Public Comment - Criterion 3 – Habitat – General comments or final feedback

Comment:

We would like to see this criterion put greater focus (or more explicit focus) on management effectiveness of the aquaculture industry development and expansion. Explicit requirement of zonal management should be the high-bar that we are striving for with this criterion. Too commonly aquaculture is regulated by a mosaic of regulations and laws that were not created for aquaculture (i.e. amended fisheries, agriculture or food safety regulations) resulting in loopholes and insufficient oversight for responsible industry growth. If greater weight were to be placed on management and zoning effectiveness of aquaculture this would lend well to the stated principle of this criterion that "[a]quaculture operations are located at sites, scales and intensities that cumulatively maintain the functionality of ecologically valuable habitats."

[16] For example if mangrove cover is supposed to be maintained at greater than 60%, is there evidence that this is achieved? Or are Allowable Zones of Affect reactively monitored?

Criterion 4 – Chemical use

Public comment guidance.
Overview – In seafood supply chains, chemical use has primarily been a food safety concern and has been addressed using withdrawal periods and sampling for residues. Evidence of environmental residues of chemicals and their by-products are common, however although impacts on non-target species appear rare they are also poorly studied. Data availability on chemical use is typically very limited and often unreliable. While human health aspects are currently beyond the scope of Seafood Watch, the apocalyptic warnings with respect to the development of antibiotic resistance seem to demand attention to these groups of chemicals. Antibiotic use has declined in some systems with the development of vaccines and improved biosecurity, but the potential remains for sudden and large increases during disease outbreaks (e.g. EMS in shrimp). Pesticide continues to be highly variable across species.

Specifics – This criterion is currently structured as a simple selection which uses a variety of examples or situations that can be used to guide the analyst to an appropriate score. The use of antibiotics listed as highly- or critically-important to human health (as defined by the World Health Organisation; WHO) has been used to highlight the concern with respect to these products.

Feedback – We welcome feedback on any minor tweaks and improvements to the table, but also welcome suggestions for an entirely different approach or structure to this criterion. We welcome feedback on the differentiation and assessment of the use of highly- and critically important antibiotics.

General Comments:

- We understand the argument that the WHO lists for antibiotics is perhaps not the most direct assessment of environmental impact of chemical use, however it remains one of the most referenced categorizations for any sort of standard setting for antibiotic use. Yes, the end-goal is the assessment of risk to developing antibiotic-resistant bacteria which could lead to serious human health implications (and this is not the direct focus of the SFW criteria), but the process of by which a bacterium becomes antibiotic-resistant is also a concern at an ecological scale (use of antibiotics in aquaculture leading to more resistant pathogens, which are then transferred to wild stocks). This later interaction is an important consideration for assessing the sustainability of an industry and although the WHO indicator is perhaps not prefect, it is an appropriate proxy.

-

Impact, unit of sustainability and principle

- *Impact:* Improper use of chemical treatments impacts non-target organisms and leads to production losses and human health concerns due to the development of chemical-resistant organisms.
- *Unit of sustainability:* Non-target organisms in the local or regional environment, presence of pathogens or parasites resistant to important treatments.

- *Principle:* Aquaculture operations by design, management or regulation avoids the discharge of chemicals toxic to aquatic life and/or effectively controls the frequency, risk of environmental impact, and risk to human health of their use.

Chemical Use: Criterion 4 – Evidence or risk of chemicals use

A measure of the risk of impacts deriving from chemical use and discharge to the environment, taking account of the fundamentally poor availability of and low confidence in chemical use data.

Chemicals treatments of concern relevant to this criterion are broadly defined as those products used in aquaculture to kill or control aquatic organisms, and/or whose use may impact non-target organisms or raise concerns relevant to human health. It does not include chemicals such as mercury, PCBs, dioxins or other environmental contaminants associated with feed ingredients. Chemicals such as antifoulants, anesthetics and others can be accounted for in this assessment when there is evidence of impacts.

Assessment scale

- Farm level assessments – apply this criterion to the farm being assessed
- Regional or national assessments – apply to relevant regional, national, or eco-certification statistics or impacts, or use data from "typical" or "average" farms.

Consider **ALL** the options in the following table and determine the appropriate level of concern before scoring. If chemical use (e.g. type or quantity) and/or impacts are unknown, use the production system-based options. While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Public comment guidance – The red/yellow and yellow/green break point occur at 3-4 and 6-7, and are intended to be practical differences
Red = demonstrable impacts, very high risk of impacts, or use of highly- or critically-important antibiotics.
Yellow = minor demonstrable impacts, or moderate risk of impacts
Green = demonstrably no impacts, or very low risk of impacts.
We welcome feedback on any aspect of this table.

Comment:

Concern	Chemical Use Examples	Score
No concern	▪ The production system is closed and does not discharge active chemicals or by-products (e.g. antibiotic resistant bacteria) ▪ The data score for chemical use is 0.75 or 1.0 and data show that chemical treatments have not been used over multiple production cycles ▪ The method of treatment does not allow active chemicals or by-products to be discharged	10
Low	▪ The data score for chemical use is 0.75 or 1.0 and data show that	8

	chemical treatments are used on average less than once per production cycle or once per year for longer production cycles ▪ The production system does not discharge water over multiple production cycles ▪ Evidence of no impacts on non-target organisms	
Low-moderate	▪ Specific data may be limited, but the species or production systems have a demonstrably low need for chemical use ▪ A lack of evidence of impacts on non-target organisms ▪ No evidence of resistance to key treatments ▪ The production system has very infrequent or limited discharge of water (e.g., once per production cycle or < 1% per day)	6
Moderate	▪ Evidence of impacts on non-target species within an allowable zone of effect ▪ Chemical use and/or impacts are unknown, the species or production system typically requires chemical use, and the treatment method allows the release of chemicals to the environment ▪ Some evidence or concern of resistance to chemical treatments ▪ No evidence of impacts on non-target species, but chemical use is known to be high and the production system allows active chemicals or by-products to be discharged[17]	4
Moderate-high	▪ Confirmed cases of resistance to chemical treatments ▪ Occasional, temporary or minor evidence of impacts to non-target organisms beyond an allowable zone of effect ▪ Chemicals highly important to human health are being used[18] in significant or unknown quantities	2
High	▪ Banned or illegal chemicals (as defined by the country of production AND the United States) have been used ▪ Chemicals critically important to human health are being used[19] in significant or unknown quantities ▪ Negative impacts of chemical use seen on non-target organisms beyond an allowable zone of effect	0
Critical	▪ Evidence of developed clinical resistance to chemicals (e.g. loss of efficacy of treatments) that are highly important or critically important to human health	C

**Note:* Intermediate values (i.e., 1,3,5,7 or 9) may be used when justified or needed.

Final chemical use criterion score = _____ (range 0–10 or critical)

Public comment guidance – Please provide any comments or suggestions below, and answer the specific questions if possible.

[17] High – chemicals are used on multiple occasions each production cycle, or the production viability is considered to be dependent on chemical intervention.
[18] Highly important chemicals listed in - http://www.who.int/foodborne_disease/resistance/cia/en/ have been used in the current or previous production cycle.
[19] Critically important chemicals listed in - http://www.who.int/foodborne_disease/resistance/cia/en/ have been used in the current or previous production cycle.

Question 1: In many cases, regulations exist to restrict or otherwise limit the types of chemicals that can be used (e.g. the types of antibiotics), but not to limit the frequency of use or the total combined use at a single farm or by multiple farms within an area or water body. While routine use may be low, a disease outbreak can trigger a large spike in use with an increased risk of impact. Should the Seafood Watch criteria penalize the lack of regulatory limits on chemical use?

Question 2 – if illegal chemical use is taking place (e.g. methyl testosterone use in Chinese tilapia hatcheries), should this automatically result in a red recommendation, or should evidence regarding the actual environmental impacts take precedent (if it is available)? That is, if the impacts of an illegal activity are ecologically sustainable, should we penalize the assessment score?

Comment:

Question 1 – Yes, SFW criteria should include a penalty for lack of regulatory limits on overall chemical use. Our suggestion would be to be to apply this qualifier to the high chemical use scores (4 or greater). This could be included in a tiered fashion; for example, a qualifier for a score of 4 would require Zonal Best Management Practices for antibiotic use while a qualifier for a score of 10 would require evidence of limits on frequency use of critically and highly important chemicals and enforcement of said limits.

Question 2 – this should result in an automatic red recommendation. These criteria are not above any regional laws and sanctioning (or not penalizing) illegal activities is not something that these criteria should condone.

Public Comment Criterion 4 Final comments and feedback

Comment:

Criterion 5 - Feed

Public comment guidance.

Overview – Assessing the sustainability of aquaculture feds involves a complex web of ecological, social and ethical debates on resource use and efficiency. The introductory text to this criterion below includes its basic overview. Feed formulations change rapidly and are commonly considered to be proprietary information; therefore the availability of current data (even aggregated or basic composition data) is often very limited. While there continue to be questions about the sustainability of aquaculture feeds, it is increasingly argued that farmed fish are more efficient than terrestrial livestock.

Specifics – This criterion is split into three factors – wild fish use (quantity and sustainability of source), net nutritional gains or losses (using a "simple" protein conversion efficiency), and an acknowledgement of the global sourcing of aquatic and terrestrial feed ingredients in a "footprint" factor. In the overall calculation, the wild fish use is given a double weighting in the final score.

Feedback – With the typically limited data and complexity of the topic, this criterion is often one of the most challenging to assess. In order to include many of the complexities, the factors and calculations are somewhat complex. We welcome feedback on any aspects of the calculations and/or the broader approach to the calculations.

General comments:

Impact, unit of sustainability and principle

- *Impact:* Feed consumption, feed type, ingredients used and the net nutritional gains or losses vary dramatically between farmed species and production systems. Producing feeds and their ingredients has complex global ecological impacts, and the efficiency of conversion can result in net food gains or dramatic net losses of nutrients. Feed use is considered to be one of the defining factors of aquaculture sustainability.
- *Unit of sustainability:* The amount and sustainability of wild fish caught for feeding to farmed fish, the global impacts of harvesting or cultivating feed ingredients, and the net nutritional gains or losses from the farming operation.
- *Principle:* Aquaculture operations source only sustainable feed ingredients, convert them efficiently and responsibly, and minimize and utilize the non-edible portion of farmed fish.

This criterion intends to:

- Promote data transparency on feed use and ingredients
- Support the reduction of wild-caught fish used in feeds
- When wild-caught fish are used, support sourcing from sustainable fisheries
- Promote the use of non-edible (to humans) feed ingredients, and recognize the conversion of non-edible feed ingredients to edible aquaculture products
- Recognize the conversion of plant proteins to animal proteins through aquaculture
- Promote a net protein gain from aquaculture operations
- Promote post-harvest use of by-products from processed (e.g., filleted) aquaculture products

Assessment scale

- Farm level assessments – apply this criterion to the farm being assessed, or to typical or average data for the species raised if specific data is unavailable.

- Regional or national assessments – apply to relevant regional or national statistics or impacts, or use data from "typical" or "average" farms, or use typical or average data for the species raised.

Feed: Rapid assessment

The feed criterion score is 10 if no external feed is provided to the cultured organisms.
All other aquaculture operations (i.e. those that use feed) are assessed using Factors 5.1 – 5.3.

Feed: Factor 5.1 – Wild fish use

A measure of the amount of wild fish used to produce farmed fish, combined with the sustainability of the fisheries from which they are sourced.

Factor 5.1a – Fish in to fish out ratio (FI:FO)
A measure of the dependency on wild fisheries for feed ingredients using the ratio of the amount of wild fish used in feeds ('fish in') to the harvested farmed fish ('fish out').[20]

Data
Recognizing that data from feed companies may not be available, use the best available (most recent or relevant) data on a precautionary basis:
a) Fishmeal inclusion level* = _____ %
b) Fish Oil Inclusion level* = _____ %
c) Fishmeal yield % = _____ (use 22.5[21] if value is unknown)
d) Fish oil yield % = _____ (use 5.0 if value is unknown)
e) Economic FCR[22] = _____

Note on fish processing by-products, trimmings, etc. **–** Feed ingredients from trimmings, by-products or other processing wastes are NOT scored in this equation as it measures direct dependence on wild fisheries. If data are available for these ingredients, they can be subtracted from the inclusion levels used in the FI:FO calculation. E.g., if total fishmeal inclusion level is 40% and a quarter of the fishmeal comes from trimmings or by-products, the final inclusion level = 30%.

Public comment guidance –
Fishery by-products are considered of low economic value to humans, but have the same ecological cost of production as whole wild fish. They are currently not included in the FI:FO calculation; should they be?
Comment:
We do not think it is necessary to include fisheries by-products in the FIFO calculation at this time.

Note on the use of whole (unprocessed) or 'trash' fish for feed **–** If whole fish are used as feed, the eFCR effectively determines the FI:FO value. Use eFCR as the FI:FO value (or entering 22.5 as the FM inclusion level and 5 for FO in the equations along with the eFCR will give the same result).

FI:FO equations

Public comment guidance – We recognize that a FIFO calculation is simplistic, but it offers one of the few straightforward metrics with which to judge marine ingredient use in aquaculture. The equation used here is the "academic" equation which uses separate calculations for fishmeal (FM) and fish oil (FO), as opposed to the "industry" calculation that combines both into

[20] Also commonly referred to as FFER – Forage Fish Efficiency Ratio, or FFDR – Forage Fish Dependency Ratio.
[21] Yield values from Tacon and Metian (2008). Other (similar) values are possible from Peron et al. (2010), but data clarity is not sufficient for a robust quantification of fishery landings.
[22] Economic FCR or eFCR = total feed used divided by total harvest of fish.

one. Acknowledging that the "academic" equation doesn't consider the "spare" fishmeal, Seafood Watch prefers it compared to the combined FM and FO yield values in the denominator of the "industry" calculation, which we consider to produce unreliable and inconsistent results across a range of species. We do not currently propose to change to the "industry" equation, but welcome feedback.
Comment:

A variety of equations are available for calculating FI:FO. The Seafood Watch equation is the same as that selected by the multi-stakeholder Aquaculture Dialogue process and will therefore continue to be used by Seafood Watch.

$$FI:FO_{FishMEAL} = \frac{a \times e}{c} = \_\_\_\_\_$$

$$FI:FO_{Fish\ OIL} = \frac{b \times e}{d} = \_\_\_\_\_$$

Final FI:FO value = the greater value of $FI:FO_{FishMEAL}$ or $FI:FO_{Fish\ OIL}$
Final FI:FO value = _____

FIFO score = 10 - (2.5 x FI:FO)
FIFO score = _____ (range 0–10)

Factor 5.1b – Source fishery sustainability

Public comment guidance – Note - this factor considers a sustainable wild fish source to be the basic requirement for sustainable aquaculture feeds, and applies an increasing score deduction with an increasingly unsustainable source.
Comment:

A simple measure of the sustainability of the fisheries providing fishmeal and fish oil.

This factor applies a negative adjustment to the FIFO score with an increasing penalty for decreasing sustainability. Using sustainable sources results in no penalty.

Note: This factor relies only on available third-party references[23] to fishery sustainability. It is not the intention of a Seafood Watch aquaculture assessment to undertake a full fishery assessment.
Note: If the source is unknown due to reasons beyond reasonable control of the operations being assessed (e.g., small-scale farmers that do not have the power to demand this information from their feed company), the penalty is smaller than if the source is unknown because the information is deliberately withheld.

[23] Third party sources – e.g., MSC, Fishsource, ICES, IFFO Responsible sourcing, other certification programs (FAO Code of Conduct), etc.

Using an average, or annual weighted mass-balance estimate of the fishery sources used in a typical feed, decide the appropriate sustainability score according to the following descriptions and examples.

Public comment guidance – Seafood Watch does not intend aquaculture analysts to do a full scale fisheries sustainability assessment. Therefore this table provides a list of "quick and easy" options to approximate the source fishery. We welcome suggestions to improve the structure or content of this table.
Comment:

Score	Fishery Sustainability Examples
0	Demonstrably sustainable[24] MSC certified without conditions Fishsource scores all > 8 SFW Green Fishery exceeds all reference points and has no significant concerns
-2	MSC certified with minor conditions All Fishsource scores ≥ 6, and one or more scores ≥ 8 Fishery meets or is close to all reference points with only minor concerns
-4	All Fishsource scores ≥ 6 MSC certified with major conditions SFW Yellow Fishery does not meet all reference points or has some significant concerns
-6	Unknown source fishery Unknown sustainability IFFO certified 'Responsible' FAO Code of Conduct compliant (independently verified) One Fishsource score < 6
-8	More than one Fishsource score < 6 SFW Red Fishery does not meet reference points or has significant concerns regarding bycatch or ecosystem impacts
-10	Demonstrably unsustainable (e.g., overfished with overfishing occurring) SFW Red Illegal, unregulated or unmanaged Unacceptable bycatch or ecosystem impacts Fishery source information deliberately withheld

Source fishery sustainability score = _____ (range 0 to -10)

Factor 5.1 Wild fish use score = FIFO score + [(FI:FO value x Sustainability score) / 10

Note: Negative values are possible with this equation, but in these cases the score is zero.

[24] On a realistic and pragmatic basis – i.e., the best current understanding of fishery sustainability (accepting that ecosystem-based forage fishery management is not yet fully developed).

Factor 5.1 – Wild fish use score = _____ (range 0–10)

Factor 5.1 is critical if the value is zero.

Feed: Factor 5.2 – Net protein gain or loss

A measure of the net protein gained or lost during the fish farming process.

Aquaculture has the potential to be a net producer of protein, but when external feed is used in any significant quantity, there is typically a net loss of protein when feed is converted into farmed fish.

The equations below will function with very limited data, if necessary, but will reward transparency and a greater amount of data availability from the aquaculture producers or their feed companies with higher scores as follows:

- Data on the amount of feed protein coming from sources unsuitable for human consumption will reduce the protein IN score (rewarding their use).
- Data on the amount of crop ingredients used will allow an adjustment to be made for the improved protein quality of harvested fish (rewarding the use of crop alternatives to fishmeal).
- Data on the beneficial use of the non-edible by-products of harvested fish will improve the protein OUT score (rewarding the use of harvest by-products as further protein sources).

Public comment guidance –
Land animal by-products and crop by-products are considered of low economic value to humans, but have the same ecological cost of production as the rest if the land animal or crop. They are currently not included in these edible protein calculations; should they be?

Comment:

Basic data (required)

a) Protein content of feed = _____ %
b) eFCR = _____
c) Protein content of whole harvested farmed fish = _____ %
d) Edible yield of harvested farmed fish[25] = _____ %

Optional data if available from the producers or their feed companies

To encourage greater transparency, these data points will all lead to improved final scores. Values for (e), (f), and (g) are zero if unknown.

e) Percentage of feed protein from sources *unsuitable* for human consumption (e.g., fish, animal or crop by-products[26] or other processing wastes)* = _____ %
f) Percentage of feed protein from crop ingredients *suitable*[27] for human consumption if known = _____ %

[25] Enter the edible yield even if the harvested farmed fish are sold whole.
[26] E.g. Distillers grains that are inedible as a result of another process
[27] All crop ingredients unless previously used for another process (e.g. soybean meal, wheat gluten, etc.)

g) Percentage of the non-edible by-products from harvested farmed fish used for other food production[28] = _____ %

**Note:* This does not include protein from fishmeal made from whole fish.

For the purposes of this assessment, (a) to (g) are allocated into protein inputs and outputs as follows (see rationale for an explanation of this equation):

Factor 5.2a -- Protein IN = [a – (a x (e + (0.286 x f)) / 100)] x eFCR
Factor 5.2b -- Protein OUT = (c / 100) x [(d + (g x (100-d)) / 100]

Net protein gain or loss % = (Protein OUT – Protein IN) / Protein IN

Net protein gain = _____ % (indicated by positive result) OR
Net protein loss = _____ % (indicated by negative result)

Public comment guidance – This scoring table is a simple category based selection to convert the % protein loss into a 0-10 score. We welcome feedback and suggestions for improvement.

Comment:

	Protein Gain or Loss (%)	Score
Net protein gain	> 0	10
Net protein loss	0.1–9.9	9
	10–19.9	8
	20–29.9	7
	30–39.9	6
	40–49.9	5
	50–59.9	4
	60–69.9	3
	70–79.9	2
	80–89.9	1
	> 90	0

Factor 5.2 score = _____ (range 0–10). This is critical if the score = zero

Feed: Factor 5.3 – Feed footprint

An approximate measure of the global resources used to produce aquaculture feeds based on the global ocean and land area used to produce the feed ingredients necessary to grow one ton of farmed fish.

Factor 5.3a – Ocean area of primary productivity appropriated by feed ingredients per ton of farmed seafood

[28] E.g. Head, skin, viscera of harvested farmed fish that is not used for any other purposes and is effectively discarded

Public comment guidance – Primary productivity values below are from general literature for shelf seas. Conversion ratios and yields from crop ingredients and land animal ingredients are also from general literature. We welcome feedback and suggestions for improvement on any aspect.
Comment:

a) Inclusion level of aquatic feed ingredients* = FM% + FO% = ____ %
b) eFCR = _____
c) Average primary productivity (carbon) required for aquatic feed ingredients = 69.7 tC t^{-1}
d) Average ocean productivity for continental shelf area = 2.68 t C ha^{-1}

*Include all aquatic ingredients; i.e., by-products or other processing wastes ARE INCLUDED in this calculation.

Ocean area appropriated = [(a x 0.01) x b x c] / d = _____ ha ton^{-1} of farmed fish

Factor 5.3b - Land area appropriated by feed ingredients per ton of production

a) Inclusion level of crop feed ingredients = ____ %
b) Inclusion level of land animal products = ____ %
c) Conversion ratio of crop ingredients to land animal products (e.g., feather meal, pig by-product meal) = 2.88 (fixed value)
d) eFCR of the farmed fish = _____
e) Average yield of major feed ingredient crops = 2.64 tons crops ha^{-1} (fixed value)

Land area appropriated (per ton of farmed fish) = [(a + (b x c)) x 0.01 x d] / e

Land area appropriated = _____ ha ton^{-1} of farmed fish

Total global area appropriated per ton of farmed fish = Ocean area + Land area

Total area = _____ ha ton^{-1} of farmed fish

Public comment guidance – This scoring table is a simple category based selection to convert a footprint area into a 0-10 score. It is based on a range from a feed based on crop ingredients (intensive production low footprint area) to high marine ingredient feeds (i.e. involveing large ocean areas of primary productivity). It is acknowledged that these are approximate estimates, and we welcome feedback and suggestions for improvement.
Comment:

Total Area	ha ton^{-1}	Score
Zero	0	10
Low	0.1–2.9	9
	3–5.9	8
Low-moderate	6–8.9	7

	9–11.9	6
Moderate	12–14.9	5
	15–17.9	4
Moderate-high	18–20.9	3
	21–23.9	2
High	24–26.9	1
Very high	> 27	0

Factor 5.3 score = _____ (range 0–10)

Final feed criterion score = [(2 x Factor 5.1 score) + Factor 5.2 score + Factor 5.3 score] / 4
= _____ (range 0–10)

Public comment guidance – Note the FIFO score (Factor 5.1) has a double weighting in this final score calculation. We welcome feedback on how to combine the different aspects of this feed criterion into a final score.
Comment:

The feed criterion is critical if:

- Wild fish use score is zero
- Net protein gain/loss score is 0, **or**
- FI:FO > 3 **and** net protein score ≤ 1.
-

Public Comment Criterion 5 – Feed: Final comments
Comment: Overall, we believe the feed criterion is robust. Although challenging to assess due to the many different components, it provides a thorough and defensible assessment of feed sustainability.

Criterion 6 – Escapes

Public comment guidance.

Overview – Aquaculture produces a wide variety of native and non-native species, and is also in the process of domesticating many of them. Well documented impacts on the genetic fitness of wild salmon populations and the concerns regarding invasive species such as tilapia, trout, and some shellfish species, all highlight the broad concern that this criterion attempts to assess

Specifics – This criterion is split into two factors; the risk of escape, and the risk of ecosystem impact of the farmed species should escapes occur (termed "invasiveness" here). Invasiveness is assessed by the native/non-native status and the potential for genetic or other ecological impacts.

Feedback – Seafood Watch recognizes there is a lag period during which increasing domestication increases the risk of genetic interaction with wild populations until a point of domestication is reached where escapes have limited or no ability to breed with wild stocks, or

even survive in the wild. For species that have ecological impacts such as competition for habitat (e.g. pacific oysters in the natural range of European oysters) it must be noted that domestication is unlikely to reduce this impact. We welcome feedback on any of the complex interactions of escape.
Comment:

Impact, unit of sustainability and principle

- *Impact:* Competition, genetic loss, predation, habitat damage, spawning disruption, and other impacts on wild fish and ecosystems resulting from the escape of native, non-native and/or genetically distinct fish or other unintended species from aquaculture operations.
- *Unit of sustainability:* Affected ecosystems and/or associated wild populations.
- *Principle:* Aquaculture operations pose no substantial risk of deleterious effects to wild populations associated with the escape of farmed fish or other unintentionally introduced species.

Assessment scale

- Farm level assessments – apply this criterion to the farm being assessed, or use average or typical data from similar production systems and species if necessary.

- Regional or national assessments – apply to relevant regional, national, or eco-certification statistics or impacts, or use typical or average data for the production system or species.

Escapes: Factor 6.1 – Escape of principal farmed species

A combined measure of the physical risk of escape (based on the production system and available data), with the ecological risk of impact for the species being farmed.

Factor 6.1a - Escape risk score

A measure of the escape risk (for the species being farmed) inherent in the production system.

Robust data on escape numbers are rarely available due the difficulty of counting total numbers of fish at stocking and harvest and knowing what proportion of any loss is due to mortalities versus escapes. Data collection and reporting of escapes (both escape 'events' and chronic trickle losses) is very rarely robust.

The following assessment is therefore based on risk associated with the characteristics of the production system, but the score can be adjusted (up or down) where available evidence or data[29] justifies such.

Considering the characteristics of the assessed or typical production system and any available data on escapes, select the most appropriate score from the following table of examples. While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

[29] As a guide, the WWF salmon dialogue is proposing 200 fish as an "escape event" and 300 maximum escapes per production cycle.

Public comment guidance – The table below is based on basic aspects of the production system. Seafood Watch recognizes that the flood risk of ponds may in fact be a greater risk of escape than well-constructed net pens, and we welcome feedback on the scoring framework in this table. Also welcome are suggestions for an alternative scoring structure.
Comment:

Concern	Escape Risk Examples	Score
Very low	▪ No connection to natural water bodies (i.e., fully biosecure)	10
Low	▪ Tank based recirculation systems with appropriate (multiple) screens, water treatment, or secondary capture devices ▪ Static ponds with no water discharge (including at harvest) over multiple production cycles; not vulnerable[30] to flood, storm or tsunami damage	8
Low-moderate	▪ Any "Moderate concern" system (as defined in this table) that also uses multiple or fail-safe escape prevention methods, or active Best Management Practices for design, construction, and management of escape prevention (biosecurity) ▪ Any "Low concern" system (as defined in this table) with uncertainty or evidence questioning the robustness of escape prevention measures ▪ Ponds with low exchange 0–3% per day	6
Moderate	▪ Ponds with moderate exchange 3–10% per day ▪ Ponds that drain externally at harvest ▪ Ponds with a moderate risk[31] of vulnerability to flooding events ▪ Flow-through tanks or raceways	4
Moderate-high	▪ Any "High concern" system (as defined in this table) with effective Best Management Practices for design, construction, and management of escape prevention (biosecurity) ▪ Any "Moderate concern" system (as defined in this table) with uncertainty or evidence questioning the robustness of escape prevention measures ▪ Ponds with high exchange > 10% per day	2
High	▪ Open systems (e.g., net pens, cages, ropes) without effective Best Management Practices for design, construction and management of escape prevention (biosecurity) ▪ Trickle losses occur in every production cycle, and/or a high risk of a large escape event exists ▪ Ponds in flood prone areas or vulnerable to flooding events ▪ Production systems that do not safeguard against reproduction (egg/fry/juvenile) escapes	0

[30] Not vulnerable – as a guide, not located in areas vulnerable to floods or tsunamis (including increasing risk due to sea level rise or storm severity), e.g., above or beyond 100 year flood event boundaries, or construction is based on 100 year flooding events

[31] Moderate risk – ponds or tanks may be located at the limits or edges of flood or tsunami zones, or constructed to withstand 50 year events

	▪ System highly vulnerable (with evidence) to predator damage and subsequent escape	

Note: Intermediate values (i.e., 1,3,5,7 or 9) may be used if needed.

Escape score = _____ (range 0–10)

Recapture & mortality score (RMS)

Public comment guidance – There is typically very little robust data on recaptures or mortality, however it is important to acknowledge that (for example) in some circumstances a large majority of escapees may perish before they are able to have an environmental impact
Comment:

The RMS allows the escape score to improve if some (or all) escapees are recaptured or do not survive long enough to have a negative environmental impact[32]. For example if the escape score is 2 out of 10 but all escapees are recaptured, then the RMS changes the escape score to 10 out of 10.

**Note*: The RMS score is only to be applied when the reduction in escapee numbers leads to a demonstrable reduction in the potential impact.

Estimated recapture rate = _____ % (zero if unknown)
Estimated direct mortality rate = _____ % (zero if unknown)

Recapture & mortality score (RMS) = (recapture % + mortality %) / 100
= _____ (range 0–1, zero if unknown)

Factor 6.1a score
Escape risk score = Escape score + [(10 – escape score) x RMS]
=_____ (range 0–10)

Factor 6.1b – Invasiveness
A trait-based measure of the likelihood of ecological disturbance from escapees based on their native or non-native status, and/or their domestication and ecological characteristics.

If the species is native, complete only Part A and then Part C
If the species is non-native, complete only Part B and then Part C

Public comment guidance – The following three scoring tables (A or B, plus C) are intended to address the different potential impacts from native and non-native species at both the genetic

[32] For example if the main impact of farmed salmon escaping from sea cages occurs when they migrate into rivers, then mortality prior to reaching rivers can be included where it demonstrably leads to a reduction in the overall impact of the escapes.

and direct ecological levels. Suggestions for improvement are welcome, particularly on how to assess species where there is little available evidence on their impacts.
Comment:

Part A – Native species

Current farmed stock is:	**Score**
Wild caught or naturally settled from the same water body, or are unable to breed with wild populations (e.g., sterile)	5
Hatchery raised for one generation (parents are wild caught)	4
Hatchery raised for two generations	3
Minor evidence of phenotypic differences[33] from selective breeding, or hatchery raised for three generations	2
Clear evidence of selected characteristics, or hatchery raised for four or more generations	1
Evidence of loss of genetic fitness in wild populations	0

Public comment guidance – There is little evidence to support a linear increase in environmental concern with increasing generations of domestication, so we welcome feedback on how to assess the potential concerns of genetic dilution from interbreeding.
Comment:

Part B – Non-native species

Current farmed stock is:	**Score**
Already *fully* established in the production region	2.5
Not established and highly unlikely to survive or establish viable populations	2
Not present, or present and not established, and not likely[34] to establish viable populations	1.5
Partly established, with the potential to extend the species range or coverage	1
Not present but establishment is possible, or similar species have already established elsewhere	0.5
On the invasive species lists[35] and establishment is theoretically possible	0

Public comment guidance – Non-native species score a maximum of 2.5 out of 5 in this section, however if they are fully established, it can be argued that there is little risk of impact from escape. We welcome feedback on balancing the escape concerns between native and non-native species.
Comment:

[33] For example, changes in growth rate, disease resistance, body shape, behavior or other changes.
[34] As a guide, introductions of the species have been unsuccessful more often than successful or the species reproductive tolerance, behavior or habitat requirements are not suited to the escape location.
[35] The Global Invasive Species Database (GISD) http://www.issg.org/database/welcome/

There is one important difference to note regarding the establishment of non-native species, which is: Did the species become established as a result of aquaculture escapements or was the species introduced prior to aquaculture for other reasons (such as fishing). It is my opinion that the former instance would result in a lower score than the latter instance given that this is an assessment of the impacts of aquaculture. Perhaps a scoring grid similar to the one in F3.1 would be appropriate as it would add the dimension of time since establishment to the assessment?

Part C – Native and non-native species
Both native and non-native species have the potential to impact surrounding ecosystems when they escape from farm systems. Regardless of the native, non-native or genetic status of the farmed species, score each of the following questions in relation to the ongoing impacts of escapees.

Each evidence-based 'Yes' answer = 0
Each theoretical 'Yes' or partial evidence = 0.5
Each 'No' answer = 1

Do escapees have a significant impact on any wild species by:	**Score**
Competing for food or habitat?	
Providing additional predation pressure?	
Competing for breeding partners or disturbing breeding behavior of the same or other species?	
Modifying habitats (e.g., by feeding, foraging, settlement or other)?	
Some other impact on species or habitats?	
Total score (0–5)	

Factor 6.1b score
Invasiveness score = (Part A or B) + Part C = _____ (range 0–10)

Final escape criterion score

Select the final escape score from the table using the 'Risk of escape' (6.1a) and the 'Invasiveness' (6.1b) scores (e.g., if the invasiveness score = 7.5, look in the < 8 column).

Public comment Guidance – This final score selection table has been constructed manually to set a final score based on the combination of the risk of escape and the risk of impact of the species involved. Red/yellow and yellow/green scoring boundaries run in curved diagonals between 3 and 4, and 6 and 7 respectively. We welcome feedback and suggestions for improvement.
Comment: One suggestion would be to create a baseline response for Part C of the above scoring tool for commonly assessed species. As is noted in the narrative above, there is often limited documented evidence of the ecological impact of escapees, but this can be assessed based on the life history traits of a given species. Typically, these responses should be the same (or at least similar) for any one species despite geographic region (i.e. you would expect the responses

to these five questions to be the same for tilapia cultured in ponds in Ecuador and Taiwan, but this is not currently the case).

		Invasiveness (Factor 6.1b)										
		10	<10	<9	<8	<7	<6	<5	<4	<3	<2	<1
Risk of escape (Factor 6.1a)	10	10	10	10	10	10	10	10	10	10	10	10
	9	10	9	8	8	7	6	6	5	4	4	3
	8	10	8	8	7	7	6	6	5	4	4	3
	7	10	8	7	7	6	6	5	5	4	3	2
	6	10	7	7	6	6	5	4	4	3	3	2
	5	10	7	6	6	5	5	4	4	3	2	1
	4	10	6	6	6	5	4	4	3	3	2	1
	3	10	6	5	5	4	3	3	3	2	2	1
	2	10	5	5	4	4	3	3	2	2	1	0
	1	10	5	4	4	3	3	2	2	1	1	0
	0	10	5	4	4	3	2	1	0	0	0	0

Final escape criterion score = _____ (range 0–10)
Escape criterion is critical if the score is ≤ 1.

Public Comment Criterion 6 – Escapes: Final or additional comments

Comment:

Criterion 7 – Disease, pathogen and parasite interaction

Public comment guidance.
Overview – A few well-documented examples of pathogen and parasite transfer from farmed fish to wild fish, and examples of increased virulence of pathogens or new strain development in intensive aquaculture environments effectively highlight the potential for disease-reated concerns. However there are relatively few examples of significant population-level disease impacts on wild species. It is also often argued that these potential impacts are poorly researched, and if aquaculture was causing disease in wild fish, it would be very difficult to observe in practice.

Specifics – This criterion is currently structured as a simple selection which uses a variety of examples or situations that can be used to guide the analyst to an appropriate score. They are based on evidence and data where they are available, or a simple risk assessment based on the relative biosecurity production system. It should be noted that there is a potential conflict in this respect between data availability and this disease criterion; for example a mature salmon farming industry with excellent data availability on sea lice monitoring on farmed and wild fish can be penalized in the disease assessment compared to another aquaculture industry that has no data available.

Feedback – Seafood Watch recognizes that while disease outbreaks are characteristic of the majority of aquaculture species and production systems, there are relatively few examples of significant population level impacts on wild species. Nevertheless the well-documented examples (e.g. farmed salmon) combined with the limited research on other species drives the necessity for this criterion. We welcome feedback on any of the complex disease and parasite interactions of wild fish.

Comment:

Impact, unit of sustainability and principle

- *Impact:* Amplification of local pathogens and parasites on fish farms and their retransmission to local wild species that share the same water body.
- *Unit of sustainability:* Wild populations susceptible to elevated levels of pathogens and parasites.
- *Principle:* Aquaculture operations pose no substantial risk of deleterious effects to wild populations through the amplification and retransmission of pathogens or parasites.

Disease: Pathogen and parasite interaction risk (biosecurity)

A measure of the infection risk between farm and wild populations, assuming that farms, by their nature, typically act as amplifiers of local naturally occurring and introduced pathogens and parasites. Most pathogens or parasites on farms are considered to originate from the surrounding water and therefore are of concern to surrounding populations when amplified.

Assessment scale

- Farm level assessments – apply this criterion to the farm being assessed, or use data from similar production systems and species if necessary.

- Regional or national assessments – apply to relevant regional or national statistics or use "typical" or "average" data for the production system or species.

Consider **ALL** the descriptions or examples below and select the most appropriate score given the available information. While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Public comment Guidance – The red/yellow and yellow/green break points occur at 3-4 and 6-7, and are intended to be practical differences:
Red = demonstrable impacts, or very high risk of impacts
Yellow = minor demonstrable impacts, or moderate risk of impacts
Green = demonstrably no impacts, or very low risk of impacts.

With the realities of data availability, this criteria is often challenging to assess (for example defining the break point between a (red) score of 2 out of 10 verses a (yellow) score of 4 out of 10). We welcome feedback and suggestions for improvement on any aspect of this table.

Comment:

Concern	Pathogen and Parasite Interaction Risk Examples	Score
No concern	▪ The production system is fully biosecure, all discharged water is treated or has no possibility for further impact ▪ The farm has no connection to wild populations	10
Low	▪ The farm does not discharge water over multiple production cycles[36]. ▪ Production practices do not increase the likelihood of pathogen amplification compared to natural populations, e.g., natural stocking density, water quality, feed type, behavior, etc.[37] ▪ Data show that the farm does not amplify pathogens or parasite numbers above background levels ▪ Data shows no evidence of increased infection rates in wild fish	8
Low-moderate	▪ Data show low, temporary or infrequent[38] occurrences of on-farm infections or mortalities ▪ The farm only discharges water once per production cycle ▪ Independently audited, scientifically robust limits[39] are in place, and data show that pathogen or parasite levels are consistently below the limits over multiple production cycles	6
Moderate	▪ The production system has biosecurity regulations or protocols in place, yet is still open to introductions of local pathogens and parasites (e.g., from water, broodstock, eggs, fry, feed, local wildlife, etc.) and is also open to the discharge of pathogens ▪ Disease-related mortalities occur on farms production systems discharge water on multiple occasions during the production cycle without relevant treatment ▪ Regulations or best practice standards do not exist, or are in place but enforcement is unknown ▪ Amplification of pathogens or parasites on the farm results in increased infection in wild fish, shellfish or other populations in the farming locality or region	4
Moderate-high	▪ The farming system is open to the environment, or exchanges water on multiple occasions during the production cycle and suffers from high disease or pathogen related infection and/or mortality ▪ Evidence of increased mortality of wild species due to infection from farm-derived pathogens	2
High	▪ Amplification of pathogens or parasites on the farm leads to significant population declines in wild species	0

[36] Multiple production cycles – as a guide, the normal production practice is to maintain the same water on the farm throughout one complete production cycle and reuse it for the next production cycle without discharge at any time.

[37] Consider examples of naturally settled shellfish, or extensive fish or shrimp ponds.

[38] Low, temporary or infrequent – as a guide, data show diagnosed clinical disease is present in less than 5% of stock, for less than 5% of the time, or combined diagnosed plus undiagnosed mortalities do not exceed 5% over multiple production cycles.

[39] Scientifically robust limits – controls on the number or occurrence of pathogens or parasites are primarily intended to protect wild populations or other ecosystem functions, or to apply a precautionary approach where research is inconclusive. The values are not contested by conservation organizations.

Critical	▪ There is a high disease concern and the affected wild stocks are considered vulnerable, endangered, IUCN red list, etc.	C

**Note:* Intermediate values (i.e., 1,3,5,7 or 9) may be used if needed.

Final disease criterion score = _____ (range 0–10 or critical)

Public Comment Criterion 7 - Disease: Final or additional comments
Comment:

Criterion 8 – Source of stock – Independence from wild fish stocks

Public comment guidance.
Overview – The majority of animals grown in aquaculture now sourced from hatchery-raised broodstocks, and previous key environmental concerns such as fine mesh wild shrimp PL harvests have ceased. Nevertheless high concerns remain for some key species such as wild fisheries for glass eels, Bluefin tuna, or Hamachi (Japanese yellowtail).

Specifics – This criterion makes a baseline assumption that wild juveniles provide greater ecosystem services as part of the ecosystem than if they are isolated in aquaculture grow-out units. Therefore the criterion does not assess the sustainability of the source fishery for juveniles and is simply a percentage score based on the reliance on wild sources. For broodstock, the numbers used are typically low, but can be significant for some species (e.g. tiger shrimp *Penaeus monodon*); in these instances, this criterion assesses the proportion of production that comes from fisheries of low concern.

Feedback – For the large majority of aquaculture species, this criterion gets a high "Green" score due to domesticated stocks. While every all aquaculture production requires a source of broodstock and juveniles and should be considered in every assessment, we are considering changing this to an exceptional criterion where there is a deduction from the total score in the rare cases when wild animals are used. We welcome feedback and suggestions for improvement on any aspect of this criterion

Comment:
Recognizing that this is still an important criterion for some cultured species, we would support changing this criterion to an exceptional criterion. We would want to ensure, however, that if this criterion were scored 'red' or 'critical' that it would be reflected in the final colour ranking.

Impact, unit of sustainability and principle

- *Impact:* The removal of fish from wild populations for growing to harvest size in farms
- *Unit of Sustainability:* Wild fish populations
- *Principle:* Aquaculture operations use eggs, larvae, or juvenile fish produced from farm-raised broodstocks and thereby avoiding the need for wild capture

Source of Stock: Independence from wild capture fisheries

A measure of the aquaculture operation's independence from active capture of wild fish for on-growing.

Source of stock score = the percentage of production that originates from either:
1. hatchery-raised broodstock[40]
2. wild-caught broodstock where the number used and/or the sustainability of the source can be demonstrated to be of minimal concern
3. passive influx or natural settlement (e.g., shellfish) of wild seed.

For variations within point 2 above (for example where the fishery is not demonstrably sustainable), the score can be allocated according to the quantity of broodstock used and the sustainability of the source based on the overarching scoring principle of these criteria where 0 to 3.3 is a high concern, 3.4 to 6.6 is a moderate concern, and 6.7 to 10 is a low concern. The score selected must be robustly justified in the Seafood Watch report.

Assessment scale

- Farm level assessments – apply this criterion to the farm being assessed, or use data from similar production systems and species if necessary.

- Regional or national assessments – apply to relevant regional or national statistics, or use "typical" or "average" data for the production system or species.

Production from Hatchery-Raised Broodstock or Natural (Passive) Settlement (%)	Score
100	10
90–99.9	9
80–89.9	8
70–79.9	7
60–69.9	6
50–59.9	5
40–49.9	4
30–39.9	3
20–29.9	2
10–19.9	1
0–9.9	0

Final source of stock criterion score = _____ (range 0–10)

**Note:* There is typically little demand for the farming of highly abundant wild species, therefore collection of wild fingerlings, seed or other life stages for growout in farms will often be from depressed species or fisheries. With the exception of sources that would otherwise not survive (for example ephemeral mussel spat), Seafood Watch considers that regardless of the sustainability of the stock, it is preferable for wild aquatic resources to continue to be part of a functioning natural ecosystem (while still maintaining a sustainable fishery, where possible) than to remove them and raise them solely in farms.

[40] Domesticated broodstocks – more than one generation from the wild is considered to be independent from wild fisheries in this criterion. That is, if the parents of the fish currently in commercial production were themselves produced in a hatchery then they are considered farm-raised broodstock and therefore independent of wild fisheries.

Public Comment Criterion 8 – Source of Stock: Final or additional comments
Comment:

Criterion 9X – Predator and wildlife mortalities

Public comment guidance. **Overview** – With a few notable exceptions, robust data on wildlife mortalities are rare. Nevertheless mortalities of protected species can occur, and routine control of nuisance species has the potential to impact local or regional populations. Recognizing that this problem does not relate to all production systems, this criterion is "exceptional" and is only scored (as a deduction from the total score) in cases where there is a demonstrable concern. **Specifics –** This criterion is currently structured as a simple selection which uses a variety of examples or situations that can be used to guide the analyst to an appropriate score. They are based on evidence and data where they are available. **Feedback** – We welcome feedback and suggestions for improvement on any aspect of this criterion
Comment:

A measure of the effects of deliberate or accidental mortality on the populations of affected species of predators or other wildlife.

This Criterion (9X) is defined as an exceptional criterion that may not be relevant to all aquaculture production, yet it can be a significant concern for those production practices where it is relevant. Whereas all other criteria or factors score positively and contribute to the overall score total, the exceptional criteria are given a negative score which is subtracted from the final total score for those aquaculture operations where it is a concern.

Although different aquaculture operations attract a variety of different predators and wildlife (e.g., starfish and crabs to shellfish aquaculture, birds to ponds, and otters, seals and other marine mammals to sea cages), the impacts of mortalities (from shooting, trapping, entanglement, drowning, etc.) vary depending on the population status, species vulnerability or productivity, and the numbers killed. Substantial numbers of fish may also be trapped as juveniles and grow within the farm until harvest.

Select the most appropriate score from the table below. Select the lowest (worst) score that is applicable to the aquaculture operations being assessed. Use time frames relevant to the impacted wild species. As a guide, use the number of years to reach first maturity (for example, consider average mortalities of Stellar sea lions over the last five years).

Assessment scale

- Farm level assessments – apply this factor to the farm being assessed

- Regional or national assessments – apply to relevant regional, national, or eco-certification statistics or impacts, or use data from "typical" or "average" farms.

While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Public comment Guidance – The red/yellow and yellow/green break point occur at -7 to -6 and -4 to -3 respectively, and are intended to be practical differences: Red (deduction of -7 to -10) = demonstrable impacts, or very high risk of impacts Yellow (deduction of -4 to -6) = minor demonstrable impacts, or moderate risk of impacts Green (deduction of 0 to -3) = demonstrably no impacts, or very low risk of impacts. With the common lack of data on this subject, this criterion often becomes a score of 4 somewhat by default. We welcome feedback and suggestions for improvement on any aspect of this table.
Comment:

Concern	Examples of Impacts on Predators or Other Wildlife	Score
No concern	▪ No direct or accidental mortality of predators or wildlife ▪ Passive non-harmful barriers or deterrents are used	-0
Low	▪ Aquaculture operation may attract or interact with predators or other wildlife, but effective management and prevention measures limit mortalities to exceptional cases	-2
Low-moderate	▪ Wildlife mortalities occur (beyond exceptional cases), but due to high population size[41] and/or high productivity[42] and/or low mortality numbers[43], they do not significantly impact[44] the affected species' population size	-4
Moderate	▪ Mortalities are known to occur but the species' status or impacts on the population size are unknown or considered 'moderate' between the definitions of Low-moderate and Moderate-high.	-6
Moderate-high	▪ Wildlife mortalities occur; due to low population size[45] and/or low productivity (or other measure of vulnerability), and/or high mortality numbers, they negatively impact the affected species' population size or its ability to recover.	-8

[41] Population is at or near its historic high or virgin biomass, or the population size is above the point where recruitment or productivity is impaired.
[42] Marine mammals, turtles, sharks, seabirds and other birds are considered to have low productivity.
[43] Mortality is low compared to natural mortality or mortality from other sources.
[44] Mortalities are at or below a level that will not reduce population productivity.
[45] The population size is below the point where recruitment or productivity is impaired.

High (critical)	▪ Affected species are protected, endangered, threatened (or other relevant classification) and mortalities significantly[46] contribute to further declines or prohibit recovery.	-10

**Note:* Intermediate values (i.e., 1,3,5,7 or 9) may be used when justified or needed.

Criterion 9X score = -_____ (range 0 to -10)

Public Comment Criterion 9X – Predators and wildlife: Final or additional comments
Comment:

Criterion 10X – Escape of unintentionally introduced species

Public comment guidance.
Overview – The international or "trans-waterbody" movement of live animals has frequently been associated with the introduction of non-native organisms (including pathogens and parasites) unintentionally transported at the same time. Where these unintentional hitchhikers are invasive species, the potential for impact at the destination is high. . Recognizing that this problem does not relate to all production systems, this criterion is "exceptional" and is only scored (as a deduction from the total score) in cases where there is a potential concern.

Specifics – This criterion is based on the dependence of the production on live animal movements, combined with the biosecurity of both the source and the destination of those movements. The highest biosecurity score is used – i.e. if the source of live animal movements is biosecure then it doesn't matter if the destination is open, or conversely, if the destination is biosecure then it is of low concern if the source has low biosecurity.

Feedback – We welcome feedback and suggest for improvement on any aspect of this criterion

Comment:

A measure of the escape risk (introduction to the wild) of alien species ***other than the principal farmed species*** unintentionally transported during live animal shipments.

This Criterion (10X) is defined as an exceptional criterion and will not be relevant to the majority of aquaculture production, yet it can be a significant concern for those production practices where it is relevant. Whereas all other criteria and factors score positively and contribute to the overall score total, the exceptional criteria are given a negative score, which is subtracted from the final score for those aquaculture operations where it is a concern.

Factor 10Xa – International or trans-waterbody live animal shipments

[46] Significantly – as a guide, mortalities rates significantly (statistically) contribute to population declines, or are comparable to natural mortality rates or mortality from other causes, or they can be demonstrated to be significantly impeding recovery.

Approximate percentage of production reliant on the ongoing international or trans-waterbody movement of broodstock, eggs, larvae, or juveniles within one generation of the farmed product.

Note: Trans-waterbody movement is defined with the source water body being ecologically distinct from the destination (farming) water body such that the live animal movements represent a risk of introducing non-native species.

Do not include historic introductions of broodstock for establishing domesticated stocks, etc.

Reliance on Animal Movements	% of production	Score
Zero	0	10
Low	0.1–9.9	9
	10–19.9	8
Low-moderate	20–29.9	7
	30–39.9	6
Moderate	40–49.9	5
	50–59.9	4
Moderate-high	60–69.9	3
	70–79.9	2
High	80–89.9	1
	> 90	0

Factor 10Xa score = _____ (range 0–10)

Factor 10Xb – Biosecurity of source and destination (for introduced species)
Considering the types of species (or life stages) potentially being transported unintentionally during international or trans-waterbody movements of the principal farmed species, use the table below *twice* to assess the biosecurity risk of both the source of animal movements (e.g., hatchery or wild seed bed, etc.) and the farm destination. Consider that biosecurity procedures for the principal farmed species may not prevent the escape of smaller unintentionally transported pathogens, parasites, plants, animals or their various life stages arriving with live fish shipments.

The score for this factor is the highest score (i.e., most biosecure) of either the source or destination. While every eventuality may not be covered in the table, use the examples as guidelines to determine the most appropriate score.

Concern	Biosecurity and Escape Risk Examples for Source and Destination	Score
Very low	▪ No connection to natural water bodies (i.e., fully biosecure)	10
Low	▪ Tank based recirculation systems with appropriate (multiple) screens, water treatment for inflowing or outflowing water. ▪ Static ponds with no water discharge (including at harvest) over multiple production cycles, not vulnerable to flood/storm/tsunami damage	8

Low-moderate	▪ Any "Moderate risk" system with multiple or fail-safe escape or entry prevention methods, or active Best Management Practices for design, construction, and management of escape and entry prevention (biosecurity) ▪ Any "Low risk" system with uncertainty or evidence questioning the robustness of entry or escape prevention measures ▪ Ponds with low exchange 0–3% per day	6
Moderate	▪ Ponds with moderate exchange 3–10% per day ▪ Static ponds that drain externally at harvest or do not screen inflow water ▪ Any ponds with a moderate risk[47] or vulnerability to flooding events ▪ Flow-through tank or raceways	4
Moderate-high	▪ Any "High risk" system with effective Best Management Practices for design, construction, and management of escape or entry prevention (biosecurity) ▪ Any "Moderate risk" system with uncertainty or evidence questioning the robustness of escape or entry prevention measures ▪ High exchange ponds > 10% per day	2
High	▪ Open systems (e.g., net pens) or wild caught sources (e.g., dredged mussel spat) ▪ Ponds in flood prone[48] areas or vulnerable to flooding events ▪ High exchange ponds > 10% per day ▪ Systems that do not safeguard against reproduction based egg/fry escapes ▪ System vulnerable (with evidence) to predator damage	0

Note: Intermediate values (i.e., 1,3,5,7 or 9) may be used if needed.

Biosecurity score of the source of animal movements = _____ (range 0–10)
Biosecurity score of the farm destination of animal movements = _____ (range 0–10)

Criterion 10Xb score = highest biosecurity score = _____ (range 0-10)

Criterion 10X score = [(10 - 10Xa) x (10 - 10Xb)] / 10 = -_____ (range 0 to -10)
Note: This is a negative score that will be subtracted from the overall final score total of the other criteria.

Exceptional Criterion 10X score = - _____ (range 0 to -10)

Public Comment Criterion 10X – Escape of unintentionally introduced species: Final or additional comments

[47] Moderate risk – ponds or tanks may be located at the limits or edges of flood or tsunami zones, or constructed to withstand 50 year events.
[48] Flood prone – as a guide, ponds in low-lying valley areas, wetlands, river flood plains, or coastal tsunami zones.

Comment:

Overall score and final recommendation

Public comment guidance.
Overview –The final scoring system combines the individual criterion scores to produce a numerical final score from 0-10, but also applies decision rules based on the number of "high concerns", i.e. "red" scoring criteria as outlined below.

Specifics – The following sections show how the final score and final recommendation are calculated from the individual criterion scores. It is the current philosophy of the SFW criteria that regardless of the final numerical score, if there is one "high concern" (i.e. a red criterion with a numerical score <3.33), then the highest final recommendation is a yellow "Good Alternative". If there are two "high concerns", then the overall final recommendation will be red "Avoid" regardless of the numerical score. If there is one or more "critical concerns" then the final recommendation is red "Avoid" regardless of the numerical score.

Feedback – In general the scoring system has worked, and the final recommendation is often decided by the presence of one or more red "high concern" scores. The criteria are not weighted in any way at present (i.e. they all have equal weighting). This part of the criteria is critical to the appropriate final recommendation for every Seafood Watch assessment, and we welcome feedback and suggestions for improvement on any aspect of this criterion

Comment:

Numerical score

The Final numerical score = [(Sum of C1–C8 scores) – (C9X + C10X)]/8
= _____ (range 0–10)

Number of Red Criteria

Any criterion (C1–C8) with a score lower than 3.3 (or less than -6.6 for C9X and C10X) is considered "Red".

Total number of Red criteria or factors = _____ (0–10)

Number of Critical Scores

A number of criteria or factors have one or more "Critical" characteristics:

- Effluent C2 score = 0 (i.e., waste discharge is high and management of cumulative impacts is weak)
- Effluent Full Assessment score = "Critical"
- Habitat C3 score = 0 (i.e., ongoing damage to high value habitats)

- Chemical use C4 score = 0 (i.e., evidence of pathogens with developed resistance to chemicals important to human health)
- Feed F5.1 FIFO value is greater than 4 (actual FIFO value, not the FIFO score)
- Feed F5.2 PRE score = 0 (i.e., > 90% of the protein provided in the feed is wasted)
- Feed F5.1 FIFO value (not score) > 3 and F5.3 PRE score < 2 (i.e., a lot of wild fish is used in the feed and most of the fed nutrients are wasted)
- Escapes F6.1 < 1 (i.e., escape numbers are very high and damaging to wild populations) and the affected wild populations are vulnerable, endangered, IUCN listed, etc.
- Escapes F6.2 = 0 (i.e., a very high risk of introduced non-native species)
- Disease C7 = Critical (a high disease concern for the affected wild stocks that are considered vulnerable, endangered, IUCN red list, etc.)
- Predator/ wildlife mortalities C9X Predators score of -10 = "Critical"

Number of Critical scores = _____

Criterion	Score (0-10)	Red? (Y/N)	Critical? (Y/N)
C1 Data			N/A
C2 Effluent			
C3 Habitat			
C4 Chemical use			
C5 Feed			
C6 Escapes			
C7 Disease			
C8 Source of stock			
C9X Wildlife	-		
C10X Introductions	-		
Overall score = (0-10)			
Number of Red Criteria =			
Number of Critical Scores =			

Final Seafood Watch Recommendation

The overall recommendation is as follows:

- **Best Choice** = Final score between and 10, **and** no Red criteria, **and** no Critical scores.

- **Good Alternative** = Final score between 3.33 and 6.66, **and/or** one Red criterion, **and** no Critical scores.

- **Avoid** = Final score between 0 and 3.33, **or** more than one Red criterion, **or** one or more Critical scores.

Final Recommendation = _____

Appendix 1 – Habitat examples

The following additional examples or indicators are provided to help the assessor determine the maintenance or loss of habitat functionality, and/or the level of impact to functioning habitats. Indicators of habitat damage vary between habitat types, are difficult to quantify for some habitats, and may not provide linear measures of damage or scores. Use any relevant indicator of habitat impact for which data or evidence are available.

Wetland ecosystems (mangroves, brackish and freshwater)

Type of Conversion	Remaining Mangrove/ Wetland Area (%)	Other Example or Indicators
Maintains full functionality	100	Undisturbed
Minimal impact	90–100	Little impact on fisheries catch
Minor impacts	70–90	Decrease in fisheries catch Reduced effect on hazard control Loss of juvenile habitat
Moderate impacts	50–70	Changes in species abundance
Major impacts – loss of functionality	0–50	Loss of hazard control capacity Changes in species diversity Significant amount of C release Loss of fisheries Loss of functional diversity

Ocean/ marine ecosystems

Note: benthic marine impacts are typically rapidly reversible, therefore impacts are considered relatively less severe and allocated to different impact groups accordingly.

Type of Conversion	Examples or Indicators				
	(EcoQ)[49]	H'	AMBI	Diversity	Effects
Maintains full functionality	High	H'>4	AMBI≥1.2	90–100% of reference station value	Undisturbed
Minimal impacts	Good	3<H'≤4	1.2<AMBI≤ 3.3	70–90% of reference station value	Slightly disturbed
Minor impacts	Moderate	2<H'≤3	3.3<AMBI≤ 4.3	50–70% of reference	Moderately disturbed

[49] EcoQ = Biotic biodiversity status

				station value	
Moderate impacts	Poor	1<H'≤2	4.3<AMBI≤ 5.5	30–50% of reference station value	No irreversible impacts on benthic communities (disturbance is rapidly reversed by fallowing) Oxygen depletion Toxic effect of H_2S
Major impact – loss of functionality	Bad	H'≤1	AMBI>5.5	Less than 30% of reference station value	Some evidence of far-field effects Irreversible impacts

Freshwater ecosystems

Note: benthic freshwater impacts are typically rapidly reversible, therefore impacts are considered less severe and allocated accordingly.

Type of conversion	Index of Biotic Integrity	Effects
Maintains full functionality	>90%	Undisturbed
Minimal impacts	75–90%	Slightly disturbed
Minor impacts	70–75%	Moderately disturbed
Moderate impacts	65–70%	No irreversible impacts (disturbance is rapidly reversed by fallowing)
Major impact – loss of functionality	<65%	Some evidence of far-field effects

Terrestrial ecosystems

Type of Conversion	Land Cover	Salinization	Effects
Maintains full functionality	70–100 %		
Minor impacts	50–70 %		Reduced C sequestration
Moderate impact	30–50%	Higher soil conductivity	Significant habitat fragmentation
Major impact –loss of functionality	0–30%	Reduced crop yields Loss of soil fertility	

Appendix 2 – Additional guidance for the habitat criterion

Historic loss of functionality

- If the farms were established historically (more than ten years ago), the score will be between 4 and 6, depending on the original habitat value.
- If the farms were established less than ten years ago in habitats that had previously lost functionality more than ten years ago, the score will be between 4 and 6, depending on the original habitat value.
- If the farms or industry are still expanding into habitats that had previously lost functionality more than ten years ago, the score will be between 4 and 6, depending on the original habitat value.
-

Recent and ongoing habitat damage resulting in loss of functionality

- If the farms have recently been established (less than ten years ago) without maintaining critical ecosystem services, the score will be between 1 and 3, depending on the original habitat value.
- If the farms are still expanding into functioning habitat (i.e., there is a continuing loss of ecosystem services), then the score will be between 0 and 3, depending on original habitat value.
- If the farms were recently established, or are still expanding into habitat that had previously lost functionality more than ten years ago, the score will be between 4 and 6, depending on the original habitat value.