

Monterey Bay Aquarium Seafood Watch®

Global Aquaculture Alliance

Finfish and Crustacean Farms BAP Standards, Guidelines (Rev. 4/13)

Applied to Shrimp



Benchmarking equivalency results assessed against the Seafood
Watch Aquaculture Criteria

February 20, 2014

Final Seafood Recommendation

Criterion	Score (0-10)	Rank	Critical?
C1 Data	9.75	GREEN	
C2 Effluent	5.00	YELLOW	NO
C3 Habitat	3.67	YELLOW	NO
C4 Chemicals	0.00	RED	NO
C5 Feed	5.74	YELLOW	NO
C6 Escapes	4.00	YELLOW	NO
C7 Disease	4.00	YELLOW	NO
C8 Source	10.00	GREEN	
C9X Wildlife mortalities	-4.00	YELLOW	NO
C10X Introduced species escape	0.00	GREEN	
Total	38.15		
Final score	4.77		

OVERALL RANKING

Final Score	4.77
Initial rank	YELLOW
Red criteria	1
Interim rank	YELLOW
Critical Criteria?	NO

FINAL RANK
YELLOW

Scoring note – scores range from zero to ten where zero indicates very poor performance and ten indicates the aquaculture operations have no significant impact.

Summary

The final numerical score for the Global Aquaculture Alliance Best Aquaculture Practices 2-, 3-, and 4-star standards (assessed for shrimp) is 4.77, which is in the yellow range.

Executive Summary

The benchmarking equivalence assessment was undertaken on the basis of a positive application of a realistic worst-case scenario:

- “Positive” – Seafood Watch wants to be able to defer to equivalent certification schemes
- “Realistic” – we are not actively pursuing the theoretical worst case score. It has to represent reality and realistic aquaculture production.
- “Worst-case scenario” – we need to know that the worst-performing farm capable of being certified to any one standard is equivalent to a minimum of a Seafood Watch “Good alternative” or “Yellow” rank.

The Global Aquaculture Alliance “Finfish and Crustacean Farm” Best Aquaculture Standards have broad applicability; they state:

- *The following Best Aquaculture Practices standards and guidelines apply to the farming of all crustacean and finfish species except salmonids reared in cages and net pens (refer to BAP’s Salmon Standards). They cover all production methods, including flowthrough, partial exchange, and closed or recirculating water systems operated in ponds, cages, net pens, tanks, raceways or closed-containment vessels.*

From a benchmarking perspective, this broad scope means the standards must be very robust to ensure they are applicable and effective across the broad range of species, farming systems and countries that could apply for certification. Unfortunately this is not the case; in reality it is relatively easy to envisage an aquaculture system that could be certified to these standards that would be ranked red in a Seafood Watch assessment (e.g. an intensive cage farm with a risk of escapes of a non-native species with high fish meal feeds, with significant chemical use, disease problems, and located in sensitive habitats in a developing country with poor environmental regulations). Therefore to be more pragmatic, Seafood Watch has benchmarked GAA’s standards with known key aquaculture species in order to try and identify species for which Seafood Watch could defer to GAA’s certification. The assessment has considered a two-, three-, or four-star GAA-certified farm (i.e. all processing and farm-level standards).

This assessment is for shrimp. The realistic worst-case scenario considered is a non-native species (e.g. *L. vannamei* in Asia), located in former mangrove areas, with daily exchange of water. In general, the current¹ GAA standards:

- in many cases only defer to (i.e. require compliance with) unknown local regulations without setting robust requirements for the intended outcomes of certification
- have lengthy supporting or implementation information which may not be supported by specific or robust standards requirements
- like all farm-level standards do not robustly address cumulative impacts of multiple neighboring, local or regional farms

¹ Finfish and Crustacean Farms BAP Standards, Guidelines. Rev 4/13.

- have weakness compared to one Seafood Watch criteria (Chemical Use) resulting in a yellow final recommendation.

Specifically for each criterion, the GAA shrimp standards:

- like all certification, require considerable data collection and combined with the farm-level certification process result in a good data score (9.75 out of 10).
- have water quality restrictions to limit the effluent concentrations but do not limit effluent volumes and therefore do not limit the total nutrient loads discharged. Sediment/sludge treatment is required but the standards do not address potential cumulative impacts of effluents from multiple farms. The Effluent score is 4 out of 10.
- do not allow certification of farms in mangrove or wetland habitats if built after 1999, but can certify farms located in these habitats if constructed before then. The farm-specific standards do not deal with cumulative impacts of neighboring farms. Benefits to ecosystem services from the restoration of the original habitats is required for any net loss of wetland habitat occurring on the facility since 1999. The Habitat Criterion score is 3.67 out of 10.
- contain no effective measures to limit the frequency or quantity of antibiotics or other chemical use (e.g. pesticides). Antibiotics highly- or critically-important to human health, or pesticides may be used in unrestricted amounts (e.g. the antibiotic oxytetracycline widely used in aquaculture and permitted in the U.S. import market). The Chemical Use score is 0 out of 10, and one of the three red criteria.
- only require data collection from feed mills until some standards become active in 2015. Taking into account GAA's choice of calculation for "Fish In:Fish Out ratio, and comparing it to FAO general shrimp feed data, the score for the Feed Criterion is 5.74 out of 10.
- have escape requirements for a non-native species that has the potential to become established in non-native environments (e.g. *L. vannamei* in Asia) that include limited daily water exchange and secondary containment measures during harvest and stock transfer operations. There are no requirements relating to flooding events. The Escape Criterion score is 4 out of 10.
- have no requirements relating to disease or pathogen discharges. With limited evidence of environmental impacts, yet an ongoing concern, the score for the Disease Criterion 4 out of 10.
- prevent the use of wild postlarvae, but not that of wild broodstock (however this is not penalized in this assessment for *L. vannamei* which is considered to be all domesticated). If *P. monodon* had been assessed, there would have been a moderate penalty for the Source of Stock Criterion. Score of 10.
- only encourage non-lethal predator control and have no robust restrictions. The Predator mortality score is a penalty of -4 out of -10 assuming mortalities occur but the numbers are not sufficient to have population level impacts on the predator species.
- have no robust requirements for international live animal movements, relying on potentially non-existent in-country regulations. However the benchmarking assumes no shipping for consistency across standards. The score is a deduction of 0.

The final result is yellow. Seafood Watch can defer to GAA-certified shrimp at the 2-, 3-, and 4-star levels as being equivalent to at least a yellow Seafood Watch “Good Alternative” recommendation.

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Introduction

Scope of the analysis and ensuing recommendation

- Species.

The Global Aquaculture Alliance (GAA) Best Aquaculture Practices (BAP) standards cover all species of farmed finfish and crustaceans (except salmon which has its own standard). The following assessment has been conducted for a shrimp species farmed where it is non-native (ex. *L. vannamei* farmed in Asia).

- Geographic coverage.

GAA standard covers all geographic regions. This benchmarking uses Asia as a realistic location for *L. vannamei* production.

- Production Methods.

GAA standard covers all production methods used for finfish and crustacean production. This benchmarking uses pond culture with daily water exchange.

Analysis

Benchmarking principles

The benchmarking equivalence assessment was undertaken on the basis of a positive application of a realistic worst-case scenario

- “Positive” – Seafood Watch wants to be able to defer to equivalent certification schemes
- “Realistic” – we are not actively pursuing the theoretical worst case score. It has to represent reality and realistic aquaculture production.
- “Worst-case scenario” – we need to know that the worst farm capable of being certified to any one standard is equivalent to a minimum of a Seafood Watch “Good alternative” or “Yellow” rank.

Benchmarking assumptions

A number of assumptions were made to enable an equivalence assessment to be made either in the face of differing language or units etc., or in the case of missing information or gaps in the standards. The assumptions enable consistency across all the standards being assessed.

Specific assumptions have been noted where relevant in the individual criteria sections below, but the following were applied to all standards:

- Anything referred to as “should”, “recommend”, “prefer”, “minimize”, “minor must” or any similarly non-specific language was ignored

- Any deferral to local or national regulations in a standard of global scope was ignored.
- Any aspirational intent not supported by robust standards was ignored (for example “You must prevent escapes” was ignored if there were not effective supporting standards to actually prevent escapes).
- Any standards based on a future timeframe were ignored.
- Assume standards are applicable globally unless the standards or the scheme’s label specify or differentiate production regions. Assume the worst-case farm is in the worst country or region.
- Requirements for the presence of (for example) animal health plans, veterinary supervision, or veterinary prescription of medications were ignored without further robust requirements in the standards.

Scoring guide

- With the exception of the exceptional factors (3.3x and 6.2X), all scores result in a zero to ten final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of ten indicates high performance. In contrast, the two exceptional factors result in negative scores from zero to minus ten, and in these cases zero indicates no negative impact.
- The full Seafood Watch Aquaculture Criteria that the following scores relate to are available here
http://www.montereybayaquarium.org/cr/cr_seafoodwatch/content/media/MBA_Seafood_Watch_AquacultureCriteriaMethodology.pdf
- The full data values and scoring calculations are available in Appendix 1

Production system

GAA 2-, 3-, and 4-star standards cover processing and farm operations for all production methods used for finfish and crustacean production. This benchmarking uses pond culture of *L. vannamei* in Asia with daily water exchange as a realistic “worst case scenario”. GAA standards limit water exchange for shrimp ponds to a mean of >10% daily for farms in all non-desert habitats. This assessment does not include hatchery standards or feed mill standards.

Criterion 1: Data quality and availability

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, nor enable businesses to be held accountable for their impacts.*
- *Sustainability unit: 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.*

Criterion 1 Summary

Data Category	Relevance (Y/N)	Data Quality	Score (0-10)
Industry or production statistics	Yes	10	10
Effluent	Yes	10	10
Locations/habitats	Yes	7.5	7.5
Predators and wildlife	Yes	10	10
Chemical use	Yes	10	10
Feed	Yes	10	10
Escapes, animal movements	Yes	10	10
Disease	Yes	10	10
Source of stock	Yes	10	10
Other – (e.g. GHG emissions)	Yes	10	10
Total			97.5

C1 Data Final Score	9.75	GREEN
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Brief Summary

Data for each criterion is readily available due to the thorough auditing process required by GAA. The data availability score for the Habitat criterion is the only one that did not get a score of 10 due to the lack of available historical data concerning habitat type prior to conversion to shrimp ponds. The Habitat criterion, however got a high score of 7.5 of 10. This has led to a final Data Availability score of 9.75 of 10.

Justification of Ranking

Assumptions:

- The “Source of stock” and “Energy use” categories were considered “non-relevant” unless the scheme specifically required data collection on these aspects. Schemes could improve their score by requirements in this respect, but would not be penalized for not providing information on what would be considered universal practice.

Requirements for data collection in the GAA standards are generally robust. The farm-level audit and certification process typically requires significant monitoring and recording, and the GAA standards are specific in this regard. The one exception pertains to “Locations/ Habitats”: while there are explicit restrictions on siting of farms in mangroves and other wetland areas, in general the standards do not require documentation or records of habitat impacts to be kept. Success of any restoration efforts, however must be documented and information provided at the time of any audit.

Data Category	Relevant Content of Standards
Industry or production statistics	10.1 The facility shall maintain accurate records of the species farmed and, where relevant, any significant stock characteristics
Effluent	5.4 Records on intake water and eluent monitoring shall be maintained and available
Locations/habitats	Implementation Guidelines: Whether the restoration is conducted by the farm or through an independent restoration program, the auditor will verify that the wetland is viable by confirming it is healthy, appropriately diverse and still healthy at subsequent annual audits. In cases where the auditor has not been able to inspect the restored wetlands in person, the farm shall provide the auditor with the evidence (e.g. maps, GPS coordinates, recent photographs and recent aerial photographs).
Predators and wildlife	10.12 The facility shall record, and report where required, the species and numbers of all avian, mammalian, and reptile mortalities
Chemical use	13.3 Records shall be maintained for every application of drugs and other chemicals that include the date, compound used, reason(s) for use, dose and harvest date for treated production lots
Feed	9.2 The facility shall record the characteristics of all feeds used, the total amounts of each feed used each year and the total annual crustacean of fish production
Escapes, animal movements	10.10 All incidents involving escapes of aquaculture animals shall be accurately documented
Disease	Record for disease diagnoses should provide supporting evidence to justify cases where therapeutants are used (pg. 23)
Source of stock	10.3 The facility shall keep records of sources and purchases of stocking material, and record the number stocked in each culture unit for each crop

The overall score for Criterion 1 – Data is an average of the relevant scores; 9.75 out of 10.

Criterion 2: Effluents

Impact, unit of sustainability and principle

- *Impact: aquaculture species, production systems and management methods vary in the amount of waste produced and discharged per unit of production. The combined discharge of farms, groups of farms or industries contributes to local and regional nutrient loads.*
- *Sustainability unit: 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.*

Criterion 2 Summary

Effluent Full Assessment

Effluent parameters	Value	Score	
F2.1a Biological waste (nitrogen) production per of fish (kg N ton-1)	61.12		
F2.1b Waste discharged from farm (%)	27		
F2 .1 Waste discharge score (0-10)		8	
F2.2a Content of regulations (0-5)	1.5		
F2.2b Enforcement of regulations (0-5)	3		
F2.2 Regulatory or management effectiveness score (0-10)		1.8	
C2 Effluent Final Score		5.00	YELLOW
Critical?	NO		

Brief Summary

Using the maximum allowable percentage of water exchange (10% daily) and an adjustment of -0.24 for proper sludge removal, 27% of the waste produced is discharged from the farm. The Factor 2.2 score for the effectiveness of the management is 1.8. The combination of these two scores results in a final Criterion 2 score of 5 of 10.

Justification of Ranking

Assumptions

- For consistency, the full assessment was used across all species
- The cumulative impacts questions on regulations and enforcement were assessed according to the standards requirements in this respect
- No fertilizer use was considered unless specified in the standards

- Tilapia, salmon and cod effluent was assessed for cages, other species were assessed for high-exchange ponds as a worst-case scenario unless otherwise specified

The GAA standards express water quality requirements in mg/l for total ammonia nitrogen and soluble phosphorous, but do not have volume limitations. Therefore the total load discharge is not restricted. The “Full assessment” in the Seafood Watch criteria was used to calculate the total waste produced and discharged per ton of production, combined with the effectiveness of management measures to control total and cumulative impacts.

Explanatory tables and scoring calculations can be found on Page 8 of the Seafood Watch Aquaculture Criteria.

Factor 2.1. Waste discharged from the farm

Factor 2.1a calculates the amount of waste produced per ton of production

Relevant Content of Standards	How we applied it
Protein content of feed Not addressed by initiative	35% average from Seafood Watch reports.
Feed conversion ratio Not addressed by initiative	1.6 from Tacon et al (2011)
Fertilizer input Not addressed by initiative	Assumed zero for all benchmarking assessments
Protein content of whole harvested shrimp Not addressed by initiative	17.8% from Boyd et al (2007)

These values result in a nitrogen waste production of 61.1kg per ton of shrimp (see Criteria - Factor 2.1a for calculations).

Factor 2.1b calculates the proportion of the waste produced that is discharged from the farm.

Relevant Content of Standards	How we applied it
5.8 For farms with outdoor ponds, the annual water usage shall not exceed 36 x total pond volume (i.e a mean exchange rate of 10% per day).	Factor 2.1b Ponds with daily exchange scored 0.51 with an adjustment of -0.24 for proper sludge removal
8.12 If the applicant’s facility produces more than 20 mt/ha/crop, the facility shall possess sufficient sedimentation basin capacity to handle the associated sludge/sediment. The facility shall process all sludge/sediment in sedimentation basins and not dump material in sensitive wetland or mangrove areas, or public water bodies.	Adjustment of -0.24 (24%) for sludge control. Therefore 27% of the waste produced by the shrimp is discharged from the farm (Factor 2.1b)

<p>Appendix A Total ammonia nitrogen (mg/L): Initial 5 mg/L, Final (after 5 years): 3 mg/L or less</p>	<p>Does not specify volume of effluent, therefore total amount of Nitrogen in effluent unknown. Assumed 100% basic score across all benchmarking unless otherwise specified in the standards.</p>
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Using the maximum allowable percentage of water exchange (10% daily) and an adjustment of -0.24 for proper sludge removal, 27% of the waste produced is discharged from the farm. This leads to a final score of 8 of 10 for F2.1.

Factor 2.2. Effluent management effectiveness (appropriate to the scale of the industry)

Factor 2.2 assesses the effectiveness of management measure or regulations to control the total waste produced from the total tonnage of the farm and the cumulative impact of multiple neighboring farms.

Factor 2.2a assesses the content of the management measures

Relevant Content of Standards	How we applied it
5.5 Effluent water quality concentrations shall comply with BAP water quality criteria or applicable regulations if they are equivalent or more rigorous	Score of 1 in F2.2a Question 1 because the standards are specific to aquaculture
Standards are global and universally applied to all certified farms, i.e. they do not lead to site specific requirements.	Score of 0 in F2.2a Question 2 because the standards are not specific to the site
Standards do not address cumulative impacts of multiple farms	Score of 0 in F2.2a Question 2 because the control measures do not address or relate to the cumulative impacts of multiple farms
Standards are global and universally applied to all certified farms, i.e. they do not lead to site specific requirements.	Score of 0 in F2.2a Question 4 because the standards are not specific to the site's ecological status
<p>7.4 Monitoring of sediment conditions shall be undertaken at the time of peak feeding during the production cycle</p> <p>The standards do not require specific measurements at harvest or other times of peak discharge.</p>	Score of 0.5 in F2.2a Question 5 because the standards cover some, but not all, aspects of the production cycle

The total for Factor 2.2a is 1.5 (out of 5).

Factor 2.2b assesses the enforcement of the above measures.

Relevant Content of Standards	How we applied it
Farms shall comply with local and national laws and environmental regulations	Score of 1 for F2.2b Question 1 because the standards defer to regional/ national enforcement agencies
	Score of 1 for F2.2b Question 2 because non-compliance results in loss of certification
7.4 Monitoring of sediment conditions shall be undertaken at the time of peak feeding during the production cycle The standards do not require specific measurements at harvest or other times of peak discharge.	Score of 0.5 in F2.2b Question 3 because the standards cover some, but not all, aspects of the production cycle
	Score of 0.5 for F2.2b Question 4 because non-compliance results in loss of certification
Farms shall comply with local and national laws and environmental regulations	Score of 0 for F2.2b Question 5 because there is no evidence of robust penalties for infringements

The total for Factor 2.2b is 3 out of 5

The Factor 2.2 score for the effectiveness of the management is 1.8. The final effluent score is a combination of the waste discharged and the effectiveness of the management to control the total and cumulative impacts. The table on Page 12 of the Aquaculture Criteria document shows how this score is calculated, producing a final Criterion 2 Effluent score of 5 out of 10.

Criterion 3: Habitat

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 and to the critical “ecosystem services” they provide.*
- *Sustainability unit: 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.*

Criterion 3 Summary

Habitat parameters	Value	Score	
F3.1 Habitat conversion and function		4.00	
F3.2a Content of habitat regulations	3.00		
F3.2b Enforcement of habitat regulations	2.50		
F3.2 Regulatory or management effectiveness score		3.00	
C3 Habitat Final Score		3.67	YELLOW
Critical?	NO		

Brief Summary

GAA standards allow for use of historical mangrove habitat for shrimp ponds, however any conversion later than 1999 must be mitigated through restoration. This leads to an F3.1 score of 4 of 10. Management and enforcement of regulations gets a score of 3 of 10, leading to a final score of 3.67 for the Habitat criterion.

Justification of Ranking

Assumptions:

- Assume farm is in high-value (or former high-value) habitat unless standards specify otherwise
- The cumulative impacts questions on regulations and enforcement were assessed according to the standards requirements in this respect

Factor 3.1. Habitat conversion and function

Factor 3.1 assesses the impact on ecosystem services at the farm site, or within an allowable zone of effect. Explanatory tables can be found on Page 14 of the Aquaculture Criteria.

Relevant Content of Standards	How we applied it
4.1: If net loss of wetland habitat (delineated by evaluation of hydrological conditions and the presence of wetland vegetation) occurred on facility property since 1999, the loss shall have been due to allowable purposes	Farms may be sited in high value habitats if constructed prior to 1999. Score Factor 3.1 as 4 (out of 10) for historic, >10 yrs loss of habitat functionality of high value habitat
4.3 Farm activities shall not alter the hydrological conditions of the surrounding watershed, and the normal flow of brackish water to mangroves or freshwater to wetlands shall not be altered, unless specific permits apply	This relates to water supply channels etc. The score of 4 (above) is unaffected by this standard.

Factor 3.1 is 4 out of 10 because farms can be located in high value habitats as long as they were built before 1999.

Factor 3.2. Habitat and farm siting management effectiveness (appropriate to the scale of the industry)

Factor 3.2a assesses the content of the management measures to manage site-specific and cumulative habitat impacts. Explanatory tables can be found on page 16 of the assessment criteria.

Relevant Content of Standards	How we applied it
Environmental impact assessment Not required by initiative	Score of 0.25 in F3.2a Question 1 because the standards have some siting/construction guidelines but do not require a comprehensive Environmental Impact Assessment or other licensing process based on ecological principles
Cumulative impacts Not addressed by initiative	Score of 0 in F3.2a Question 2 because the certification has no control over neighboring farms.
4.1: If net loss of wetland habitat (delineated by evaluation of hydrological conditions and the presence of wetland vegetation) occurred on facility property since 1999, the loss shall have been due to allowable purposes Allowable purposes defined as: If a farm operation requires access to water resources, removal of wetland vegetation shall only be allowed for the installation of inlet and outlet canals, pump stations and docks. Wetland removed for such purposes shall be mitigated by restoring an appropriately diverse area of wetland three times the size of the area removed. This practice is only allowable if local regulations don't prohibit it.	Score of 0.75 in 3.2a Question 3 because ongoing conversion of mangroves for specific uses is allowed. However standards for successful restoration mitigate most impacts from ongoing conversion of mangroves.
4.1: If net loss of wetland habitat (delineated by evaluation of hydrological conditions and the presence of wetland vegetation) occurred on facility property since 1999, the loss shall have been due to allowable purposes See definition of Allowable purposes above	Score of 0.75 for F3.2a Question 4 because high value habitats are avoided, but not for sites constructed prior to 1999.
4.4 If wetland restoration has been conducted, the restored vegetation shall be maintained in a healthy state, viable and appropriately diverse. Addition to implementation guidelines:	Score of 0.75 for F3.2a Question 5 because siting is allowed in former mangrove areas with habitat restoration required for mangroves/wetlands converted

Whether the restoration is conducted by the farm or through an independent restoration program, the auditor will verify that the wetland is viable by confirming it is healthy, appropriately diverse and still healthy at subsequent annual audits. In cases where the auditor has not been able to inspect the restored wetlands in person, the farm shall provide the auditor with the evidence (e.g. maps, GPS coordinates, recent photographs and recent aerial photographs).	after 1999.
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The total for Factor 3.2a is 3 (out of 5).

Factor 3.2b assesses the enforcement of the above measures.

Relevant Content of Standards	How we applied it
Farms shall comply with local and national laws and environmental regulations	Score of 1 for F3.2b Question 1 because the standards defer to regional/ national enforcement agencies as well as maintaining compliance with GAA BAP
Enforcement of ecosystem based on zoning or cumulative management plans Not addressed by initiative	Score of 0 for F3.2b Question 2 as there are no ecosystem based cumulative habitat standards
Cumulative impacts of multiple farms Not addressed by initiative	Score of 0 for F3.2b Question 3 as there are no ecosystem based cumulative habitat standards
Transparency of the enforcement process	Score of 0.5 for F3.2b Question 4 as the transparency of the audit process and farm level information availability from certified farms is moderate
Evidence that restrictions or control measures are being achieved	Score of 1 for F3.2b Question 5 based on audit and certification process

The total for Factor 3.2b is 2.5 (out of 5).

The combined score for Factor 3.2 is 3.

The final score for Criterion 3 – Habitat combines Factors F3.1 and F3.2 (see Aquaculture Criteria document Page 16 for calculation) to give a score of 3.67 out of 10.

Criterion 4: Evidence or Risk of Chemical Use

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.*
- *Sustainability unit: 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 avoid the discharge of chemicals toxic to aquatic life, and/or effectively control the frequency, risk of environmental impact and risk to human health of their use*

Criterion 4 Summary

Chemical Use parameters	Score	
C4 Chemical Use Score	0.00	
C4 Chemical Use Final Score	0.00	RED
Critical?	NO	

Brief Summary

GAA standards do not include measures to effectively limit the use of chemicals or antibiotics including chemicals both highly and critically important to human health. The final score for Criterion 4 is 0 of 10.

Justification of Ranking

Assumptions:

- Assume un-restricted use of critically important antibiotics unless specifically prohibited in the standards
- If antibiotics are prohibited but other chemicals are permitted, the score was based on any further standards limitations, or the typical use for the species and production system (whichever was lower).

Explanatory score table can be found on Page 20 of the Aquaculture Criteria.

Relevant Content of Standards	How we applied it
13.2 If used, drug treatments shall be based on recommendations and authorization overseen by a fish health specialist only to treat diagnosed diseases in accordance with instructions on product labels and national regulations.	Standards contain no effective measures to control antibiotic or other chemical use. Antibiotics critically important to human health
13.3 Records shall be maintained for every application of drugs	may be used in unrestricted

and other chemicals that include the date, compound used, reason(s) for use, dose and harvest date for treated production lots. 13.6 Antibiotics or chemicals that are proactively prohibited in the producing or importing country shall not be used in feeds, pond additives or any other treatment.	amounts. Scored as 0.
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Final score for Criterion 4 is 0 out of 10.

Criterion 5: Feed

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 their 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.*
- *Sustainability unit: 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.*

Criterion 5 Summary

Feed parameters	Value	Score	
F5.1a Fish In: Fish Out ratio (FIFO)	1.14	7.16	
F5.1b Source fishery sustainability score		-6.00	
F5.1: Wild Fish Use		6.47	
F5.2a Protein IN	42.87		
F5.2b Protein OUT	13.97		
F5.2: Net Protein Gain or Loss (%)	-67.40	3	
F5.3: Feed Footprint (hectares)	7.99	7	
C5 Feed Final Score		5.74	YELLOW
Critical?	NO		

Brief Summary

GAA standards require a FI:FO value of 1.2 or less, using an “industry” calculation which is different from the “academic” calculation used by Seafood Watch. However when the same typical FAO shrimp feed data is used in both calculations, both FI:FO values are lower than 1.2. The FI:FO score (F5.1a) is 7.16 of 10. Combined with a 5.2b score of -6 of -10 the Factor 5.1 score is 6.47 of 10.

Factor 5.2 shows a net protein loss of -67.4% leading to a score of 3 of 10. This combined with a F5.3 score of 7 leads to a final criterion 5 score of 5.74 of 10.

Justification of Ranking

Assumptions

- If un-specified in the standards, assume the 2011 species-average FCR, fishmeal and oil levels from FAO (Tacon et al, 2011).
- Assume all non-aquatic feed ingredients are from edible crops unless otherwise specified (this generates the overall worst-case scenario score for feed in the criteria).
- If standards have some requirements for fishery sustainability but insufficient to deserve a better score, the sustainability score is -6 which assumes the very worst fisheries will be avoided. If there are no fishery sustainability standards then the score is -10.
- Assume a fishmeal protein content of 66.5% from FAO Technical paper 540 (2009). Assume remaining non-fishmeal protein comes from edible crops.
- Assume by-product ingredients in feed is zero unless specified in the standards
- For all species, assume 50% of by-products from harvested fish are utilized unless otherwise specified in the standards.

Explanatory score tables and calculations can be found on Pages 22-26 of the Aquaculture Criteria. Breakdown of calculations and data points can be found in Appendix 1 of this report.

Factor 5.1. Wild Fish Use

Factor 5.1 combines a Fish In:Fish Out ratio (F5.1a) with a source sustainability factor (F5.1b) to give a “wild fish use” score. Explanatory tables and calculations can be found on Page 22 of the Aquaculture Criteria document.

The GAA standards dictate a maximum allowable Fish In:Fish Out (FIFO) ratio for several species, including *L. vannamei*. GAA uses the “industry” method of calculating a FIFO ratio (Equation 2 [Page 17] in GAA standards); this is a different calculation than the “academic” equation used by Seafood Watch. Therefore this assessment has made a calculation based on typical FAO shrimp feed data (from Tacon et al., 2011) and compared that to the GAA standard value. The GAA FIFO value for *L. vannamei* is 1.2.

Factor 5.1a Fish In: Fish Out ratio (FIFO)

Relevant Content of Standards	How we applied it
Fishmeal inclusion level Not addressed by initiative	Used 16% from Tacon et al (2011)
Fishmeal from by-products Not addressed by initiative	Assumed zero
Fish oil inclusion level Not addressed by initiative	Used 2% from Tacon et al (2011)
Fish oil from by-products Not addressed by initiative	Assumed zero
FCR Not addressed by initiative	Used 1.6 from Tacon et al (2011)

Using these values in the SFW Aquaculture Criteria, the resulting FIFO value is 1.14. When the FAO values above are used with the GAA calculation, the resulting FIFO ratio is 1.05 (i.e. lower than the Seafood Watch calculation). As both these values are lower (i.e. better) than the GAA standards value of 1.2, this value has been used as the worst case.

This results in a score of 7.16 out of 10 for Factor 5.1a.

Factor 5.1b Fishery source sustainability

Relevant Content of Standards	How we applied it
<p>Feedmill 3.3: The applicant shall develop and implement a clear, written plan of action defining policies for responsibly sourcing fishmeal and fish oil.</p> <p>Feedmill 3.4: (Future critical standard.) After June 1, 2015, at least 50% of the fishmeal and fish oil derived from reduction fisheries shall come from approved certified sources.</p> <p>Feedmill 3.5: (Future critical standard.) After June 1, 2015, at least 50% of the fishmeal or fish oil derived from fishery by-products such as trimmings and offal shall come from approved certified sources.</p> <p>9.1: The applicant's facility shall use feed for which the manufacturer has provided data on the wild fishmeal and fish oil content or feed fish inclusion factor.</p> <p>9.6: The applicant shall obtain feed from a BAP-certified feed mill or a feed mill that declares and documents compliance with standards 3.1 through 3.3 of the BAP feed mill standards</p>	<p>F5.1b scored -6 on the above assumption because the standards do not include any specific requirements, but written plans are assumed to avoid the very worst fisheries.</p>

9.7: If there is a lack of availability of marine ingredients from certified responsible sources, the feed supplier shall use ingredients from fishery improvement projects as these become available.	
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The source sustainability score (F5.1b) is -6 out of -10.
Factor 5.1 score 6.47 out of 10.

Factor 5.2. Net Protein Gain or Loss

Explanatory tables and calculations can be found on Page 24 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
Protein content of feed Not addressed by initiative	Used 35% from Seafood Watch Thailand farmed shrimp report.
Percentage of crop or animal ingredients in feed Not addressed by initiative	Assumed all non-marine ingredients are edible crop ingredients
FCR Not addressed by initiative	Used 1.6 from Tacon et al (2011)
Protein content of harvested shrimp Not addressed by initiative	Used 17.8% from Boyd et al (2007)
Edible yield of harvested shrimp Not addressed by initiative	Used 57% from Briggs et al (2004)
Percentage of non-edible byproducts from harvested shrimp utilized Not addressed by initiative	Used 50% across all standards for consistency as not specified

Protein input in feeds is 42.87.

Protein output in harvested shrimp is 13.97

Net edible protein loss is 67.4% which equates to a score of 3 out of 10.

Factor 5.3. Feed Footprint

Explanatory tables and calculations can be found on Page 24 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
Inclusion of aquatic ingredients Not addressed by initiative	16% fishmeal + 2% fish oil = 18%
Inclusion of crop ingredients Not addressed by initiative	Assumed all non-aquatic ingredients are edible crops – i.e. 82%
Inclusion of land animal ingredients Not addressed by initiative	Assumed zero for all standards unless specified

Final feed footprint is 7.99 hectares per ton which equates to a score of 7 out of 10.

The final feed criterion (C5) score is a combination of the three feed factors with a double weighting on FIFO. The final score is 5.74 out of 10.

Criterion 6: Escapes

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*
- *Sustainability unit: 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.*

Criterion 6 Summary

Escape parameters	Value	Score	
F6.1 Escape Risk		5.00	
F6.1a Recapture and mortality (%)	0		
F6.1b Invasiveness		4.5	
C6 Escape Final Score		4.00	YELLOW
Critical?	NO		

Brief Summary

Shrimp ponds are assumed to have a moderate escape risk, however GAA standards require limited daily water exchange (annual mean of $\leq 10\%$) as well as the use of secondary capture methods during harvest. This leads to a score of 5 of 10 for F6.1.

F6.1b is comprised of a Part B score of 0.2 of 2.5 for potential to establish in a non-native ecosystem and an ecosystem impact score of 4 of 10. These scores led to an F6.1b score of 4.5.

The final Escapes criterion score is 4 of 10.

Justification of Ranking

Assumptions

- Assume high exchange ponds and cages are high escape risk unless the standards require limited water exchange or other realistically effective prevention measures above industry norms.

- Assume worst case scenario species/location (e.g. non-native or heavily domesticated native)

Factor 6.1a. Escape risk

Explanatory score table can be found on Page 28 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
<p>5.7 The farm shall provide the auditor with an estimated annual water use during the last calendar year, as illustrated in Appendix C, and the input data shall also be available for review</p> <p>10.6 All holding, transport and culture systems shall be designed, operated and maintained to minimize the release of eggs, larval forms, juveniles and adult animals.</p> <p>10.7 Screens and nets sized to retain the smallest farmed animals present shall be installed on water outlet pumps, pipes or sluices. Screens, nets or other controls shall be installed on or near pump intakes to minimize the introduction of local aquatic fauna.</p> <p>10.8 During harvesting and stock transfer operations, effective secondary containment measures shall be applied to control the escape of animals.</p> <p>17.3 The mean water exchange rate shall not exceed 10% per day (i.e., on an annual basis, 36 x total pond volume). This limit does not apply to shrimp ponds in deserts.</p>	<p>Standards have no requirements relating to flooding events. Scored as 5 of 10 based on moderate risk system with limited water exchange and secondary escape prevention measures during harvest</p>

The initial escape risk score is 5 out of 10.

Recaptures and mortality

Relevant Content of Standards	How we applied it
<p>No relevant standards requiring recaptures of any escapees.</p>	<p>Scored zero</p>

The recaptures and mortality score can improve the escape risk score, but the final escape risk remains 5 out of 10.

Factor 6.1b. Invasiveness

Explanatory score table and scoring questions for native and non-native species can be found on Page 28 of the Aquaculture Criteria document.

Part B assesses the establishment potential for non-native species

Relevant Content of Standards	How we applied it
10.5 Where the species farmed is not native, not feral or not already farmed, further documents shall be provided to demonstrate that regulatory approval for farming is based on the 2005 ICES Code of Practice on Introductions and Transfers of Marine Organisms or, for freshwater species, the Codes of Practice and Manual of Procedures for Consideration of Introduction and Transfers of Marine and Freshwater Organisms, FAO 1988.	Factor 6.1b PART B scored as 0.5 for non-native species (e.g. <i>L. vannamei</i> in SE Asia): “Not present, but establishment is possible, or similar species have established elsewhere”.

Part B score is 0.5 of 2.5

Part C assesses the ecological impacts of escapees regardless of their native or on-native status.

Relevant Content of Standards	How we applied it
There are no standards to limit the direct impact of escapees (e.g. competition for food, predation on wild species, disturbance of breeding sites or other habitat modification)	Factor 6.1b PART C scored 4 out of 5 based on basic species life history (see scores in Appendix 1)

Part C score is 4 out of 10.

Final invasiveness score combines Part A or B, and Part C and is 4.5 out of 10.

The final Criterion 6 – Escapes numerical score combines the escape risk score with the invasiveness score (see Aquaculture Criteria document p30 for scoring matrix) and is 4 out of 10 for the potentially high risk of escape of a non-native species with the potential to establish in the wild.

Criterion 7: Disease; pathogen and parasite interactions

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*
- *Sustainability unit: 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.*

Criterion 7 Summary

Pathogen and parasite parameters	Score	
C7 Biosecurity	4.00	
C7 Disease; pathogen and parasite Final Score	4.00	YELLOW
Critical?	NO	

Brief Summary

Criterion 7 is scored as a Moderate risk for disease and given a score of 4 of 10 based on the requirements for biosecurity measures by GAA standards. Despite the biosecurity requirements, disease related mortalities may still occur and GAA certified farms may discharge water multiple times during a cycle without relevant treatment.

Justification of Ranking

Assumptions

- Unless standards robustly specify otherwise, assume a score of 4 for species other than salmon based on the Seafood Watch criteria definition: *“Disease-related mortalities occur and farms discharge water on multiple occasions during the production cycle without relevant treatment”*, and *“Amplification of pathogens or parasites on the farm results in increased infection of wild fish, shellfish or other populations in the farming locality or region”*

Explanatory score table can be found on Page 34 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
15.1: The applicant shall have in place biosecurity controls that seek to prevent the introduction and spread of disease agents and disease on the farm, including the sanitization of equipment and personnel when disease is suspected or confirmed at the farm site, and these shall be detailed in a biosecurity plan as described in the Implementation guidelines above.	Scored as "4" Moderate - Disease-related mortalities occur and farms discharge water on multiple occasions during the production cycle without relevant treatment.
15.2: Farm staff shall be trained in biosecurity procedures and shall, along with all visitors, comply with them.	
15.3: A plan for prompt and responsible disposal of excessive mortalities of culture animals by incineration, burial, composting or removal by a competent contractor shall be available for inspection and applied.	

<p>15.4: Where slaughtering is conducted at the farm, blood water and other effluents generated through processing shall be contained or treated so they do not contaminate the environment or present a biosecurity risk.</p> <p>17.3 The mean water exchange rate shall not exceed 10% per day (i.e., on an annual basis, 36 x total pond volume). This limit does not apply to shrimp ponds in deserts.</p>	
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The final disease criterion (C7) score is 4 out of 10.

Criterion 8: Source of Stock – independence from wild fisheries

Impact, unit of sustainability and principle

- *Impact: the removal of fish from wild populations for on-growing to harvest size in farms*
- *Sustainability unit: wild fish populations*
- *Principle: aquaculture operations use eggs, larvae, or juvenile fish produced from farm-raised broodstocks, use minimal numbers, or source them from demonstrably sustainable fisheries.*

Criterion 8 Summary

Source of stock parameters	Score	
C8 % of production from hatchery-raised broodstock, natural (passive) settlement, or sourced from sustainable fisheries	100	
C8 Source of stock Final Score	10.00	GREEN

Brief Summary

GAA standards specifically prohibit the sourcing of wild postlarvae for stocking of shrimp ponds. This benchmarking assumes that 100% is sourced from hatcheries. This results in a score of 10 of 10 for Criterion 8.

Justification of Ranking

Assumptions

- For the species covered by the standards in this assessment, assume 100% is sourced from hatcheries (because almost all are) except shrimp standards that do not specifically prohibit capture of wild postlarvae.

Explanatory score table can be found on Page 35 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
10.4 Wild juveniles shall not be stocked, other than as incidental introduction when extensive ponds are first filled.	This is a critical requirement in the standards, and therefore considered evidence that no wild caught postlarvae are used. It is not considered to prevent the use of wild-caught broodstock, but the assessment is based on <i>L. vannamei</i> which uses domesticated broodstock, and also referring to the above assumption, the score is 10.

The final Criterion 8 - Source of Stock score is 10 out of 10.

Criterion 9X: Wildlife and predator mortalities

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

This is an “exceptional” factor that may not apply in many circumstances. It generates a negative score that is deducted from the overall final score. A score of zero means there is no impact.

Criterion 9X Summary

Wildlife and predator mortality parameters	Score	
F9X Wildlife and predator mortality Final Score	-4.00	YELLOW
Critical?	NO	

Brief Summary

GAA standards favor but do not require non-lethal methods of predator control. Non-lethal measures are required for any species listed as endangered or highly endangered by the IUCN Red List or are protected by any local or national laws. Because of this it is assumed that mortalities do occur, but not in a way that would significantly impact the population size of the predator.

Justification of Ranking

Assumptions:

- Assume score of -4 unless standards specify otherwise. This is based on an assumption that wildlife mortalities will occur if the standards do not specifically require non-lethal controls, but that in the large majority of cases, the mortality numbers will not significantly impact the predator populations.

Explanatory score table can be found on Page 17 of the Aquaculture Criteria.

Relevant Content of Standards	How we applied it
<p>10.11 The facility shall use humane methods of predator deterrents and actively favor non-lethal methods. No controls, other than non-lethal exclusion, shall be applied to species that are listed as endangered or highly endangered on the IUCN Red List or that are protected by local or national laws.</p> <p>10.12: The facility shall record, and report where required, the species and numbers of all avian, mammalian and reptilian mortalities</p>	<p>Standards suggest but do not require non-lethal predator deterrents. Scored as -4 on the above assumption.</p>

Final score for Factor 9X is -4 out of -10.

Criterion 10X: Escape of unintentionally introduced species

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

This is an “exceptional criterion that may not apply in many circumstances. It generates a negative score that is deducted from the overall final score.

Criterion 10X Summary

Escape of unintentionally introduced species parameters	Score	
F6.2Xa International or trans-waterbody live animal shipments (%)	5.00	
F6.2Xb Biosecurity of source/destination	5.00	
C6 Escape of unintentionally introduced species Final Score	0.00	GREEN

Brief Summary

F10Xa was scored as 10 of 10 based on 0 reliance on trans-waterbody shipments of live animals.

F10Xb was scored as 5 of 10 for both the source and the destination of stock based on water exchange rates $\leq 10\%$ and biosecurity measures required by GAA standards.

These factors lead to a final Criterion 10X score of 0 of -10.

Justification of Ranking

Assumptions

- Assume zero international shipping of livestock for finfish and shrimp

Factor 10Xa International or trans-waterbody live animal shipments

Explanatory score table can be found on Page 31 of the Aquaculture Criteria document.

Relevant Content of Standards	How we applied it
10.3 The facility shall keep records of sources and purchases of stocking material, and record the number stocked in each culture unit for each crop.	Assumed zero reliance on shipments as 100% is unrealistic, and it was not possible to set a consistent alternative arbitrary percentage across all standards.

The score for Factor 10Xa is 10 of 10.

Criterion 10Xb Biosecurity of source/destination

Relevant Content of Standards	How we applied it
<p>10.6 All holding, transport and culture systems shall be designed, operated and maintained to minimize the escape of eggs, larval forms, juveniles and adult animals</p> <p>10.7 Screens and nets sized to retain the smallest farmed animals present shall be installed on water outlet pumps, pipes or sluices. Screens, nets or other controls shall be installed on or near pump intakes to minimize the introduction of local aquatic infauna</p> <p>10.8 During harvesting and stock transfer operations, effective secondary containment measures shall be applied to control the escape of animals that manage to elude primary harvest nets or capture vessels</p> <p>17.3 The mean water exchange rate shall not exceed 10% per day (i.e., on an annual basis, 36 x total pond volume). This limit does not apply to shrimp ponds in deserts.</p>	<p>Moderate water exchange and biosecurity measures for prevention of escapes and entries are used. Scored 5 of 10</p>

The score for Factor 10Xb is 5 of 10

Final score for Factor 10X is 0 of -10

About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished² or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following **guiding principles** illustrate the qualities that aquaculture must possess to be considered sustainable by the Seafood Watch program:

Seafood Watch will:

- Support data transparency and therefore aquaculture producers or industries that make information and data on production practices and their impacts available to relevant stakeholders.
- Promote aquaculture production that minimizes or avoids the 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.
- Promote aquaculture production at locations, scales and intensities that cumulatively maintain the functionality of ecologically valuable habitats without unreasonably penalizing historic habitat damage.
- Promote aquaculture production that by design, management or regulation avoids the use and 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
- Within the typically limited data availability, use understandable quantitative and relative indicators to recognize the global impacts of feed production and the efficiency of conversion of feed ingredients to farmed seafood.
- Promote aquaculture operations that pose no substantial risk of deleterious effects to wild fish or shellfish populations through competition, habitat damage, genetic introgression, hybridization, spawning disruption, changes in trophic structure or other impacts associated with the escape of farmed fish or other unintentionally introduced species.
- Promote aquaculture operations that pose no substantial risk of deleterious effects to wild populations through the amplification and retransmission of pathogens or parasites.
- promote the use of eggs, larvae, or juvenile fish produced in hatcheries using domesticated broodstocks thereby avoiding the need for wild capture
- recognize that energy use varies greatly among different production systems and can be a major impact category for some aquaculture operations, and also recognize that improving

² “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates.

practices for some criteria may lead to more energy intensive production systems (e.g. promoting more energy-intensive closed recirculation systems)

Once a score and rank has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ranks and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

Best Choices/Green: Are well managed and caught or farmed in environmentally friendly ways.

Good Alternatives/Yellow: Buy, but be aware there are concerns with how they're caught or farmed.

Avoid/Red: Take a pass on these. These items are overfished or caught or farmed in ways that harm other marine life or the environment.

Appendix 1 - Data points and all scoring calculations

This is a condensed version of the criteria and scoring sheet to provide access to all data points and calculations. See the Seafood Watch Aquaculture Criteria document for a full explanation of the criteria, calculations and scores. Yellow cells represent data entry points.

Criterion 1: Data quality and availability

Data Category	Relevance (Y/N)	Data Quality	Score (0-10)
Industry or production statistics	Yes	10	10
Effluent	Yes	10	10
Locations/habitats	Yes	7.5	7.5
Predators and wildlife	Yes	10	10
Chemical use	Yes	10	10
Feed	Yes	10	10
Escapes, animal movements	Yes	10	10
Disease	Yes	10	10
Source of stock	Yes	10	10
Other – (e.g. GHG emissions)	Yes	10	10
Total			97.5

C1 Data Final Score	9.75	GREEN
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Criterion 2: Effluents

Factor 2.1a - Biological waste production score

Protein content of feed (%)	35
eFCR	1.6
Fertilizer N input (kg N/ton fish)	0
Protein content of harvested fish (%)	17.8
N content factor (fixed)	0.16
N input per ton of fish produced (kg)	89.6
N in each ton of fish harvested (kg)	28.48
Waste N produced per ton of fish (kg)	61.12

Factor 2.1b - Production System discharge score

Basic production system score	0.51
Adjustment 1 (if applicable)	-0.24
Adjustment 2 (if applicable)	0
Adjustment 3 (if applicable)	0
Discharge (Factor 2.1b) score	0.27

27 % of the waste produced by the fish is discharged from the farm

2.2 – Management of farm-level and cumulative impacts and appropriateness to the scale of the industry**Factor 2.2a - Regulatory or management effectiveness**

Question	Scoring	Score
1 - Are effluent regulations or control measures present that are designed for, or are applicable to aquaculture?	Yes	1
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?	No	0
3 - Do the control measures address or relate to the cumulative impacts of multiple farms?	No	0
4 - Are the limits considered scientifically robust and set according to the ecological status of the receiving water body?	No	0
5 - Do the control measures cover or prescribe including peak biomass, harvest, sludge disposal, cleaning etc?	Moderately	0.5
		1.5

Factor 2.2b - Enforcement level of effluent regulations or management

Question	Scoring	Score
1 - Are the enforcement organizations and/or resources identifiable and contactable, and appropriate to the scale of the industry?	Yes	1
2 - Does monitoring data or other available information demonstrate active enforcement of the control measures?	Yes	1
3 - Does enforcement cover the entire production cycle (i.e. are peak discharges such as peak biomass, harvest, sludge disposal, cleaning included)?	Moderately	0.5
4 - Does enforcement demonstrably result in compliance with set limits?	Moderately	0.5
5 - Is there evidence of robust penalties for infringements?	No	0
		3

F2.2 Score (2.2a*2.2b/2.5)	1.8
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C2 Effluent Final Score	5.00	YELLOW
	Critical?	NO

Criterion 3: Habitat

3.1. Habitat conversion and function

F3.1 Score	4
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3.2 Habitat and farm siting management effectiveness (appropriate to the scale of the industry)

Factor 3.2a - Regulatory or management effectiveness

Question	Scoring	Score
1 - Is the farm location, siting and/or licensing process based on ecological principles, including an EIAs requirement for new sites?	Mostly	0.75
2 - Is the industry's total size and concentration based on its cumulative impacts and the maintenance of ecosystem function?	No	0
3 - Is the industry's ongoing and future expansion appropriate locations, and thereby preventing the future loss of ecosystem services?	Mostly	0.75
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)	Mostly	0.75
5 - Do control measures include requirements for the restoration of important or critical habitats or ecosystem services?	Mostly	0.75
		3

Factor 3.2b - Siting regulatory or management enforcement

Question	Scoring	Score
1 - Are enforcement organizations or individuals identifiable and contactable, and are they appropriate to the scale of the industry?	Yes	1
2 - Does the farm siting or permitting process function according to the zoning or other ecosystem-based management plans articulated in the control measures?	No	0
3 - Does the farm siting or permitting process take account of other farms and their cumulative impacts?	No	0
4 - Is the enforcement process transparent - e.g. public availability of farm locations and sizes, EIA reports, zoning plans, etc?	Moderately	0.5
5 - Is there evidence that the restrictions or limits defined in the control measures are being achieved?	Yes	1
		2.5

F3.2 Score (2.2a*2.2b/2.5)	3.00
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C3 Habitat Final Score	3.67	YELLOW
	Critical?	NO

Criterion 4: Evidence or Risk of Chemical Use

Chemical Use parameters	Score	
C4 Chemical Use Score	0.00	
C4 Chemical Use Final Score	0.00	RED
Critical?	NO	

Criterion 5: Feed

5.1. Wild Fish Use

Factor 5.1a - Fish In: Fish Out (FIFO)

Fishmeal inclusion level (%)	16
Fishmeal from by-products (%)	0
% FM	16
Fish oil inclusion level (%)	2
Fish oil from by-products (%)	0
% FO	2
Fishmeal yield (%)	22.5
Fish oil yield (%)	5
eFCR	1.6
FIFO fishmeal	1.14
FIFO fish oil	0.64
Greater of the 2 FIFO scores	1.14
FIFO Score	7.16

Factor 5.1b - Sustainability of the Source of Wild Fish (SSWF)

SSWF	-6
SSWF Factor	-0.682666667

F5.1 Wild Fish Use Score	6.47
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5.2. Net protein Gain or Loss

Protein INPUTS	
Protein content of feed	35
eFCR	1.6
Feed protein from NON-EDIBLE sources (%)	0
Feed protein from EDIBLE CROP sources (%)	82
Protein OUTPUTS	
Protein content of whole harvested fish (%)	17.8
Edible yield of harvested fish (%)	57
Non-edible by-products from harvested fish used for other food production	50

Protein IN		42.87
Protein OUT		13.973
Net protein gain or loss (%)		-67.4037
	Critical?	NO
F5.2 Net protein Score	3.00	

5.3. Feed Footprint

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

Inclusion level of aquatic feed ingredients (%)	18
eFCR	1.6
Average Primary Productivity (C) required for aquatic feed ingredients (ton C/ton fish)	69.7
Average ocean productivity for continental shelf areas (ton C/ha)	2.68
Ocean area appropriated (ha/ton fish)	7.49

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

Inclusion level of crop feed ingredients (%)	82
Inclusion level of land animal products (%)	0
Conversion ratio of crop ingredients to land animal products	2.88
eFCR	1.6
Average yield of major feed ingredient crops (t/ha)	2.64
Land area appropriated (ha per ton of fish)	0.50

Value (Ocean + Land Area)	7.99
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F5.3 Feed Footprint Score	7.00
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C5 Feed Final Score	5.74	YELLOW
	Critical?	NO

Criterion 6: Escapes

6.1a. Escape Risk

Escape Risk	5
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Recapture & Mortality Score (RMS)	
Estimated % recapture rate or direct mortality at the escape site	0

Recapture & Mortality Score	0
Factor 6.1a Escape Risk Score	5

6.1b. Invasiveness

Part A – Native species

Score	0
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Part B – Non-Native species

Score	0.5
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Part C – Native and Non-native species

Question	Score
Do escapees compete with wild native populations for food or habitat?	To some extent
Do escapees act as additional predation pressure on wild native populations?	No
Do escapees compete with wild native populations for breeding partners or disturb breeding behavior of the same or other species?	To some extent
Do escapees modify habitats to the detriment of other species (e.g. by feeding, foraging, settlement or other)?	No
Do escapees have some other impact on other native species or habitats?	No
	4

F 6.1b Score	4.5
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Final C6 Score	4.00	YELLOW
	Critical?	NO

Criterion 7: Diseases

Pathogen and parasite parameters	Score	
C7 Biosecurity	4.00	
C7 Disease; pathogen and parasite Final Score	4.00	YELLOW
Critical?	NO	

Criterion 8: Source of Stock

Source of stock parameters	Score	
C8 % of production from hatchery-raised broodstock, natural (passive) settlement, or sourced from sustainable fisheries	100	
C8 Source of stock Final Score	10	GREEN

Exceptional Factor 9X: Wildlife mortalities

Wildlife and predator mortality parameters	Score	
C9X Wildlife and Predator Final Score	-4.00	YELLOW
Critical?	NO	

Exceptional Factor 10X: Escape of unintentionally introduced species

Escape of unintentionally introduced species parameters	Score	
C10Xa International or trans-waterbody live animal shipments (%)	5.00	
C10Xb Biosecurity of source/destination	5.00	
C10X Escape of unintentionally introduced species Final Score	0.00	GREEN