# ASC SHRIMP STANDARD REVISION

Revision of Current Metrics
Background Analysis Document

March 2020

# Revision of current metrics – Background analysis document

## Shrimp Standard Revision

## Purpose

The purpose of this document is to present the acquired data for the revision of the ASC Shrimp Standard v.1.1 and propose changes to the metric requirements where relevant. This document will be used for the decision-making process within the revision.

## Background

The ASC Shrimp Standard v.1.1 is based on the anterior work of the Shrimp Aquaculture Dialogue (ShAD) and sets requirements that define what has been deemed 'acceptable' levels as regards the major social and environmental impacts of saltwater shrimp farming. The purpose of the ASC Shrimp Standard was and is to provide means to measurably improve the environmental and social performance of shrimp aquaculture operations worldwide. The Standard currently covers species under the genus *Penaeus* (previously *Litopenaeus*)[1] and is oriented towards the production of *P. vannamei*[2] and *P. monodon.*

A Rationale document[3] was produced as part of the ASC Shrimp Standard revision to evaluate the necessity to specifically include *Penaeus stylirostris* (Blue Shrimp), *Penaeus merguiensis* (Banana Prawn), *Penaeus japonicus* (Kuruma Prawn) and *Penaeus ensis* (Greasyback Shrimp) within the ASC Shrimp Standard. It was concluded that specific metrics for these species are not necessary and certification can remain on the basis of the metrics already contained therein for *P. vannamei* and *P. monodon.*

## Corresponding Metrics

The ASC Shrimp Standard covers seven principles regarding legal regulations, environmentally suitable sighting and operation, community interactions, responsible operation practices, shrimp health management, stock management and resources use.

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[1] The ASC's Technical Advisory Group (TAG) supported in November 2019 the proposal that based on recent research re. phylogenetic analyses of several shrimp within the family Penaidae, the *Penaeus* genus should be used to define all potential new saltwater shrimp species. This also means that from the Shrimp Standard Review's public consultation of March 2020, references to the 'Litopenaeus' genus will be removed and replaced by 'Penaeus', and/or used interchangeably. Notably, the Whiteleg shrimp *may* be referred to by ASC as 'Penaeus (Litopenaeus) vannamei' – or 'P. vannamei' – and if so: this latter species refers to the same as the one listed in the scope of the Shrimp Standard v1.1 as '*Litopenaeus vannamei*' or 'L. vannamei'.

[2] Ibid.

[3] See Document #8.a published during the March 2020 Public Consultation and titled "*Data Overview & Rationale for Change of Scope re. Saltwater Shrimp Species*".

Principles are then divided into different criteria and indicators, each with qualitative or quantitative requirements. Indicators with a corresponding metric requirement are listed in Table 1 below.

***Table 1:*** *Species specific indicators within the ASC Shrimp Standard v.1.0*

| Indicator | Requirement | Metric | Additional Information |
|---|---|---|---|
| **2.5.3** | Water-specific conductance or chloride concentration in concentration in freshwater wells used by the farm or located on adjacent properties | < 1,500 mhos (conductance)<br>Or<br>< 300 mg/L chloride | For all freshwater wells |
| **5.1.3** | Annual average farm survival rate (SR)<br>1) unfed and non-permanently aerated pond<br>2) fed but non-permanently aerated pond<br>3) fed and permanently aerated pond | 1)>25%<br>2)>45%<br>3)>60% | |
| **5.1.4** | Percent of stoked lost larvae that are specific pathogen free (SPF) of specific pathogen resistant (SPR) for all important pathogens | 100% | If commercially available |
| **6.2.2** | Percent of total post larvae from closed loop hatchery | 100% | Reachable within 6 year after publication of the ASC Shrimp Standard **(2020)** |
| **7.2.1a** | FM and FO used in feed to come from fisheries certified by a full ISEAL member | 100% | Within 5 years following the date of standards publication **(2019)** |
| **7.2.1b** | Fishscource Score for the fisheries from which a minimum of 80% of the FM and FO by volume is derived<br>a. Fishsource Criteria 4<br>b. Fishsource Criteria 1, 2, 3 and 5 | a. 8<br>b. 6 | **See Feed *Interim Solution*[4]** |
| **7.2.2** | Percentage of non-marine ingredients from sources certified by an ISEAL members certification scheme that addresses environmental and social sustainability | 80% | Soy and palm oil within five years from the date of the standard publication **(2019)** |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER) | 1.35:1<br>1.9:1 | *L. vannamei*<br>*P. monodon* |
| **7.4.2 a** | economic Feed Conversion Ratio (eFCR) | | Records available |
| **7.4.2 b** | Protein Retention Efficiency (PRE) | | Records available |
| **7.5.1** | Nitrogen effluent per tonne of shrimp produced over a 12-month period | <25.2 kg/T<br><32.4 kg/T | *L. vannamei*<br>*P. monodon* |
| **7.5.2** | Phosphorous effluent per tonne of shrimp produced over a 12 month period | <3.9 kg/T<br><5.4 kg/T | *L. vannamei*<br>*P. monodon* |
| **7.5.4** | Treatment of effluent water from permanently aerated ponds; concentration of settleable solids | <3.3 mL/L | Evidence that discharge water goes through a treatment system |
| **7.5.5** | Percentage change in diurnal DO relative to DO at saturation in receiving water body for the waters specific salinity and temperature | <65% | |

[4] See the *Interim Feed Solution* announcement and document (2016).

The ASC Shrimp Standard does not yet provide a threshold for eFCR and the protein retention efficiency (PRE) but requires the farmer to provide the records for the data within the audit. The Rationale of Criterion 7.4 states that the PRE "*is a relatively undocumented parameter in the field*, [thus] *the ShAD has preferred not to set a requirement at this stage. This is a starting point on a critical issue and ASC will be able to set a requirement as information is collected and if it proves to be a useful indicator of responsible shrimp production"*. The PRE or PPV (protein productive value) evaluates the conversion efficiency of protein in the feed into body protein. Setting a limit for the PRE can thus be an outcome of the current Revision.

## Data Collection – Sample Size

Within the revision of the ASC Shrimp Standard v1.1 data from non-certified farms as well as literature data will be taken into account. The data obtained will then be compared and used to set the new metric requirements within the revised standard. In order to determine the correct sample size a power analysis[5] was undertaken based on the knowledge from ASC certified farm data and a first literature review.

The power analysis and sample size determination has been conducted using R. Standard deviation within samples was estimated using data from the ASC certified farms. Standard deviation between samples was estimated based on the average of ASC certified farms and the average in the literature, based on an initial literature review. Significance level (type I error (α)) was set to 0.05 and the power (type II error (β)) was set to 80% based on the suggestions by Cohen (1992).

The resulting sample sizes can be seen in Table 2.

[5] Power analysis is described in more detail by Cohen (1992).

**Table 2:** Sample size calculation based on data from ASC certified farms and literature

| Indicator # | Requirement | n | Additional Information/ relevance |
|---|---|---|---|
| **2.5.3** | Water-specific conductance or chloride concentration | 40 | No literature data, assumption that variance would be ¼ of allowed maximum |
| **5.1.3** | Annual average farm survival rate (SR) | | |
| | 1) unfed and non-permanently aerated pond | 77 | Based on a low sample size (n=34) with very high fluctuations |
| | 2) fed but non-permanently aerated pond | 65 | |
| | 3) fed and permanently aerated pond | 40 | |
| **5.1.4** | SPF or SPR larvae | Not relevant | |
| **6.2.2** | PL from closed loop hatchery | Not relevant | |
| **7.2.1a** | FM/FO from certified source | Not relevant | |
| **7.2.1b** | Fishsource Score<br>Criteria 4<br>Criteria 1, 2, 3 and 5 | Not relevant | |
| **7.2.2** | Non-marine ingredients from certified source | Not relevant | |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER) | | |
| | *P. vannamei* | 10 | |
| | *P. monodon* | 10 | |
| **7.4.2 a** | economic Feed Conversion Ratio (eFCR) | 207 | No distinction between species |
| **7.4.2 b** | Protein retention efficiency (PRE)<br>*P. vannamei*<br>*P. monodon* | 49 | |
| **7.5.1** | Nitrogen effluent | | |
| | *P. vannamei* | 133 | No literature data found thus assumed to be similar to *P. monodon* |
| | *P. monodon* | 82 | Very little literature data available |
| **7.5.2** | Phosphorous effluent | | |
| | *P. vannamei* | 5 | |
| | *P. monodon* | 23 | |
| **7.5.4** | Concentration of settleable solids | 17 | Very limited dataset as often not applicable for farms |
| **7.5.5** | Percentage change in diurnal DO | 37 | |

Indicators 5.1.4 and 6.2.2 were deemed 'not relevant' for the revision as they are set at 100% for sustainability reasons and there is no intention to change this. The feed related indicators (7.2.1a and 7.2.1b and 7.2.2) were also deemed 'not relevant' for this revision as these indicators are now covered by the [forthcoming] ASC Feed Standard.

Indicator 7.4.2 a and b (eFCR and PRE) is not a performance metric requirement indicator *as such,* but requires the farm to measure and report on the eFCR. It will therefore not be taken into account for the determination of sample size. Best data availability for both ASC certified farms and literature was obtained for the survival rate in fed and permanently aerated ponds as well as FFER.

Required sample size for data form non-certified farms is therefore set at n = 40 for data covering both species. Species specific data should show a minimum sample size of n = 10 per species (see FFER). Data collection should be equally spread among the main producer countries.

## ASC Certified Farms

Based on audit reports (initial audits, surveillance audits and recertification audits), the following metrics have been reported by ASC certified farms (Table 3).

***Table 3:*** *Data from ASC certified farms (as of March 2019)*

| Indicator | Requirement | Value | Sample Size | Remarks |
|---|---|---|---|---|
| **2.5.3** | Water-specific conductance (< 1,500 mhos) | 1104.5 ± 1310.5 | n = 136 | |
| | Chloride concentration ( < 300 mg/L) | 113.0 ± 69.1 | n = 19 | |
| **5.1.3** | Annual average farm survival rate<br>unfed and non-permanently aerated pond (>25%)<br>fed but non-permanently aerated pond (>45%)<br>fed and permanently aerated pond (>60%) | <br>33.4 ± 14.4<br>62.9 ± 12.2<br>78.3 ± 9.7 | <br>n = 31<br>n = 94<br>n = 188 | Highest: 87.7 %<br>Lowest: 25.3 % |
| **5.1.4** | SPF or SPR larvae (100%) | not extracted | | |
| **6.2.2** | PL from closed loop hatchery (100%) | not extracted | | |
| **7.2.1a** | ISEAL certified FM/FO (100%) | not extracted | | |
| **7.2.1b** | Fishscource Score Criteria 4 (8) | 7.1 ± 1.5 | n = 125 | |
| | Fishsource Criteria 1, 2, 3 and 5 (6) | 6.3 ± 1.2 | n = 110 | |
| **7.2.2** | ISEAL certified non-marine ingredients (80%) | not extracted | | |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER)<br>(*P. vannamei: 1.35*)<br>(*P. monodon: 1.9*) | <br>0.9 ± 0.4<br>1.6 ± 0.4 | <br>n = 210<br>n = 28 | |
| **7.4.2 a** | eFCR<br>(*P. vannamei*)<br>(*P. monodon*) | 1.4 ± 0.4<br>1.5 ± 0.4<br>1.7 ± 0.1 | n = 321<br>n = 147<br>n = 5 | All species |
| **7.4.2 b** | Protein Retention Efficiency (PRE)<br>(*P. vannamei*)<br>(*P. monodon*) | 36.6 ± 7.4<br>34.6 ± 8.1<br>33.4 ± 5.8 | n = 279<br>n = 138<br>n = 4 | Unrealistic values (> 100 or < 1) excluded |
| **7.5.1** | Nitrogen effluent<br>(*P. vannamei:* <25.2 kg/T)<br>(*P. monodon*: <32.4 kg/T) | <br>13.8 ± 9.9<br>21.8 ± 9.9 | <br>n = 262<br>n = 45 | |
| **7.5.2** | Phosphorous effluent<br>(*P. vannamei:* <3.9 kg/T)<br>(*P. monodon*: <5.4 kg/T) | <br>2.2 ± 1.6<br>2.7 ± 2.2 | <br>n = 233<br>n = 33 | several NCs |
| **7.5.4** | Concentration of settleable solids (<3.3 mL/L) | 1.8 ± 1.0 | n = 54 | n/a for most farms, measurements from n = 10 |
| **7.5.5** | Percentage change in diurnal DO (<65%) | 25.9 ± 17.3 | n = 242 | |

## Non-certified Farms

In order to evaluate the performance of ASC certified shrimp farms, it is crucial to compare these farms with non-certified farms. A request for data from non-certified farms has been published on the website and social media and send to stakeholders via email in December 2019. Only very few, limited datasets have been received so far, mainly covering Ecuador and Thailand. This list will be updated in case other data sources can be identified (Table 4).

**Table 4:** Data from non-certified farms. This Table is based on a very limited dataset.

| Indicator | Requirement | Value | Sample Size | Remarks |
|---|---|---|---|---|
| **2.5.3** | Water-specific conductance (< 1,500 mhos) | 6620 | n = 1 | |
| | Chloride concentration ( < 300 mg/L) | | | |
| **5.1.3** | Annual average farm survival rate<br>unfed and non-permanently aerated pond (>25%)<br>fed but non-permanently aerated pond (>45%)<br>fed and permanently aerated pond (>60%) | 61.0<br>50.3 ± 13.1<br>53.6 ± 7.7 | n = 1<br>n = 5<br>n = 40 | |
| **5.1.4** | SPF or SPR larvae (100%) | 0 % | | General information from Ecuador |
| **6.2.2** | PL from closed loop hatchery (100%) | 0 % | | General information from Ecuador |
| **7.2.1a** | ISEAL certified FM/FO (100%) | 9.66 % | n = 1 | |
| **7.2.1b** | Fishscource Score Criteria 4 (8) | | | |
| | Fishsource Criteria 1, 2, 3 and 5 (6) | | | |
| **7.2.2** | ISEAL certified non-marine ingredients (80%) | 38.5 % | n = 1 | |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER)<br>(*P. vannamei: 1.35*)<br>(*P. monodon: 1.9*) | 1.2 ± 0.2 | n = 68 | Calculated from FCR, based on FM content of 20% |
| **7.4.2 a** | eFCR<br>(*P. vannamei*)<br>(*P. monodon*) | 1.4 ± 0.2 | n = 68 | |
| **7.4.2 b** | Protein Retention Efficiency (PRE)<br>(*P. vannamei*)<br>(*P. monodon*) | 59.8 | n = 1 | |
| **7.5.1** | Nitrogen effluent<br>(*P. vannamei:* <25.2 kg/T)<br>(*P. monodon*: <32.4 kg/T) | 19.5 | n = 1 | |
| **7.5.2** | Phosphorous effluent<br>(*P. vannamei:* <3.9 kg/T)<br>(*P. monodon*: <5.4 kg/T) | 2.1 | n = 1 | |
| **7.5.4** | Concentration of settleable solids (<3.3 mL/L) | | | |
| **7.5.5** | Percentage change in diurnal DO (<65%) | | | |

## Literature Research

The global (all species) aquaculture production has risen continuously in the last decades and was at a total of 80.031 million tonnes in 2016 with about 7.862 million tonnes of crustaceans (FAO, 2018b). In 2016 about 72,000t of shrimp were certified under the ASC Shrimp Standard. The amount tripled to about 224,500t as of February 2020[6].

Shrimp and prawn farming has been identified as one of the aquaculture practices with the greatest environmental impact (Hall et al., 2011). It is thus paramount to drive the shrimp aquaculture industry towards more environmentally sustainable and responsible practices.

Penaeid shrimp have been researched and farmed since the early 1970s with an initial focus on *P. monodon*, switching to *P. vannamei*[7] and *P. stylirostris* due to several farming advantages and the increasing market demands (Briggs et al., 2004).

[6] Based on ASC audit reports (asc-aqua.org). See ASC Certification Update February 2020: https://mailchi.mp/c8978ec37674/xr162vrjvq-2692789

[7] [7] The ASC's Technical Advisory Group (TAG) decided in November 2019 that based on recent research re. phylogenetic analyses of several shrimp within the family Penaidae, the *Penaeus* genus will be used to define all potential new saltwater shrimp species. This also means that from the Shrimp Standard Review's public consultation of March 2020 onwards, references to the 'Litopenaeus' genus will be removed and replaced by 'Penaeus'. Notably, the Whiteleg shrimp will now be referred to by ASC as 'Penaeus (Litopenaeus) vannamei' – or 'P. vannamei' – and this latter species refers to the same as the one listed in the scope of the Shrimp Standard v1.1 as 'Litopenaeus vannamei' or 'L. vannamei'.

**Table 5:** Data from scientific literature

| Indicator | Requirement | Value | Sample Size | Remarks |
|---|---|---|---|---|
| **2.5.3** | Water-specific conductance (< 1,500 mhos) | No data | | |
| | Chloride concentration (< 300 mg/L) | No data | | |
| **5.1.3** | Annual average farm survival rate | | | |
| | Unfed and non-permanently aerated pond (>25%) | No data | | Only covered in one paper without mentioning survival rate |
| | Fed but non-permanently aerated pond (>45%) | 60.3 ± 14.1 | n = 15 | |
| | Fed and permanently aerated pond (>60%) | 81.8 ± 15.9 | n = 52 | |
| **5.1.4** | SPF or SPR larvae (100%) | 100% | | Seldom mentioned |
| **6.2.2** | PL from closed loop hatchery (100%) | | | not mentioned in research |
| **7.2.1a** | ISEAL certified FM/FO (100%) | 38.4 ± 7.2 | n = 39 | Average FM or protein content in diet, origin of FM not mentioned |
| **7.2.1b** | Fishscource Score Criteria 4 (8) | | | |
| | Fishsource Criteria 1, 2, 3 and 5 (6) | | | |
| **7.2.2** | ISEAL certified non-marine ingredients (80%) | 52.4 ± 0.0 | n = 7 | Average protein from non-marine ingredients, origin not specified |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER) | | | Calculated based on FCR and either mentioned FM/protein content in diet or 25% FM (based on FAO average) |
| | (*P. vannamei: 1.35*) | 1.4 ± 0.6 | n = 27 | |
| | (*P. monodon: 1.9*) | 2.3 ± 1.3 | n = 38 | |
| **7.4.2 a** | eFCR | | | |
| | (*P. vannamei*) | 1.4 ± 0.3 | n = 27 | |
| | (*P. monodon*) | 1.5 ± 0.8 | n = 38 | |
| **7.4.2 b** | Protein Retention Efficiency (PRE) | | | |
| | (*P. vannamei*) | No data | | |
| | (*P. monodon*) | 21.5 ± 11.4 | n = 16 | |
| **7.5.1** | Nitrogen effluent | | | |
| | (*P. vannamei:* <25.2 kg/T) | No data | | |
| | (*P. monodon*: <32.4 kg/T) | 39.0 ± 15.4 | n = 7 | Calculated based on N input and formula used in ASC Standard |
| **7.5.2** | Phosphorous effluent | | | |
| | (*P. vannamei:* <3.9 kg/T) | n No o data | | |
| | (*P. monodon*: <5.4 kg/T) | 6.5 ± 2.9 | n = 7 | Calculated based on P input and formula used in ASC Standard |
| **7.5.4** | Concentration of settleable solids (<3.3 mL/L) | No data | | |
| **7.5.5** | Percentage change in diurnal DO (<65%) | 34.1 ± 16.4 | n = 15 | |

The following articles and papers have been consulted in order to obtain the data cited above in Table 5. No paper provided information for all indicators in the ASC Shrimp Standard; and some did not yield any useful information. Papers focused both on farm-research as well as laboratory-based research on new feed ingredients, optimal water quality etc. Literature data is therefore taken as an indication of what is possible but does not necessarily represent feasible practices.

**Ahmmed, F., Ahmmed, M.K., Shah, S., Banu, G.R., 2018**. Use of indigenous beneficial bacteria (*Lactobacillus spp.)* as probiotics in shrimp (*Penaeus monodon*) aquaculture. Agric. Livest. Fish. 5, 127–135.

**Ali, H., Meezanur, M., Rico, A., Jaman, A., Basak, S.K., Islam, M.M., Khan, N., Keus, H.J., Mohan, C.V., 2018**. An assessment of health management practices and occupational health hazards in tiger shrimp (*Penaeus monodon*) and freshwater prawn (*Macrobrachium rosenbergii*) aquaculture in Bangladesh. Vet. Anim. Sci. 5, 10–19. https://doi.org/10.1016/j.vas.2018.01.002

**Anand, P.S.S., Balasubramanian, C.P., Christina, L., Kumar, S., Biswas, G., De, D., Ghoshal, T.K., Vijayan, K.K., 2019**. Substrate based black tiger shrimp, *Penaeus monodon* culture: Stocking density, aeration and their effect on growth performance, water quality and periphyton development. Aquaculture 507, 411–418. https://doi.org/10.1016/j.aquaculture.2019.04.031

**Arnold, S., Smullen, R., Briggs, M., West, M., Glencross, B., 2015**. The combined effect of feed frequency and ration size of diets with and without microbial biomass on the growth and feed conversion of juvenile *Penaeus monodon*. Aquac. Nutr. 22, 1–8. https://doi.org/10.1111/anu.12338

**Boyd, C.E., Mc Nevin, A.A., Racine, P., Tinh, H.Q., Minh, H.N., Viriyatum, R., Paungkaew, D., Engle, C., 2017**. Resource Use Assessment of Shrimp, *Litopenaeus vannamei* and *Penaeus monodon*, Production in Thailand and Vietnam. J. World Aquac. Soc. 48, 201–226. https://doi.org/10.1111/jwas.12394

**Briggs, M., Funge-Smith, S., Subasinghe, R., Phillips, M., 2004**. Introductions and movement of *Penaeus vannamei* and *Penaeus stylirostris* in Asia and the Pacific. FAO RAP Publ. 75, 1–12.

**Briggs, M.R.P., Funge-Smith, S.J., 1994**. A nutrient budget of some intensive marine shrimp ponds in Thailand. Aquac. Fish. Manag. 25, 789–811. https://doi.org/https://doi.org/10.1111/j.1365-2109.1994.tb00744.x

**Duan, Y., Zhang, Y., Dong, H., Wang, Y., Zheng, X., Zhang, J., 2017a**. Effect of dietary *Clostridium butyricum* on growth, intestine health status and resistance to ammonia stress in Pacific white shrimp *Litopenaeus vannamei*. Fish Shellfish Immunol. 65, 25–33. https://doi.org/10.1016/j.fsi.2017.03.048

**Duan, Y., Zhang, Y., Dong, H., Zheng, X., Wang, Y., Li, H., Liu, Q., Zhang, J., 2017b**. Effect of dietary poly-β-hydroxybutyrate (PHB) on growth performance, intestinal health status and body composition of Pacific white shrimp *Litopenaeus vannamei* (Boone, 1931). Fish Shellfish Immunol. 60, 520–528. https://doi.org/10.1016/j.fsi.2016.11.020

**Fan, L., Wang, A., Miao, Y., Liao, S., Ye, C., Lin, Q., 2016**. Comparative proteomic identification of the hepatopancreas response to cold stress in white shrimp, *Litopenaeus vannamei*. Aquaculture 454, 27–34. https://doi.org/10.1016/j.aquaculture.2015.10.016

**Huang, Z., Li, X., Wang, L., Shao, Z., 2014**. Changes in the intestinal bacterial community during the growth of white shrimp, *Litopenaeus vannamei*. Aquac. Res. 1–10. https://doi.org/10.1111/are.12628

**Li, Y., Wei, L., Cao, J., Qiu, L., Jiang, X., Li, P., Song, Q., Zhou, H., Han, Q., Diao, X., 2016**. Oxidative stress, DNA damage and antioxidant enzyme activities in the pacific white shrimp (*Litopenaeus vannamei*) when exposed to hypoxia and reoxygenation. Chemosphere 144, 234–240. https://doi.org/10.1016/j.chemosphere.2015.08.051

**Liang, Z., Liu, R., Zhao, D., Wang, L., Sun, M., Wang, M., Song, L., 2016**. Ammonia exposure induces oxidative stress, endoplasmic reticulum stress and apoptosis in hepatopancreas of pacific white shrimp (*Litopenaeus vannamei*). Fish Shellfish Immunol. 54, 523–528. https://doi.org/10.1016/j.fsi.2016.05.009

**Niu, J., Chen, X., Zhang, Y.-Q., Tian, L.-X., Lin, H.-Z., Wang, J., Wang, Y., Liu, Y.-J., 2016**. The effect of different feeding rates on growth , feed efficiency and immunity of juvenile *Penaeus monodon.* Aquac. Int. 101–114. https://doi.org/10.1007/s10499-015-9911-x

**Nunes, B.A.J.P., Ph, D., Coutinho, A.G., Sena, D.C. De, Alves, L., Campos, S., Neto, O., Neto, H.S., Ph, D., Basílio, I., Nepomuceno Soares, A., 2019**. Culture of Pacific white shrimp juveniles in super-intensive conditions [WWW Document]. Glob. Aquac. Advocate. URL https://www.aquaculturealliance.org/advocate/culture-of-pacific-white-shrimp-juveniles-in-super-intensive-conditions/?utm_source=Informz&utm_medium=email&utm_campaign=Informz email&_zs=C9lIi1&_zl=7UFN6 (accessed 12.19.19).

**Palanikumar, P., Velmurugan, S., Citarasu, T., 2011**. Factors influencing success of *Penaeus vannamei* culture. Aquac. Asia Mag. 10–15.

**Palanikumar, P., Wahjuningrum, D., Abinaya, P., Babu, M.M., Citarasu, T., 2019**. Usage of plant natural products for prevention and control of white feces syndrome ( WFS ) in Pacific whiteleg shrimp *Litopenaeus vannamei* farming in India. Aquac. Int. https://doi.org/https://doi.org/10.1007/s10499-019-00448-5

**Ray, A.J., Drury, T.H., Cecil, A., 2017**. Comparing clear-water RAS and biofloc systems: Shrimp (*Litopenaeus vannamei*) production, water quality, and biofloc nutritional contributions estimated using stable isotopes. Aquac. Eng. 77, 9–14. https://doi.org/10.1016/j.aquaeng.2017.02.002

**Romano, N., Zeng, C., 2009**. Evaluating the newly proposed protocol of incorporated potassium in nitrate toxicity experiments at different salinities: A case study with the tiger prawn, *Penaeus monodon*, juveniles. Aquaculture 289, 304–309. https://doi.org/10.1016/j.aquaculture.2009.01.035

**Shiau, S., Peng, C., 1992**. Utilization of different carbohydrates at different dietary protein levels in grass prawn , *Penaeus monodon* , reared in seawater. Aquaculture 101, 241–250.

**Thakur, D.P., Lin, C.K., 2003**. Water quality and nutrient budget in closed shrimp (*Penaeus monodon*) culture systems. Aquac. Eng. 27, 159–176. https://doi.org/https://doi.org/10.1016/S0144-8609(02)00055-9

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## Recommendations

As previously mentioned within the 'Data Collection - Sample Size' section, some of the indicators are deemed 'not relevant' for the revision as they are now covered by the ASC Feed Standard (7.2.1a, 7.2.1b, 7.2.2). Furthermore, requirements for SPF larvae and origin of PL (5.1.4, 6.2.2) will also stay at 100%.

The new metric indicators for the revised ASC Shrimp Standard will be informed by Table 6, which summarises data from literature and certified and non-certified farms, and shows the average and quartiles (Q[8]) (either $Q_1$ (lowest 25%) or $Q_3$ (highest 25%), depending on the requirement[9]).

[8] $Q_1$ = 1st Quartile, $Q_3$ = 3rd Quartile; the first quartile is defined as the middle number between the median of the dataset and the smallest number, the third quartile is defined as the middle number between the median of the dataset and the highest number in the dataset.

[9] Indicators with a requirement above a certain metric limit (e.g. survival rate) show the data for the 3rd Quartile, whereas indicators with a requirement below a certain metric limit (e.g. FFER) show the data for the 1st Quartile.

**Table 6:** Summary of data from literature and certified and non-certified farms

| Ind. | Requirement | certified farms | | non-certified farms | | Literature | | Proposed Requirement |
|---|---|---|---|---|---|---|---|---|
| | | average | Q | average | Q | average | Q | |
| **2.5.3** | Water-specific conductance (< 1,500 mhos) | 1104.5 ± 1310.5 | 555.0 | 6620 | | No data | | No changes |
| | Chloride concentration ( < 300 mg/L) | 113.0 ± 69.1 | 58.1 | No data | | No data | | No changes |
| **5.1.3** | Annual average farm survival rate | | | | | | | |
| | unfed and non-permanently aerated (>25%) | 33.4 ± 14.4 | 30.9 | 61.0 | n/a | No data | | >30% |
| | fed but non-permanently aerated (>45%) | 62.9 ± 12.2 | 70.0 | 50.3 ± 13.1 | 65.0 | 60.3 ± 14.1 | 68.0 | >50% |
| | fed and permanently aerated (>60%) | 78.3 ± 9.7 | 84.5 | 53.6 ± 7.7 | 61.0 | 81.8 ± 15.9 | 94.4 | >65% |
| **7.4.1** | Feed Fish Equivalence Ratio (FFER) | | | | | | | |
| | (*P. vannamei: 1.35*) | 0.9 ± 0.4 | 0.7 | 1.2 ± 0.2 | 1.1 | 1.4 ± 0.6 | 1.1 | 1.3 |
| | (*P. monodon: 1.9*) | 1.6 ± 0.4 | 1.4 | No data | | 2.3 ± 1.3 | 1.2 | 1.8 |
| **7.4.2a** | eFCR | 1.4 ± 0.4 | | | | | | |
| | (*P. vannamei*) | 1.5 ± 0.4 | 1.2 | 1.4 ± 0.2 | 1.2 | 1.4 ± 0.3 | 1.2 | No req. |
| | (*P. monodon*) | 1.7 ± 0.1 | 1.6 | | | 1.5 ± 0.8 | 1.1 | No req. |
| **7.4.2b** | Protein Retention Efficiency (PRE) | | | | | | | |
| | (*P. vannamei*) | 34.6 ± 8.1 | 41.0 | 59.8 | n/a | No data | | >20%?? |
| | (*P. monodon*) | 33.4 ± 5.8 | 37.4 | no data | | 21.5 ± 11.4 | 23.9 | |
| **7.5.1** | Nitrogen effluent | | | | | | | |
| | (*P. vannamei:* <25.2 kg/T) | 13.8 ± 9.9 | 3.2 | 19.5 | n/a | n No o data | | No changes |
| | (*P. monodon*: <32.4 kg/T) | 21.8 ± 9.9 | 21.6 | No data | | 39.0 ± 15.4 | 35.8 | No changes |
| **7.5.2** | Phosphorous effluent | | | | | | | |
| | (*P. vannamei:* <3.9 kg/T) | 2.2 ± 1.6 | 0.6 | 2.1 | | No data | | No changes |
| | (*P. monodon*: <5.4 kg/T) | 2.7 ± 2.2 | 3.1 | No data | | 6.5 ± 2.9 | 3.9 | No changes |
| **7.5.4** | Concentration of settleable solids (<3.3 mL/L) | 1.2 ± 1.0 | 1.8 | No data | | No data | | No changes |
| **7.5.5** | Percentage change in diurnal DO (<65%) | 25.9 ± 17.3 | 11.3 | No data | | 34.1 ± 16.4 | 20.0 | No changes |

- Based on the fact that the ASC is currently working on the future [‘Aligned’] ASC Farm Standard, which will combine all existing species-specific ASC Standards into one ASC Farm Standard, it was also decided to *not update* the effluent related indicators (7.5.) within the scope of this revision of the ASC Shrimp Standard. The effluent related indicators will be revised for all species and farming purposes within the Alignment project, based on an assessment of their environmental impact. The collected data will be used for the revision.
- Proposed changes within the revision are to increase the survival rate for each category by 5%. The collected data indicates to increase the survival rate further. Nevertheless, it was decided not to change any of the indicators by more than 20% from the original value as a measure of practicability for farmers and auditors.
- FFER is proposed to be decreased by 0.05 for *P. vannamei* and 0.1 for *P. monodon* to account for the improved feed formulation (and thus better resource use) and also to slowly start aligning the values for the two species.
- The protein retention efficiency (PRE) is a measure of the amount of protein provided in the feed that is retained in the harvested shrimp. The ASC Shrimp Standard v1.0 required farmers to report on the PRE in order for the ASC to collect data and potentially form this into a requirement within the revision. The provided data suggests that in more than 80% of the reported cycles PRE is well above 30% with only a few farms having a PRE of slightly below 20% (one farm has a PRE of 4.7%). In order to slowly transition into this requirement and improve the use of protein as a resource, it is therefore suggested to set the requirement at 20% for all certifiable shrimp species.

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