Monterey Bay Aquarium Seafood Watch®

Farmed Tilapia

(Oreochromis aureus)

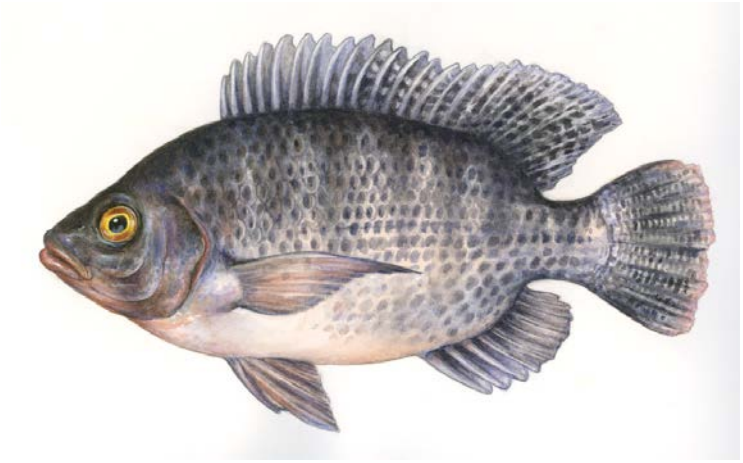

Image courtesy of Monterey Bay Aquarium

Peru

Raceways

October 26, 2015

Valerie Ethier, independent contractor

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.

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.

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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 fished[1] 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 practices for some criteria may lead to more energy-intensive production systems (e.g. promoting more energy-intensive closed recirculation systems).

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

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.

Final Seafood Recommendation

Criterion	Score (0-10)	Rank	Critical?
C1 Data	4.40	YELLOW	
C2 Effluent	5.00	YELLOW	NO
C3 Habitat	5.17	YELLOW	NO
C4 Chemicals	8.00	GREEN	NO
C5 Feed	6.57	YELLOW	NO
C6 Escapes	10.00	GREEN	NO
C7 Disease	6.00	YELLOW	NO
C8 Source	10.00	GREEN	
C9X Wildlife mortalities	0.00	GREEN	NO
C10X Introduced species escape	0.00	GREEN	
Total	**55.18**		
Final score	**6.90**		

OVERALL RANKING

Final Score	6.90
Initial rank	GREEN
Red criteria	0
Interim rank	GREEN
Critical Criteria?	NO

FINAL RANK

GREEN

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 Peruvian farmed tilapia is 6.90, which is in the green range. The majority of criterion scores are yellow with the exception of Chemicals, Escapes and Source of Stock, which are green. The final recommendation for aquaculture production of tilapia in Peru is green overall, or “Best Choice.”

Executive Summary

Tilapia was introduced to Peru in 1962 as feed for a native species (paiche), and aquaculture development began in the 1970s and continued to grow in the 1980s through pond and cage culture. The majority of tilapia operations in Peru are small-scale, semi-extensive pond culture. Total production reached 3,174 mt in 2012 (RNIA 2013).

Several land-based tank operations have more recently been developed, including American Quality Aquaculture S.A.C. (AQA S.A.C.). Production from pond operations in Peru stays in local markets. Fish from the flow-through raceway operations at AQA S.A.C. is the only tilapia currently being exported to the U.S. market, so this is the only system considered in this report. AQA S.A.C. produces approximately 2,000 mt per year, and exported approximately 228 mt to the U.S. in 2013. Approximately 50% of the tilapia at AQA S.A.C. is produced according to the standards specified by Whole Foods Markets. Although the audits are confidential, some audit data has been made available for the purpose of this assessment. The only difference in management of the production lines (for Whole Foods vs. regular) is that sex reversal hormones are provided to the non-Whole Foods fish.

Much of the data used for this assessment were from personal communications with producers, researchers, and government contacts. Very little recent peer-reviewed data or academic information are available regarding the land-based Peruvian tilapia aquaculture industry, due to its relatively small production volume. Anecdotal evidence provided by personal contacts is not verified, so Criterion 1: Data receives a moderate score of 4.40 out of 10.

The flow-through raceway tanks used by AQA S.A.C. enable the collection of solids from feed and fish wastes before an on-farm treatment plant processes effluent. After treatment, water is released into irrigation canals and used for agricultural application. However, publicly available data about effluent compliance and enforcement for aquaculture in Peru are lacking. Overall, there is a moderate concern from effluent impact, which results in a Criterion 2: Effluents score of 5.00 out of 10.

AQA S.A.C. was established in the late 1990s on land previously used for agricultural purposes. Although some conversion and functionality loss occurred for the original use, no further loss of ecosystem services was required for the construction of the farm. Environmental Impact Assessments are required for aquaculture projects over a certain size, and environmental studies for smaller production, but the thresholds are not readily defined and some subjectivity remains. The current industry is small and not very concentrated, and cumulative impacts on habitat are not presently covered by regulation. With habitat maintaining functionality with minor to moderate impacts, and with somewhat robust and effective habitat regulation and management, the Criterion 3: Habitat receives a score of 5.17 out of 10.

Chemical therapeutants such as antibiotics and parasiticides are not used in tilapia aquaculture in Peru. The Whole Foods standard does not allow the use of the sex reversal hormones typically used in tilapia aquaculture. About 50% of production at AQA S.A.C. is not produced for Whole Foods purchase, and a small amount of hormone-treated feed is provided. As no

antibiotics or parasiticides are used and the small amount of hormone is greatly diluted prior to release into irrigation channels, Peruvian tilapia scores a high 8.00 out of 10 for Criterion 4: Chemicals.

Tilapia in Peru are fed with commercial feed pellets. As a low trophic-level species, the majority of feed is crop-based and only 10% fishmeal is included, with 25% coming from byproducts. Thus, the FI:FO value is 0.6. When combined with the sustainability of the wild stock used for fish meal, the wild fish use score is 8.14 of 10. Due to Whole Foods standards, no animal byproducts are included, and the remainder of tilapia feed is from edible crops. Protein in feeds is almost entirely derived from crop ingredients, with a small percentage from fishmeal. The majority of crop ingredients are edible to humans, leading to a net protein loss: –77.7%. With an average FCR of 1.8, tilapia feeds have a low use of wild marine ingredients, high loss of edible protein (from edible crops), and a small feed footprint, leading to an overall high Criterion 5: Feed score (6.57 out of 10).

Although it is not a native species, tilapia has become widespread and fully ecologically established in most areas of Peru since its introduction in 1962. Despite this, tilapia is a known invasive species that can impact the integrity of an ecosystem with characteristics such as habitat modification and competition with native species. The raceway facilities at AQA S.A.C. use multiple escape-prevention measures to ensure biosecurity of their production fish, and no escapes have been observed by the farm. All effluent exits the farm via a treatment plant, which either removes or kills all potential escapees. So an exception is made for a system that eliminates all risk and a perfect Criterion 6: Escapes score is assigned (10.00 out of 10).

There have been no diseases reported by AQA S.A.C. The farm operates using preventative disease management strategies including monitoring stress levels, maintaining high water quality, and using optimal stocking densities. The absence of disease on the farm and the lack of a connection between aquaculture production and wild, native populations nearly eliminate the risk of disease transmission; there is no evidence of transfer to wild populations or amplification of naturally occurring pathogens. The Criterion 7: Disease score is a moderate 6.00 out of 10.

AQA S.A.C. is a fully integrated tilapia operation, which includes maintenance and supply of their own broodstock and fry (the hatchery is a closed life-cycle operation). There is no sourcing of wild tilapia and no concern of impact on wild population, resulting in a high score on Criterion 8: Source (10.00 out of 10).

The AQA S.A.C. facilities are covered by netting to prevent predation by birds, and no lethal control methods are used. This results in no points being removed for predator interactions (Criterion 9X: Wildlife Mortalities scores 0 out of –10). Criterion C10X (Introduced Species Escape) is also not scored because the farm produces its own stock rather than importing fish from other countries or water bodies.

With regard to environmental impacts, American Quality Aquaculture S.A.C.'s production of tilapia in Peru has high (green) scores in Chemicals, Escapes, and Source of stock, with the remaining categories all scoring moderately (yellow). Overall, farming tilapia in land-based

raceways in Peru does not result in significant ecological risks or impacts. With a final score of 6.90 out of 10, tilapia aquaculture in Peru receives a “Best Choice” seafood recommendation.

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Introduction

Scope of the analysis and ensuing recommendation

Species
Several species of tilapia are produced in Peru, but the only company currently producing for the U.S. market is raising blue tilapia (*Oreochromis aureus*).

Geographic coverage
Peru

Production Methods
Tilapia exported to the U.S. is produced in flow-through raceway systems, with solids filtration, effluent treatment, and use of remaining effluent for irrigation.

Species Overview

Tilapia is a fast-growing tropical species native to Africa and is now one of the most widely produced aquaculture species in the world. Tilapia is omnivorous, can live in either fresh or salt water, and must live in temperatures above 50 °F (Fitzsimmons and Watanabe 2010). Tilapia is a common name applied to three genera: *Oreochromis* (maternal mouthbrooders), *Sarotherodon* (paternal mouthbrooders), and *Tilapia* (substrate spawners).

Tilapia was introduced to Peru in 1962 as feed for paiche in Willow Lake in the San Martin region. Tilapia research and cultivation was initiated in the late 1970s to mid-1980s, and has since expanded through both pond and cage production (Deza 2006) (Halwart et al. 2007) (Hurtado n.d.). Intensive production in Peru was developed in the late 1990s by Dan Cohen and Aquaculture Production Technology (Israel) Ltd via the American Quality Aquaculture S.A.C. farm (AQA S.A.C.), which are raceway facilities using water from the Poechos dam (pers. comm., Favre). Land-based tilapia culture is growing in Peru, with several farms using technology ranging from traditional flow-through to full recirculation. Increasing water reuse means that farms are able to expand to areas typically avoided due to lack of water (pers. comm., Favre).

Production statistics
In 2012, global farmed tilapia production was approximately 4.2 million metric tons (mt) (Fitzsimmons 2013). Tilapia is produced in more than 100 nations, surpassing any other farmed fish, and was the fourth-most consumed fish in the United States after shrimp, tuna, and salmon (Fitzsimmons et al. 2011) (National Fisheries Institute 2012).

Tilapia production in Peru has been steadily increasing in recent years, growing from 1,740 mt in 2007 to 3,174 mt in 2012. AQA S.A.C. is the largest commercial production, responsible for

approximately 2,000 mt per year. More than 95% of tilapia in Peru is produced in the Piura and San Martin regions, with small amounts coming from Cajamarca and Lima (RNIA 2013).

Table 1: Tilapia production in Peru (RNIA 2013)

Year	mt
2007	1739.51
2008	1713.73
2009	1260.83
2010	2013.39
2011	2422.38
2012	3173.58

Import and export sources and statistics

Tilapia produced in Peru is mostly consumed domestically with some exports, mainly to the United States. Peru represents a minor amount of the tilapia imported by the United States relative to other major producers. China dominates U.S. imports at 84% of total tilapia in 2013 (over 19,000 mt), with Indonesia as the second-largest at 995 mt in the same year (NMFS 2014). Chinese products dominated the frozen sector of the U.S. market in 2013, providing about 97% of the whole tilapia and 91% of the tilapia fillets (USDA 2014). Latin American countries dominated the market of fresh products; in 2013, Honduras, Ecuador, Costa Rica, and Colombia supplied 86% of imported fresh fillets to the U.S. market (USDA 2014). Peru's exports to the United States have increased over the past 8 years to a high of 228 metric tons in 2013 (RNIA 2015). American Quality Aquaculture S.A.C. is the only producer currently exporting tilapia to the U.S. (pers. comm., Favre) (pers. comm., Geller).

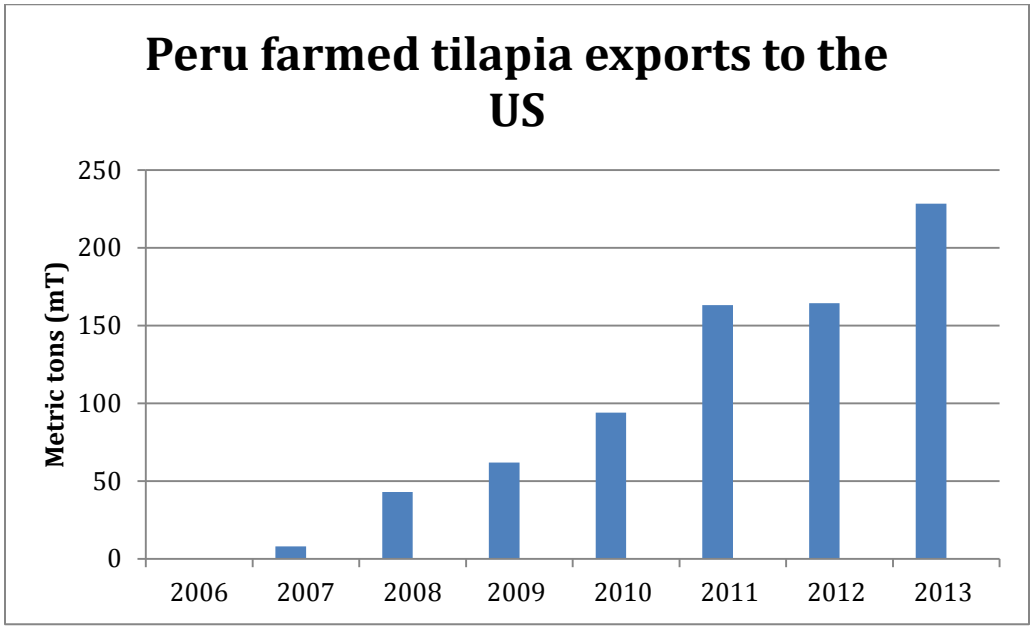

Figure 1: Peruvian tilapia exports 2004–2013 (RNIA 2015)

Common and market names
Blue tilapia, Peruvian blue tilapia

Product forms
Fillets, mostly fresh with some frozen product

Analysis

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.seafoodwatch.org/-/m/sfw/pdf/criteria/mba-seafoodwatch-aquaculture-critera-methodology.pdf?la=en
- The full data values and scoring calculations are available in Annex 1.

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	7.5	7.5
Effluent	Yes	2.5	2.5
Locations/habitats	Yes	5	5
Predators and wildlife	Yes	5	5
Chemical use	Yes	5	5
Feed	Yes	5	5
Escapes, animal movements	Yes	5	5
Disease	Yes	2.5	2.5
Source of stock	Yes	2.5	2.5
Other – (e.g. GHG emissions)	No	n/a	n/a
Total			**40**

C1 Data Final Score	**4.4**	**YELLOW**

Brief Summary

Peruvian tilapia that is exported to the North American market is currently produced on only one farm. Likely due to the small size of the industry, there is limited peer-reviewed scientific literature or official regulatory monitoring reports. The farm manager, another familiar producer in the region, and industry experts were very cooperative during the assessment process. Data availability is therefore considered moderate to high (mostly anecdotal), but because many data points are not verified, quality is low and results in an overall low data score of 4.4 of 10.

Justification of Ranking

Research on tilapia production in Peru is almost non-existent in peer-reviewed journals, but information can be found in country reports[2] and in the presentations of local workshops.[3] National production and export statistics for tilapia in Peru are available, and management practices are fairly well documented at the farm level. Because the only Peruvian producer currently exporting to the U.S. market is American Quality Aquaculture S.A.C., this assessment is more similar to a farm-level analysis than a country-level report. The author has been in contact with representatives from the farm, and most of the requested data have been provided either anecdotally or in farm reports and manuals, with some confirmed by a recent Whole Foods Market audit.

Industry or production statistics scored 7.5 out of 10 because there was little peer-reviewed and published information. However, most relevant production and export data were available via the National Aquaculture Information Network (Red National de Información Acuícola) (RNIA 2013) (RNIA 2015) website. Confirmation of export data was available from the USDA Economic Research Center (USDA 2014).

The *Effluent* criterion scored 2.5 out of 10 for data availability. Most effluent information was obtained from the farm manager and includes eFCR and feed protein content, production system characteristics and effluent treatment procedure, effluent testing results for N and P, and effluent discharge used for irrigation (pers. comm., Favre) (pers. comm. Geller). Regulations (for effluent limits and testing) were obtained from government websites (RNIA), and reports available within and from the FAO National Aquaculture Legislation Overview (FAO 2014). Although the effluent testing records are verified, they cover a 2-month period and no data were available regarding effluent impact in the area surrounding the farm.

Habitat received a moderate score of 5 out of 10. AQA S.A.C. provided information regarding the site characteristics, and the WFM audit and standard confirm some elements of this data (pers. comm., Favre) (pers. comm., Geller) (IMO 2014) (WFM 2014). As with the effluent data, government websites and reports informed the management and regulatory section of the Habitat criterion (pers. comm., Geller) (RNIA, FAO 2014).

[2] http://rnia.produce.gob.pe/

[3] http://rnia.produce.gob.pe/index.php?option=com_content&view=article&id=227:taller-cadena-productiva-tilapia-peces-amazonicos&catid=7:eventos-y-actividades&Itemid=75

Evidence or Risk of Chemical Use also received a moderate score of 5 due to available anecdotal and verified information. Chemical treatment information was described by farm management, farm manual, and confirmed by WFM audits (AQA S.A.C. 2015) (pers. comm., Geller) (IMO 2014). But because only approximately 50% of production is audited against the WFM standard, the data quality is not considered more than moderate.

The data score for the criterion *Feed* was a moderate 5 out of 10. Available feed information includes protein, fishmeal, fish oil, and wild fish source. The score is moderate because only some of the data points were confirmed through the Whole Foods Market Feed Compliance Statement, whereas others were provided by farm management and another producer in the region (pers. comm., Favre) (pers. comm., Geller) (WFM 2015).

The *Escapes* criterion scored 5 out of 10 because the farm manager (pers. comm., Geller) provided a description of the escape prevention measures that were verified through the WFM audit (IMO 2014). However, no evidence of potential impacts (or lack thereof) within the region could be identified.

The *Disease* criterion also scored a low 2.5 out of 10 for data. The farm manager described the health management plan with most points corroborated by the farm manual or the Whole Foods Market audit (AQA S.A.C. 2015) (pers. comm., Geller) (IMO 2014). But reports regarding disease incidence were only available anecdotally, leading to a lower score for data quality.

The *Source of Stock* criterion scored 2.5 out of 10 for data. Although the AQA S.A.C. farm is integrated, with a hatchery that is supported by farm-supplied broodstock, there was no third party confirmation of the fact that no wild broodstock are brought in.

The *Wildlife and Predator Mortalities* exceptional criterion received a moderate data score of 5 out of 10. A description of on-farm predator deterrents was provided by the farm manager, which was verified by the WFM audit (pers. comm., Geller) (IMO 2014). Predator interactions are apparently recorded for farm records (IMO 2014), but this was not provided for the purpose of this report.

Approximately 50% of American Quality Aquaculture S.A.C. output is produced to the specifications of the Whole Foods Market standards. According to farm management, the only difference in practice is that no sex reversal hormones are applied to WFM fish, while the remaining 50% are treated with methyltestosterone to ensure an all-male population (pers. comm., Geller) (IMO 2014) (WFM 2014). Some data points were confirmed via independently verified audit data but, because gaps still exist and the audit does not verify data for all of production, data quality scores are generally moderate or low. Overall data quality for Peruvian tilapia scores 4.4 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 Risk-based Assessment

Effluent parameters	Value	Score	
F2.1a Biological waste (nitrogen) production per ton of fish (kg N ton-1)	69.76		
F2.1b Waste discharged from farm (%)	50		
F2.1 Waste discharge score (0-10)		6	
F2.2a Content of regulations (0-5)	2.5		
F2.2b Enforcement of regulations (0-5)	3		
F2.2 Regulatory or management effectiveness score (0-10)		3	
C2 Effluent Final Score		**5.00**	**YELLOW**
Critical?	NO		

Summary

The risk-based effluent assessment was used to examine the impact of effluent from Peruvian tilapia due to the lack of verified data available. Peruvian tilapia exported to the U.S. market is raised in flow-through raceways with solids filtration and water treatment prior to the use of effluent for agriculture irrigation. Effluent releases are low, but the lack of verified effluent monitoring and regulation combines for an overall score of 5 out of 10.

Justification of Ranking

Factor 2.1a – Biological waste production per ton of fish

Peruvian tilapia FCRs range from 1.6–2.0, with an average of 1.8 (pers. comm., Favre) (pers. comm., Fitzsimmons) (pers. comm., Geller). Tilapia feeds used by American Quality Aquaculture S.A.C. have an average protein content of 32% (pers. comm., Geller) (AQA S.A.C 2015). Harvested tilapia contain 14% protein, which results in 69.76 kilograms of nitrogen waste produced per metric ton of tilapia.

Factor 2.1b – Production system discharge score

The American Quality Aquaculture S.A.C. tilapia facilities in Peru are raceways originally built in the late 1990s. The farm sources water from the nearby Poechos Dam and, after running through hatchery and on-farm growing systems, the solids are filtered, collected, and disposed of by a third party. Effluent then runs through an on-farm treatment plant before being released for irrigation use on surrounding rice fields (pers. comm., Favre) (pers. comm., Geller). The combined treatment measures on the farm and the use for agriculture means that very little (if any) nitrogen remains in the wastewater by the time it reaches natural waterways (Endut et al. 2011). Effluent testing indicates nitrogen and phosphorus levels ranging from 1.37–2.08 mg/L and 0.01–0.07 mg/L, respectively (Bureau Veritas Inspectorate 2015). However, because no downstream monitoring data is available, the production system is assigned the basic score for a flow-through system with solids filtration, collection, and appropriate disposal (0.8 or 80% of waste entering the environment) and an adjustment (due to effluent use for irrigation) that results in a nutrient capture that falls between the raceway with solids collection basic score and a recirculation system. Approximately 50% of the waste produced by this farm is discharged.

Factor 2.2 – Management of farm-level and cumulative impacts and appropriateness to the scale of the industry

The farm is subject to effluent regulations and management by a number of Peruvian agencies and institutions, including the General Directorate of Environmental Health (DIGESA - www.digesa.sld.pe) and the Agency for Assessment and Environmental Control (OEFA - www.oefa.gob.pe). DIGESA requires water quality testing on surface water and is the authority charged with establishing limits in wastewater discharge, which are revised periodically as per the General Law of Water (Decree No. 17752) (Ley General de Aguas, Decreto, Ley N. 17752) (FAO 2014). The enforcement agency is identifiable, contactable, and appropriate to the scale of the industry and, although discharge limits are not designed for aquaculture, they are applicable. Scores of 0.75 and 1 are awarded for questions 1 in 2.2a and 2.2b, respectively. Aquaculture production in Peru is subject to environmental impact assessment (or study depending on the size of facility) under the General Environmental Law (Ley N. 28611). OEFA is responsible for overseeing administration of and compliance with environmental obligations and standards. The organizations responsible for management and regulation of effluent impacts are suitable to the scale of the industry, and future development planning takes into consideration ecological limits (Ministerio de la Producción 2010, 2013). The effluent limits are not set according to the receiving water or site-specific conditions, but are considered robust and lead to site-specific limits. Due to this, questions 2 and 4 of 2.2a score moderately, or 0.5 of 1. The impact from multiple farms is not taken into consideration, but effluent monitoring does cover the full production cycle, with scores of 0 and 0.75, respectively, for questions 3 and 5 of 2.2a.

Monitoring of effluent and calculation of loads is also required by Whole Foods Market Standards (WFM 2014). Effluent testing data (for N and P) was provided by the farm and demonstrates compliance with regionally set limits. Monitoring data is not made publicly available for all tilapia farms in Peru, but personal communications with contacts at AQA S.A.C.

and other producers in the region indicate that a framework is in place via mandatory monitoring and reporting and that there are penalties for infringement (i.e., fines); however, evidence of enforcement is difficult to find outside that provided anecdotally by producers (pers. comm., Favre) (pers. comm., Geller). Partial scores were awarded for questions 2–5 of 2.2b.

The waste discharge score resulting from the quantity of waste production and system discharge is a moderate 6 out of 10. Although there is some oversight regarding effluent impacts on the surrounding environment, few details are publicly available regarding enforcement or outcomes, and this results in a regulatory and management score of 3 out of 10. The overall combination of the solids collection, water treatment, use of remaining water for agricultural purposes, and government and standard regulations result in a moderate concern of effluent impact and a final 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		6.00	
F3.2a Content of habitat regulations	2.50		
F3.2b Enforcement of habitat regulations	3.50		
F3.2 Regulatory or management effectiveness score		3.50	
C3 Habitat Final Score		**5.17**	**YELLOW**
Critical?	NO		

Summary

Tilapia aquaculture in Peru (destined for the U.S. market) is produced in land-based facilities with a small footprint, on former agricultural land. Moderately strong environmental regulations exist in Peru, which prevent the loss of high value ecosystems or ecological services, as do (to some extent) the Whole Foods standards that American Quality Aquaculture S.A.C. follows. The Habitat criterion receives a score of 5.17 out of 10.

Justification of Ranking

Factor 3.1. Habitat conversion and function

American Quality Aquaculture S.A.C. is a land-based raceway operation in the Piura region of Peru, near the Poechos Dam. Although a number of cages have recently been added to the Poechos Reservoir for tilapia, 95% of production comes from the tank facilities. The farm was developed in the late 1990s by Dan Cohen and Aquaculture Production Technology (Israel) Ltd, and it introduced a method of intensive tilapia production to Peru (pers. comm., Favre) (Hurtado n.d.). The farm was constructed on land formerly used for agricultural purposes and did not result in the further loss of any ecosystem services (pers. comm., Geller). Although originally the conversion of natural habitats to agricultural land may have resulted in loss of ecosystem service and function, the construction of buildings and raceways for tilapia production has not resulted in further impacts to the surrounding ecosystem.

The lack of farms sited in high-value habitat, no further loss of ecosystem services, and minimal impacts on habitat functionality results in a Habitat conversion and function (Factor 3.1) score of 6 out of 10.

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

Factor 3.2 is separated into two sub-factors: 3.2a examines the content and effectiveness of habitat regulations and management regime, and 3.2b assesses the enforcement of the measures identified in 3.2a. These aspects are discussed below.

Habitat requirements stipulated by the Peruvian government and Whole Foods standards prevent the location or expansion of aquaculture from affecting ecosystem functionality (FAO 2014) (WFM 2014). The National System for Environmental Impact Assessment oversees the process of Environmental Impact Statement (DIA), an Environmental Impact Study (EIA), or the Adaptation Program for Environmental Impact (PAMA), depending on the scale of aquaculture operation (FAO 2014). Permits are required for aquaculture, and are based upon ecological principles (and an Environmental Impact Assessment) as required by the General Environmental Law and Law of Promotion and Development of Aquaculture, Ley N. 27460 (Evans and Tveteras 2011) (FAO 2014) (Ministerio de la Producción 2010).

The future development of the aquaculture industry is articulated clearly through the Law of Promotion and Development of Aquaculture, the National Plan for Aquaculture Development (2010–2021) and National Science Program, Technological Development and Aquaculture Innovation (Evans and Tveteras 2011) (Ministerio de la Producción 2010, 2013). The future development is planned around both the growth of the industry and supporting infrastructure (educational, policy, monitoring, and technology). Whole Foods standards also require compliance with all local, state, and national laws, codes, and regulations governing operations (WFM 2014). The Whole Foods standards do not necessitate land-based aquaculture to be sited in areas previously developed or formerly used for agriculture rather than converting sensitive natural areas to farms, but it is strongly encouraged, and farm siting and construction must not disturb local hydrology (WFM 2014).

AQA S.A.C was established prior to the implementation of environmental impact assessment requirements and, although there is no specified size threshold, the farm would likely require one for any substantial farm expansion (FAO 2014) (pers. comm., Geller). Question 1 in 3.2a scored at 0.75 because siting requirements are in place to prevent loss of ecosystem functionality, but because much of the Peruvian tilapia industry is small scale, not all farms require Environmental Impact Assessments. Similarly, although the industry is still relatively small and of low density, growth is being promoted (within defined locations) but cumulative impact has not been examined, resulting in scores of 0 and 0.5 for questions 2 and 3, respectively, in 3.2a. Questions 4 and 5 in 3.2a receive partial scoring (0.75 and .5, respectively) because Peru is a Ramsar country (Convention on Wetlands), high-value ecosystems are largely protected from aquaculture siting through the General Environmental Law requirements, and the WFM standards necessitate restoration of mangroves and wetlands.

The combined oversight by local agencies and enforcement of the WFM audit process results in administrating organizations that are identifiable and contactable; this results in a full score for question 1 in 3.2b. Partial scores are awarded for questions 2 and 3 of 3.2b (0.75 and 0.5, respectively) because the aquaculture permitting process is based upon ecological principles and does consider neighboring farms, but does not include robust guidance regarding cumulative impact. Though the enforcement process is largely transparent and there is evidence of enforcement, the content of available documents and documented results of the control measures are in Spanish and it can be difficult to determine how complete they are. Thus, scores of 0.5 and 0.75 are awarded for questions 4 and 5 of 3.2b.

Overall, there is some uncertainty whether the industry's future expansion is limited to an appropriate scale and will prevent cumulative impacts, but Factor 3.2a scores 2.5 out of 5 due to requirements for Environmental Impact Assessments and other high-value habitat restrictions. Factor 3.2b for enforcement scores slightly better, with 3.5 out of 5. The final score for habitat and farm siting management effectiveness is 3.5 out of 10.

Peruvian tilapia aquaculture receives a high score for Habitat conversion and function (8 of 10) and a moderately high score for Regulatory and management effectiveness (3.5 of 10), resulting in a moderate overall score of 5.17 out of 10 for the Habitat criterion.

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	**8.00**	
C4 Chemical Use Final Score	**8.00**	**GREEN**
Critical?	NO	

Summary

Tilapia farming in Peru employs little to no use of chemicals, due both to the management goals of the farm and to production under the Whole Foods standards, which require that none be used during production (pers. comm., Favre) (pers. comm., Geller) (WFM 2014). About 50% of the fish produced in the American Quality Aquaculture S.A.C. farm have sex reversal induced via feed with included hormones. The hormone is used early in the production cycle at a low dosage, and water is reused in production raceways prior to release, at which point the hormone is reduced to a concentration of parts per trillion (pers. comm., Fitzsimmons). No antibiotics or pesticides are used in the production of tilapia at AQA S.A.C. The Chemical criterion score is 8 out of 10.

Justification of Ranking

Land-based flow-through farming is generally more intensive than pond farming, meaning higher stocking densities and an increased need to keep stress levels low to prevent disease occurrence. Maintenance of water quality and close monitoring of fish health (to remove any individuals showing signs of disease) are the main approaches to avoid the need for chemicals. Approximately 50% of tilapia produced by American Quality Aquaculture S.A.C. are raised according to the specifications of the Whole Foods standards, which prohibit the use of antibiotics or methyltestosterone on fish for grow-out (IMO 2014). The only difference for the remaining 50% is the application of the sex-reversal hormone 17-alpha-methyltestosterone (pers. comm., Geller). The hormone is included at about 60 ppm in feeds during the first 21 days of the production cycle (Deza 2009) (pers. comm., Fitzsimmons). Sex reversal is induced in female tilapia by applying these androgenic hormones to get all-male populations (Deza 2006,

2009). The stocking of all-male tilapia seeks to avoid the unwanted reproduction (and the resulting overpopulation) due to the early maturation and frequent breeding that characterize tilapia populations, and to achieve the faster growth of males compared to females (Deza 2006) (Phelps 2006). The hatchery system effluent is treated with all other water from the farm, and MT levels in feed are small enough that any remaining hormones released into the environment are at concentrations of parts per trillion (pers. comm., Fitzsimmons). MT use is considered a low risk to human health and the environment if the recommended best practices are being observed (Macintosh 2008). As outlined in the AQA S.A.C. best practices manual, saline baths are the only treatment used on the tilapia (AQA S.A.C. 2015). The disuse of chemicals during production with the exception of methyltestosterone on 50% of production fish, and the resulting low environmental risk, determine a high overall score for the chemical use criterion (8 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)	0.60	8.50	
F5.1b Source fishery sustainability score		6.00	
F5.1: Wild Fish Use		8.14	
F5.2a Protein IN	41.54		
F5.2b Protein OUT	9.28		
F5.2: Net Protein Gain or Loss (%)	-77.67	2	
F5.3: Feed Footprint (hectares)	5.52	8	
C5 Feed Final Score		**6.57**	**YELLOW**
Critical?	NO		

Summary

Tilapia is a low trophic-level species, meaning that it occupies a low position on the food web and its natural diet mainly consists of phytoplankton and other aquatic vegetation. However, it is an omnivore and is often given commercial feeds with marine ingredients (Huntington and Hasan 2009). Feeds consist mostly of crop ingredients, and the resulting Fish In:Fish Out ratio is 0.6. The Whole Foods standards provide some guidance for American Quality Aquaculture S.A.C. with regard to marine ingredient inclusion and raw material origin. There is a net protein loss of –77.7% due to the low protein content of a harvested farmed tilapia and a relatively low edible yield. However, when combined with a high score for Factor 5.3 (feed footprint) due to the majority of ingredients being crops, the final score for the Feed criterion is 6.57 of 10.

Justification of Ranking

Factor 5.1. Wild Fish Use

Tilapia feeds used by American Quality Aquaculture S.A.C. have low marine ingredient inclusion levels. The FCR values for Peruvian tilapia range from 1.6–2.0, with an average conversion ratio of 1.8 (pers. comm., Favre) (pers. comm., Fitzsimmons) (pers. comm., Geller). Although some Peruvian feed formulations provided by contacts during research for this report include some amount of fish oil and animal byproducts, the feed used by AQA S.A.C. contains neither of these (pers. comm., Fitzsimmons 2015) (pers. comm., Geller) (WFM 2015). The same feed is used for all tilapia raised on the farm because managers stated that they found the price to be roughly equivalent to others available (pers. comm., Geller). With 10% fishmeal inclusion and 25% of this from by-products (WFM 2015), the Fish In:Fish Out ratio is 0.6 and scores 8.5 out of 10 in Factor 5.1a. The species listed on the Whole Foods Market Feed Compliance Statement are as follows: skipjack tuna (*Katsuwonus pelamis*), frigate tuna (*Auxis thazard*), chub mackerel (*Scomber japonicas*), Pacific thread herring (*Opisthonema libertate*), round eye herring (*Etrumeus teres*), Pacific sardine (*Sardinops sagax sagax*) and Pacific bumper (*Chloroscombrus orqueta*) (WFM 2015). The tunas are included as byproduct as is some crustacean byproduct meal. However, the majority of the wild fishery stocks included in the feed have currently undefined sustainability status. With unknown sustainability, the wild fishery source score is a deduction of –6, which lowers the final Wild Fish Use score to 8.14 out of 10.

Factor 5.2. Net Protein Gain or Loss

To meet feed protein requirements averaging 32%, tilapia feeds often contain terrestrial animal protein and/or crop ingredients that are unsuitable for human consumption (pers. comm., Fitzsimmons) (pers. comm., Geller). These ingredients offset the loss of edible protein that often occurs in aquaculture production. However, Whole Foods standards do not allow for any animal products in feed (WFM 2014) and crop ingredient byproducts are avoided by AQA S.A.C. to ensure compliance with the non-GMO origin requirements (pers. comm., Geller) (WFM 2015). As a result, the majority of the protein (80%) in the Peruvian tilapia feed is from edible crop sources, with the remainder coming from whole fish (15%) and non-edible fisheries byproducts (5%). The protein content of a whole harvested farmed tilapia is around 14% (Boyd, 2007). Tilapia has a relatively low edible yield of 30%–35%, but the remainder of harvested fish is used in a number of ways: fishmeal for poultry or shrimp feed, heads in fish soup, and skins to Italy (for collagen), and some plants even collect oil from viscera to use for biofuel (Favre 2013) (pers. comm., Fitzsimmons). Because the exact proportion of harvest byproduct used in further feed production is not known, the assessment default of 50% is used. Tilapia production at AQA S.A.C. operates with a loss of edible protein of –77.7% and a net protein gain or loss score of 2 out of 10.

Factor 5.3. Feed Footprint

All feed ingredients are included in the calculation of the feed footprint, even byproducts. Crop ingredients appropriate the least amount of area of primary productivity to produce a given amount of feed, followed by land animal ingredients, then marine ingredients. A high edible

crop inclusion rate of 89% and low percent of marine ingredients (10.5%) result in a small feed footprint (5.52 hectares). The Feed footprint score is a high 8 out of 10.

The feed used by AQA S.A.C. to raise Peruvian tilapia destined for the U.S. market has a high loss of edible protein, but moderately low use of marine resources and a small feed footprint. This results in an overall moderate Feed criterion score of 6.57 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

C6 Escape Final Score		**10.00**	**GREEN**
Critical?	NO		

Summary

The criterion score results from the combination of the escape risk and the invasiveness of the farmed species. Tilapia has high potential to become an invasive species (Diana 2009) (Zambrano et al. 2006). The risk of escape in tilapia operations in Peru is considered to be low because they operate as a flow-through system with multiple escape prevention measures and Best Management Practices in place. No evidence of escape from this farm has been registered in the monitoring performed by AQA S.A.C. (pers. comm., Geller). Tilapia populations are already established in the wild from deliberate introductions and from aquaculture, but escaped individuals still present additional pressure. The combination of the risk of escape score (6 of 10) and the invasiveness score (3.5 of 10) results in a “yellow” score for the escapes criterion (4 out of 10) for tilapia production in Peru. However, in this instance, all water leaving the AQA S.A.C. farm exits through a water treatment plant where any escapees will die or be removed. This results in an escape score of 10 out of 10.

Justification of Ranking

Factor 6.1a. Escape risk

The escape of farmed species poses a potential threat to ecosystem integrity, but the impact is often difficult to assess and quantify. So the escapes criterion uses the risk of escape (based on production system biosecurity) to evaluate the likelihood of escape events occurring. American Quality Aquaculture S.A.C. facilities are flow-through with mesh grids on the entry and exit of each raceway, a high perimeter wall (beyond the jumping capabilities of the fish), a main capture net on the exit of the farm, and an additional metal mesh (pers. comm., Geller). No escapees have been observed in the first capture net, and the biosecurity measures are considered adequate (pers. comm., Geller) (IMO 2014). No water is released directly into natural waterways and all water is treated in the on-site water treatment facility and then

released to irrigation canals for agriculture; any fish that make it outside of the growout system would be captured by the water treatment system and die or be removed. The risk of escape in raceways is considered to be moderate, but multiple fail-safe escape prevention measures are in place and AQA S.A.C.'s water treatment plant kills or removes any escapees; thus, the risk of escape is considered to be of no concern (10 out of 10).

Factor 6.1b. Invasiveness

Invasiveness is defined as "…the degree to which an organism is able to spread from the site of primary introduction, to establish a viable population in the ecosystem, to negatively affect biodiversity on the individual, community, or ecosystem level and cause adverse socioeconomic consequence" (Panov et al. 2008). Tilapia is a non-native species in Peru, but tilapia populations are already established in the wild and the risk from newer established populations is low. Tilapia was introduced to Peru in 1962 as feed for paiche in Willow Lake in the San Martin region. Tilapia aquaculture research and cultivation in Peru was initiated in the late 1970s to mid-1980s, and has since expanded both through pond and cage production (Deza 2006) (Halwart et al. 2007) (Hurtado n.d.). The spread of tilapia through irrigation canals has been encouraged for their propensity to eat weeds and clear the channels; tilapia populations are established throughout Peru from the western slopes of the Andes (pers. comm., Fitzsimmons). Tilapia production is prohibited east of the Andes to prevent the spread of this non-native species known for its invasive potential (Supreme Decree No. 011-2006-PRODUCE). So tilapia in Peru are considered only partly established, with the potential to extend the species range or coverage. Tilapia has a high invasive potential, mainly due to the presence of many traits that favor invasion, such as broad environmental tolerance and rapid growth (Diana 2009). Although the ecologically established presence of tilapia in the wild contributes to a higher invasiveness score, the potential ecological impacts of this species, such as the competition for food and habitat if significant escapes did occur, result in a moderate score for invasiveness (5 out of 10).

The farm practices, management, and facilities used by American Quality Aquaculture S.A.C. are successfully designed to eliminate escape opportunities for tilapia, resulting in a low risk of escape. Tilapia are not native to Peru and can cause impacts due to certain life-history characteristics, but are partly established (with the potential to extend the species range), which somewhat diminishes potential effects. The combination of the risk of escape score (10 of 10) and the invasiveness score (3.5 of 10) results in a "green" score for the escapes criterion (10 out of 10) for tilapia production in Peru.

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	6.00	
C7 Disease; pathogen and parasite Final Score	**6.00**	**YELLOW**
Critical?	**NO**	

Summary

There have been no diseases reported by AQA S.A.C. The farm operates using preventative disease management strategies including monitoring stress levels, maintaining high water quality, and using optimal stocking densities. The absence of disease on the farm and the lack of connection between aquaculture production and wild, native populations nearly eliminate the risk of disease transmission; there is no evidence of transfer to wild populations or amplification of naturally occurring pathogens. The disease criterion score is a moderate 6 out of 10.

Justification of Ranking

Aquaculture operations have the potential to increase pathogens and parasites in wild populations through amplification and transfer, depending on the nature of the production system. American Quality Aquaculture S.A.C. reports no problems with disease throughout the production cycle (pers. comm., Favre) (pers. comm., Geller). The fish are constantly monitored for condition in order to prevent the spread of disease within and outside the operations (AQA S.A.C. 2015) (pers. comm., Geller) (IMO 2014). No chemical treatments are permitted under the Whole Foods standards, so preventative health management and monitoring procedures are strictly adhered to (AQA S.A.C. 2015) (IMO 2014) (WFM 2014). Health and chemical management practices are consistent for WFM and non-WFM fish (with the exception of the use of methyl testosterone on non-WFM fish). No effluent is released directly into natural waterways; rather, it is used for irrigation. The farm also has the ability to retain water if a disease outbreak were to occur, due to the use of an on-farm water treatment facility. Although there have been no disease events reported for Whole Foods audit purposes, the system is still open to pathogens and parasites, because it operates as a flow-through raceway. Therefore it is considered that there is still a risk of disease transmission from farmed to wild

fish populations through the amplification and potential retransmission of pathogens or parasites in tilapia production in Peru. Based on the lack of past disease occurrences, the risk is considered to be moderately low, and the overall score for the diseases criterion is 6 (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 thereby avoiding the need for wild capture*

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**

Justification of Ranking

All tilapia raised by American Quality Aquaculture S.A.C. are produced in hatchery facilities owned by the farm and operated as a fully closed life cycle (broodstock are maintained by the farm rather than captured in the wild (pers. comm., Geller)). No wild populations are affected by broodstock, juvenile, or egg harvesting, resulting in a Source of Stock criteria score of 10 of 10.

Factor 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.

Factor 9X Summary

Wildlife and predator mortality parameters	Score	
F9X Wildlife and predator mortality Final Score	**0.00**	**GREEN**
Critical?	NO	

Justification of Ranking

Peruvian tilapia in the U.S. market comes from land-based aquaculture facilities that manage interactions with wildlife and predators using non-lethal deterrents. Predatory birds are present around American Quality Aquaculture S.A.C., but anti-bird nets are placed above the raceways (pers. comm., Geller). Whole Foods standards require the use of passive predator deterrents as a first defense, and there are no reported mortalities of wildlife (deliberate or accidental) associated with AQA S.A.C. tilapia aquaculture (pers. comm., Geller) (IMO 2014). With verified audit data outlining that only non-lethal control methods are used and with no reports of any deaths, this exceptional criterion is not scored (i.e., the penalty score is 0 out of –10).

Factor 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.

Factor 10X Summary

Escape of unintentionally introduced species parameters	Score	
F10X International or trans-waterbody live animal shipments (%)	10.00	
F10X Escape of unintentionally introduced species Final Score	**0.00**	**GREEN**

Justification of Ranking

International or trans-waterbody live animal shipments receive a deduction of 0 out of –10 (high score) because there is zero reliance on shipping of live animals (broodstock) from other countries or water bodies. American Quality Aquaculture S.A.C. operates its own hatchery at the farm site; therefore, there is no risk of unintentionally introducing non-native species as a result of tilapia production in Peru (pers. comm., Geller). The final score for Criterion 10X is therefore 0 out of –10.

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Personal Communications

Jorge Luis Favre, Acuicultura De Huaura S.A.C, March 2014

Dr. Kevin Fitzsimmons, Professor, Research Scientist and Extension Specialist, Department of Soil, Water and Environmental Science, University of Arizona, January 2013

Jonathan Geller, American Quality Aquaculture S.A.C., April 2014

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*	7.5	7.5
Effluent	Yes	2.5	2.5
Locations/habitats	Yes	5	5
Predators and wildlife	Yes	5	5
Chemical use	Yes	5	5
Feed	Yes	5	5
Escapes, animal movements	Yes	5	5
Disease	Yes	2.5	2.5
Source of stock	Yes	2.5	2.5
Other – (e.g. GHG emissions)	No	n/a	n/a
Total			**40**

C1 Data Final Score	4.40	GREEN

Criterion 2: Effluents

Factor 2.1a - Biological waste production score

Protein content of feed (%)	32
eFCR	1.8
Fertilizer N input (kg N/ton fish)	0
Protein content of harvested fish (%)	14
N content factor (fixed)	*0.16*
N input per ton of fish produced (kg)	92.16
N in each ton of fish harvested (kg)	22.40

Waste N produced per ton of fish (kg)	**69.76**

Factor 2.1b - Production System discharge score

Basic production system score	0.8
Adjustment 1 (if applicable)	–0.3
Adjustment 2 (if applicable)	0
Adjustment 3 (if applicable)	0
Discharge (Factor 2.1b) score	**0.5**

5
0 % 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?	Mostly	0.75
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?	Moderately	0.5
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?	Moderately	0.5
5 - Do the control measures cover or prescribe including peak biomass, harvest, sludge disposal, cleaning etc.?	Mostly	0.75
		2.5

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	Yes	1

industry?		
2 - Does monitoring data or other available information demonstrate active enforcement of the control measures?	Moderately	0.5
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?	Moderately	0.5
		3

F2.2 Score (2.2a*2.2b/2.5)	**3**

C2 Effluent Final Score	**5.00**	**YELLOW**
	Critical?	NO

Criterion 3: Habitat

3.1. Habitat conversion and function

F3.1 Score	**6**

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 in appropriate locations, and thereby preventing the future loss of ecosystem services?	Moderately	0.5
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?	Moderately	0.5
		2.5

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	Mostly	0.75

other ecosystem-based management plans articulated in the control measures?		
3 - Does the farm siting or permitting process take account of other farms and their cumulative impacts?	Moderately	0.5
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?	Mostly	0.75
		3.5

F3.2 Score (2.2a*2.2b/2.5)	**3.50**

C3 Habitat Final Score	**5.17**	**YELLOW**
	Critical?	NO

Criterion 4: Evidence or Risk of Chemical Use

Chemical Use parameters	Score	
C4 Chemical Use Score	**8.00**	
C4 Chemical Use Final Score	**8.00**	**GREEN**
Critical?	NO	

Criterion 5: Feed

5.1. Wild Fish Use

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

Fishmeal inclusion level (%)	10
Fishmeal from by-products (%)	25
% FM	7.5
Fish oil inclusion level (%)	0.5
Fish oil from by-products (%)	0
% FO	0.5
Fishmeal yield (%)	22.5
Fish oil yield (%)	5
eFCR	1.8
FIFO fishmeal	0.60
FIFO fish oil	0.18
Greater of the 2 FIFO scores	0.60
FIFO Score	**8.50**

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

SSWF	-6
SSWF Factor	–0.36

F5.1 Wild Fish Use Score	**8.14**

5.2. Net protein Gain or Loss

Protein INPUTS		
Protein content of feed		32
eFCR		1.8
Feed protein from NON-EDIBLE sources (%)		5
Feed protein from EDIBLE CROP soruces (%)		80
Protein OUTPUTS		
Protein content of whole harvested fish (%)		14
Edible yield of harvested fish (%)		32.5
Non-edible by-products from harvested fish used for other food production		50
Protein IN		41.54
Protein OUT		9.275
Net protein gain or loss (%)		–77.672
	Critical?	NO
F5.2 Net protein Score	**2.00**	

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 (%)	10.5
eFCR	1.8
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)	4.92

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

Inclusion level of crop feed ingredients (%)	89
Inclusion level of land animal products (%)	0
Conversion ratio of crop ingedients to land animal products	*2.88*
eFCR	1.8
Average yield of major feed ingredient crops (t/ha)	*2.64*
Land area appropriated (ha per ton of fish)	0.61

Value (Ocean + Land Area)	**5.52**

F5.3 Feed Footprint Score	8.00

C5 Feed Final Score	6.57	YELLOW
	Critical?	NO

Criterion 6: Escapes

Final C6 Score	10.00	GREEN
	Critical?	NO

Criterion 7: Diseases

Pathogen and parasite parameters	Score	
C7 Biosecurity	6.00	
C7 Disease; pathogen and parasite Final Score	**6.00**	**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 and predator mortalities

Wildlife and predator mortality parameters	Score	
F9X Wildlife and Predator Final Score	**0.00**	**GREEN**
Critical?	NO	

Exceptional Factor 10X: Escape of unintentionally introduced species

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Escape of unintentionally introduced species parameters	Score	
F10Xa International or trans-waterbody live animal shipments (%)	10.00	
F10X Escape of unintentionally introduced species Final Score	**0.00**	
		GREEN