Monterey Bay Aquarium Seafood Watch®

Striped Bass

Morone saxitilis

Mexico

Marine Net Pens

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Final Seafood Recommendation

Striped Bass from Mexico, farmed in marine net pens.

Criterion	Score	Rank	Critical?
C1 Data	7.95	GREEN	NO
C2 Effluent	8.00	GREEN	NO
C3 Habitat	6.27	YELLOW	NO
C4 Chemicals	8.00	GREEN	NO
C5 Feed	5.52	YELLOW	NO
C6 Escapes	5.00	YELLOW	NO
C7 Disease	4.00	YELLOW	NO
C8X Source	0.00	GREEN	NO
C9X Wildlife mortalities	-2.00	GREEN	NO
C10X Introduced species escape	0.00	GREEN	
Total	**42.74**		
Final score (0-10)	**6.11**		

OVERALL RANKING

Final Score	6.11
Initial rank	YELLOW
Red criteria	0
Interim rank	YELLOW
Critical Criteria?	NO

FINAL RANK
YELLOW

Scoring note – scores range from 0 to 10, where 0 indicates very poor performance and 10 indicates the aquaculture operations have no significant impact. Criteria 8X, 9X, and 10X are exceptional criteria, where 0 indicates no impact and a deduction of -10 reflects a very significant impact. Two or more red criteria result in a red Avoid final recommendation.

Summary

The final numerical score for striped bass farmed in marine net pens in Mexico is 6.11 out of 10, and with no red criteria, the final ranking is yellow and a recommendation of Good Alternative.

Executive Summary

There is currently only one marine striped bass (*Morone saxatilis)* producer in Mexico (and indeed on the entire west coast of the Americas), and the farm (Pacifico Aquaculture) is based in Ensenada in Baja California. This assessment and report therefore rely heavily on this company. The striped bass species produced in Mexico (*Morone saxatilis)* is not to be confused with the hybrid striped bass (hybrid of *M. saxatilis* and its congener *M. chrysops*, known as Palmetto Bass or Sunshine Bass) that is commonly grown in freshwater in other locations in the Americas.

The grow-out site consists of floating net pens on the eastern (lee) side of Isla Todos Santos, a small group of islands approximately 11 miles offshore from Ensenada in the state of Baja California in the northwest of Mexico. The company operates a freshwater hatchery on the mainland in Ensenada and supplies all its fry. Total production in 2018 was 545 metric tons (MT) with a large increase to a projected harvest of 1,200 MT in 2019; all is exported to the United States.

This Seafood Watch assessment involves several different criteria covering impacts associated with effluent, habitat, wildlife and predator interactions, chemical use, feed use, escapes, the introduction of secondary organisms, disease, the source of stock, and general data availability.[1]

Due to the single-producer nature of the industry, and the company's commitment to data provision, the data availability on all aspects of the production was good. Information on the broader Mexican regulatory systems for aquaculture and relevant academic studies in the region are somewhat limited, particularly regarding the rapidly expanding production, but overall, there is currently a good understanding of the site's practices and potential impacts, and the score for Criterion 1 – Data is 8.0 out of 10.

For soluble nutrients in the water column, the available monitoring data from Pacifico Aquaculture is supported by academic studies on net pen aquaculture in exposed locations, indicating that impacts beyond the immediate farm area are highly unlikely (see Criterion 3 – Habitat for impacts within the farm area). For benthic impacts of settling particulate wastes, the available monitoring data appear to support the comprehensive independent modeling assessment, which concludes that while there will be some change and degradation to benthic communities in the immediate farm area, it is highly unlikely that there will be significant impacts beyond the immediate farm area. With little potential for cumulative impacts due to the isolated nature of the site, overall, the data show no evidence that effluent discharges cause or contribute to cumulative impacts at the waterbody or regional scale, and the final score for Criterion 2 – Effluent is 8 out of 10.

[1] The full Seafood Watch Aquaculture Standard is available at: http://www.seafoodwatch.org/seafood-recommendations/our-standards

The independent benthic footprint assessments undertaken for two of the industry's three production modules indicate that despite their differing hydrographic conditions, the seabed impacts are likely to be moderate, and limited to a small area around the net pens. This is supported by the available monitoring data from the largest (south) module, and any such habitat impacts are considered rapidly reversible. Despite the limited requirements in Mexican regulations regarding potential cumulative impacts of multiple farms, the company's practical measures in terms of site selection and current scale of production mean there is a negligible risk of cumulative impacts with other aquaculture operations. The final score for Criterion 3 – Habitat is 6.27 out of 10.

There are no Mexican regulations limiting the volume or frequency of antibiotic use, but data from the last three years show that, on average, the industry has administered less than one antibiotic treatment per year (and less than once per production cycle of 24 to 30 months); treatments are restricted to individual pens (rather than treating the entire site). Although there are some concerns regarding reduced efficacy of some antibiotic treatments, there is no evidence that the farm's antibiotic use led to its development, and the ongoing independent testing ensures only effective antibiotics are used when a bacterial disease necessitates treatment. The types of antibiotic used are listed as highly important for human medicine by the World Health Organization, but as antibiotic use is less than once per production cycle, the final score for Criterion 4 – Chemical Use is 8 out of 10.

Detailed feed data were provided by Pacifico Aquaculture and their feed manufacturer (EWOS-Cargill), and showed that although inclusion levels of fishmeal and fish oil are relatively high (34% and 14% respectively), more than three-quarters of the fishmeal and all of the fish oil come from trimmings and byproduct sources. With an economic feed conversion ratio of 2.01, the Feed Fish Efficiency Ratio (i.e., an indicator of the amount of wild fish used to produce farmed fish) is 0.63 based on fishmeal. The feed protein content for striped bass is high (43%), and considering the use of fishmeal from whole fish, in addition to edible crop protein ingredients, there is a net loss of 42.0% of edible protein. With high total levels of marine ingredients (including by-products), the feed footprint area is also high at 25.5 hectares (ha) per ton of striped bass production. Overall, the final score for Criterion 5 – Feed is 5.52 out of 10.

Striped bass are a non-native species in the Pacific; they were introduced into California in the 1880s and the only established population is in San Francisco Bay. The industry's single producer has best management practices in place within their Containment Management System (CMS) and has not had any reported escape events; however, the open net pen production system and offshore site is still considered to represent a high risk of escape (of both large scale and smaller chronic trickle losses) from natural causes or human error. In the event of an escape from the Isla Todos Santos site, the nearest suitable freshwater habitats for reproduction is more than 550 miles north (i.e., San Francisco Bay). Therefore, successful reproduction in the event of an escape is considered highly unlikely. Only occasional reports of anglers catching striped bass on Southern California coasts are available, both before and after the farm was established. Considering the predatory nature of the species, there is a likelihood of some impact on native species in the immediate farm area in the event of a large escape, although it is not known to what extent, due to the likely rapid dispersion from the offshore farming location. Overall, the combination of escape risk and potential impacts result in a final score of 5 out of 10.

The State Committee on Health and Safety of Baja California (*Comité Estatal de Sanidad e Inocuidad De Baja California A.C.* – CESAIBC) considers striped bass to be susceptible to two notifiable diseases listed by the World Organization for Animal Health, OIE (Red Sea Bream Iridovirus (RSIV) and Viral Hemorrhagic Septicemia (VHS). These diseases have not been detected in routine (independent) monitoring. The average monthly mortality in 2018 was 2.82%, but no classification records are available to indicate what proportion of mortality is due to infectious diseases. The primary pathogens treated (with antibiotics) from 2016 to 2018 were *Tenacibaculum maritimum*, *Vibrio* (species not identified) and *Flexibacter columnaris.* Various parasites have also been noted as requiring treatment (but environmentally benign chemicals have been used). There are very little data with which to understand potential impacts on wild fish in the area, but since there are considered to be some disease-related mortalities on the farm and the production system is open to the introduction and discharge of pathogens and parasites, there is an inherent risk of amplification and retransmission to native fish. Therefore, the final score for Criterion 7 – Disease is a moderate 4 out of 10.

Pacifico Aquaculture has a freshwater hatchery at the shore base in the town of Ensenada. The broodstock are of farm origin, having been domesticated from strains originally imported from the east coast of the United States (Delaware). The marine site at Isla Todos Santos has a separate array of smaller net pens for the culture of broodstock before they are transferred to the hatchery for spawning. With this system, Mexican striped bass production does not use any wild broodstock or fry for its operations. The score for Criterion 8X – Source of Stock is therefore a deduction of 0 out of –10.

The Isla Todos Santos site is considered of high ecological importance with several endemic species. In addition to the net pen arrays adjacent to the shore, the company operates a small shore base on the southern island (Todos Santos Sur). The original EIA report identifies the colonies of seals, sea lions and large numbers of birds as the primary concern for interaction with the farm, but the company has a comprehensive written policy of exclusion, which was observed in practice with seal and bird nets on all net pens. Though impossible to verify (there do not appear to be any official data), the company reports no accidental (e.g., entanglement) or deliberate mortalities. The dominant impact to wildlife species on the island or in its waters has been shown to be the historical introduction of rabbits and cats, and the current shore-based activities are considered to have a minimal impact on the island's flora and fauna. Overall, the farm is in an area of high ecological value, and inevitably interacts to some extent with marine mammals and birds; however, preventive measures appear sufficient to limit any mortalities to exceptional cases. The final numerical score for Criterion 9X – Wildlife Mortalities is –2 out of –10.

Striped bass are non-native in the Pacific, and although there is an established population in San Francisco Bay with historic active stocking of hatchery raised fish, Pacifico Aquaculture originally imported juveniles and broodstock from a selective breeding program in Delaware in the United States. The company now has a broodstock unit at the Isla Todos Santos site and a freshwater hatchery established on the mainland in Ensenada. Movements of fish between these two locations on either side of Ensenada Bay are considered to be within the same waterbody, and there are also quarantine facilities at the hatchery. Production is now considered independent of international or trans-waterbody movements of fish, and the final numerical score for Criterion 10X – Escape of Secondary Species is a deduction of 0 out of –10.

Overall, the final numerical score for striped bass farmed in net pens in Mexico is 6.11 out of 10, and with no red "High" concern criteria, the final recommendation is a yellow "Good Alternative."

Table of Contents

Introduction

Scope of the analysis and ensuing recommendation

Species
Striped bass – *Morone saxatilis*
(Note: this is not hybrid striped bass, the more commonly farmed hybridization of *M. saxatilis* and its congener *M. chrysops*, known as Palmetto Bass or Sunshine Bass)

Geographic Coverage
Mexico

Production Method(s)
Marine net pens

Species Overview

Brief overview of the species
According to NOAA (2015):

- Striped bass are native to the Atlantic Coast of North America, ranging from the St. Lawrence River in Canada to St. John's River in Florida. They are anadromous, meaning they live in the ocean but return to freshwater to spawn. Larvae and postlarvae drift downstream toward nursery areas located in river deltas and the inland portions of the coastal sounds and estuaries. Juveniles typically remain in estuaries for 2 to 4 years and then migrate out to the ocean. Striped bass spend most of their adult life in coastal estuaries or the ocean and migrate north and south seasonally and ascend rivers to spawn in the spring.

According to the California Department of Fish and Wildlife (formerly "Game") (CDFG 2001)

- Striped bass was introduced to the Pacific coast of the US in 1879. The only major population is in the San Francisco Bay and delta, approximately 550 miles north of the Pacifico Aquaculture farm site in northern Mexico. This population has been supported by California Department of Fish and Wildlife with active stocking of millions of hatchery-raised fish that continued until the year 2000.

Production system
The single producer, Pacifico Aquaculture, operates a land-based freshwater hatchery in Ensenada, Mexico. Fingerling juveniles, at approximately five grams (g), are moved from the hatchery to small-mesh cages in seawater at offshore sites at Isla Todos Santos, 11 miles off the coast from Ensenada. Growout occurs in floating net pens until harvest and takes an average of 24 to 30 months (although this time will be reduced as the company's use of larger fingerlings increases).

The sites are in the lee (eastern side) of the largest island of the Isla Todos Santos group, with three modules of net pens located over a distance of 2.2 miles (Figure 1); the north module (9 pens) is situated in water depth of 25 to 35 m over a moderately sloping seabed; the central (10 pens) and south modules (24 pens) are situated in water depth of approximately 30 to 100 m over a steeply sloping seabed on the edge of a submarine canyon at 120 m depth to the east of the site. The sites are supported by workboats from Ensenada, and by a small shore base on the island.

Since the primary environmental impacts are considered to occur at the sea site (as opposed to the land-based hatchery), this assessment focuses on the growout phase of production at Isla Todos Santos.

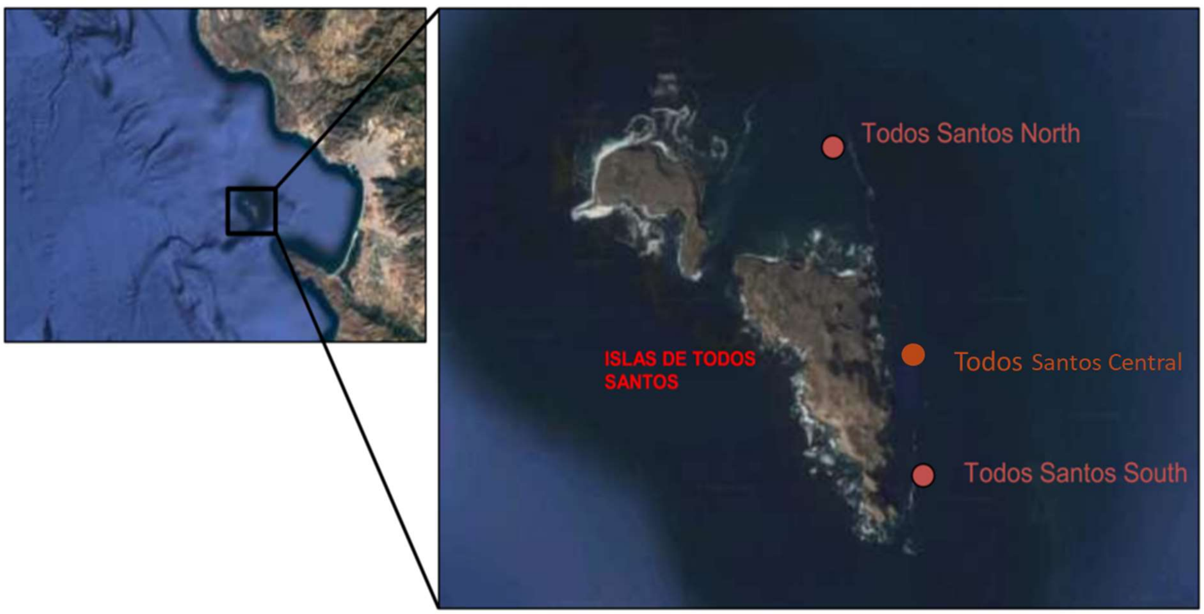

Figure 1. Site location maps. The left image shows Ensenada Bay and the surrounding coast, with the location of the Isla Todos Santos in the box. The right image shows the islands and the locations of the three net pen modules. Images provided by Pacifico Aquaculture from (AMSL 2018) Image copied from AMS (2018a).

Production Statistics

Pacifico Aquaculture is the only marine-sited striped bass farm in the Americas. It must be noted that this is not the hybrid variant of striped bass (i.e., *M. saxatilis* X *M. chrysops*, known as Palmetto and Sunshine bass) that is grown in significant volumes in freshwater. Pacifico Aquaculture previously produced white seabass (*Atractoscion nobilis*) at the Isla Todos Santos site, but transitioned to striped bass through 2015 with the final harvests of white seabass in 2016. Production figures for both species are shown in Figure 2. The volume of striped bass increased from 2.6 metric tons (MT) in 2013 to 632 MT in 2017 but declined slightly to 545 MT in 2018. The predicted harvest for 2019 (as of October 2019) is a large increase to 1,200 MT with an approximate monthly harvest of 100 MT.

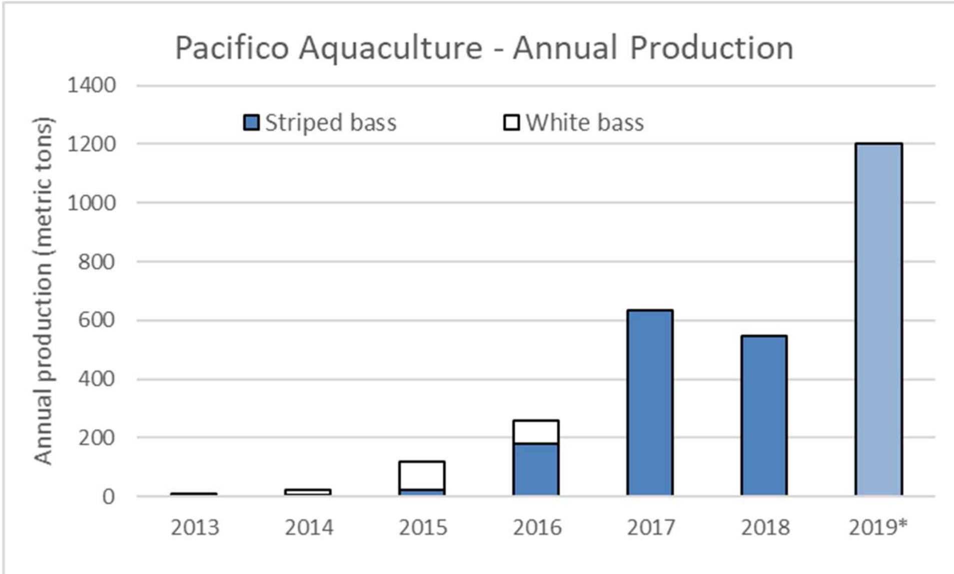

Figure 2. Annual production of white seabass and striped bass at Pacifico Aquaculture, from 2013 to 2019 (note the 2019 figure is an estimate reported in October 2019). Data provided by the company.

Import and Export Sources and Statistics
All striped bass produced in Mexico is exported to the United States.

Common and Market Names

Scientific Name	*Morone saxatilis*
Common Name	Striped bass
Spanish	Lobina rayada
Sushi	Suzuki

Product forms
Exports are of whole gutted fish, but the fish are commonly served as sushi.

Analysis

Scoring guide

- With the exception of the exceptional criteria (8X, 9X and 10X), all scores result in a zero to ten final score for the criterion and the overall final rating. A zero score indicates poor performance, while a score of ten indicates high performance. In contrast, the three exceptional criteria result in negative scores from zero to minus ten, and in these cases zero indicates no negative impact.
- The full Seafood Watch Aquaculture Standard that the following scores relate to are available on the Seafood Watch website. http://www.seafoodwatch.org/seafood-recommendations/our-standards

Criterion 1: Data quality and availability

Impact, unit of sustainability and principle

- Impact: poor data quality and availability, limits the ability to assess and understand the impacts of aquaculture production. It also does not enable informed choices for seafood purchasers, nor enable businesses to be held accountable for their impacts.
- Sustainability unit: the ability to make a robust sustainability assessment.
- Principle: having robust and up-to-date information on production practices and their impacts publicly available.

Criterion 1 Summary

Data Category	Data Quality	Score (0-10)
Industry or production statistics	10	10
Management	7.5	7.5
Effluent	7.5	7.5
Habitat	7.5	7.5
Chemical use	7.5	7.5
Feed	10	10
Escapes	5	5
Disease	5	5
Source of stock	10	10
Predators and wildlife	7.5	7.5
Introduced species	10	10
Other – (e.g. GHG emissions)	Not Applicable	n/a
Total		**87.5**

C1 Data Final Score (0-10)	**7.95**	**GREEN**

Brief Summary

Due to the single-producer nature of the industry, and the company's commitment to data provision, the data availability on all aspects of the production was good. Information on the broader Mexican regulatory systems for aquaculture and relevant academic studies in the region are somewhat limited, particularly in regard to the rapidly expanding production, but overall, there is a currently a good understanding of the site's practices and potential impacts, and the score for Criterion 1 – Data is 7.95 out of 10.

Justification of Rating

The single-producer nature of the industry means that detailed information was provided by the Pacifico Aquaculture management on all aspects of production. External data sources from the region and more broadly from Mexico were limited, but some useful academic studies are available as described below. A site visit was made in May 2016, including the hatchery and offices in Ensenada and the marine site at Isla Todos Santos. All management and monitoring documents were presented at the site and made available electronically post-visit.

Industry and Production Statistics
The industry consists of a single producer company. This company, Pacifico Aquaculture, provided basic information of production volumes, site locations, site characteristics, and the various production characteristics and data considered in the following sections. This was verified during a site visit and scrutiny of various company records. Other sources of production data include the Mexican *Comisión Nacional de Acuacultura y Pesca* (CONAPESCA), which publishes an annual yearbook of fisheries and aquaculture statistics by species and region in Mexico (*Estadistíca Pesquera y Acuícola de México*).[2] Accessed most recently in October 2019, the latest version available has data through 2017, although there is a discrepancy with the reported harvest data (695 MT) compared to the farm records (632 MT) for 2017. In addition, State Committee on Health and Safety in Baja California (*Comité Estatal de Sanidad e Inocuidad De Baja California A.C.,* CESAIBC) has data sheets on the aquaculture species produced and approximate site locations, but annual production figures are only available up to 2015. With specific annual and monthly harvest figures from Pacifico Aquaculture, the data score for the Industry and Production statistics is 10 out of 10.

Management and Regulations
Pacifico Aquaculture provided all information requested on the company's production and management practices. The company has three manuals on best management practices:

- Pacifico Aquaculture Environmental Best Management Practices
- Pacifico Aquaculture Best Management Practices for the Use of Aquaculture Drugs and Chemicals
- Pacifico Aquaculture Best Feed Management Practices for Feeds and Feeding

Detailed information on aquaculture laws, regulations, rules, and decrees is available (in Spanish) from the CONAPESCA website,[3] particularly:

- Mexican Official Standards Fisheries and Aquaculture (*Normas Oficiales Mexicanas Pesqueras y Acuícolas)*
- Mexican Official Standards Fisheries - Aquaculture Health (*Normas Oficiales Mexicanas Pesqueras (Sanidad Acuícola)*
- Mexican Official Standards in Environmental Protection – Ecological (*Normas Oficiales Mexicanas en Materia de Protección al Ambiente (Ecológicas)*
- Mexican Official Standards for Seafood *(Normas Oficiales Mexicanas de Pescados y Mariscos)*

[2] Estadistíca Pesquera y Acuícola de México – http://www.gob.mx/conapesca/documentos/estadistica-pesquera-y-acuicola-de-mexico
[3] http://www.conapesca.gob.mx/

A review of Mexican aquaculture legislation is also available from the FAO country overview with the Spanish version updated more recently (FAO 2013) than the English version (2004). The Mexican law on Sustainable Fishing and Aquaculture of 2015 (*Ley General de Pesca y Acuacultura Sustentables* DOF-04-06-2015) is available on Conapesca's website.[4] In addition, state-specific regulations apply; for example, the 2008 Law on Fisheries and Aquaculture in the State of Baja California (*Ley de Pesca y Acuacultura Sustentables para el Estado de Baja California*) is available from Baja California's Secretariat of Fisheries and Aquaculture (*Secretaria de Pesca y Acuicultura* – SEPESCA[5]). The full requirements of the Mexican regulations and their enforcement are challenging to understand fully but considering the access to the company's management plans and records, the data score is 7.5 out of 10.

Effluent and Habitat

Pacifico Aquaculture provided a range of information relating to the fate of soluble and particulate effluent wastes form the Isla Todos Santos site. For soluble nutrients, monitoring data from two sampling periods in April and June 2017 were provided for 13 parameters (biological oxygen demand, chemical oxygen demand, total suspended solids, sulfur, copper, nitrate, nitrite, ammonia, total nitrogen, phosphate, and total phosphorus). Samples were from two transects at the cage edge and 30 m (at the larger southern module), and from two reference sites. Previous data from 2016 were also provided, but due to changes in the net pen numbering system and the module layouts, these earlier data merit lower confidence in accuracy.

The company provided two comprehensive independent benthic modeling assessments carried out by Anderson Marine Surveys Ltd. for the South and North modules. This provided information on the predicted benthic footprint at different production intensities (in terms of peak biomass). In addition, the company provided benthic monitoring results from annual surveys in 2017 and 2018 with 15 parameters (water content, organic matter, total carbon, biological oxygen demand, pH, sulfur, oxygen reduction potential, total nitrogen, total phosphorous, and the metals: zinc, cadmium, lead, copper, mercury, and iron). Samples were taken at the same two transects at 0 m and 30 m from the edge of the net pens with two reference points.

Pacifico Aquaculture provided a copy of its sampling plan for the water column and benthic locations. In addition, there is a large volume of scientific literature relating to the fate and potential impact of soluble nutrients in the water column from net pen fish farms e.g., (Price et al. 2015) (Svåsand et al. 2017) (Keeley et al. 2013, 2015). Although the data were provided by the company and cannot be directly verified, the data are considered to give a reliable representation of the operations impacts and the score for the Effluent and Habitat Criteria are both 7.5 out of 10.

Chemical Use

[4] https://www.gob.mx/conapesca/documentos/ley-general-de-pesca-y-acuacultura-sustentables

[5] http://www.sepescabc.gob.mx/x/marcoLegal/

Pacifico Aquaculture provided treatment records from 2016 to 2018 for antibiotics and other non-therapeutic treatments (e.g., immunostimulants and vitamin supplements), including the date, fish batch number, net pen module and net pen reference number, type of antibiotic prescribed, the dose and duration, the treatment method, and the location (i.e., hatchery or offshore site). Examples of recent prescriptions and results of antibiotic efficacy testing were also provided for 2018. The records cannot be independently verified, but sufficient detail is available to provide reliable representation of the farm operations. The data score for chemical use is 7.5 out of 10.

Feed

EWOS Canada (Cargill Animal Nutrition) and Pacifico Aquaculture provided detailed data on the feed characteristics, key ingredients used, and feeding performance necessary for this assessment. Marine ingredient inclusion levels, proportions from by-products, species and fisheries were provided, and all major crop ingredients and inclusion levels were listed with protein contents and ingredient labels where relevant.

Detailed production records showing monthly feed inputs and harvests for recent production cycles harvested to date, allowed a calculation of the economic Feed Conversion Ratio (eFCR), and published literature provided remaining values, e.g., a whole-body protein content for striped bass (Karahadian et al. 1995), and a gutted weight conversion (FAO 1997). All necessary data points were provided with supporting data as necessary. The data score for feed is 10 out of 10.

Escapes

Pacifico Aquaculture provided management plans and evidence of best practices for escape prevention, in addition to escape monitoring and recording procedures. Since there have been no reported escapes, there were no specific escape records (blank reporting forms were available). Academic studies in other net pen production systems note the potential for undetected or unreported trickle losses from these systems (Skilbrei et al. 2015).

A variety of academic literature was reviewed regarding the fate and potential impact of escaping striped bass at the Isla Todos Santos site. This was supported by reference and monitoring information from the California Department of Fish and Wildlife, and by personal communication with their striped bass specialist (Marty Gingras). There is considered to be a good understanding of the fate of any escapes, but there is inevitably some uncertainty regarding escapes from open net pen systems, and the data score is 5 out of 10.

Disease

Mexico's State Committee on Aquaculture Health and Safety Baja California (*Comité Estatal de Sanidad Acuícola e Inocuidad de Baja California*, CESAIBC) has a factsheet on striped bass in Mexico specific to the industry's sole producer's site. It provides basic information on diseases of striped bass, and specifically lists the notifiable diseases specified by the World Organisation for Animal Health (OIE). Pacifico Aquaculture provided fish health monitoring data consistent with these notifiable diseases, in addition to mortality numbers and veterinary treatment records. There is little information to understand any potential impacts to wild fish should a disease outbreak occur, and given the rapidly increasing production volumes, there remains some uncertainty. The data score is 5 out of 10.

Source of Stock

The single hatchery in Ensenada was toured as part of the site visit. The history of the broodstock was provided, including their domestication status (i.e., they were hatchery raised). The data score is 10 out of 10.

Wildlife and Predator Mortalities

Pacifico Aquaculture provided management plans and notes of regulations relating to predator control. The EIA report includes information on species at the site and the most likely to interact with it. Some management aspects were visible during the site visit (e.g., predator nets), as was the presence of various species of marine mammal and birds at the Isla Todos Santos site. A limited number of academic articles, e.g., (Donlan et al. 2000) and (Arrellano-Peralta and Medrano-Gonzalez 2015) provide a background to the species of importance in the region, at the marine site, and on the Isla Todos Santos themselves. A local conservation organization (*Grupo de Ecologia y Conservacion de las Isla*) could not be contacted during the assessment. While the company reported a lack of lethal predator interactions (either deliberate or accidental), this is largely impossible to verify. No public data regarding interactions or mortalities exist. The data score is therefore 7.5 out of 10.

Escape of Secondary Species

Pacifico Aquaculture provided information on the initial movement of broodstock from the United States into Mexico and the subsequent development of broodstock units at the marine site and at the hatchery. Full data on movements of fish between these two locations within the same waterbody (the bay of Ensenada) were available. The data score is 10 out of 10.

Conclusions and Final Score

The final numerical score for Criterion 1 – Data is 7.95 out of 10.

Criterion 2: Effluent

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: not allowing effluent discharges to exceed, or contribute to exceeding, the carrying capacity of receiving waters at the local or regional level.

Criterion 2 Summary

Effluent Evidence-Based Assessment

C2 Effluent Final Score (0-10)	**8**	**GREEN**

Brief Summary

The Mexican striped bass industry is currently limited to a single producer company. For soluble nutrients in the water column, the available monitoring data from Pacifico Aquaculture is supported by academic studies on net pen aquaculture in exposed locations and indicate impacts beyond the immediate farm area are highly unlikely (see Criterion 3 – Habitat for impacts within the farm area). For benthic impacts of settling particulate wastes, the available monitoring data appear to support the comprehensive independent modeling assessment, which concludes that although there will be some change and degradation to benthic communities in the immediate farm area, it is highly unlikely there will be significant impacts beyond the immediate farm area. With little potential for cumulative impacts due to the isolated nature of the site, overall, the data show no evidence that effluent discharges cause or contribute to cumulative impacts at the waterbody or regional scale, and the final score for Criterion 2 – Effluent is 8 out of 10.

Justification of Rating

The Seafood Watch Effluent Criterion considers impacts of farm wastes beyond the immediate farm area or outside a regulatory allowable zone of effect (AZE), and the subsequent Habitat Criterion considers impacts within the immediate farm area. Though the two criteria cover different impact locations, there is inevitably some overlap between them in terms of monitoring data and scientific studies of the real and/or potential impacts of aquaculture. Most of this information will be presented in this Effluent Criterion, with the intent of minimizing (but not entirely avoiding) replication in the Habitat Criterion.

With good monitoring data both in the water column and seabed, in addition to benthic footprint and impact assessments at two of the three net pen modules, the data score for the Effluent category is 7.5 out of 10 in Criterion 1 – Data. As such, the Evidence-Based Assessment method in the Seafood Watch Aquaculture Standard has been used.

There is a substantial amount of literature on the physical, chemical, and biological implications of nutrient waste discharges from net pen fish farms, and reviews such as Price et al. (2015) provide a useful summary; for example, they conclude that modern operating conditions have minimized the impact of individual fish farms on marine water quality; effects on dissolved oxygen and turbidity have been largely eliminated through better management, and near-field nutrient enrichment to the water column is usually not detectable beyond 100 m of the farm (when formulated feeds are used, feed waste is minimized, and farms are properly sited in deep waters with flushing currents) (Price et al. 2015). However, when sited nearshore, extra caution should be taken to manage farm location, size, biomass, feeding protocols, orientation with respect to prevailing currents, and water depth to minimize near- and far-field impacts.

Farm site

The Mexican striped bass industry is currently limited to a single producer company. Production facilities are located adjacent to Isla Todos Santos in Ensenada Bay. The Isla Todos Santos production area has three production modules: north, central, and south, with their locations relative to the islands and the wider region mapped in Figure 1. Production is dominated in the southern module of 24 cages. An independent survey and analysis of the north and south locations (conducted by Anderson Marine Surveys Ltd; AMS) showed current velocities were moderately high for an open ocean location, with maximum recorded surface velocities of 0.41 m/s and 0.28 m/s at the north and south modules respectively.

The producer company, Pacifico Aquaculture, performs a comprehensive water quality and benthic impact analysis twice per year. For example, Figure 3 shows the sampling locations at the larger south module, which are based on the current characteristics identified in the AMS analysis (i.e., any nutrient plume is anticipated to move in a NE direction from the net pens). Fewer data were available from the newly positioned north module, so with consideration of the scale of production at the south module, this assessment focuses on the large south module and refers to the other modules only when relevant. Samples were taken on two SW-NE transects (T1 and T2) with two sampling locations on each at the cage edge (S1 and S3) and at 30 m horizontally (S2 and S4). These samples can be compared to reference locations R1 and R2 located “upstream” of the anticipated effluent plume.

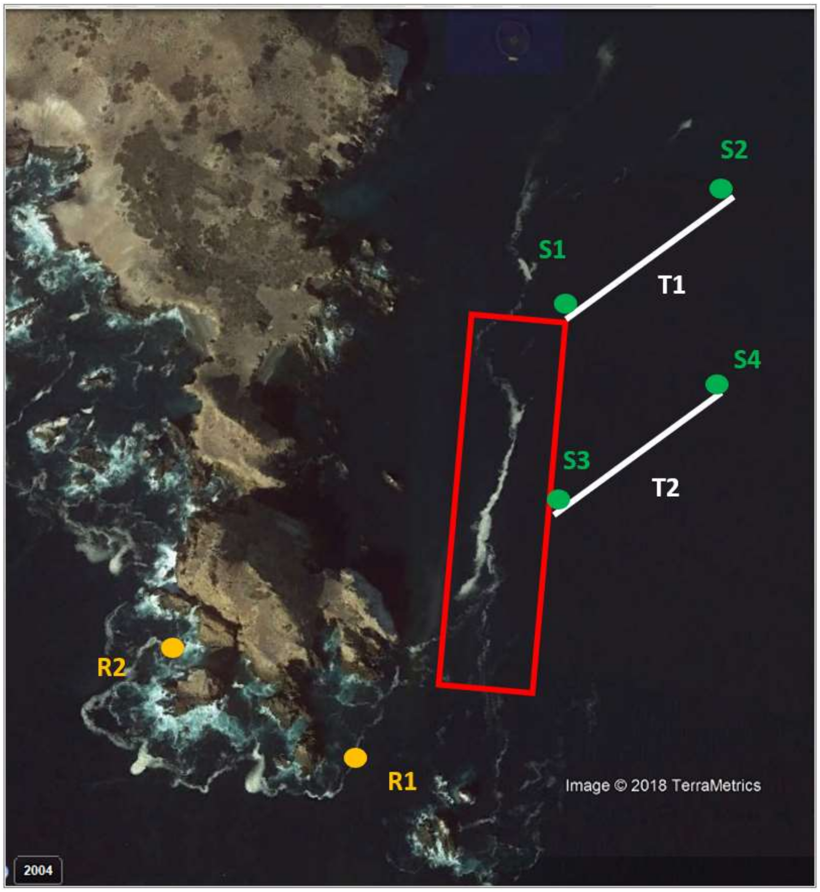

***Figure 3*.** Sampling locations for the southern module. The red box shows the proposed location and outline of the net pen array that was used by Anderson Marine to predict benthic impacts before production in this location began (the southern-most net pen in the previous site configuration can be seen at the top of this image before being moved into the area defined by the red box). The Green S1-S4 dots are sampling locations used during production and the orange R1-R2 dots are the reference locations. Image provided by Pacifico Aquaculture from the Anderson Marine report (AMS 2018) Image copied from AMS (2018a).

<u>Soluble nutrients in the water column</u>

In order to identify potential impacts beyond the immediate farm area (i.e., the area of relevance to this Effluent Criterion), the available data at 0 and 30 m from the net pens (horizontal distances) are presented in the absence of specific monitoring data distant to the site. Monitoring data for key parameters from the larger southern module are shown in Figure 4 below, with error bars of +/- one standard deviation. Samples were taken at the net-pen edge (0 m) and at 30 m as shown in Figure 3 above (note the net pens cannot be seen in Figure 3 because the image was taken as part of Anderson Marine's modeling assessment of potential impacts prior to production at that location). Data are pooled from two sampling periods (April and June 2017). As noted in Criterion 1 – Data, sampling records for other parameters were made available (i.e., sulfur, copper, nitrate, nitrite, phosphate), but these did not show any clear pattern of variation and have been omitted in this analysis for clarity.

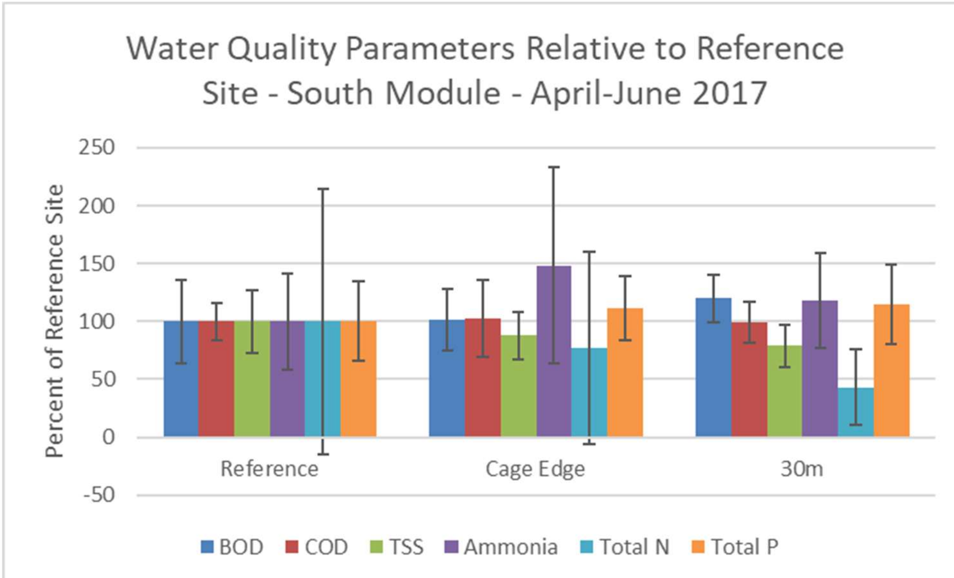

Figure 4. Soluble nutrient monitoring at the south module cage edge and at 30 m, relative to reference sites for key parameters. Error bars show standard deviation. Data provided by Pacifico Aquaculture. BOD = biological oxygen demand, COD = chemical oxygen demand, TSS = total suspended solids, Total N = total nitrogen, Total P = total phosphorous.

As noted above, Price at el. (2015) in their review of marine net pen fish farms, concluded that a near-field nutrient enrichment to the water column is usually not detectable beyond 100 m of the farm (Price at el. 2015). Considering the high energy nature of the Isla Todos Santos site, it is not surprising that there is little clear evidence of patterns in the increased detection of nutrients, other than for an increase in ammonia at the cage edge, which had reduced substantially by 30 m from the cage. For all parameters included in Figure 4, there is no statistical significance in the difference between any of the values. An indicator of the challenge in measuring these parameters is the lower levels of suspended solids (TSS) and total nitrogen at the farm locations compared to the reference site. In the case of total nitrogen, the level at 30 m from the net pens is nearly 60% lower than the reference point. The specific reason for this is unclear.

Figure 5 shows the same data in absolute values with error bars of +/- one standard deviation and shows that any patterns of nutrient concentrations at the site are within the range of sampling variability compared to the reference site.

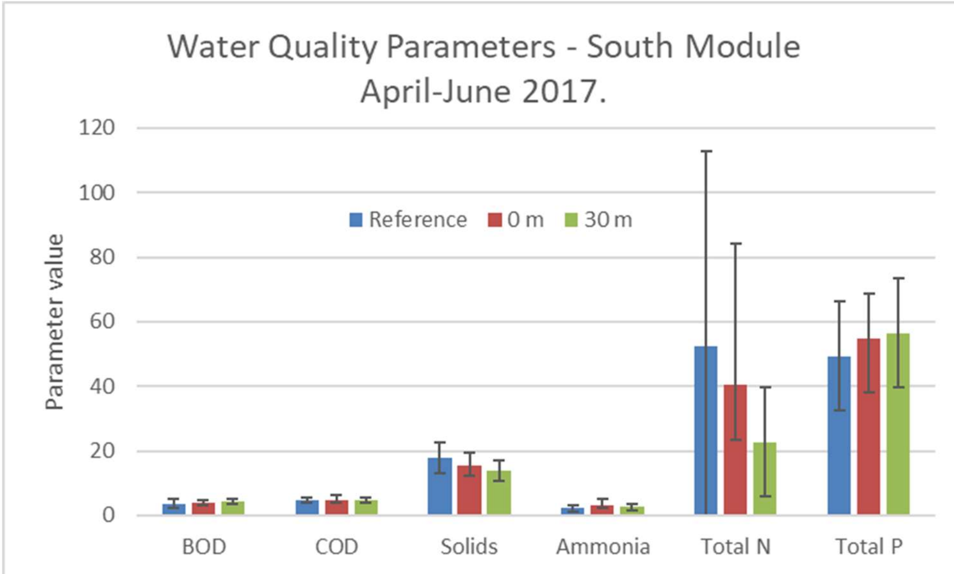

Figure 5. Soluble nutrient monitoring absolute data values at the south module cage edge, 30 m and at the reference sites for key parameters with +/- one standard deviation bars. BOD, COD and suspended solid values are in mg O_2/l, and ammonia, total N and total P are in µg/l. Data provided by Pacifico Aquaculture.

Overall, these data for the largest production module support a prediction based on the scientific literature and on the current dynamics of the site that soluble nutrients in the water column are transported NE into the broader All Saints Bay and dispersed rapidly at low concentrations. Therefore, the effluent wastes appear highly unlikely to cause a significant impact at or beyond the site.

Benthic impacts – modeling

Two aspects are presented below; the first is the result of an independent benthic footprint modeling assessment for both the north and the south modules (the central module was not modeled), followed by the monitoring data from Pacifico Aquaculture for the larger south module.

A comprehensive “biomass and benthic footprint” assessment was conducted by AMS for the site at Isla Todos Santos. The bathymetric analysis shows the southern module is located over a steeply sloping seabed; Figure 6 shows the depth contours relative to the farm location and the impact modeling area (red box) studied by AMS. The contours in Figure 6 are difficult to read, but the net pen array is situated in water depth of approximately 30 to 100 m on the edge of a submarine canyon descending to 120 m to the east of the site.

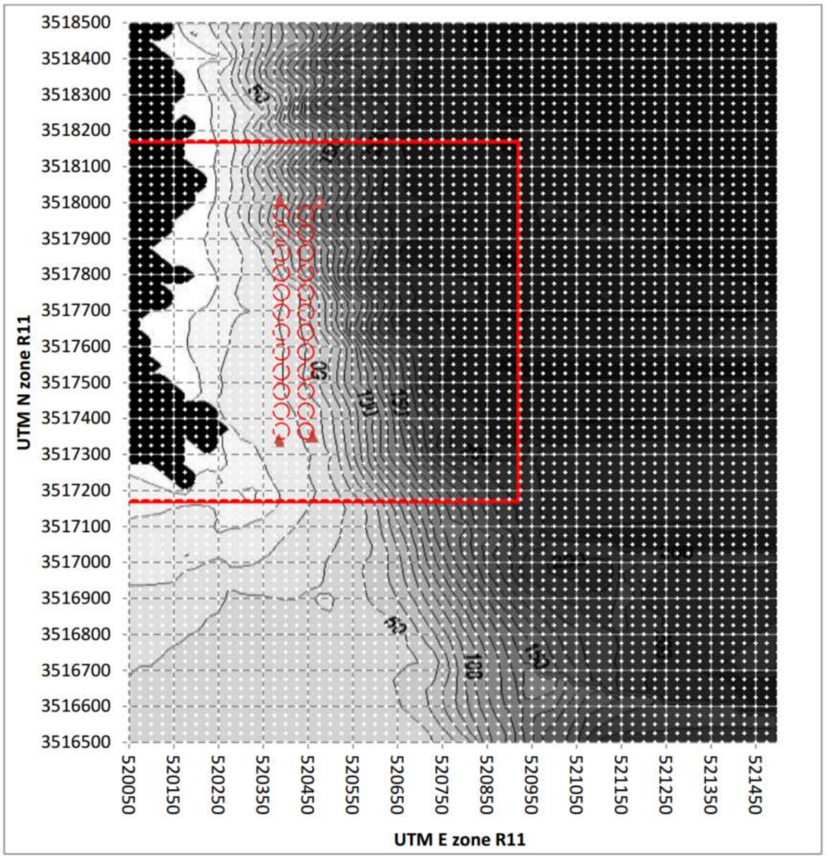

Figure 6. Depth contours at the southern module with net pen locations (red circles) in the location boxed in Figure 3. In this image, the red box is the boundary of the modeling area used by Anderson Marine for predicting benthic impacts. Image copied from (AMS 2018) Image copied from AMS (2018a).

Given the challenge in predicting the potential area of impact, AMS modeled the fate of particulate wastes (feces and uneaten feed) based on two measures of impact; the first is based on the Scottish Environmental Protection Agencies' (SEPA) Infaunal Trophic Index and the threshold at which there would or would not be expected to be any change or degradation of benthic fauna.[6] In the AMS model, this is equivalent to a solids flux of 191.8 g/m^2/year. To give a robust comparison, AMS also included a boundary based on Riera et al. (2017) who concluded that a much higher flux threshold of 12,000 g/m^2/year was predicted as a boundary from which ecological degradation occurs in similar habitats (i.e., there would not be ecological degradation below this depositional rate).

AMS predicted that at a realistic stocking density of 20 kg/m^3, the SEPA threshold for "change or degradation" is reached in the immediate area of under the cages (i.e., the gray area in Figure 7), but the higher Riera deposition rate would not be reached (i.e., there is no blue color showing in Figure 7; see north module map in Figure 9 for comparison). AMS also ran the

[6] The thresholds applied by SEPA are considered by Anderson Marine (AMS 2018) to be a reasonable measure of an acceptable level of environmental effect in Mexico compared to Scotland since macrofaunal community structure is broadly comparable in continental shelf habitats from the sub-arctic to sub-tropical areas.

model[7] at an unrealistic stocking density of 40 kg/m^3 and due to the current characteristics at the site, the model predicted the Riera deposition rate would still not be met.

Figure 7. Modeling of area receiving >191.8g/m^2/year at a realistic stocking density of 20 kg/m^3 therefore exceeding SEPA's threshold of "change or degradation" of benthic communities. The blue threshold of 12,000 g/m^2/year was not reached Image copied form AMS (2018) Image copied from AMS (2018a).

Figure 7 thus shows that at a realistic stocking density of 20 kg/m^3 the area potentially "changed or degraded" according to the SEPA threshold is closely related to the net pen array; therefore, any significant impacts beyond the immediate farm area of relevance to this criterion are considered to be unlikely. In support of this, AMS concluded: "at realistic stocking densities and peak biomass, the predicted spatial area of ecological effect at the seabed is limited to the immediate vicinity of the site (area < 0.06 km^2). The site is predicted to be dispersive and significant effects of material re-suspended and exported from the depositional footprint are considered very unlikely."

Figures 8 and 9 show a similar picture for the northern module—although here, there is a greater reduction of current speeds with depth, and the net pen array is located over a shallower and less-steeply sloping seabed. Therefore, the modeling by AMS shows the Riera et al. (2017) threshold of ecological degradation is met directly under the net pens (blue area in Figure 9) at the highest modeling stocking density for the north module of 25 kg/m^3.

[7] AMS modeled two stocking densities of 15 and 25 kg/m^3 for the north module, giving a peak biomass of 994 to 1,657 MT. For the dispersive south module, the model was run at a realistic stocking density of 20 kg/m^3 and at an unrealistic stocking density of 40 kg/m^3 with a peak biomass of 7,068 MT.

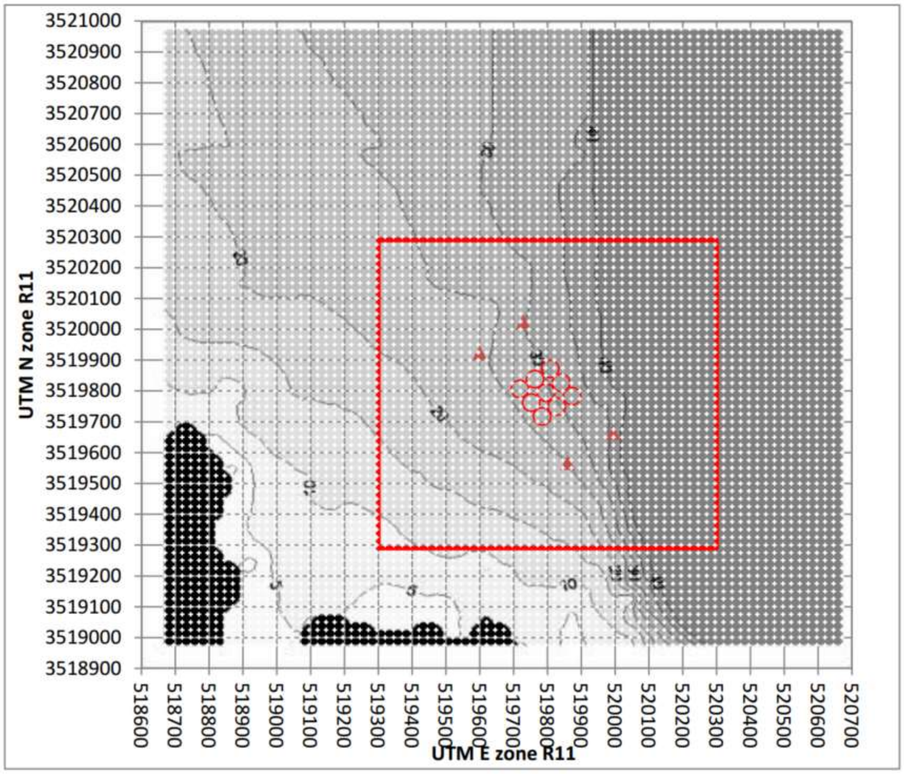

Figure 8. Depth contours at the northern module with net pen locations (red circles) and the modeling area for benthic impacts (red box). Image copied from (AMS 2018) Image copied from AMS (2018b).

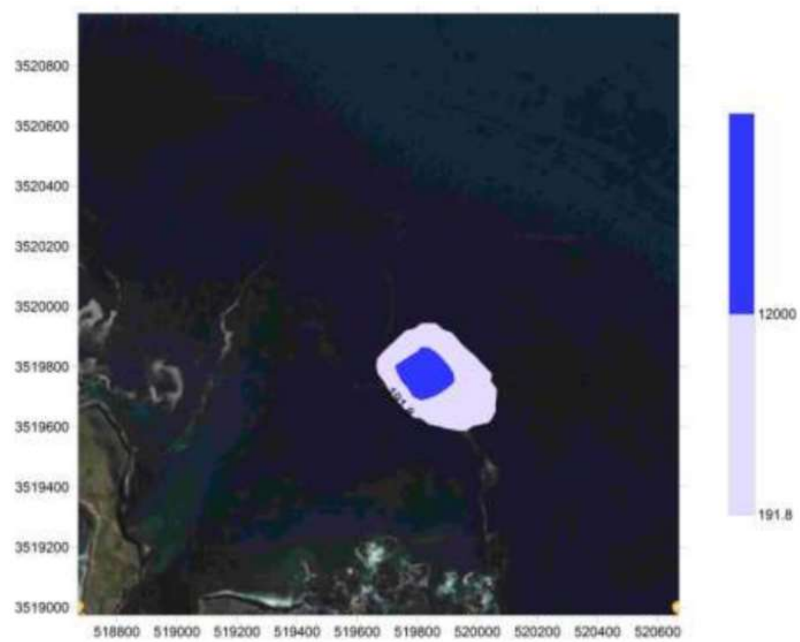

Figure 9. Gray = modeling of area receiving >191.8g/m^2/year and therefore exceeding SEPA's threshold of "change or degradation" of benthic communities. Blue area = modeling area receiving >12,000 g/m^2/year. Models run with a stocking density of 25 kg/m^3 Image copied from AMS (2018) Image copied from AMS (2018b).

Due to the lower current speeds near the seabed, the modeling for the north location predicts insignificant export of particulate material from the model domain (red box in Figure 8); specifically, the model predicted only 9 to 11% of the total particulate wastes would leave the model domain. The modeled area indicates the area of ecological change or degradation is closely limited to the area immediately around the net pens even at the highest modeled stocking density; therefore, impacts beyond the immediate farm area of relevance to Criterion 2 – Effluent are not considered likely. AMS concluded: "at realistic stocking densities and peak biomass, the predicted spatial area of ecological effect at the seabed is limited to the immediate vicinity of the site (area < 0.1 km^2). The site is predicted to be non-dispersive and significant effects of material resuspended and exported from the depositional footprint are considered very unlikely."

<u>Benthic Impacts – Site monitoring data</u>

Figure 10 shows data for key benthic parameters measured on the seabed below the edge of the larger southern net pen array and also on the seabed at 30 m horizontally from the cage edge. As for the water column samples, the results can be compared to the two reference sites, (sampling locations shown in Figure 3). Similar to the numerous water quality parameters listed above, other benthic variables were recorded by Pacifico Aquaculture but not analyzed here (water content, pH, zinc, cadmium, lead, copper, mercury, iron). The selected benthic data show high variability at the reference sites, but a substantial increase in some parameters can be seen at the cage edge but decreasing to 30 m. Sulphur and phosphorous are still elevated at 30 m compared to the reference values. The reason for high variability in the oxidation-reduction potential (ORP) reference values at the reference sites is unclear, but average values at the 30 m sampling points are still negative (i.e., indicating an impact) compared to the reference sites. Figure 11 shows the absolute values and emphasizes the high variability in the ORP with positive and negative values present.

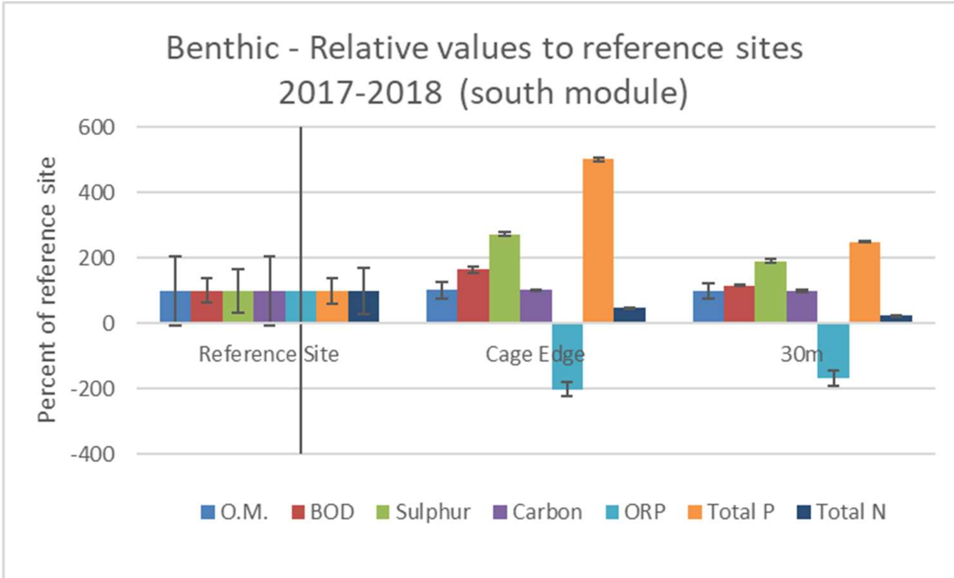

Figure 10. Benthic nutrient monitoring at the south module cage edge and at 30 m, relative to reference sites for key parameters. Data provided by Pacifico Aquaculture. O.M. = organic matter, BOD = biological oxygen demand, ORP = oxidation-reduction potential, Total N = total nitrogen, Total P = total phosphorous.

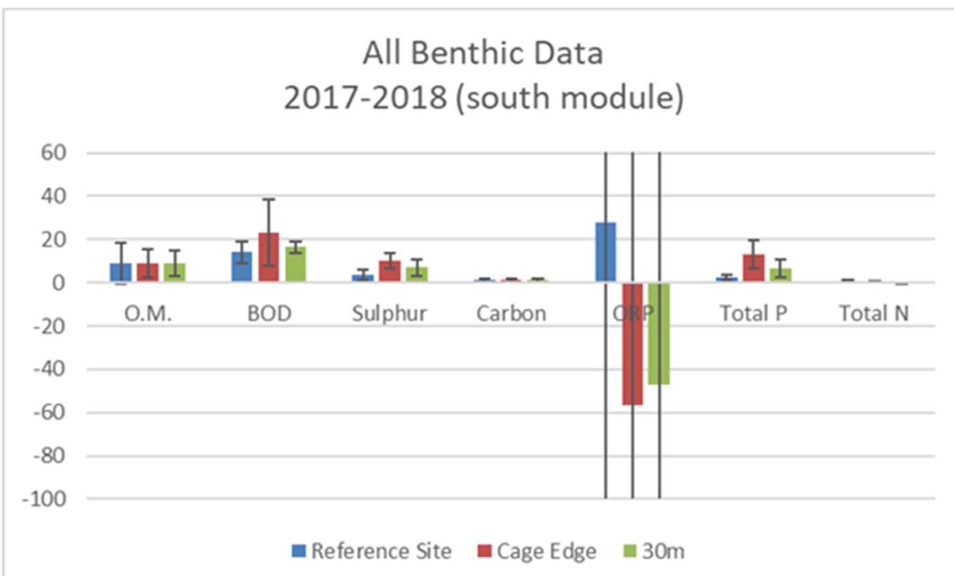

Figure 11: Benthic nutrient monitoring absolute data values at the south module cage edge, 30 m and at the reference sites for key parameters with +/- one standard deviation bars. Labels are the same as the previous graph. O.M. units are %; BOD are mg O2/g; sulfur, carbon, total P and N are µg/g, ORP are mV COD. Data provided by Pacifico Aquaculture.

Cumulative Impacts

Pacifico Aquaculture is the only marine striped bass farm in the Americas. According to aquaculture site and production information on Baja California’s aquaculture health committee

(*Comité Estatal de Sanidad Acuícola e Inocuidad de Baja California*; CESAIBC) website[8] there are registered sites for the production of 10 species farmed in the northern state of Baja California; of these, five are finfish and the remainder are molluscs. The remaining finfish beyond Pacifico Aquaculture's striped bass (and previously white bass) in Baja California are rainbow trout, bluefin tuna, yellowtail (*Seriola dorsalis*) and tilapia. One small rainbow trout site and one tuna operation are located at the southern and northern tips respectively of All Saints Bay (of which Isla Todos Santos is offshore), but the sites are greater than six miles from Pacifico Aquaculture (the other species mentioned are produced in other locations in Baja California and have no connection to the striped bass production). AMS concludes: "The available receiving area (All Saints Bay) is extensive, and significant ecological effect from production operations at the envisaged scale is considered very unlikely."

Conclusions and Final Score

For soluble nutrients in the water column, the available monitoring data are supported by academic studies on net pen aquaculture in exposed locations that conclude significant impacts beyond the immediate farm area are highly unlikely. For benthic impacts, the available monitoring data appear to support the comprehensive modeling assessment by AMS, which concludes that although there will be some change and degradation to benthic communities in the immediate farm area, and though some parameters are elevated at 30 m from the net pens compared to the reference sites, it is highly unlikely that there will be significant impacts much beyond this immediate farm area, particularly considering the rapidly increasing depth with increasing distance from the net pens.

Overall, with consideration of the isolated nature of the striped bass farm, the data show no evidence that effluent discharges cause or contribute to cumulative impacts at the waterbody/regional scale, and the final score for Criterion 2 – Effluent is 8 out of 10.

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[8] http://www.cesaibc.org/sitio/especies.php

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: being located at sites, scales and intensities that maintain the functionality of ecologically valuable habitats.

Criterion 3 Summary

Habitat parameters	Value	Score
F3.1 Habitat conversion and function		7
F3.2a Content of habitat regulations	4	
F3.2b Enforcement of habitat regulations	3	
F3.2 Regulatory or management effectiveness score		4.8
C3 Habitat Final Score (0-10)		**6.27**
Critical?	NO	**YELLOW**

Brief Summary

The independent benthic footprint assessments undertaken for two of the industry's three production modules indicate that despite their differing hydrographic conditions, the seabed impacts are likely to be moderate, and limited to a small area around the net pens. This is supported by the available monitoring data from the largest (south) module, and any such habitat impacts are considered to be rapidly reversible. Despite the limited requirements in Mexican regulations regarding potential cumulative impacts of multiple farms, the company's practical measures in terms of site selection and current scale of production mean there is a negligible risk of cumulative impacts with other aquaculture operations. The final score for Criterion 3 – Habitat is 6.27 out of 10.

Justification of Rating

This Habitat criterion assesses the impact in the immediate area of the farm. For floating net pen production systems, this is the area directly under the net pens and to approximately 30 m beyond them (impacts beyond this area are assessed in Criterion 2 – Effluent). Note that due to the proximity of the site to the Isla Todos Santos, there is some interaction with marine mammals and birds; this is discussed in Criterion 9X – Predators and Wildlife.

Factor 3.1. Habitat conversion and function

Particulate wastes generate a localized gradient of organic enrichment in the underlying and adjacent sediments and can strongly influence the abundance and diversity of infaunal communities. For a review of these impacts, see (Black et al. 2008).

Much of the information relevant here has already been presented in Criterion 2 – Effluent and will be referred to below as necessary.

The two AMS benthic footprint modeling assessments for the north and south modules show that the two locations differ in terms of their dispersive or non-dispersive characteristics in regard to settling particulate wastes from the farm. That is, the north module is in an area with considerable vertical shear (i.e., the surface current is strong but is slower near the seabed) such that the site is considered non-dispersive for particulate wastes. The south module is in deeper water with faster currents near the seabed and is considered dispersive. As such, the AMS assessments indicate the north module is capable (at high levels of production) of exceeding both definitions used by AMS for “change or ecological degradation of benthic fauna” in the immediate area of the net pen module (i.e., according to SEPA and Riera et al., 2017; see Criterion 2 – Effluent). The AMS assessment indicates the south module can only exceed the lower (i.e., more conservative) SEPA definition of degradation at high levels of production in the immediate area under the net pen module.

The farming scale at Pacifico Aquaculture does not yet approach these “high levels of production,” [9] but the available benthic monitoring data from Pacifico Aquaculture (Figure 10 and 11) show elevated levels of some nutrient parameters under the cages and to a lesser extent at 30 m from them. These monitoring results are not easy to directly correlate with specific impacts to benthic faunal communities, but using examples taken from net pen salmon farming (i.e., the most-studied net pen aquaculture industry), even severe benthic impacts are considered to be relatively rapidly reversed with the cessation of production or fallowing. For example, although the time taken for recovery of this area is highly variable, it is frequently substantial in 2 to 3 years (Black et al. 2008). Although Pacifico Aquaculture operates continuously at the three modules (i.e., there is not a formal fallow period between cycles), production volumes are currently lower than the figures used in the AMS models.

Overall, the current level of production and the direct monitoring data suggest that seabed impacts in the immediate farm area are moderate at most, and such impacts are considered to be rapidly reversible. The score for Factor 3.1 – Habitat Functionality is 7 out of 10.

Factor 3.2. Farm siting regulation and management

Husa et al. (2014) noted the cumulative effect of numerous impacted areas around multiple fish farms must be taken into consideration when further evaluating the total impact from fish

[9] The Anderson Marine model maximum stocking density was 25 kg/m^3 in all net pens at peak biomass (the more dispersive south module was also modeled at an unrealistic stocking density of 40 kg/m^3). Pacifico Aquaculture currently uses stocking densities of up to 20 kg/m^3 but mixes production cycles in different net pens therefore approximately half of the pens could reach peak biomass at the same time.

farming on ecosystem functioning, and Factor 3.2 assesses the effectiveness of the regulatory and farm management practices in addressing the potential cumulative impacts from multiple farming sites. The isolated nature of the Isla Todos Santos site will be discussed accordingly.

Factor 3.2a: Content of habitat management measures

With regard to the general regulatory framework, according to the 2013 UN FAO country profile for Mexico[10] (accessed October 2019, the General Law on Sustainable Fisheries and Aquaculture of 2007 (*Ley General de Pesca y Acuacultura Sustentables*, amended 2012) and the Regulation to the Fisheries Act (*Reglamento de la Ley de Pesca*, 1999 and subsequent amendments) are the main legislative documents governing fisheries and aquaculture. Since 2001, the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura y Desarrollo Rural* or SADAR, formerly *Secretaría de Agricultura, Ganadaría, Desarrollo Rural, Pesca y Alimentación* or SAGARPA) is responsible for administering the fisheries and aquaculture legislation.

SAGARPA has developed the Sectoral Program for Agriculture, Livestock, Rural Development, Fisheries and Food 2001–2006 (*Programa Sectorial de Agricultura, Ganadería, Desarrollo Rural Pesca y Alimentación*), which addresses the sustainable exploitation of fishery and aquaculture resources and the promotion of profitability, both in economic and social terms, of the fishery and aquaculture sector. The National Commission on Aquaculture and Fisheries (*Comisión Nacional de Acuacultura y Pesca*, CONAPESCA), is an administrative entity of SADER, and the establishment of aquaculture concessions, such as the site at Isla Todos Santos, is administered under CONAPESCA and the Secretariat of Environment and Natural Resources (*Secretaría del Medio Ambiente y Recursos Naturales*, SEMARNAT).

Within this overarching regulatory structure, the practical implications for the industry with regard to habitat impacts (i.e., the potential benthic impacts described above) are limited. AMS (2018) indicates there are no specific regulatory requirements regarding benthic impacts, and the only action necessary appears to be the submission of monitoring data and an Environmental Impact Assessment (EIA) to the Secretariat of Environment and Natural Resources (*Secretaría del Medio Ambiente y Recursos Naturales*, SEMARNAT) under the Regulation to the General Law of Ecological Equilibrium and Environmental Protection Regarding Environmental Impact Assessment (*Reglamento de la Ley General del Equilibrio Ecológico y la Protección al Ambiente en Materia de Evaluación del Impacto Ambiental*). The EIA for the single in-operation farm site (Bajamachi 2002) was conducted in 2002 in an original aquaculture application for the site as a tuna ranching operation (although dated, and conducted with a focus of Pacific bluefin tuna fattening, the 2002 EIA for the Isla Todos Santos site is still considered valid with regard to the baseline assessment of the site's physical and hydrodynamic characteristics, and therefore its innate carrying capacity). The recent assessments by AMS (2017 and 2018) are seen as robust updates using established methods.

[10] Spanish version accessed October 2019: http://www.fao.org/fishery/countrysector/naso_mexico/es

Given the lack of formal regulation of benthic impacts, the most important aspect is the company-level management of Pacifico Aquaculture, the selection and operation of the site, and its proximity to other aquaculture sites. As discussed in Criterion 2 – Effluent, the Isla Todos Santos site is at least six miles from the nearest aquaculture operation. The AMS assessment for the north module concluded: "For the modelled site configuration at realistic stocking densities and peak biomass, the predicted spatial area of ecological effect at the seabed is limited to the immediate vicinity of the site (area < 0.1 km^2); the site is predicted to be non-dispersive and significant effects of material resuspended and exported from the depositional footprint are considered very unlikely." The AMS assessment of the south module concluded: "For the modelled site configuration at realistic stocking densities and peak biomass, the predicted spatial area of ecological effect at the seabed is limited to the immediate vicinity of the site (area < 0.06 km^2). The site is predicted to be dispersive and significant effects of material re-suspended and exported from the depositional footprint are considered very unlikely." Therefore, the management of site selection and current operational scales of production mean there is a negligible risk of cumulative habitat impacts with other aquaculture operations. Despite the lack of a formal regulatory system in Mexico, the operational management at the site is considered to be robust and the score for Factor 3.2a: Content of habitat management measures is 4 out of 5.

<u>Factor 3.2b: Enforcement of habitat management measures</u>
SADAR is in charge of administering the fisheries and aquaculture legislation, and they are considered to be identifiable and contactable. But as noted above, there is only a requirement that the industry provides monitoring data, and not to meet specific benthic impact limits.

The industry's sole producer company, Pacifico Aquaculture, has a benthic sampling plan in terms of sampling locations and frequency, and these are tied to requirements for certification to the Global Aquaculture Alliance Best Aquaculture Practices standards and the Whole Foods Markets purchasing requirements. Local enactment of the monitoring plan is demonstrated by the monitoring data provided, but it is limited by some uncertainty in monitoring frequency for the smaller north and central modules. Laboratory analysis is conducted by Assesoria Integral Ambiental, accredited to the Secretariat of Environmental Protection (*Secretaría de Protección al Ambient*, SPA). The data provided in addition to the AMS benthic footprint assessment reports indicate company-level activity is currently effective in that production levels are below limits that indicate any risk of cumulative impacts with other aquaculture operations. With some gaps in data for the north and central modules, the score for Factor 3.2b is therefore 3 out of 5.

When combining the scores for Factors 3.2a (4 out of 5) and 3.2b (3 out of 5), the lack of an official regulatory regime, but the presence of practical measures at the company level means the final Factor 3.2 score is 4.8 out of 10.

Conclusions and Final Score
The benthic footprint assessments for two of the three production modules indicate that despite their differing hydrographic conditions, the benthic impacts at all three locations are

likely to be moderate and limited to a small area around the net pens. This is supported by the available monitoring data from the south module, and any such habitat impacts are considered to be rapidly reversible. Despite the limited requirements in Mexican regulations with regard to potential cumulative impacts of multiple farms, the company's practical measures in terms of site selection and current scale of production mean there is a negligible risk of cumulative impacts with other aquaculture operations. The combined scores for Factors 3.1 and 3.2 result in a final score for Criterion 3 – Habitat of 6.27 out of 10.

Criterion 4: Evidence or Risk of Chemical Use

Impact, unit of sustainability and principle

- Impact: Improper use of chemical treatments impacts non-target organisms and leads to production losses and human health concerns due to the development of chemical-resistant organisms.
- Sustainability unit: non-target organisms in the local or regional environment, presence of pathogens or parasites resistant to important treatments
- Principle: limiting the type, frequency of use, total use, or discharge of chemicals to levels representing a low risk of impact to non-target organisms.

Criterion 4 Summary

Chemical Use parameters	Score	
C4 Chemical Use Score (0-10)	**8**	
Critical?	NO	**GREEN**

Brief Summary

There are no Mexican regulations limiting the volume or frequency of antibiotic use, but data from the last three years show that on average, the industry has administered less than one antibiotic treatment per year (and less than once per production cycle of 24 to 30 months); treatments are restricted to individual pens (rather than treating the entire site). Although there are concerns regarding reduced efficacy of some antibiotic treatments, there is no evidence that the farm's antibiotic use led to its development and the ongoing independent testing ensures only effective antibiotics are used when a bacterial disease necessitates treatment. The types of antibiotic used are listed as highly important for human medicine by the World Health Organization, but since antibiotic use is less than once per production cycle, the final score for Criterion 4 – Chemical Use is 8 out of 10.

Justification of Rating

According to the company's Best Management Practices for Drug and Chemical Use (BMP), the policy is to maintain compliance with United States Federal Drug Administration (FDA) requirements, which means antibiotics for aquaculture are limited to Terramycin® (active ingredient oxytetracycline), florfenicol, and Romet®30 (active ingredients sulfadimethoxine and ormetoprim). All these antibiotics, with the exception of ormetoprim, are listed as highly important for human medicine by the World Health Organization (WHO 2017). Their application for striped bass must follow the FDA "extra-label" guidelines (i.e., the FDA full approvals for antibiotic use in aquaculture do not include use on striped bass); these are detailed in the Federal Food, Drug, and Cosmetic Act and outlined on the FDA website,[11] and include requirements for prescriptions by veterinarians and thorough record-keeping. Mexican

[11] http://www.fda.gov/AnimalVeterinary/ResourcesforYou/ucm380135.htm

regulation NOM-005-STPS-1998 specifies the requirements for the safe and appropriate handling, transportation, and storage of chemicals; however, no evidence was found of more comprehensive regulations on the use of antibiotics or other veterinary treatments in Mexico.

As discussed in Criterion 1 – Data, the industry's single producer, Pacifico Aquaculture, provided treatment records from 2016 to 2018, in addition to recent examples of prescriptions and results of pathogen/antibiotic sensitivity testing. The records did not include treatments for external parasites for which formalin (hatchery only) and hydrogen peroxide have been used (see Criterion 7 – Disease; hydrogen peroxide is considered to rapidly dissociate into environmentally-benign byproducts upon contact with seawater in the immediate farm area [Lillicrap et al. 2015]).

Prior to 2016, there had not been any antibiotic treatments, but an outbreak of Flavobacterium (*Tenacibaculum maritimum*) in June/July 2016 required treatment of young fish in 19 net pens after transfer from the hatchery to the ongrowing site. Since then, a variable portion of pens (shown in Table 1) have been treated each year for *T. maritimum* plus Vibriosis (*Vibrio* species) and Flexibacteriosis (*Flexibacter columnaris*).

Table 1 below shows the number of individual net pens treated per year from 2016 to 2018, and the treatments used. For reference, the total number of active production pens in 2018 was 33. While Romet®30 was the dominant treatment in 2016, its use has declined to zero in 2018, replaced by oxytetracycline and florfenicol. Some of these treatments were undertaken in the same net pen in the same cycle, with 6, 1, and 2 pens each receiving two treatments in 2016, 2017, and 2018 respectively; that is, the 10 antibiotic treatments in 2018 were applied to 8 pens, with two of those pens receiving two treatments.

Table 1: Antibiotic treatments in number of pen-treatments per year. The total number of active pens in 2018 was 33. Data provided by Pacifico Aquaculture.

Antibiotic product	**2016**	**2017**	**2018**
Romet®30	15	1	0
Oxytetracycline	4	3	5
Florfenicol	0	4	5
Total # net pen treatments	**19**	**8**	**10**

Considering the proportion of net pens treated (e.g., 10 out of 33 in 2018) and the limited number of pens receiving more than one treatment (e.g., 2 in 2018), it is clear that fish on average are receiving less than one antibiotic treatment per year. Using the average number of net pen treatments per year over the last three years (12.3) and the current number of stocked pens (33), the frequency of treatment is less than once per year (0.37). For the 2018 value of 10 treatments, the average is 0.33 treatments per year.

With the maximum production cycle duration of 30 months (the range is 24 to 30 months) and the current number of stocked pens (33), the frequency of treatment is also less than once per production cycle (0.93) based on the three-year average of 12.3 treatments per year. Using the most recent 2018 number of treated pens (10) with the same 33 stocked pens and maximum 30-month cycle, the current treatment frequency is 0.75 treatments per 30-month production cycle.

The results of independent antibiotic sensitivity assessments made available by Pacifico Aquaculture show that the efficacy of antibiotics against bacteria sampled from the farm is being tested during use. The 2018 testing results showed some bacteria samples were not affected by Romet®30, and minor reductions in the expected effectiveness of oxytetracycline and florfenicol were observed in some samples. The results also show "resistance" to other antibiotics that have never been used at the farm site (e.g., neomycin and enrofloxacin). There were 15 pens treated with Romet®30 in 2016, but it is not possible to demonstrate that the reduced effectiveness of this antibiotic seen in 2018 is evidence of developed clinical resistance (Romet®30 was only used once in 2017, and not at all in 2018), or simply due to the variable sensitivity of different strains of bacteria. The resistance to multiple antibiotics that have never used at the site supports the latter theory or indicates a general regional background resistance from other sources. The three sensitivity tests conducted in 2018 show that antibiotics are only being used by Pacifico Aquaculture when the pathogens are shown to be susceptible to them (as a result there was no use of Romet®30 in 2018). Therefore, the use of antibiotics follows commonly accepted guidelines for responsible use (RUMA 2019), and the risk of contributing to resistance appears limited due to the low frequency of use.

Conclusion and Final Score

There are no Mexican regulations limiting the volume or frequency of antibiotic use, but data from the last three years show antibiotics are used on average less than once per year (0.33 in 2018, or 0.37 on average over the last three years) and treatments are restricted to individual pens (rather than treating the entire site). Although there are some concerns regarding reduced efficacy of some antibiotic treatments, there is no evidence that the farm's use led to its development and the ongoing testing ensures only effective antibiotics are used. The treatments used are listed as highly important for human medicine by the World Health Organization (WHO 2017), but as antibiotic use is less than once per production cycle, the final score for Criterion 4 – Chemical Use is 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: sourcing sustainable feed ingredients and converting them efficiently with net edible nutrition gains.

Criterion 5 Summary

Feed parameters	Value	Score
F5.1a Feed Fish Efficiency Ratio (FFER)	0.63	8.42
F5.1b Source fishery sustainability score	-3.00	
F5.1: Wild fish use score		8.04
F5.2a Protein IN (kg/100 kg fish harvested)	56.58	
F5.2b Protein OUT (kg/100 kg fish harvested)	32.80	
F5.2: Net Protein Gain or Loss (%)	-42.03	5
F5.3: Feed Footprint (hectares)	25.49	1
C5 Feed Final Score (0-10)		**5.52**
Critical?	NO	**YELLOW**

Brief Summary

Detailed feed data were provided by Pacifico Aquaculture and their feed manufacturer (EWOS-Cargill), and showed that although inclusion levels of fishmeal and fish oil are relatively high (34% and 14% respectively), more than three-quarters of the fishmeal and all of the fish oil come from trimmings and by-product sources. With an economic feed conversion ratio of 2.01, the Feed Fish Efficiency Ratio (i.e., an indicator of the amount of wild fish used to produce farmed fish) is 0.63 based on fishmeal. The feed protein content for striped bass is high (43%), and considering the use of fishmeal from whole fish, in addition to edible crop protein ingredients, there is a net loss of 42.0% of edible protein. With high total levels of marine ingredients (including by-products), the feed footprint area is also high at 25.5 ha per ton of striped bass production. Overall, the final score for Criterion 5 – Feed is 5.52 out of 10.

Justification of Rating

The Feed Criterion includes three factors – wild fish use (including the sustainability of the source), net protein gain or loss, and the feed "footprint" or global area required to supply the ingredients. For a full explanation of the calculations, see the Seafood Watch Aquaculture Standard document[12]

EWOS Canada (Cargill Animal Nutrition) and Pacifico Aquaculture provided detailed data on the feed characteristics, key ingredients used, and feeding performance necessary for this assessment. These data are provided below and used in the relevant calculations.

Factor 5.1. Wild Fish Use

Factor 5.1a – Feed Fish Efficiency Ratio (FFER)

The fishmeal content of the growout feeds ranges from 30% to 40% depending on the size of the fish, with a weighted average over the production cycle of 34%. A large proportion (78.5%) of that fishmeal comes from trimmings and byproduct sources. For fish oil, the weighted average inclusion level is 14% with all (100%) coming from byproduct sources. The fishmeal content therefore drives the FFER calculations, and yield data from EWOS (Table 3) shows an average fishmeal yield of 23.2%. Based on detailed feed use and harvest records provided by Pacifico Aquaculture for production cycles stocked from 2015 and harvested to date, the economic Feed Conversion Ratio (eFCR) is 2.01.

Table 2: The parameters used and their calculated values to determine the use of wild fish in feeding Mexico striped bass

Parameter	**Data**
Fishmeal inclusion level	34%
Percentage of fishmeal from byproducts	78.5%
Fishmeal yield (from wild fish)	23.2%
Fish oil inclusion level	14%
Percentage of fish oil from byproducts	100%
Fish oil yield	9.1%
Economic Feed Conversion Ratio (eFCR)	2.01
Calculated Values	
Feed Fish Efficiency Ratio (fishmeal)	0.66
Feed Fish Efficiency Ratio (fish oil)	0.00
Seafood Watch FFER Score (0–10)	**8.42**

Using these data, the FFER values for fishmeal and oil are 0.63 and 0.00 respectively. Using the higher of these two values (0.63 for fishmeal), the initial score for Factor 5.1a – Feed Fish Efficiency Ratio is 8.42 out of 10.

Factor 5.1b – Sustainability of the source of wild fish

The FFER score is adjusted by a factor determined by the sustainability of the fisheries sourced to provide whole-fish (i.e., not byproduct) marine ingredients (in this case just fishmeal); an increasingly negative penalty is generated by increasingly unsustainable sources.

[12] https://www.seafoodwatch.org/seafood-recommendations/our-standards

The species and fisheries provided by Pacifico Aquaculture (from EWOS) for fishmeal are listed in Table 3 (data on the proportions of each source used were not provided).

Table 3: Fishery sources for non-byproduct fishmeal; data from EWOS

Origin	Fisheries Management Areas	Species	% in Catch	Common Species Names	Common Names of Fishery	Jurisdiction	ISEAL Member?	Certificates	Yield (%)	FishSource Score					
										Last Updated on	Management Quality			Fish Stock	
											1. Is the management strategy precautionary?	2. Do managers follow scientific advice?	3. Do fishers comply?	4. Is the fish stock healthy?	5. Will the fish stock be healthy in future?
Fish Meal :															
Gulf of Mexico	US EEZ (3-200 nm from shore) in the Gulf of Mexico	*Brevoortia patronus*	100%	Gulf Menhaden	Gulf Menhaden	United States	No	Friend of the Sea, IFFO - RS	25	29-Jun-19	≥ 6	≥ 8	≥ 6	10	9.5
Southern Peru/Northern Chile	Southern Peru/Northern Chile	*Engraulis ringens*	100%	Anchoveta	Anchoveta	Southern Peru/ Northern Chile	No	IFFO - RS	21.4	18-Jul-18	≥ 6	≥ 8	≥ 8	≥ 6	≥ 6

The certification of the Gulf of Mexico menhaden fishery by the Marine Stewardship Council supersedes the data in Table 3, and both fishmeal sources come from reduction/processing plants certified to the IFFO RS[13] program (Holmyard 2017). Both fisheries have been assessed by FishSource[14] and as shown in Table 3, all scores are ≥6 with the menhaden fishery having a high stock health score. Based on these FishSource scores, the Factor 5.1b score is –3 out of –10. This creates an adjustment to the FFER score of –0.38 and when combined, the Factor 5.1a and Factor 5.1b scores result in a final Factor 5.1 score of 8.04 out of 10.

Factor 5.2. Net protein gain or loss

The weighted average feed protein content is 43.0%. A breakdown of the feed ingredients shows the total protein is supplied by both fishmeal and terrestrial crop ingredients (e.g., wheat, corn). No terrestrial land animal ingredients are used. Although ingredient labels provided by EWOS/Pacifico show some ingredients (wheat gluten and corn gluten) were animal feed grade, all crop ingredients are considered suitable for human consumption unless they are clearly a secondary byproduct of an intermediate process (e.g., distillers grains).

As a result, 44% of the total protein is calculated to come from fishmeal (9.5% from whole fish and 34.5% from trimmings and byproduct sources), and the remaining 56.0% comes from crop meals. Approximately 65.5% of the total protein therefore comes from sources considered to be edible for human consumption, and (using the FCR of 2.01) the edible protein input per 100 kg of fish produced is 56.6 kg.

[13] https://www.iffors.com/

The whole protein content of striped bass is 19.55% (Karahadian et al. 1995). The filet yield of striped bass is 40%,[15] but seafood markets desire head on striped bass, and fish are sold as "gutted head on" with a yield from whole fish of 90% according to a general FAO "seabass" yield figure (FAO 1997). All of the fish guts (i.e., the remaining 10% from live harvest weight) are processed in Ensenada for further uses (receipt documents were provided by Pacifico Aquaculture). Therefore, all the protein from the harvested fish is considered to be utilized; after adjustments according to the Seafood Watch Aquaculture Standard to allow for the conversion of crop proteins to higher quality fish proteins, the protein output is 32.8 kg per ton of production; therefore, there is a net loss of 42.0% of edible protein during production resulting in a Factor 5.2 score of 5 out of 10.

Table 4: The protein budget for Mexican striped bass aquaculture

Parameter	Data
Protein content of feed	43.0%
Percentage of total protein from non-edible sources (i.e., byproducts)	34.5%
Percentage of protein from edible sources (i.e., edible marine and crop)	65.5%
Economic Feed Conversion Ratio	2.01
Edible protein INPUT per 100 kg of farmed bass	56.6 kg
Protein content of whole harvested bass	19.55%
Edible yield of harvested bass	40%
Percentage of farmed bass byproducts utilized	100%
Utilized **protein OUTPUT** per ton of farmed bass	32.8 kg
Net protein loss	–42.0%
Seafood Watch Score (0–10)	**5**

Factor 5.3. Feed footprint

The data provided by EWOS show that 48% of the total feed is from marine ingredients, and the remaining 52% (allowing some minor error for vitamin and mineral premixes, processing ingredients, etc.) comes from crop sources.

Table 5: Marine, crop, and land animal inclusion in Mexican striped bass feed and the ocean and land areas necessary to support one ton of farmed fish production

Parameter	Data
Marine ingredients inclusion	48%
Crop ingredients inclusion	52%
Land animal ingredients inclusion	0%
Ocean area (hectares) used per ton of farmed trout	25.1
Land area (hectares) used per ton of farmed trout	0.4
Total area (hectares)	25.5
Seafood Watch Score (0–10)	**1**

[15] According to "Chef Resources" https://www.chefs-resources.com/seafood/finfish/striped-bass/

The area of aquatic and terrestrial primary productivity required to produce these ingredients is calculated (using the equations in the Seafood Watch Aquaculture Standard) to 25.1 ha and 0.4 ha respectively. With the high inclusion level of marine ingredients, the total area of 25.5 ha equates to a score of 1 out of 10 for the Factor 5.3.

Conclusions and Final Score

The final Feed Criterion score is calculated from the scores for Factors 5.1 (8.04 out of 10), 5.2 (5 out of 10), and 5.3 (1 out of 10). With moderate to high marine ingredient use, a relatively high eFCR, and a moderate to high loss of edible protein, the final score for Criterion 5 – Feed is 5.52 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: preventing population-level impacts to wild species or other ecosystem-level impacts from farm escapes.

Criterion 6 Summary

Escape parameters	Value	Score
F6.1 System escape risk	4	
F6.1 Recapture adjustment	0	
F6.1 Final escape risk score		4
F6.2 Competitive and Genetic Interactions		6
C6 Escape Final Score (0-10)		**5**
Critical?	NO	**YELLOW**

Brief Summary

Striped bass are a non-native species in the Pacific; they were introduced into California in the 1880s and the only established population is in San Francisco Bay. The industry's single producer has best management practices in place within their containment management system (CMS) and has not had any reported escape events; however, the open net pen production system and the offshore site is still considered to represent a high risk of escape (of both large scale and smaller chronic trickle losses) from natural causes or human error. In the event of an escape from the Isla Todos Santos site, the nearest suitable freshwater habitats for reproduction is more than 550 miles north (i.e., San Francisco Bay). Therefore, successful reproduction in the event of an escape is considered highly unlikely. Very occasional reports of anglers catching striped bass on Southern California coasts are available, both before and after the farm was established. Considering the predatory nature of the species, there is a likelihood of some impact on native species in the immediate farm area in the event of a large escape, although it is not known to what extent due to the likely rapid dispersion from the offshore farming location. Overall, the combination of escape risk and potential impacts result in a final score of 5 out of 10.

Justification of Rating

Factor 6.1. Escape risk

In Mexico, striped bass are grown in a floating net pen containment system similar in construction to the system used ubiquitously by the salmon farming industry. A significant characteristic of striped bass is the much smaller size of fingerlings (e.g., compared to salmon) at transfer to marine sites; Pacifico moves fish to the Isla Todos Santos site at <10 g (compared to ~70 to 150 g for salmon smolts). They are moved into smaller floating enclosures with fine mesh net, located within the main net pen, until they are large enough to be released into the main pen.

The original environmental impact assessment for the site, conducted for the initial development of the site for tuna ranching (Bajamachi 2002), describes the exposure characteristics; tides are moderate with a maximum recorded tidal height of 1.5 m, and though the exposed side of the island experiences wave heights up to 10 m (and boasts a big-wave surfing location known as "Killers"), the sheltered lee (eastern) side is protected. Wave heights in the larger Todos Santos Bay, between the islands and the mainland at Ensenada, range from 0.2 m in the summer to 2.4 m in the winter, with 50- and 100-year wave heights calculated to be in the range 3.4 to 3.8 m. Considering the offshore nature of the site, waves are a significant concern for escapes but the protection of the islands is critical. The northern cage module appears particularly vulnerable to wave exposure.

The majority of hurricanes and tropical storms that make landfall on Mexico's Pacific coast do so to the south of the country, but northern Baja California, including Ensenada, is not entirely out of their possible tracks. Since 1948, four Category 1 hurricanes (the lowest wind speed hurricane classification), and four tropical storms have affected northern Baja California (Anonymous 2016).

Pacifico Aquaculture provided their Environmental Best Management Practices manual, which includes details on the containment management system (CMS), and evidence of these measures was seen during the site visit for all sizes of fish present. The manual includes sections on net pen design and construction, site maintenance including net management and testing, moorings and subsurface components, predator control, all fish handling procedures, and escape response and recapture plans. The CMS includes a Hazard Analysis and Critical Control Point Assessment (HACCP) for the site, and an assessment of the fate and potential impacts of a hypothetical striped bass escape from the site.

There have been no reported escapes from the Isla Todos Santos site, and no recent reports were found of striped bass being captured in local commercial or recreational fisheries. As discussed in Factor 6.2 below, captures of striped bass by recreational anglers in the US are likely to be reported on social media sites and blogs, but no information could be found locally in the Ensenada area. Despite the escape management measures in place, net pen systems are considered to be inherently vulnerable to escapes (as is well documented in the salmon farming industry) primarily due to weather, human error of various forms, or damage by predators (e.g., net damage by seals). Although a secondary net is in place as a predator deterrent, the mesh size is too large to act as a secondary containment for any escapes from the main fish containment nets. Due to limitations in counting technology in hatcheries during stocking and at harvest, an accurate escape inventory is typically not possible, and the counting error typically represents thousands of fish. Studies on similar (i.e., net pen) facilities used for salmon maintain the likelihood that fish (such as striped bass) can escape from the net pens undetected by the farm, and therefore unreported; consequently, estimates of actual escapes may be significantly higher than reported numbers (Skilbrei et al. 2015).

The CMS and management documentation available, in addition to the evidence of measures in place at the site, are considered to represent typical best practice for an open net pen production system, but there is no formal escape reporting protocol in place. Although captures of escaped striped bass are likely to be reported by anglers to the north in the US, this is not reliable enough to be defined as monitoring data that would indicate occasional detection of low numbers of escapes in the wild, and despite the long track record of no reported escapes, a substantial risk of escape is considered to remain. Overall, the vulnerability of the production system weighed against the company's claimed track record of no escapes and lack of evidence of escaped fish in the wild, resulting in a score of 4 out of 10 for Factor 6.1 – Escape Risk.

Escape response measures in the CMS and the presence of an active commercial and sport fishery in the Ensenada region indicate that recaptures at the site and immediately beyond it are likely to be significant; however, with no reported escapes, there is no evidence with which to specify an appropriate adjustment for recaptures. The final score for Factor 6.1 is therefore 4 out of 10.

Factor 6.2. Competitive and genetic interactions

Striped bass is a non-native species on the Pacific coast of the Americas, introduced into California from the US east coast in 1879 and again in 1882; by 1900, there was a fishery of over 1 million lb (454 MT) per year in the San Francisco area, with a peak of over 2 million lb (>900 MT) in 1903 (CDFG 2016). The population continued to thrive through the 1960s but has faced major declines more recently (Ostrach et al. 2008); the first significant decline occurred in the 1970s, followed by additional declines in the mid-1980s and mid-1990s. As part of conservation plans for striped bass, California Department of Fish and Game (CDFG) began a hatchery program for supplemental stocking in 1981, with the number of fish stocked increasing from about 63,000 in 1980 to almost 3.4 million in 1990 (CDFG 2001). All stocking was suspended in 1992 due to concern over potential predation by striped bass on threatened and endangered species (such as Sacramento River winter-run Chinook salmon and Sacramento delta smelt), but was resumed as part of a Striped Bass Management Conservation Plan designed to maintain the striped bass population and sport fishery and to be consistent with recovery of other listed species (CDFG 2001). This stocking stopped in 2000, and there has been no stocking since then (M. Gingras, California Department of Fish and Wildlife, personal communication May 2016). No information could be found to indicate any stocking of striped bass in Mexican waters.

According to the reviewed literature and data described in the following sections, if an escape event were to occur at Pacifico Aquaculture, the potential impacts of non-native striped bass appear to be governed by three key aspects:

1 – The potential for the species to establish new populations in the escape area or elsewhere

2 – The potential for escaped fish to migrate to the nearest suitable breeding area (San Francisco Bay)

3 – Direct predation by striped bass on fish and other marine life in the vicinity of the farm site

These three aspects are reviewed below:

1 – Potential population establishment in the escape area or elsewhere

In addition to the San Francisco area, striped bass have been introduced into many other places on the Pacific coast including the lower Colorado River, several reservoirs, and the Pacific Ocean in southern California (CDFG 2001). Although the primary California population of striped bass is in the San Francisco Bay estuary, the species has been documented up and down the Pacific coast from 40 km south of the California/Mexico border to British Columbia (Stevens 1980); however, at this southern limit, the numbers of fish reported are very small. For example, two individuals were caught at Redondo Beach in 1894 (Stevens 1980), three at La Jolla in 1931 (CDFG 1931), and a single fish 25 km south of the California border in Mexico in 1959 (CDFG 1961). More recent anecdotal angling reports show occasional individuals are caught in southern California (e.g., one in San Diego area in 2014 and 2017,[16] one in Los Angeles area in 2013.[17] There is also an anecdotal mention of an "unusual invasion of southern California beaches by stripers in the warm-water year of 1998"[18] (which was well before any striped bass aquaculture facility was established in Mexico).

With relevance to the industry's operation in Ensenada (80 miles south of the California border, and approximately 550 miles south of San Francisco Bay), CDFW (2016) show that the only striped bass fisheries of consequence have remained within the San Francisco delta with occasional fish caught up to 90 miles to the south. Raddovich et al. (1961) concluded that striped bass did not establish off southern California or northern Baja California because there was insufficient freshwater in which to spawn, and CDFG (2001) concluded that conditions are generally not suitable for striped bass spawning in marine waters off southern California. Therefore, the establishment of new populations south of San Francisco by escaping fish from Pacifico is considered highly unlikely, if not impossible. This conclusion is considered reasonable by the California Department of Fish and Wildlife's west coast striped bass expert (M. Gingras, personal communication May 2016). Ultimately, the failed historic attempts to stock striped bass in locations throughout California—with the exception of the discrete San Francisco Bay population—demonstrate that the likelihood of striped bass escapees establishing new populations in the greater Ensenada area of northern Baja California or beyond is low.

2 – Potential migration to the nearest suitable breeding area (San Francisco Bay)

On the east coast of the US in the native habitat of striped bass, recent research has shown that large fish (>90 cm total length) can migrate more than 600 miles from their natal rivers on annual migrations (Callihan et al. 2015); these large fish can travel 36 miles per day. Considering the hatchery- and farm-raised nature of the farmed fish in Mexico, their smaller (pre-sexual maturity) size, and their lack of a natal river, it seems unlikely—but not impossible—that significant numbers of escapees would make the migration of 550 miles north from the Todos

[16] SD Fish – San Diego fishing forum. September 10 2017.

[17] www.stripersonline.com, April 12, 2013.

[18] http://kenjonesfishing.com/2016/09/striped-bass/

Santos site in Baja California to San Francisco Bay—the nearest site where reproduction with wild (though still non-native) stocks would be possible.

In the scenario that escaped fish from Mexico did migrate to San Francisco Bay, striped bass are known to prey on a number of species in the Sacramento delta, including some that are listed under the Endangered Species Act (e.g., spring-run Chinook, Central Valley steelhead, delta smelt, Sacramento splittail); however, in research conducted by California DFG, the anticipated predation by the current striped bass population was low (steelhead: 0.8% of the population; Chinook: 1.1%; delta smelt: 0.9%; split tail: 0.9%), and insignificant or negligible with regard to population levels of the preyed-upon species (CDFG 1999). More recently, Nobriga et al. (2013) reported a growing concern that predation by juvenile striped bass (ages 1 to 3) may negatively affect the population dynamics of delta smelt; however, they found no evidence for a correlation between juvenile striped bass abundance and delta smelt survival. In contrast, Sabala et al. (2015) estimated mortality of emigrating juvenile Chinook salmon in a "predation hotspot" to be 8 to 29% per year due to striped bass.

The conditions that allowed striped bass populations to establish in the San Francisco Bay in the late 1800s appear to be deteriorating, and fish numbers have declined markedly in recent years as shown in Figure 13 (Gingras 2010). More importantly, the potential impact of farm escapees arriving from Mexico is considered to be low compared to the historical active stocking of millions of striped bass, deliberately released into the estuary by the CDFG/CDFW. This conclusion is considered reasonable by the California Department of Fish and Wildlife's West Coast striped bass expert (M. Gingras, personal communication May 2016).

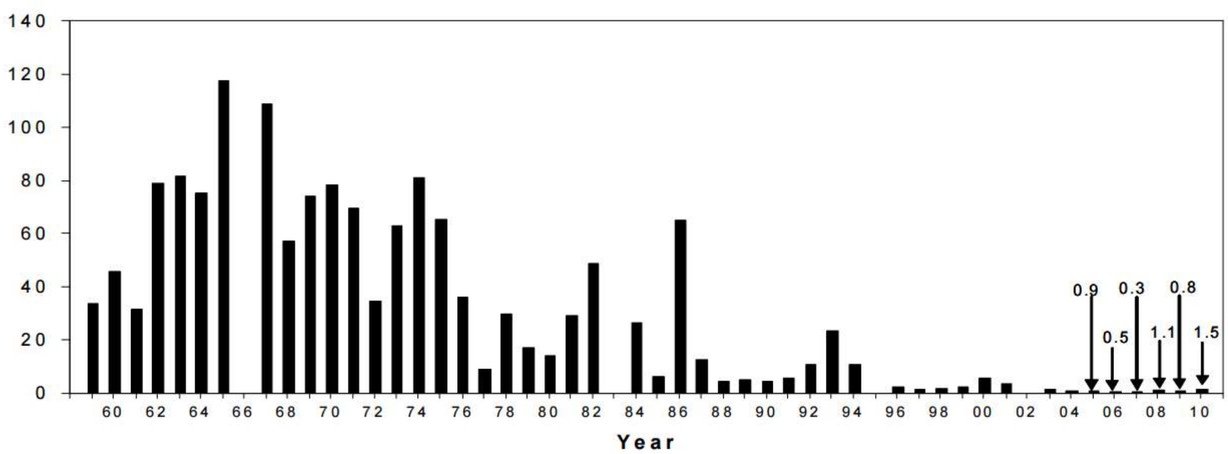

***Figure 12*.** Striped bass abundance index from 1960 to 2010, showing the marked decline in abundance. Graph from (Gingras 2010).

<u>3 – Direct predation by striped bass on species in the vicinity of the farm site</u>

With no wild populations of striped bass in the area, any potential escaped striped bass would not have any competition or disturbance of breeding behavior on conspecifics. Nevertheless, Loboschefsky et al. (2013) showed that wild striped bass, in their second and third year, switch to a dominant diet of fish. Escaping striped bass would therefore likely be active piscivores;

however, it is uncertain how a hatchery- and farm-raised striped bass, accustomed to a constant diet of pelleted feeds, would behave following a potential escape. Although some well-studied species, such as farmed Atlantic salmon, have been shown to have low success at feeding on live prey (i.e., hunting) after escape (Arismendi 2012), Atlantic salmon have also been shown to be unsuccessful colonizers in general—unlike striped bass in the San Francisco Bay. The farm's environmental impact assessment notes populations of several predatory species, such as seals and sea lions, and these are visually present at the site. They would be expected to have an immediate impact on escape numbers via predation, but the scale is unknown. Given the offshore location of the site, it is also likely that some escapees would disperse into open waters around the islands and, given the inability of striped bass to reproduce in the region, any predatory impacts on native, local fauna by escapees would be considered short term as the fish disperse. There is also an active sport fishery in the Ensenada area that would likely reduce escape numbers to some extent. It must also be noted that despite the known predation of striped bass on endangered species in the San Francisco Bay and delta, these impacts were considered appropriately managed during a period of intense stocking of millions of hatchery-raised striped bass. Therefore, though some predation on local wild fish populations is possible, if not likely, following a large escape event, population-level impacts to native species are considered unlikely. This conclusion is also considered reasonable by the California Department of Fish and Wildlife's west coast striped bass expert (M. Gingras, personal communication May 2016).

Overall, if an escape were to occur at Isla Todos Santos, it is considered likely that there would be some predation on local fish populations. The inability of striped bass to breed and establish new populations in the region is clear, and the presence of significant seal and sea lion colonies, in addition to the likely dispersal of escapees into open water, would be expected to reduce the striped bass escapee density to levels that would be unlikely to affect population levels of local fish species.

Overall, striped bass are non-native to the Pacific, and though historical stocking efforts have helped a discrete population to establish >500 miles to the north, geographic expansion of the population has not occurred and it therefore seems highly unlikely that escapees from Mexican net pens would establish viable populations, especially given the lack of suitable spawning habitat in the area. Escapees may, however, have some impact on wild species through direct predation or competition for food resources. The score for Factor 6.2 is therefore 6 out of 10.

Conclusions and Final Score

The final score for Criterion 6 – Escapes is a combination of the escape risk and the potential impacts of escapees. Although best management practices are in place for escape prevention and no escapes are reported by the industry's single producer, the net pens used are inherently vulnerable to both large-scale and small-scale escapes; the score for Factor 6.1 is 4 out of 10. Striped bass are non-native to the Pacific coast of North America, and despite a decades-long stocking program throughout California, only a discreet population in San Francisco Bay remains. The likelihood of significant impacts to native species either near to or distant from the farm site is low, but short-term predation impacts are possible; the score for Factor 6.2 is 6 out of 10. Ultimately, the final score for Criterion 6 – Escapes is 5 out of 10.

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: preventing population-level impacts to wild species through the amplification and retransmission, or increased virulence of pathogens or parasites.

Criterion 7 Summary

Disease Risk-based assessment

Pathogen and parasite parameters	Score	
C7 Disease Score (0-10)	4	
Critical?	NO	YELLOW

Brief Summary

The State Committee on Health and Safety of Baja California (*Comité Estatal de Sanidad e Inocuidad De Baja California A.C.* – CESAIBC) considers striped bass to be susceptible to two notifiable diseases listed by the World Organization for Animal Health, OIE: Red Sea Bream Iridovirus (RSIV) and Viral Hemorrhagic Septicemia (VHS). These diseases have not been detected in routine (independent) monitoring. Average monthly mortality in 2018 was 2.82%, but no classification records are available to indicate what proportion of mortality is due to infectious diseases. The primary pathogens treated (with antibiotics) from 2016 to 2018 were *Tenacibaculum maritimum*, *Vibrio* (species not identified) and *Flexibacter columnaris.* Various parasites have also been noted as requiring treatment. There are very little data with which to understand potential impacts to wild fish in the area, but since disease related mortalities are considered to be on the farm and the production system is open to the introduction and discharge of pathogens, there is an inherent risk of pathogen amplification and retransmission to native fish. Therefore, the final score for Criterion 7 – Disease is 4 out of 10.

Justification of Rating

Although useful farm-level data on parasites and pathogens were provided for the production fish, there are no data with which to robustly understand the impact of on-farm diseases to wild fish in the area. The data score for disease is 5 out of 10 (in Criterion 1 – Data); therefore, the Risk-Based Assessment option in the Seafood Watch Aquaculture Standard was used.

According to the State Committee on Health and Safety of Baja California (*Comité Estatal de Sanidad e Inocuidad De Baja California A.C.* – CESAIBC), striped bass are susceptible to the following notifiable diseases listed by the World Organisation for Animal Health (OIE):

- Red Sea Bream Iridovirus (RSIV)

- Viral Hemorrhagic Septicemia (VHS)

Should outbreaks of these diseases occur, any aquaculture operation in the state would be required to report them to CESAIBC; to date, annual independent PCR screening for both diseases have returned "undetected" results (records provided by Pacifico Aquaculture for 2016 to 2018 annual screenings). According to CESAIBC's technical specification for striped bass ("Lobina Rayada"), no causative agents of diseases have been detected of economic importance to the species. In contrast, the company reports that a variety of pathogens and parasites have affected production and required treatment (see Criterion 4 – Chemical Use for additional treatment information).

In the last three years (2016 to 2018), the company has detected the following parasites and pathogens (note these are reported from the freshwater hatchery in addition to the growout site).

Table 6: Parasitic pathogens identified at Pacifico Aquaculture from 2016-2018. Data from Pacifico Aquaculture

Parasites		
Causative agent	**Common name**	**Primary chemical treatment**
Benedenia sp.	Pulgas	Hydrogen peroxide or formalin
Cymothoa sp.	Cimotoidos	Not treated to date at Pacifico
Ichthyobodo sp.	Costiosis	Not treated to date at Pacifico
Epistylis sp.	Epistilis	Hydrogen peroxide
Lernea sp.	Lerneosis	Formalin
Microcotyle sp.	Fluke	Hydrogen peroxide or formalin
Cryptocaryon irritans	Punto blanco	Hydrogen peroxide or formalin
Trichodina sp.	Tricodinas	Hydrogen peroxide and paracetic acid
Vorticella sp.	Vorticelaas	Hydrogen peroxide and paracetic acid
Neascus sp.	Punto negro, black pepper	Not treated to date at Pacifico

Table 7: Bacterial pathogens identified at Pacifico Aquaculture from 2016-2018. Data from Pacifico Aquaculture

Bacterial Infections		
Causative agent	**Common (local) name**	**Treatment**
Flavobacterium sp.	Flavobacteriosis	Antibiotic – Romet 30 TC Antibiotic – florfenicol
Aeromonas salmonicida subsp. *achromogenes* and *masoucida*	Atypical Furrunculosis atípica	Not treated to date at Pacifico Aquaculture
Pseudomonas putida and *Pseudomonas fluorescens*	Peste roja/red plague	Antibiotic – florfenicol
Pseudomonas sp. *Aeromonas* sp. Mycobacterias y Mixobacterias	Podredumbre de aletas/fin rot	Nutritional supplements (e.g., vitamin C)

Aeromonas hydrophila, A. formicans, A. liquefacienciens y A. sobria	Septicemia by mobile aeromonas	Antibiotic – oxytetracycline
Staphylococcus sp.	Staphylococosis	Antibiotic - oxytetracycline
Tanacibaculum aritimum	Tenacibaculosis	Various – hydrogen peroxide, Antibiotics – Romet 30, oxytetracycline, florfenicol
Vibrio anguillarum, *Vibrio* spp. *Vibrio spendidus*	Vibriosis	Antibiotic – florfenicol

Regarding the potential impact to farmed fish, an example of monthly mortality data was provided by Pacifico Aquaculture for the calendar year of 2017. The data show an average monthly mortality of 2.82% with a minimum of 0.46% and a maximum of 10.45%, but these figures represent total mortalities, of which disease will be one of many causes of mortality. According to the industry's sole producer, the very small size at stocking in the marine net pens (~5 g, compared to 70 g to 170 g for salmon) causes a significant daily mortality after transfer from the freshwater hatchery primarily associated with an insufficient osmoregulatory capacity to cope with the abrupt change from freshwater to seawater causing a stress that favors the appearance of mucus, which is vulnerable to the development of parasitosis (i.e., as opposed to an infectious disease of interest to this Disease Criterion).

Examining the chemical treatment records (discussed in Criterion 4 – Chemical Use) shows the pathogens treated were *Tenacibaculum maritimum*, Vibrio (species not identified), and Flexibacteriosis (*Flexibacter columnaris*). Prior to late 2018 (due to a change in veterinary staff), there was no regular diagnosis, classification, and/or recording of the causes of death. With new veterinary staff, records will now be kept, but until a track record is available, there are no robust data on the mortality of striped bass due to parasites and bacterial/viral pathogens.

With no movements of live striped bass into or out of the production area, all the parasites and pathogens listed above (Tables 6 and 7) are considered to originate in the local environment, and due to the open nature of the net pen growout system, there is an inherent risk of pathogen amplification and retransmission to native wild fish, even though these fish are the most likely source of initial infection in the system. There is also a risk of pathogen transfer from the hatchery to the marine growout site, although again, these are likely to mimic natural pathogen movements from freshwater environments to the ocean.

Conclusion and Final Score

Without data on the impact of on-farm pathogens to wild species, the Risk-Based Assessment option was used. Data from the industry indicate the occurrence of some disease related mortalities on the farm and that survival is occasionally reduced for undetermined reasons. The net pen production system is open to the introduction and discharge of pathogens and there is an inherent risk of pathogen amplification and retransmission to native fish. Therefore, the final score for Criterion 7 – Disease is 4 out of 10.

Criterion 8X: 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: using eggs, larvae, or juvenile fish produced from farm-raised broodstocks thereby avoiding the need for wild capture.

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. A score of zero means there is no impact

Criterion 8X Summary

Source of stock parameters	Score	
C8 Independence from unsustainable wild fisheries (0-10)	-0.0	
Critical?	NO	GREEN

Brief Summary

With a purpose-built hatchery and dedicated broodstock facility, striped bass production is fully independent of wild fisheries for broodstock and juveniles. The final score for Criterion 8X – Source of Stock is therefore a deduction of 0 out of –10.

Justification of Rating

The industry is supported by one purpose-built freshwater hatchery at the shore base in the town of Ensenada. The broodstock are of farm origin, having been domesticated from strains originally imported from the east coast of the United States (Delmarva Aquatics, Delaware). The marine site at Isla Todos Santos holds broodstock before they are transferred to the hatchery for spawning. With this system, there is no sourcing of any wild broodstock or fry for its operations.

The final score for Criterion 8X – Source of Stock is 0 out of –10.

Criterion 9X: Wildlife and predator mortalities

Impact, unit of sustainability and principle

- Impact: mortality of predators or other wildlife caused or contributed to by farming operations
- Sustainability unit: wildlife or predator populations
- Principle: aquaculture populations pose no substantial risk of deleterious effects to wildlife or predator populations that may interact with farm sites.

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. A score of zero means there is no impact.

Criterion 9X Summary

Wildlife and predator mortality parameters	Score	
C9X Wildlife and predator mortality Final Score (0-10)	-2	
Critical?	NO	GREEN

Brief Summary

The Isla Todos Santos site is considered of high ecological importance with several endemic species. In addition to the net pen arrays adjacent to the shore, the company operates a small shore base on the southern island (Todos Santos Sur). The original EIA report identifies the colonies of seals, sea lions, and large numbers of birds as the primary concern for interaction with the farm, but the company has a comprehensive written policy of exclusion, which was observed in practice with seal and bird nets on all net pens. Though impossible to verify, the company reports no accidental (e.g., entanglement) or deliberate mortalities. The dominant impact to wildlife species on the island or in its waters has been shown to be the historical introduction of rabbits and cats. The current shore-based activities are considered to have a minimal impact on the island's flora and fauna. Overall, the farm is in an area of high ecological value and inevitably interacts to some extent with marine mammals and birds; however, preventive measures appear sufficient to limit any mortalities to exceptional cases. The final numerical score for Criterion 9X – Wildlife Mortalities is –2 out of –10.

Justification of Rating

There are over 230 islands and islets in northwest (NW) Mexico harboring considerable biodiversity, including a wide taxonomic range of endemics (Knowlton et al. 2007) (Donlan et al. 2000 and references within). The presence of farmed fish in net pens, at higher densities than they are found in the wild, inevitably attracts opportunistic coastal marine mammals, seabirds, and fish that normally feed on native fish stocks (Sepulveda et al. 2015). According to the EIA report for the Isla Todos Santos site, pinnipeds (mainly sea lions and harbor seals) and various species of birds have the highest potential to interact with the site. Elephant seals also use the islands as a haul-out site, but Pacifico Aquaculture reports they have not been seen to interact with the farm's net pens. Donlan et al. (2000) report that double-crested and Brandt's cormorants and western gulls nest on the island, and the presence of the now-extirpated Cassin Auklet (see information on introduced cats below). During the site visit in May 2016, both harbor seals and sea lions were seen to be hauled out on the island, and two harbor seals were observed on the floating collars of the farm's net pens. A large number of birds and bird species were also observed. An island conservation group, *Grupo de Ecología y Conservación de la Isla*, is involved in the "integrated conservation and sustainable development of the islands of Mexico," but attempts to establish contact with them during the writing of this assessment were unsuccessful, and the website[19] does not show any active projects at Isla Todos Santos.

In the broader Baja California coastal region, Arrallano-Peralta and Medrano-Gonzalez (2015) report there are 43 marine mammal species, of which 8 are threatened, including the critically endangered Vaquita (*Phocoena sinus*); however it is important to note that this region also includes eastern coastlines on the Gulf of California. Figure 15 taken from Arrallano-Peralta and Medrano-Gonzalez shows the species richness in the region of the Isla Todos Santos to be of moderate marine mammal species richness, and after assessing a variety of human impacts in the region, they did not list aquaculture as a threat (Arrallano-Peralta and Medrano-Gonzalez 2015).

Pacifico Aquaculture's Environmental Best Management Plan details predator avoidance and deterrence measures, which are primarily aimed at exclusion. The company reports that no seals or sea lions have been accidentally or deliberately killed at the site since the company's operations began, and all the farm's pens were seen to be covered with well-tensioned bird nets and surrounded by seal exclusion nets underwater and above the surface.[20] The company's Environmental Best Management Practices manual states a policy of no lethal control; however, it is impossible to verify that there have been no mortalities. There do not appear to be any legal requirements in Mexico to report wildlife mortalities.

[19] https://www.islas.org.mx/

[20] The predator nets allow seals to rest on the walkway around the edge of each circular pen but prevent them from entering the pen itself.

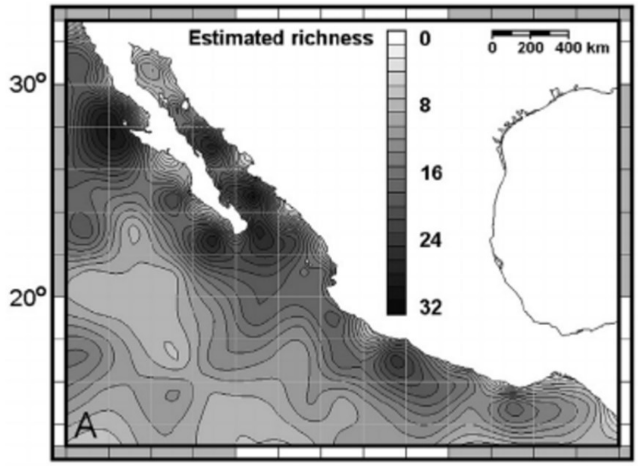

Figure 13. Maps of species richness for the Pacific coast of Mexico. Image copied from (Arrallano-Peralta and Medrano-Gonzalez 2015).

The company also operates a small shore base on the main (south) island (Todos Santos Sur) with security staff and basic facilities for farm workers. Donlan et al. (2000) show that this facility was previously built to service an abalone farm that occupied the site prior to tuna ranching operations and, subsequently, Pacifico Aquaculture's operations (Donlan et al. 2000). Isla Todos Santos, and specifically the South Island, are reported to be "depauperate[21] in botanical endemism"; however, Donlan et al. (2000) and references therein note there are three endemic extant vertebrates:

- Todos Santos ringneck snake *(Diadophis punctatus anthonyi*)
- Todos Santos mountain kingsnake (*Lampropeltis zonata herrarae*)
- Todos Santos white-footed mouse (*Peromyscus maniculatus dubius*)

Although it is possible that the activities at the shore site disturb these organisms, the activities cover a very small area. During the site visit, a tourist boat was also seen to moor off the southern island and shuttle passengers to the island. According to Knowlton et al. (2007) and Donlan et al. (2000), the dominant impact to the island's biodiversity has been the introduction of cats and rabbits in the early and mid-1900s (trapping efforts in 1997 and 1998 subsequently removed them), and the prior extinction of endemic species and the local extinction of other species is attributed to the cats. The current activities of Pacifico Aquaculture in the very restricted area of the shore base are therefore not considered to be a significant threat to the wildlife species inhabiting the island or the wider group of islands.

Conclusions and Final Score

The colonies of seals and sea lions and large numbers of birds (observed during the site visit) are the primary concern for wildlife interactions with the farm, but the company has a comprehensive written policy of exclusion, which was observed in practice with seal and bird

[21] Lacking in numbers or variety of species

nets on all net pens. Although there are no official reporting requirements or data, it is reported that no accidental (e.g., entanglement) or deliberate mortalities have occurred. The dominant impact to the island has been shown to be the introduction in the last century of rabbits and cats, and the latter have been associated with the extinction of two endemic species (the Todos Santos rufous-crowned sparrow and the Todos Santos wood rat) and the extirpation of the non-endemic Cassin auklet. Overall, the farm is in an area of high ecological value, and inevitably interacts to some extent with marine mammals and birds; however, preventive measures appear sufficient to limit any mortalities to exceptional cases. The final numerical score for Criterion 9X – Wildlife Mortalities is –2 out of –10.

Criterion 10X: Escape of secondary species

Impact, unit of sustainability and principle

- Impact: movement of live animals resulting in introduction of unintended species
- Sustainability unit: wild native populations
- Impact: aquaculture operations by design, management or regulation avoid reliance on the movement of live animals, therefore reducing the risk of introduction of unintended species.

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

Criterion 10X Summary

Escape of secondary species parameters		Score	
F10Xa International or trans-waterbody live animal shipments (%)		10	
F10Xb Biosecurity of source/destination		n/a	
C10X Escape of secondary species Final Score		**-0.00**	**GREEN**

Brief Summary
Striped bass are non-native in the Pacific, and although there is an established population in the San Francisco Bay with historic active stocking of hatchery-raised fish, Pacifico Aquaculture originally imported juveniles and broodstock from a selective breeding program in Delaware in the United States. The company now has a broodstock unit at the Isla Todos Santos site and a freshwater hatchery established on the mainland in Ensenada. Movements of fish between these two locations on either side of Ensenada Bay are considered to be within the same waterbody, and there are also quarantine facilities at the hatchery. Production is now considered independent of international or trans-waterbody movements of fish, and the final numerical score for Criterion 10X – Escape of Secondary Species is a deduction of 0 out of –10.

Justification of Rating
This criterion provides a measure of the escape risk (introduction to the wild) of species <u>other than the principal farmed species</u> unintentionally transported during animal shipments.

Factor 10Xa International or trans-waterbody live animal shipments
Striped bass are non-native in the Pacific, and although there is an established population in the San Francisco Bay with stocking of hatchery-raised fish in the past, Pacifico Aquaculture originally imported juveniles and broodstock from 2012 to 2014 from a selective breeding program in Delaware in the United States (Delmarva Aquatics). Since then, broodstock cages

have been located at the Isla Todos Santos site and with the hatchery in Ensenada, the company is now considered independent of imports of live animals.

A routine movement of fish also occurs between the freshwater hatchery and the sea site, but this is considered to be in the same waterbody, particularly as the primary source of unintended organisms coming into the hatchery would be the movement of broodstock from the sea site into the hatchery (where quarantine procedures were observed on the site visit). Therefore, there are not considered to be any international or trans-waterbody movements of live fish, and the score for Factor 10Xa is 10 out of 10.

Factor 10Xb Biosecurity of source and destination

Since international or trans-waterbody movements of fish do not occur, and Factor 10Xa is scored 10 out of 10, Factor 10Xb is not relevant.

Conclusions and Final Score

With no international or trans-waterbody movements of fish, Factor 10Xb is not relevant, and the final numerical score for Criterion 10X – Escape of Secondary Species is a deduction of 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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References

AMS. 2018a. Todos Santos South - Biomass and benthic footprint determination. Anderson Marine Surveys Ltd. AMSL Report No 18/04.1 – rev0. April 2018.

AMS. 2018b. Todos Santos North - Biomass and benthic footprint determination. Anderson Marine Surveys Ltd. AMSL Report No 18/09.1 – rev0. September 2018.

Anonymous. 2016. Baja's Hurricane History. Bajainsider.com. http://www.bajainsider.com/article/bajas-hurricane-history

Arismendi, L. (2012). "Differential Invasion Success of Atlantic and Pacific Salmon in Southern Chile: Patterns and Hypotheses " American Fisheries Society 142nd Annual meeting abstract M-10-19.

Arrallano-Peralta, V., Medrano-Gonzalez. L. 2015. Ecology, conservation and human history of marine mammals in the Gulf of California and the Pacific coast of Baja California. Ocean and Coastal Management, 104, 90-105.

Bajamahi, S.A. 2002. Acuacultura de Atun Aleta Azul, Jurel y Atun Aleta Amarilla, en aguas costeras se las Isla Todos Santos, Baja California, Mexico. Bajamachi S.A. Ensenada, Mexico. January 2002.

Black, K., P. K. Hansen, and M. Holmer. 2008. Working Group Report on Benthic Impacts and Farm Siting. Salmon Aquaculture Dialogue, WWF.

Callihan, J., Harris, J., Hightower, J.2015 Coastal Migration and Homing of Roanoke River Striped Bass. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 7:301–315.

CDFG. 1931. Striped bass – life history notes. Vol 17, p488, Sacramento, October 1931.

CDFG. 1991. Conservation plan for The California Department of Fish and Game Striped Bass Management Plan.

CDFG, 2001. Striped Bass. California Living Resources – A status report. P450-464.

CESAIBC (2016a). Lobina Rayada (Morone saxatilis). Ficha Técnica Sanitaria de Especies de Cultivo en el Estado. Comité Estatal De Sanidad E Inocuidad De Baja California. http://www.cesaibc.org/sitio/archivos/FICHA%20TEC.%20SANITARIA%20DE%20LOBINA%20RAYADA_070616204229.pdf

CESAIBC (2016b) Produccion de Peces de Cultivo en Baja California. Comité Estatal De Sanidad E Inocuidad De Baja California.

http://www.cesaibc.org/sitio/archivos/Producci%C3%B3n%20de%20Peces%20de%20Cultivo%20en%20Baja%20California_280116132531.pdf

Donlan, C., Tershy, B., Keitt, B., Sanchez, J., Wood, B., Weinstein, A., Croll, D., Hermosillo, M., and Aguilar, J. (2000). "Island conservation action in Northwest México." Proceedings 5th Calif. Islands Symposium: 330-338.

FAO. 1997. Report of the seventeenth session of the Coordinating Working Party on Fishery Statistics. Hobart, Tasmania, 3-7 March 1997. FAO Fisheries Report. No. 555. Rome, FAO. 1997. 43p.

FAO. 2016. National Aquaculture Legislation Overview – Mexico. Food and Agriculture Organization of the United Nations.
http://www.fao.org/fishery/legalframework/nalo_mexico/en

Gingras 2010. CDFG Annual Project Performance Report. Grant number: F-123-R-1 Grant name: Inland and Anadromous Sport Fish Management and Research Project number and name: #71 – Bay-Delta Sport Fish Resource Assessment – Striped Bass

Holmyard, N. 2017. Cargill leveraging scale to bring changes to fishmeal market. SeafoodSource.com. June 26, 2017.

Husa, V., Kutti, T., Ervik, A., Sjøtun, K., Kupka, P., Aure, H. 2014. Regional impact from fin-fish farming in an intensive production area (Hardangerfjord, Norway), Marine Biology Research, 10:3, 241-252, DOI: 10.1080/17451000.2013.810754

Karahadian, C., Fowler, K. P., & Cox, D. H. 1995. Comparison of chemical composition of striped bass (Marone saxatilis) from three Chesapeake Bay tributaries with those of two aquaculture hybrid striped bass types. Food Chemistry, 54(4), 409–418.

Keeley KN, Cromey CJ, Goodwin EO, Gibbs MT, MacLeod CK. 2013. Predictive depositional modelling (DEPOMOD) of the interactive effect of current flow and resuspension on ecological impacts beneath salmon farms. Aquaculture Environment Interactions. 3:3, 275-291.

Keeley NB, Forrest BM, Macleod CK 2015. Benthic recovery and re-impact responses from salmon farm enrichment: Implications for farm management. Aquaculture. Volume 435. Pages 412-423.

Knowlton, J., Donlan, C., Roemer, G., Samaniego-Herrera, A., Keitt, G., Wood, B., Aguirre-Muñoz, A., Faulkner, K., Bershy, B.2007. Eradication of Non-Native Mammals and the Status of Insular Mammals on the California Channel Islands, USA, and Pacific Baja California Peninsula Islands, Mexico. The Southwestern Naturalist. Vol. 52, No. 4 (Dec., 2007), pp. 528-540

Lillicrap, A., Macken, A., Thomas, K. (2015). Recommendations for the inclusion of targeted testing to improve the regulatory environmental risk assessment of veterinary medicines used in aquaculture. Environment international. 85. 1-4. 10.1016/j.envint.2015.07.019.

Loboschefsky, E., G. Benigno, T. Sommer, Rose, K. T. Ginn, A. Massoudieh, K. Rose, and F. Loge. 2012. Individual-level and Population-level Historical Prey Demand of San Francisco Estuary Striped Bass Using a Bioenergetics Model. San Francisco Estuary and Watershed Science, 10(1), p1-23.

NOAA. 2015. Fish Facts – striped bass. National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Office. Website accessed August 24 2016. http://chesapeakebay.noaa.gov/fish-facts/striped-bass

Nobriga, M., Loboschefsky, E., & Feyrer, F. 2013 Common Predator, Rare Prey: Exploring Juvenile Striped Bass Predation on Delta Smelt in California's San Francisco Estuary. Transactions of the American Fisheries Society Volume 142, Issue 6, 2013

Ostrach et al 2008. Maternal transfer of xenobiotics and effects on larval striped bass in the San Francisco Estuary. PNAS December 9, 2008 vol. 105 no. 49 19353–19358

Price C, Black KD, Hargrave BT, Morris JA Jr (2015) Marine cage culture and the environment: effects on water quality and primary production. Aquacult Environ Interact 6:151-174. https://doi.org/10.3354/aei00122

Raddovich, J. 1961. Relationships of Some Marine Organisms of the Northeast Pacific to Water Temperatures Particularly During 1957 Through 1959. California Dept Fish Game. Fish Bulletin No. 112.

RUMA. 2019. Responsible use of Antimicrobials in Fish Production. RUMA - Responsible use of Medicines in Agriculture. https://www.ruma.org.uk/fish/responsible-use-antimicrobials-fish-production/. Website accessed January 2019, Guidelines document is dated 2004.

Sabala, M., Hayes, S.,, Merzc, J., Setkad, J. 2015. Habitat Alterations and a Nonnative Predator, the Striped Bass, Increase Native Chinook Salmon Mortality in the Central Valley, California. North American Journal of Fisheries Management, Volume 36, Issue 2, 2016,201-214.

Stevens, 1980. Marine Recreational Fisheries 5. Proceeding of the Fifth Annual Marine Recreational Fisheries Symposium Boston, Massachusetts, March 27-28, 1980. Clepper, H. Ed.

Svåsand T., Grefsrud E.S., Karlsen Ø., Kvamme B.O., Glover, K. S, Husa, V. og Kristiansen, T.S. (red.). 2017. Risikorapport norsk fiskeoppdrett 2017. Fisken og havet, særnr. 2-2017

Taranger, G. L., Karlsen, Ø., Bannister, R. J., Glover, K. A., Husa,V., Karlsbakk, E., Kvamme, B. O., Boxaspen, K. K., Bjørn, P. A., Finstad, B., Madhun, A. S., Morton, H. C., and Sva˚sand, T. 2015.

Risk assessment of the environmental impact of Norwegian Atlantic salmon farming. – ICES Journal of Marine Science, 72: 997–1021.

WHO (2011). "Critically important antimicrobials for human medicine. 3rd revision - 2011." World Health Organization.

About Seafood Watch®

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

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

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

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

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Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished[22] 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

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

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

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

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

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

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

Appendix 1 - Data points and all scoring calculations

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

Criterion 1: Data Quality and Availability

Data Category	Data Quality (0-10)
Industry or production statistics	10
Management	7.5
Effluent	7.5
Habitats	7.5
Chemical use	7.5
Feed	10
Escapes	5
Disease	5
Source of stock	10
Predators and wildlife	7.5
Unintentional introduction	10
Other – (e.g. GHG emissions)	n/a
Total	**87.5**

C1 Data Final Score (0-10)	**7.95**	**GREEN**

Criterion 2: Effluent

Effluent Evidence-Based Assessment

C2 Effluent Final Score (0-10)	**8**	**GREEN**
Critical?	NO	

Criterion 3: Habitat

Factor 3.1. Habitat conversion and function

F3.1 Score (0-10)	7

Factor 3.2 – Management of farm-level and cumulative habitat impacts

3.2a Content of habiat management measure	4
3.2b Enforcement of habitat management measures	3
3.2 Habitat management effectiveness	**4.8**

C3 Habitat Final Score (0-10)	**6**	**YELLOW**
Critical?	NO	

Criterion 4: Evidence or Risk of Chemical Use

Chemical Use parameters	Score	
C4 Chemical use score (0-10)	**8**	
C4 Chemical Use Final Score (0-10)	**8**	**GREEN**
Critical?	NO	

Criterion 5: Feed

5.1. Wild Fish Use

Feed Parameters	Score
5.1a Fish In : Fish Out (FIFO)	
Fishmeal inclusion level (%)	34
Fishmeal from byproducts (%)	78.5
% FM	7.31
Fish oil inclusion level (%)	14
Fish oil from byproducts (%)	100
% FO	0
Fishmeal yield (%)	23.2
Fish oil yield (%)	9.1
eFCR	2.01
FIFO fishmeal	0.63
FIFO fish oil	0.00
FIFO Score (0-10)	**8.42**
Critical?	NO
5.1b Sustainability of source fisheries	
Sustainability score	-3
Calculated sustainability adjustment	-0.38
Critical?	NO
F5.1 Wild Fish Use Score (0-10)	**8.04**

Critical?	NO

5.2 Net protein Gain or Loss

Protein INPUTS	
Protein content of feed (%)	43
eFCR	2.01
Feed protein from fishmeal (%)	44.00
Feed protein from EDIBLE sources (%)	65.46
Feed protein from NON-EDIBLE sources (%)	34.54
Protein OUTPUTS	
Protein content of whole harvested fish (%)	19.55
Edible yield of harvested fish (%)	40
Use of non-edible by-products from harvested fish (%	100
Total protein input kg/100kg fish	86.43
Edible protein IN kg/100kg fish	56.58
Utilized protein OUT kg/100kg fish	32.80
Net protein gain or loss (%)	-42.03
Critical?	NO
F5.2 Net protein Score (0-10)	**5**

5.3. Feed Footprint

5.3a Ocean Area appropriated per ton of seafood	
Inclusion level of aquatic feed ingredients (%)	48
eFCR	2.01
Carbon required for aquatic feed ingredients (ton C/ton fish)	*69.7*
Ocean productivity (C) for continental shelf areas (ton C/ha)	*2.68*
Ocean area appropriated (ha/ton fish)	25.09
5.3b Land area appropriated per ton of seafood	
Inclusion level of crop feed ingredients (%)	52
Inclusion level of land animal products (%)	0
Conversion ratio of crop ingedients to land animal products	*2.88*
eFCR	2.01
Average yield of major feed ingredient crops (t/ha)	*2.64*
Land area appropriated (ha per ton of fish)	0.40
Total area (Ocean + Land Area) (ha)	25.49
F5.3 Feed Footprint Score (0-10)	1

Feed Final Score

C5 Feed Final Score (0-10)	**5.52**	**YELLOW**
Critical?	**NO**	

Criterion 6: Escapes

6.1a System escape risk (0-10)	4

6.1a Adjustment for recaptures (0-10)	0	
6.1a Escape risk score (0-10)	**4**	
6.2. Invasiveness score (0-10)	**6**	
C6 Escapes Final Score (0-10)	**5**	**YELLOW**
CriticaL?	**NO**	

Criterion 7: Diseases

Disease Evidence-based assessment (0-10)		
Disease Risk-based assessment (0-10)	4	
C7 Disease Final Score (0-10)	**4**	**YELLOW**
Critical?	NO	

Criterion 8X: Source of Stock

C8X Source of stock score (0-10)	0	
C8 Source of Stock Final Score (0-10)	**0**	**GREEN**
Critical?	NO	

Criterion 9X: Wildlife and Predator Mortalities

C9X Wildlife and predator score (0-10)	**-2**	
C9X Wildlife and Predator Final Score (0-10)	**-2**	**GREEN**
Critical?	NO	

Criterion 10X: Escape of Secondary Species

F10Xa live animal shipments score (0-10)	10.00	
F10Xb Biosecurity of source/destination score (0-10)	0.00	
C10X Escape of Secondary Species Final Score (0-10)	**0.00**	**GREEN**
Critical?	n/a	