Monterey Bay Aquarium Seafood Watch®

In collaboration with

SeaChoice.org for healthy oceans

Arctic Char

Salvelinus alpinus

Sustainable Blue, Nova Scotia, Canada

Closed-Containment

January 19, 2013

Jenna Stoner, Independent contractor

Disclaimer

Seafood Watch® strives to ensure all our Seafood Reports and the recommendations contained therein are accurate and reflect the most up-to-date evidence available at time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or 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. We always welcome additional or updated data that can be used for the next revision. Seafood Watch and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

Final Seafood Recommendation

Arctic char raised in closed-containment at Sustainable Blue received an overall green rank and a final score of 9.47. All individual criterion received high scores and ranked green as a result of the farms ability to control on-site farm environments and minimize overall environmental impacts.

Arctic Char

Nova Scotia, Canada
Sustainable Blue – Closed-Containment

Criterion	Score (0-10)	Rank	Critical ?
C1 Data	9.44	GREEN	
C2 Effluent	10.00	GREEN	NO
C3 Habitat	8.79	GREEN	NO
C4 Chemicals	10.00	GREEN	NO
C5 Feed	7.51	GREEN	NO
C6 Escapes	10.00	GREEN	NO
C7 Disease	10.00	GREEN	NO
C8 Source	10.00	GREEN	
3.3X Wildlife mortalities	0.00	GREEN	NO
6.2X Introduced species escape	0.00	GREEN	n/a
Total	**75.75**		
Final Score	**9.47**		

OVERALL RANKING

Final Score	9.47
Initial rank	GREEN
Red Criteria	0
Intermediate Rank	GREEN
Critical Criteria?	NO
Final Rank	BEST CHOICE

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

Executive Summary

Sustainable Blue is a land-based, closed-containment fish farm located in Centre Burlington, Nova Scotia. The farm is one of a few farms in Canada currently farming Arctic char in closed-containment at a commercial scale and they produce a modest 180 mT annually, all of which is sold fresh to regional high-end markets. The small-scale of this farm, relative to the broader aquaculture industry in both Nova Scotia and Canada, greatly limited the amount of publicly available data needed to conduct this assessment. This challenge was overcome by working with the farm owners who were highly cooperative in responding to data requests.

Sustainable Blue operates a state-of-the-art 100% recirculation system and employs stringent biosecurity policies that have allowed them to operate pathogen- and chemical-free. The nature of the closed-containment system allowed for scores of 10 (green) to be achieved in the following criteria: effluent (C2), chemicals (C4), escapes (C6), and disease (c7). The source of stock criterion (C8) also scored 10 (green) because the operation is reliant on sourcing fully domesticated juveniles from a Canadian hatchery.

The habitat criterion scored slightly lower (8.79, green) namely as a result of challenges observed within the effectiveness of local management and regulatory bodies. These challenges stem from the relatively young history of closed-containment aquaculture in Canada such that policy and regulation has yet to 'catch-up' with advances in the industry and hence there are no legislations in place that speak to closed-containment aquaculture directly.

The feed criterion (C5) received a score of 7.51 (green), which resulted from a low wild fish use (due to high by-product inclusion rates), a high net protein gain, and a nominal appropriation of land and ocean area.

Overall, Arctic char farmed in closed-containment at Sustainable Blue received an overall green ranking and a final score of 9.47, suggesting that this product is a good alternative for seafood buyers.

Table of Contents

Introduction

Scope of the Analysis and Ensuing Recommendation

Arctic char (*Salvelinus alpinus*) farming is a growing industry in Canada, however, it is still difficult to identify farms producing quantities at market-scale. Neither Fisheries and Oceans Canada (DFO) nor Statistics Canada publicly publish production volumes or farming details specific to Arctic char farms because there are simply not enough producers from which to aggregate data. Due to challenges faced in identifying and contacting land-based Arctic char producers and the dependency on producer participation to acquire the necessary data, this assessment is specific to Arctic char (*Salvelinus alpinus)* raised in closed-containment at Sustainable Blue—a land-based, closed-containment aquaculture facility located in Centre Burlington, Nova Scotia.

Species Overview

Arctic char are part of the salmonid family and genetically are most closely linked to trout. They represent the freshwater species with the most northerly distribution and thrive in the circumpolar region. There are two distinct subgroups: the sea-run group and the freshwater (landlocked) group. Commercial and subsidence fisheries have long targeted the species. Early attempts to hatch and fertilize Arctic char eggs occurred in the early 1980s and on-growing began in the 1960s (Icelandic Fisheries n.d.). In Canada, research into Arctic char aquaculture first took off in the late 1970s at the Fisheries and Oceans Canada's Freshwater Institute in Winnipeg and the Huntsman Marine Science Laboratory in New Brunswick (DFO 2006).

Although it has a relatively long exploratory research history, the Arctic char farming industry has been slow to take off due to challenges faced in breeding and strain selection that will perform for consistency. The Food and Agriculture Organization (FAO) Fishery and Aquaculture Global Statistics (2012) states that Iceland, Norway, Italy, Austria, Ireland, the United Kingdom and the U.S. produced aproximately 3200 tonnes of Arctic char in 2010, which is negligable compared to other more widely produced species such as Atlantic salmon, of which approximately 1.4 million tonnes was produced globally in 2010. Note that although Canada is considered a leading producer of farmed Arctic char (PEI Department of Agriculture and Forestry 2000; Marsh 2006), national production values are not available and the countries production volume is not included in the FAO Fishery and Aquaculture Global Statistics 2010 estimate of global Arctic char production.

Sustainable Blue is currently one of the few farms in Canada to be farming Arctic char at a commercial scale. They produce approximately 180 mT annually. All of the product is sold fresh, with approximately 50% sold as fillets and 50% as head-on gutted, to high end restaurants across the country.

Analysis

Scoring guide

- Excluding the exceptional factors (3.3x and 6.2X), all scores result in a zero to ten final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of ten indicates high performance. In contrast, the two exceptional factors result in negative scores from zero to minus ten, and in these cases zero indicates no negative impact.
- The full Seafood Watch Aquaculture Criteria that the following scores relate to are available here.
- The full data values and scoring calculations are available in Annex 1.

Criterion 1: Data Quality and Availability

Impact, unit of sustainability and principle

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

Criterion 1 Summary

Data Category	Relevance (Y/N)	Data Quality	Score (0-10)
Industry or production statistics	Yes	10	10
Effluent	Yes	10	10
Locations/habitats	Yes	7.5	7.5
Predators and wildlife	Yes	10	10
Chemical use	Yes	10	10
Feed	Yes	7.5	7.5
Escapes, animal movements	Yes	10	10
Disease	Yes	10	10
Source of stock	Yes	10	10
Other – (e.g. GHG emissions)	no	not relevant	n/a
Total			**85**

C1 Data Final Score	**9.44**	**GREEN**

Justification of Ranking

Sustainable Blue is one of a few farms raising Arctic char in a closed-containment system and they represent a relatively small portion of the aquaculture industry both at a provincial and national scale. Because of this, and in order to protect business identity, production values and farm-specific data are not disclosed by Statistics Canada, the Department of Fisheries and Oceans (DFO), or by the Nova Scotia Department of Fisheries and Aquaculture. The farm owners, however, were highly cooperative in the assessment process and provided much of the required information. Additionally, the farm maintains a relatively informative website that provides a description of their farm site and addresses general farming practices.

For all data categories that received a data quality score of 10 (production statistics, effluent, predators and wildlife, chemical use, escapes, disease and source of stock) the president and co-owner of Sustainable Blue, Jeremy Lee, provided the needed information.

Farm location and siting details were provided in part by Lee and through Sustainable Blue's website, however further details were taken form Nova Scotia's agriculture and fisheries department in order to accurately score the management effectiveness factors included in this criterion. Very few of the provincial and national aquaculture legislations speak directly to land-based systems and thus some data gaps had to be inferred from more general information and, as such, the locations/habitats data category scored a 7.5 for data quality.

Much of the information required in assessing the feed criterion (C5) was provided directly by the feed producer from which Sustainable Blue sources their feed, however, some non-critical data gaps remained, which were addressed by nominal data aggregation. As such, this category scored a 7.5 on data quality.

Overall, a very high data quality score of 9.4 was achieved. It should be noted that due to the scale of production and the focus of this assessment on a single farm that much of the information was not independently verified or peer-reviewed and it was collected over a relatively short time frame. However, with the data provided by the producer and some working background knowledge of the closed-containment system used, the author was able to conduct the assessment with confidence and strongly believes that the assessment properly reflects the sustainability of the farm.

Criterion 2: Effluents

Impact, unit of sustainability and principle

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

Criterion 2 Summary

Effluent Rapid Assessment

C2 Effluent Final Score	**10.00**	**GREEN**

Rapid Assessment – used when good quality data clearly defines an appropriate score
The rapid assessment was used here because the data quality for this criterion was high and the nature of the closed-containment production system greatly minimizes the concern of effluents.

Justification of Ranking
Sustainable Blue operates as a land-based, closed-containment system with 100% water recirculation. This system allows for the collection and treatment of solid effluent. At this time, effluent slurry is kept in a large tank with bacteria that allow anaerobic fermentation to convert nitrogen wastes into nitrogen gas. All left over solid wastes are then trucked, once per year, to a landfill (Jeremy Lee, pers. comm.). In the future, Sustainable Blue hopes to use the collected effluent slurry as fertilizer; however, they are still in the development phase for this project.

Criterion 3: Habitat

Impact, unit of sustainability and principle

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

Criterion 3 Summary

Habitat parameters	Value	Score	
F3.1 Habitat conversion and function		10.00	
F3.2a Content of habitat regulations	3.75		
F3.2b Enforcement of habitat regulations	4.25		
F3.2 Regulatory or management effectiveness score		6.38	
C3 Habitat Final Score		**8.79**	**GREEN**
Critical?	NO		

Justification of Ranking

Factor 3.1. Habitat Conversion and Function

The farm is located on 55 acres of woodland in Centre Burlington, NS. Prior to its conversion into an aquaculture farm, the site was an old orchard that was no longer productive. The land borders the Avon Estuary, however, the farm is sited 1.5 km from the high water mark (Jeremy Lee, pers. comm.). Given that the farm operates at 100% recirculation and does not discharge wastes, it was determined that the farm is maintaining full functionality of the surrounding habitat.

Factor 3.2. Habitat and Farm Siting Management Effectiveness (appropriate to the scale of the industry)

This factor is certainly the weakest scoring within this criterion, however, this is more reflective of lagging management and regulatory regimes at a larger scale. As is often the case with most advancement in industry technology, closed-containment aquaculture can be viewed as being ahead of the curve whereby the technology is being developed and implemented at a faster rate than regulation and policy can be drafted and implemented for appropriate management. The farm is adherent to current national and provincial legislation, which are enforced by the Department of Fisheries and Oceans (DFO) and the Nova Scotia Department of Fisheries and Aquaculture (NSDFA), respectively. Both regulatory bodies have thorough regulation that addresses growth and siting of the aquaculture industry, however, much of it speaks specifically to net pen and cage farming. For instance, Nova Scotia released the Environmental Monitoring Program in 2005 that is quite comprehensive, however, at this point it does not address land-

based aquaculture sites. Personal communications with NSDFA identified that land-based facilities are subject to regulatory review and some approvals have required site specific monitoring.

At this time, the more general regulations designed for net pen aquaculture set out by DFO and NSDFA were applied to this assessment in order to ensure that a conservative approach is taken to this assessment. By doing so, the assessment reflects the fact that a regulatory body exists, and also accounts for the lag in developing closed-containment specific regulation. Overall, this approach ensures the effectiveness of management score is not over- or understated.

According to DFO's frequently asked questions webpage "in the ***vast majority of cases***, aquaculture operations undergo a thorough environmental assessment and appropriate mitigating measures are adopted before the facilities can be approved" (DFO 2005). According to section 19(a) of the *Canadian Environmental Act*, all projects undergoing an environmental impact assessment (EIA) must include a review of cumulative impacts. The Canadian Environmental Assessment Agency (CEAA) maintains an online, publicly available database of all ongoing and completed environmental assessments. While undergoing the siting process, proposed aquaculture farms must consider cumulative impacts of neighboring industries and avoid high-value habitats (DFO 2005). The future expansion of the industry does not appear to be limited at this time, while in fact both the provincial and national government are throwing their support behind the aquaculture industry in general. Overall, the regulatory and management regime was deemed to be moderately effective and a score of 3.75 was awarded.

Enforcement personnel at both the provincial (NS Department of Fisheries and Aquaculture (NSDFA)) and federal level (DFO) could be identified and their capacity appears to be sufficient for the current scale of the industry. The enforcement process, however, is only nominally transparent as the NSDFA provides a map of active aquaculture farms, but environmental impact assessments (EIAs) and zoning reports are challenging to come by, particularly for closed-containment aquaculture sites. Resultantly, the siting regulatory or management enforcement factor (F3.2b) scored 4.25.

Overall, a score of 6.38 was achieved for the effectiveness of regulatory and management regimes due to a moderate-high degree of content and enforcement of habitat regulations.

Factor 3.3X: Wildlife and Predator Mortalities

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

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

Factor 3.3X Summary

Wildlife and predator mortality parameters	Score	
F3.3X Wildlife and predator mortality Final Score	**0.00**	**GREEN**
Critical?	NO	

Justification of Ranking

F3.3X Wildlife and Predator Score
The farm operates as a land-based system where tanks are located in fully enclosed buildings. As such there are no interactions with wildlife or predators and this factor is of no concern.

Criterion 4: Evidence or Risk of Chemical Use

Impact, unit of sustainability and principle

- *Impact: improper use of chemical treatments impacts non-target organisms and leads to production losses and human health concerns due to the development of chemical-resistant organisms.*
- *Sustainability unit: non-target organisms in the local or regional environment, presence of pathogens or parasites resistant to important treatments.*
- *Principle: aquaculture operations by design, management or regulation avoid the discharge of chemicals toxic to aquatic life, and/or effectively control the frequency, risk of environmental impact and risk to human health of their use.*

Criterion 4 Summary

Chemical Use parameters	Score	
C4 Chemical Use Score	**10.00**	
C4 Chemical Use Final Score	**10.00**	**GREEN**
Critical?	NO	

Justification of Ranking

The Sustainable Blue website (2012) states that they are a disease-free farm and hence do not apply any chemicals on-site; a statement that was confirmed by president and co-owner, Jeremy Lee. In addition, the production system operates at 100% recirculation and no wastewater is ever discharged, which suggests that if chemical treatments did need to be applied, then active chemicals or by-products could not be released into the environment. Overall, this criterion was rated as being of no concern resulting in a score of 10 (green).

Criterion 5: Feed

Impact, unit of sustainability and principle

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

Criterion 5 Summary

Feed parameters	Value	Score	
F5.1a Fish In: Fish Out ratio (FIFO)	0.96	7.60	
F5.1b Source fishery sustainability score		-6.00	
F5.1: Wild fish use		7.22	
F5.2a Protein IN	6.36		
F5.2b Protein OUT	16.98		
F5.2: Net protein gain or loss (%)	157.48	10	
F5.3: Feed footprint (hectares)	10.64	6	
C5 Feed Final Score		**7.51**	**GREEN**
Critical?	NO		

Justification of Ranking

Factor 5.1. Wild Fish Use

The feed used for raising Arctic char at Sustainable Blue was found to have fishmeal and fish oil inclusion levels of 25% and 8% respectively. The feed company that supplies Sustainable Blue sources 50% of their fishmeal and fish oil from by-products of the Canadian herring fishery, which reduced the fishmeal and fish oil inclusion levels to 12.5% and 4%, respectively, for the calculation of this factor. The remainder of the fishmeal and fish oil is sourced from a purse seine Peruvian anchovy fishery, which, under FishSource, scores ≥ 6 on all criteria with the exception of one factor. The Canadian herring fishery remains unassessed by either the Seafood Watch Program or FishSource, but is currently undergoing the Marine Stewardship Council (MSC) certification process. The MSC assessment has yet to be completed, however, and therefor the sustainability of this fishery is considered to be unknown at this time. Resultantly, an overall score of -6 was achieved for the sustainability score for the source of wild fish. This data in combination with the relatively low feed conversion ratio of 1.2 observed on-site allowed for a final score of 7.22 for the wild fish use factor.

Factor 5.2. Net Protein Gain or Loss

The feed used at Sustainable Blue has a protein content of 45% which is derived primarily from fishmeal, corn protein concentrate and soya bean meal. Of these ingredients, the only portion that may be considered fit for human consumption is the fishmeal sourced from a non-byproduct fishery (i.e., the 50% sourced from the Peruvian anchovy fishery) and, as such, it was found that 83.5% of the protein was derived from non-edible sources.

The protein content of a whole harvested Arctic char is 21%, while the edible yield of the fish being harvested is approximated 78% (Jeremy Lee, pers. comm.). The farm did not provide details regarding use of non-edible byproducts from harvested farmed fish and hence this factor was scored as zero. This resulted in an overall net protein gain of 157% and a final score of 10 for factor 5.2.

Factor 5.3. Feed Footprint

The feed used at Sustainable Blue is derived primarily from crop and marine-based ingredients with only a small inclusion level (10%) of land-based animal products. As such, it was found that 0.34 hectares of land area and 10.30 hectares of ocean area are being appropriated per tonne of fish farmed, which results in a final feed footprint score of 6.

Criterion 6: Escapes

Impact, unit of sustainability and principle

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

Criterion 6 Summary

Escape parameters	Value	Score	
F6.1 Escape risk		10.00	
F6.1a Recapture and mortality (%)	0		
F6.1b Invasiveness		3	
C6 Escape Final Score		**10.00**	**GREEN**
Critical?	NO		

Justification of Ranking

Factor 6.1a. Escape Risk

The production system used at Sustainable Blue is a land-based, recirculation system with appropriate treatments and screens that completely eliminates the risk of escapes from the facility. They operate at 100% recirculation and do not discharge any liquid wastes, suggesting there is no discharge pipes through which fish could escape and no connection to natural water bodies, resulting in an overall escape risk score of 10. Additionally, Sustainable Blue does not sell any live fish, which eliminates the risk of unintentional escapes from the marketplace. No details could be found with respect to recapture and mortality of escapees, because this has not been an issue on-site and is not expected to be with the low escape risk.

Factor 6.1b. Invasiveness

Sustainable Blue source their juvenile fish from Icy Waters Ltd. (IWL)—a hatchery and Arctic char farm in the Yukon territory. IWL has been working with Simon Fraser University to develop their genetic broodstock program in which they have been breeding Arctic char and selecting for certain culture-favorable characteristics since 1997 (Jonathan Lucas, pers. comm.). This suggests that current farmed stock is more than four generations hatchery-raised and thus scored a 1 for the genetic difference from wild populations. The ecosystem impact of ongoing escapes received a low-moderate score of 2 as escapees could, in theory, compete with wild native populations for food and habitat, act as additional predation pressure on wild native populations, and may disturb breeding behavior of other species. Overall, a final invasiveness score of 3 was awarded to Arctic char raised at Sustainable Blue.

Factor 6.2X: Escape of Unintentionally Introduced Species

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

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

Factor 6.2X Summary

Escape of unintentionally introduced species parameters	Score	
F6.2Xa International or trans-waterbody live animal shipments (%)	0.00	
F6.2Xb Biosecurity of source/destination	10.00	
C6 Escape of unintentionally introduced species Final Score	**0.00**	**GREEN**

Justification of Ranking

Factor 6.2Xa International or Trans-Waterbody Live Animal Shipments
Sustainable Blue sources their juvenile Arctic char from Icy Waters Ltd.—a hatchery located in the Yukon—which suggests that they are fully reliant on trans-waterbody live animal shipments and this exception factor scored 10.

Factor 6.2Xb Biosecurity of Source/Destination
Icy Waters Ltd. operate a land-based, flow-through hatchery systems, which, according to the scoring table herein, rates as a system of low-moderate biosecurity concern (score of 6). The biosecurity of the destination farm (i.e., Sustainable Blue), however, is of very low concern (score of 10) because as a land-based, closed-containment system with no discharges it has no connection to natural water bodies. As a result of the stringent biosecurity level of the destination farm, this exceptional factor scores zero overall.

Criterion 7. Disease; Pathogen and Parasite Interactions

Impact, unit of sustainability and principle

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

Criterion 7 Summary

Pathogen and parasite parameters	Score	
C7 Biosecurity	10.00	
C7 Disease; pathogen and parasite Final Score	**10.00**	**GREEN**
Critical?	**NO**	

Justification of Ranking

The website states that Sustainable Blue operates as a pathogen-free farm as a result of rigorous husbandry and exhaustive testing of fry and water before they enter the system—a statement that was confirmed by president and co-owner, Jeremy Lee. Additionally, the farm does not have any connections to natural water bodies as it does not discharge any wastewater and all solid wastes are collected and held in an on-site septic tank. Overall, this criterion scored 10 (green) as the farm was deemed fully biosecure.

Criterion 8. Source of Stock—Independence from Wild Fisheries

Impact, unit of sustainability and principle

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

Criterion 8 Summary

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

Justification of Ranking

As previously mentioned, Sustainable Blue sources their juveniles from a Yukon-based hatchery called Icy Waters Ltd (IWL). IWL began collaborating with Simon Fraser University in 1997 to develop an Arctic char breeding program. The broodstock, which is now fully domesticated, are derived from three strains of Arctic char: Fraser River, Nauyuk Lake and Three River (Jonathan Lucas, pers. comm.). Current efforts of the breeding program are to improve genetic management of the species, as well as to select for heat and disease resistance. Because Sustainable Blue is fully dependent on domesticated broodstock this factor received a score of 10.

Overall Recommendation

The overall final score is the average of the individual criterion scores (after the two exceptional scores have been deducted from the total). The overall ranking is decided according to the final score, the number of red criteria, and the number of critical scores as follows:

- **Best Choice** = Final score ≥6.6 AND no individual criteria are Red (i.e. <3.3)
- **Good Alternative** = Final score ≥3.3 AND <6.6, OR Final score ≥ 6.6 and there is one individual "Red" criterion
- **Red** = Final score <3.3, OR there is more than one individual Red criterion, OR there is one or more Critical score

Arctic Char
Nova Scotia, Canada
Sustainable Blue – Closed-Containment

Criterion	Score (0-10)	Rank	Critical ?
C1 Data	9.44	GREEN	
C2 Effluent	10.00	GREEN	NO
C3 Habitat	8.79	GREEN	NO
C4 Chemicals	10.00	GREEN	NO
C5 Feed	7.51	GREEN	NO
C6 Escapes	10.00	GREEN	NO
C7 Disease	10.00	GREEN	NO
C8 Source	10.00	GREEN	
3.3X Wildlife mortalities	0.00	GREEN	NO
6.2X Introduced species escape	0.00	GREEN	n/a
Total	**75.75**		
Final Score	**9.47**		

OVERALL RANKING

Final Score	9.47
Initial rank	GREEN
Red Criteria	0
Intermediate Rank	GREEN
Critical Criteria?	NO
Final Rank	BEST CHOICE

Acknowledgements

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.

Seafood Watch® would like to thank Dr. Steve Summerfelt, Director of Aquaculture Systems Research at the Conservation Fund Freshwater Institute for graciously reviewing this report for scientific accuracy.

References

Fisheries and Oceans Canada (DFO). 2006. *Arctic Char*. [Internet] accessed 12 July 2012 from http://www.dfo-mpo.gc.ca/aquaculture/finfish-poissons/char-omble-eng.htm

FishSource. 2011. *Atlantic herring - SW Nova Scotia and Bay of Fundy*. [Internet] accessed 10 May 2012 from http://www.fishsource.com/fishery/data_summary?fishery=Atlantic+herring+-+SW+Nova+Scotia+and+Bay+of+Fundy

Icelandic Ministry of Fisheries and Agriculture. n.d. *Icelandic Fisheries – Arctic Char*. [Internet] accessed 12 July 2012 from http://www.fisheries.is/aquaculture/species/arctic-charr/

Prince Edward Island (PEI) Department of Agriculture and Forestry. 2000. *Agricultural Business Profile on Land-Based Fish Farming of Arctic Char*. [Internet] accessed 13 July 2012 from http://www.gov.pe.ca/photos/original/af_fact_char.pdf

Sustainable Blue. n.d. (a). *Our Species*. [Internet] accessed 1 March 2012 from http://sustainableblue.com/ourspecies.php

Sustainable Blue. n.d. (b). *Our Contribution to Sustainable Sea Food Production*. [Internet] accessed 1 March 2012 from http://www.sustainableblue.com/sustainability.php

Food and Agriculture Organization (FAO). 2012. FishStat Plus. Universal software for fishery statistical time series. Version 2.3. [Software]. Available from: http://www.fao.org/fishery/statistics/software/fishstat/en (Data sources: Aquaculture Production (1950–2010) and Capture Production)

About SeaChoice®

SeaChoice, Canada's most comprehensive sustainable seafood program, is about solutions for healthy oceans. Launched in 2006, SeaChoice was created to help Canadian businesses and shoppers take an active role in supporting sustainable fisheries and aquaculture at all levels of the seafood supply chain. Based on scientific assessments, SeaChoice has created easy-to-use tools that help you make the best seafood choices.

Working in collaboration with the Monterey Bay Aquarium's acclaimed Seafood Watch program, SeaChoice undertakes science-based seafood assessments, provides informative resources for consumers, and supports businesses through collaborative partnerships.

The SeaChoice program is operated by the Canadian Parks and Wilderness Society, David Suzuki Foundation, Ecology Action Centre, Living Oceans Society and Sierra Club BC. Our work is funded by the David and Lucile Packard Foundation, the Webster Foundation, and the Eden Foundation.

About Seafood Watch®

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

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

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

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

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

Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

Seafood Watch will:

- Support data transparency and therefore aquaculture producers or industries that make information and data on production practices and their impacts available to relevant stakeholders.
- Promote aquaculture production that minimizes or avoids the discharge of wastes at the farm level in combination with an effective management or regulatory system to control the location, scale and cumulative impacts of the industry's waste discharges beyond the immediate vicinity of the farm.
- Promote aquaculture production at locations, scales and intensities that cumulatively maintain the functionality of ecologically valuable habitats without unreasonably penalizing historic habitat damage.
- Promote aquaculture production that by design, management or regulation avoids the use and discharge of chemicals toxic to aquatic life, and/or effectively controls the frequency, risk of environmental impact and risk to human health of their use.
- Within the typically limited data availability, use understandable quantitative and relative indicators to recognize the global impacts of feed production and the efficiency of conversion of feed ingredients to farmed seafood.
- Promote aquaculture operations that pose no substantial risk of deleterious effects to wild fish or shellfish populations through competition, habitat damage, genetic introgression, hybridization, spawning disruption, changes in trophic structure or other impacts associated with the escape of farmed fish or other unintentionally introduced species.
- Promote aquaculture operations that pose no substantial risk of deleterious effects to wild populations through the amplification and retransmission of pathogens or parasites.
- Promote the use of eggs, larvae, or juvenile fish produced in hatcheries using domesticated broodstocks thereby avoiding the need for wild capture.
- Recognize that energy use varies greatly among different production systems and can be a major impact category for some aquaculture operations, and also recognize that improving

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

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

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

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

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

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

Data points and all scoring calculations

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

Criterion 1: Data Quality and Availability

Data Category	Relevance (Y/N)	Data Quality	Score (0-10)
Industry or production statistics	*Yes*	10	10
Effluent	Yes	10	10
Locations/habitats	Yes	7.5	7.5
Predators and wildlife	Yes	10	10
Chemical use	Yes	10	10
Feed	Yes	7.5	7.5
Escapes, animal movements	Yes	10	10
Disease	Yes	10	10
Source of stock	Yes	10	10
Other – (e.g. GHG emissions)	no	not relevant	n/a
Total			**85**

C1 Data Final Score	9.44444	GREEN

Criterion 2: Effluents

Rapid Assessment

C2 Score	**10**

Criterion 3: Habitat

3.1 Habitat conversion and function

F3.1 Score	**10**

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

Factor 3.2a – Regulatory or management effectiveness

Question	Scoring	Score
1 - Is the farm location, siting and/or licensing process based on ecological principles, including an EIAs requirement for new sites?	mostly	0.75
2 - Is the industry's total size and concentration based on its cumulative impacts and the maintenance of ecosystem function?	yes	1
3 - Is the industry's ongoing and future expansion appropriate locations, and thereby preventing the future loss of ecosystem services?	mostly	0.75

4 - Are high-value habitats being avoided for aquaculture siting? (i.e. avoidance of areas critical to vulnerable wild populations; effective zoning, or compliance with international agreements such as the Ramsar treaty)	Yes	1
5 - Do control measures include requirements for the restoration of important or critical habitats or ecosystem services?	partly	0.25
		3.75

Factor 3.2b – Siting regulatory or management enforcement

Question	Scoring	Score
1 - Are enforcement organizations or individuals identifiable and contactable, and are they appropriate to the scale of the industry?	yes	1
2 - Does the farm siting or permitting process function according to the zoning or other ecosystem-based management plans articulated in the control measures?	Yes	1
3 - Does the farm siting or permitting process take account of other farms and their cumulative impacts?	Yes	1
4 - Is the enforcement process transparent—e.g., public availability of farm locations and sizes, EIA reports, zoning plans, etc?	Partly	0.25
5 - Is there evidence that the restrictions or limits defined in the control measures are being achieved?	Yes	1
		4.25

F3.2 Score (2.2a*2.2b/2.5)	**6.38**

C3 Habitat Final Score	**8.79**	**GREEN**
	Critical?	NO

Exceptional Factor 3.3X: Wildlife and predator mortalities

Wildlife and Predator Mortality Parameters	Score	
F3.3X Wildlife and Predator Final Score	**0.00**	**GREEN**
Critical?	NO	

Criterion 4: Evidence of Risk of Chemical Use

Chemical Use parameters	Score	
C4 Chemical Use Score	**10.00**	
C4 Chemical Use Final Score	**10.00**	**GREEN**
Critical?	NO	

Criterion 5: Feed

5.1 Wild Fish Use

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

Fishmeal inclusion level (%)	25
Fishmeal from by-products (%)	50
% FM	12.5
Fish oil inclusion level (%)	8
Fish oil from by-products (%)	50
% FO	4
Fishmeal yield (%)	22.5
Fish oil yield (%)	5
eFCR	1.2
FIFO fishmeal	0.67
FIFO fish oil	0.96
Greater of the 2 FIFO scores	0.96
FIFO Score	**7.60**

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

SSWF	-6
SSWF Factor	-0.576

F5.1 Wild Fish Use Score	**7.02**

5.2 Net Protein Gain or Loss

Protein INPUTS		
Protein content of feed		45
eFCR		1.2
Feed protein from NON-EDIBLE sources (%)		83.5
Feed protein from EDIBLE CROP sources (%)		16.5
Protein OUTPUTS		
Protein content of whole harvested fish (%)		21
Edible yield of harvested fish (%)		78
Non-edible by-products from harvested fish used for other food production		0
Protein IN		6.36
Protein OUT		16.38
Net protein gain or loss (%)		-157.476
	Critical?	NO
F5.2 Net protein Score	**10.00**	

5.3 Feed Footprint

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

Inclusion level of aquatic feed ingredients (%)	33
eFCR	1.2
Average Primary Productivity (C) required for aquatic feed ingredients (ton C/ton fish)	*69.7*
Average ocean productivity for continental shelf areas (ton C/ha)	*2.68*
Ocean area appropriated (ha/ton fish)	10.30

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

Inclusion level of crop feed ingredients (%)	47
Inclusion level of land animal products (%)	10
Conversion ratio of crop ingredients to land animal products	*2.88*
eFCR	1.2
Average yield of major feed ingredient crops (t/ha)	*2.64*
Land area appropriated (ha per ton of fish)	0.24

Value (Ocean + Land Area)	**10.64**

F5.3 Feed Footprint Score	**6.00**

C5 Feed Final Score	**7.51**	**GREEN**
	Critical?	**NO**

Criterion 6: Escapes

Factor 6.1a – Escape Risk

Escape Risk	**10**

Recapture & Mortality Score (RMS)	
Estimated % recapture rate or direct mortality at the escape site	0
Recapture & mortality score	0
Factor 6.1a Escape Risk Score	**10**

Factor 6.1b – Invasiveness

Part B – Non-Native Species

Score	1

Part C – Native and non-native species

Question	Score	
Do escapees compete with wild, native populations for food or habitat?	yes	1
Do escapees act as additional predation pressure on wild, native populations?	yes	1
Do escapees compete with wild, native populations for breeding partners or disturb breeding behavior of the same or other species?	Yes	1
Do escapees modify habitats to the detriment of other species (e.g. ,by feeding, foraging, settlement or other)?	No	0
Do escapees have some other impact on other native species or habitats?	no	0
	2.5	2

F 6.1b Score	**3**

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

Exceptional Factor 6.2X: Escape of Unintentionally Introduced Species

Escape of unintentionally introduced species parameters	Score	
F6.2Xa International or trans-waterbody live animal shipments (%)	0.00	
F6.2Xb Biosecurity of source/destination	10.00	
F6.2X Escape of unintentionally introduced species Final Score	**0.00**	
		GREEN

Criterion 7: Diseases

Pathogen and parasite parameters	Score	
C7 Biosecurity	10.00	
C7 Disease; pathogen and parasite Final Score	**10.00**	
Critical?	NO	**GREEN**

Criterion 8: Source of Stock

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