



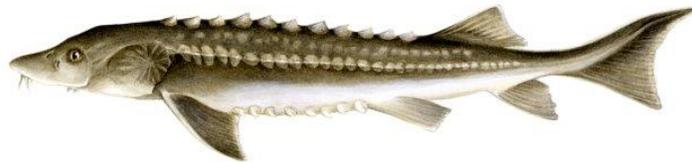
MONTEREY BAY AQUARIUM®

Seafood WATCH

In collaboration with



White Sturgeon
Acipenser transmontanus



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Target Marine Hatcheries, British Columbia, Canada

Closed-containment: land-based recirculating system

December 3, 2012

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Final Seafood Recommendation

White sturgeon farmed in closed-containment from Target Marine Hatcheries scored green in all criteria with the exception of the 'Feed' criterion,' which scored yellow. Overall, a score of 8.80 and a final green ranking was achieved making white sturgeon meat and caviar produced at Target Marine Hatcheries a **Best Choice**.

White Sturgeon

Acipenser transmontanus

Target Marine Hatcheries, British Columbia, Canada

Closed-containment

Criterion	Score (0-10)	Rank	Critical?
C1 Data	8.89	GREEN	n/a
C2 Effluent	10.00	GREEN	NO
C3 Habitat	8.51	GREEN	NO
C4 Chemicals	10.00	GREEN	NO
C5 Feed	4.97	YELLOW	NO
C6 Escapes	10.00	GREEN	NO
C7 Disease	8.00	GREEN	NO
C8 Source	10.00	GREEN	n/a
3.3X Wildlife mortalities	0.00	GREEN	NO
6.2X Introduced species escape	0.00	GREEN	n/a
Total	70.37		
Final Score	8.80		

OVERALL RANKING

Final Score	8.80
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

Target Marine Hatcheries first started farming white sturgeon in 2000 and remains, at the time of writing, the only white sturgeon farm in Canada that is bringing product to market. The expected harvest for this year (2012) is 17 tonnes of sturgeon meat and 500 kg of sturgeon roe, which is marketed under the brand name Northern Divine. Located in Sechelt, British Columbia, Target Marine operates ninety percent of its production system as closed-containment attaining 99% recirculation. The farm and its products have been certified under the Ocean Wise program as a sustainable alternative for sturgeon caviar. Due to the small scale of this industry, this report represents a farm-level assessment of white sturgeon farmed in closed-containment at Target Marine Hatcheries and is largely based on personal communications with the farm manager.

Overall, Target Marine Hatcheries received high green rankings for all criteria with the exception of the 'Feed' criterion. A high data quality score was achieved as the farm manager willingly provided much of the data required to accurately complete this assessment. Criteria 2, 6, and 3.3X (effluent, escapes, and wildlife mortalities) all scored high greens as a fully covered, land-based, closed-containment system is being used on-site. This system allows for all effluents to be collected and properly disposed of, eliminates the risk of escapes and excludes any possible interactions with wildlife.

Criteria 4 and 7 (chemical use and pathogens) both scored high greens as the farm has had only one disease event (for which they did not use any prophylactic treatment), in the twelve years they have been raising sturgeon. The oldest fish on-site are 12 years of age and completely antibiotic and hormone free. In addition, the nature of the closed-containment recirculating system allows the producer to maintain a high level of biosecurity, minimizing the risk of introducing pathogens to the farm, and allowing treatment to all discharges prior to their release.

Criteria 3 (habitat) achieved a green rank due to the inherent low-impact nature of closed-containment aquaculture and the moderately effective local regulations, while Criteria 8 and 6.2X (source and introduced species escapes) both scored 10 as the farm is fully dependent on their hatchery broodstock.

Criteria 5 (feed) received a final score of 4.97 and ranks yellow as a result of low-moderate wild fish use, a high net protein loss, and a high-moderate feed footprint.

Overall, white sturgeon raised in a closed-containment, recirculating system at Target Marine Hatcheries achieved a final score of 8.80, which is a high green, making it a sustainable alternative source for white sturgeon roe and meat.

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Introduction

Scope of the analysis and ensuing recommendation

Target Marine Hatcheries first opened its doors in 1994 with a focus on raising coho salmon smolts. Although it still brings a very small amount of coho salmon smolts to market (5 MT), it has primarily converted its farm to the culture of white sturgeon. In 2000, it stocked its first generation of white sturgeon, and brought its first sturgeon meat to market in 2002. The expected harvest for this year (2012) is 17 tonnes of sturgeon meat and 500 kg of sturgeon roe, which is marketed under the brand name Northern Divine. The farm has, over the past few years, worked hard to convert the original flow-through system to a closed-containment system that operates at 99% recirculation. At the time of this writing, 10% of the operation still operated as flow-through; however, they plan to convert the remaining tanks to closed-containment in the near future.

When this report was written, Target Marine Hatcheries was the only white sturgeon farm in Canada that was bringing product to market. Two other Canadian sturgeon farms, Supreme Sturgeon and Caviar and Acadian Sturgeon, were identified through Internet research and discussions with farm personnel and other industry persons, but neither of these was included in this assessment because they were farming alternative sturgeon species or they were not yet fully operational. As such, this assessment remains farm-specific—all information, data, scores and rankings address only white sturgeon raised in closed-containment at Target Marine Hatcheries in Sechelt, British Columbia.

Species Overview

The white sturgeon is one of five sturgeon species found in Canada and is the largest sturgeon species in North America. They are native to the Eastern Pacific from Alaska south to Monterey, California, however, in BC they are primarily found in the Fraser and Columbia River watersheds. They can grow to be six meters long and individuals may live up to 100 years. Females do not typically come to reproductive age until about 18 years. This slow-growing, long-lived life history strategy has made the white sturgeon particularly vulnerable to external pressures on wild stock including fishing, construction of hydro-electric dams, and declining water quality, and has left all of the species populations listed as endangered by the Committee on the Status of Endangered Species in Canada (COSEWIC) and the US Endangered Species Act. (DFO 2009).

Declining stock status has been an increasing reality for all of the 26 species of sturgeon found globally. All the while, a steady or, in some geographic locations, increasing demand for sturgeon meat and caviar drove the advancements in sturgeon aquaculture technology. The early 1800s and late 1900s witnessed the first attempts at artificial sturgeon reproduction in both Russia and in the US; however, it was not until the 1950s that Russian scientists succeeded in whole –cycle cultivation of a great sturgeon/sterlet hybrid, known as a bester (Burtzev,

1999). The US managed to spawn and culture paddlefish, Atlantic, shortnose, white and lake sturgeon throughout 1960s to the mid-1980s (Van Eenennaam et al., 2004). At least 7 species of sturgeon and paddlefish are now being farmed in 23 countries in hope of developing a sustainable source for high-valued caviar and meat.

Target Marine Hatcheries represents the only white sturgeon farm in Canada. And, with an expected harvest in 2012 of only 17 tonnes of meat and 500 kg of roe, they represent a very small fraction of the provincial and national aquaculture sectors. The industry is, overall, slow-growing, with only nine farms intensively farming white sturgeon in the US (Monterey Bay Aquarium 2007). Target Marine markets its caviar under the name Northern Divine and currently sells it for \$304 per 100g. It sells its other meat products either dressed or as bullets (head and fins off). The majority of its product is sold locally, within BC, to high-end retailers and restaurants, however, its caviar can be ordered online and shipped across Canada and the US (<http://northerndivine.com/products>).

Analysis

Scoring guide

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

The manager at Target Marine was highly cooperative in this assessment and provided as much information as possible, which resulted in a high data quality score of 8.89 (green).

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	2.5	2.5
Escapes, animal movements	Yes	10	10
Disease	Yes	10	10
Source of stock	Yes	10	10
Other – (e.g. GHG emissions)	No	n/a	n/a
Total			80

C1 Data Final Score	8.89	GREEN
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Justification of Ranking

This assessment focuses on a single farm, Target Marine Hatcheries, raising white sturgeon in closed-containment. Justin Henry, the site manager, was highly cooperative throughout the assessment process and consistently provided all details and data requested by the author. The locations/habitats criterion received a slightly lower score because some of the points contained within this factor speak to provincial and national management strategies; information that Mr. Henry did not have. The data quality of the 'Feed' criterion was the main anomaly within the data set. Mr. Henry provided as much information as he could with respect to where they source their feed, however, many of the data points within this factor could not be confirmed by the feed company supplying the farm due to proprietary rights. The author did attempt to contact the feed company on numerous occasions but never received a response.

It should be noted that due to the narrow focus of this assessment on a single farm that is a relatively small producer in the broader scheme of the Canadian aquaculture industry, the data are not peer-reviewed and were collected over a short time frame. The assessor remains confident, however, that this 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
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Target Marine Hatcheries operates largely as a closed-containment, recirculating facility whereby effluent can be collected, treated and disposed of appropriately.

Rapid assessment—used when good quality data clearly defines an appropriate score

The high data quality score for the effluent criterion allowed the rapid assessment to be applied with confidence. The nature of the production system, which minimizes the amount of waste discharged and ensures that any discharged waste is treated prior to release, also added confidence to using the rapid assessment.

Justification of Ranking

Ninety percent of the tanks at Target Marine Hatcheries operate as closed-containment, recirculation tanks. The remaining 10% operate as a flow-through system; however, there are plans to convert these into closed-containment tanks in the near future.

Scrubbing towers, drum filters and biological filters are used on-site to strip CO₂, ammonia and solid wastes from the water, and allow up to 99% water recirculation. All collected solid waste is used in local composting programs, which ensures proper disposal of the wastes.

Additionally, any outflowing water is discharged into salt water over a large eelgrass bed. The eelgrass bed is monitored and acts as an ecological indicator to any potential impacts the discharges may be causing. As of yet, no such impacts have been observed.

Overall, the production system at Target Marine Hatcheries inherently minimizes the amount of wastes being discharged by the farm and ensures that any wastes that are released are properly treated prior to discharge. The farm also has an appropriate monitoring system in

place that allows it to observe any impacts of outflowing water on the surrounding ecosystem. As such, a score of 10 was awarded for the 'Effluent' criterion.

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

The location of Target Marine Hatcheries is maintaining full functionality of the surrounding ecosystem. Although it did not conduct an environmental impact assessment when the farm was first established in 1986, it remains governed by the laws, regulations and management by the Department of Fisheries and Oceans—a federal body—and certain provincial legislations. Overall, the ‘Habitat’ criterion scored 8.51 and ranked green due to the inherent low-impact nature of closed-containment aquaculture in combination with strong local regulation.

Justification of Ranking

Habitat parameters	Value	Score	
F3.1 Habitat conversion and function		10.00	
F3.2a Content of habitat regulations	3.25		
F3.2b Enforcement of habitat regulations	4.25		
F3.2 Regulatory or management effectiveness score		5.53	
C3 Habitat Final Score		8.51	GREEN
Critical?	NO		

Factor 3.1. Habitat conversion and function

The farm site was originally developed in 1986, operating exclusively as a flow-through system. The property spans some 60 acres of coniferous forest, of which approximately 5 acres are cleared and contain all operations of the farm. Target Marine Hatcheries purchased the farm in the early 1990s and has since been retrofitting it to a closed-containment system. At the time of this writing, approximately 10% of the farm still operated as flow-through. Water is drawn from a small creek and seven wells located on the property. Any discharges are released into salt water and the discharge point is monitored on a regular basis. Overall, no negative impacts have been observed since the farms siting in 1986, and, as such, this factor scored 10 as the surrounding habitat is maintaining full functionality.

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

The site that is now owned by Target Marine Hatcheries was first sited for aquaculture in 1986. A full environmental impact assessment (EIA) was not conducted; however, the Department of Fisheries and Oceans did conduct a partial EIA prior to licensing the farm (Justin Henry, pers. Comm.). Since 2010, the DFO has taken over full regulatory oversight of British Columbia's aquaculture sector. The program, known as the British Columbia Aquaculture Regulatory Program (BCARP), operates with 54 staff members located in Vancouver and on Vancouver Island, and is responsible for monitoring existing aquaculture farms and regulating further development of the industry. It maintains a public reporting schedule for wildlife interaction and mortalities, fish health, escapes and facility operations, which are reported on a quarterly or annual basis and are typically available online (Fisheries and Oceans Canada 2011).

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" (Fisheries and Oceans Canada 2005). The Canadian Environmental Assessment Agency (CEAA) maintains an online, publicly available database of all ongoing and completed environmental assessments. No results could be found, however, for environmental assessments of closed-containment aquaculture although multiple searches were conducted. This highlights the growing issue whereby management and regulation are not keeping up with the advancements of the aquaculture industry. As such, closed-containment aquaculture can be seen as being 'ahead of the curve.' It has addressed many of the environmental issues of conventional fish farming, but remains, in its own way, unregulated. In this assessment, the mandates and regulations of DFO and the BCARP, although specific to net pen and cage farming, have been applied to closed-containment farming. By doing so, the assessment reflects the fact that a regulatory body exists but also accounts for the lag in developing closed-containment specific regulation. Overall, this approach ensures that the effectiveness of management score is not over- or understated.

In the case of Target Marine Hatcheries, it was found that there is also strong municipal influence in the siting and zoning regulation of the farm. The farm's application to re-zone its operation to include an onsite processing plant took four years to pass. The process included many public hearings and much debate within the municipal government, and permission for re-zoning was granted last year (District of Sechelt, 2011). The extended municipal process suggests that any increase in the scale of Target Marine's farming operations would undergo much regulatory review prior to approval.

Overall, this factor scored 5.53, which reflects the challenges associated with managing and regulating a relatively new practice that accounts for a small portion of the aquaculture industry as a whole.

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	

Interactions with wildlife and predators are of no concern at Target Marine Hatcheries because the tanks are fully enclosed in secure buildings and as such this exceptional factor scored 0.

Justification of Ranking

F3.3X Wildlife and predator score

At Target Marine Hatcheries, all operations are conducted in fully covered buildings, which completely eliminates any risk of wildlife and predator interactions and suggests that this factor is of no concern (score is 0).

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	

The risk of chemical use at Target Marine Hatcheries is of no concern because chemicals have not been used over multiple production cycles, and the nature of the closed-containment production system ensures that if chemicals were used, no active chemicals or byproducts could be released.

Justification of Ranking

The oldest fish on the farm are 12 years old, at the time of this writing, and are completely antibiotic and hormone free as they have not experienced any pathogen problems onsite. The introduction of pathogens onto the farm is greatly minimized by the nature of the closed-containment production system, which allows the farmers to tightly control the farming environment. All incoming water is sourced from wells on the property and, if needed, is treated with salt. Tanks and wells are disinfected by changing the pH of the water and strong biosecurity practices are upheld for all personnel coming on site. Additionally, if chemicals were to be used on site, the nature of the production system ensures that any discharges could be properly treated prior to release to ensure no active chemicals or byproducts are released. The evidence or risk of chemical use at Target Marine Hatcheries was determined to be of no concern and scored 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

The final feed score is 4.97 and ranks yellow as a result of low-moderate wild fish use, a high net protein loss and a high-moderate feed footprint.

Feed parameters	Value	Score	
F5.1a Fish In: Fish Out ratio (FIFO)	0.88	7.80	
F5.1b Source fishery sustainability score		-4.00	
F5.1: Wild Fish Use		7.45	
F5.2a Protein IN	62.25		
F5.2b Protein OUT	18.20		
F5.2: Net Protein Gain or Loss (%)	-72.10	2	
F5.3: Feed Footprint (hectares)	18.92	3	
C5 Feed Final Score		4.97	YELLOW
Critical?	NO		

Justification of Ranking

Factor 5.1. Wild Fish Use

Target Marine sources their feed from Taplow Feeds, a local Chilliwack-based company. Justin Henry, farm manager of Target Marine Hatcheries, contacted the feed company personally to try to get the necessary information to complete this criterion; however, specific datum points were not always made available due to proprietary rights. One such example was the fishmeal and fish oil inclusion levels which were not disclosed by Taplow, however, they did state that their sturgeon feed contains approximately 13% fishmeal from marine sources once you have accounted for by-product inclusion (Justin Henry, pers. comm.). By applying this datum, it was determined that based on a typical sturgeon feed fishmeal inclusion of 33% (MBA, 2007) approximately 60% of the fishmeal is being source from by-product. A similar statement was made with respect to fish oil inclusion whereby the Taplow feed contains approximately 2% fish

oil from marine sources once by-product inclusion is accounted for (Justin Henry, pers. comm.). Again, this datum can be applied to a typical sturgeon feed that has 14% fish oil inclusion level (MBA 2007) to determine that about 85% of the fish oil is being sourced from by-product. According to Justin Henry the average economic feed conversion ratio for the sturgeon grow-out phase is 1.5. This resulted in fish in: fish out values of -.88 and 0.63 for fishmeal and fish oil, respectively.

Taplow informed Mr. Henry that the majority of the fishmeal, if not sourced from by-product, is sourced from the BC herring and hake fisheries. The BC hake fishery has a FishSource score of ≥ 6 , with at least one factor scoring ≥ 8 , which would translate into a sustainability score of -2 (FishSource, 2011). The herring fishery, on the other hand, is not scored by FishSource and would typically be scored as a fishery of unknown sustainability (-6). As such, the sustainability score was averaged between these two fisheries and scored -4.

With the above data the overall 'Fish Use' was determined to be relatively low with a score of 7.45.

Factor 5.2. Net Protein Gain or Loss

The protein content of the feed used at Target Marine is 43.5%. Details about inclusion rates of protein from edible versus non-edible sources were not provided and as such these factors both scored 0, as this is the default value in the assessment tool. The protein content of a whole harvested fish was found to be 18.2%, while the edible yield is 53% (Price et al., 2006). After processing of harvested farmed fish, all non-edible by-products are used for other food production. At the time of this writing, all of the by-products were being composted and used as fertilizer, however, the company was working, with some preliminary success, on finding markets for the liver, heads and swim bladders. They also hope to start selling the fins as a replacement for shark fin. This results in an overall 'Protein Loss' of 72.1%, which translates into a score of 2 for this factor.

Factor 5.3. Feed Footprint

Details about inclusion levels of crop feed versus land animal products could not be found. Values for these factors were, therefore, calculated by subtracting the inclusion level of marine ingredients and dividing the remaining portion evenly between crop feed and land animal products.

Calculation used to determine inclusion level of crop feed and land animal products:

$$\text{Inclusion level of crop feed/ Land animal product} = \frac{100 - (\% \text{ inclusion of fishmeal} + \% \text{ inclusion of fish oil})}{2}$$

Using the above equation, the inclusion levels of crop feed ingredients and land animal products were determined to be 26.5%. This resulted in an overall 'Feed Footprint' score of 3.

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		6	
C6 Escape Final Score		10.00	GREEN
Critical?	NO		

The nature of the closed-containment production system eliminates the risk of escapes. As such, even though the invasiveness of a potential escapee has a moderate score (6), the overall escape risk score is 10 (green).

Justification of Ranking

Factor 6.1a. Escape risk

No escape events have ever occurred in Target Marine’s operational history. Additionally, the production system inherently minimizes the risk of escapes. Any discharges go through a number of treatments, including drum and biological filter, prior to being released into salt water. At a small size, the fish could, theoretically, escape through the piping; however, at that size they are intolerable to salt water and would not survive. Once fish grow to a size where they would be able to tolerate salt water they are much too large to fit into any of the pipes. Moreover, staff is on-site 24 hours a day so that any serious issues can be handled immediately. Overall, there is very low concern for escape risk from Target Marine Hatcheries and as such this factor scored 10. The recapture and mortality rate was scored as 0%, because there are no escape events upon which this factor can be assessed. Due to the minimal ‘Escape Risk,’ however, this did not impact the overall score.

Factor 6.1b. Invasiveness

Target Marine Hatcheries received its brood fish from Vancouver Island University’s International Center for Sturgeon Studies (ICSS). ICSS has a number of live sturgeons collected from ponds and illegal harvesting within the Fraser Valley region that they use for breeding programs and research. Target Marine Hatcheries is currently spawning their F1 fish (i.e. 2nd generation) and because the species is octoploid they are not yet likely to be genetically

different from wild stocks. DFO is working closely with the farm and has identified genetic markers that will allow them to identify the family of origin and to continue measuring the genetic difference from wild populations.

Theoretically, if an escape event were to occur, escapees would act as competitors with wild native populations for food, habitat and breeding partners, as well as act as additional predation pressure on wild populations. Overall, the ‘Invasiveness’ of potential escapees was determined to be moderate with a score of 6.

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	10.00	GREEN

There is no international or trans-waterbody live animal shipments occurring with Target Marine Hatcheries’ farming of white sturgeon and as such the escape of unintentionally introduced species is of no concern and scored 10 (green).

Justification of Ranking

Factor 6.2Xa International or trans-waterbody live animal shipments

No live animal shipments are occurring across waterbodies and hence this factor is of no concern.

Factor 6.2Xb Biosecurity of source/destination

This factor was not scored because Target Marine Hatcheries does not depend on the international or trans-waterbody shipment of live animals for their farming of white sturgeon.

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	8.00	
C7 Disease; pathogen and parasite Final Score	8.00	GREEN
Critical?	NO	

There has only been one incidence of disease on-site at Target Marine Hatcheries since they started farming white sturgeon, which is strong evidence that the farm does not amplify pathogen or parasite numbers above background levels. Additionally, the farm discharges relatively little water over multiple production cycles compared to flow-through facilities, as Target Marine Hatcheries operate a recirculating system. However, a small percentage of the farm was still operating under flow-through at the time of this writing, and as such, this factor scored 8.

Justification of Ranking

Target Marine Hatcheries has not experienced any parasite events within its white sturgeon stock. In 2002/2003 it experienced some mortality on-site due to an unknown virus that was never identified. During this time it optimized water quality and conditions and waited for the disease to pass. At the time of this writing, a small portion of the farm (10%) still operated as a flow-through system, and thus this factor could not be scored as 'no concern.' There is strong evidence, however, that due to the limited disease events that have occurred on-site, the farm does not amplify pathogen or parasite numbers above background levels. The risk of disease and pathogen interaction was assessed to be low and scored 8 (green).

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

This criterion scored 10 (green) because Target Marine Hatcheries is fully independent from the wild fishery.

Justification of Ranking

Target Marine Hatcheries sourced its original brood fish from Vancouver Island University's International Center for Sturgeon Studies, where they have a number of sturgeon collected from ponds and illegal harvests from the Fraser Valley region that they use for breeding programs and research. Target Marine Hatcheries, however, is now spawning its second generation fish and has become fully independent of wild stock. Overall, 100% of the production is from hatchery-raised brood stock, which results in a score of 10 (green).

Overall Recommendation

The overall recommendation is as follows:

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.

White Sturgeon

Acipenser transmontanus

Target Marine Hatcheries, British Columbia, Canada

Closed-containment

Criterion	Score (0-10)	Rank	Critical?
C1 Data	8.89	GREEN	n/a
C2 Effluent	10.00	GREEN	NO
C3 Habitat	8.51	GREEN	NO
C4 Chemicals	10.00	GREEN	NO
C5 Feed	4.97	YELLOW	NO
C6 Escapes	10.00	GREEN	NO
C7 Disease	8.00	GREEN	NO
C8 Source	10.00	GREEN	n/a
3.3X Wildlife mortalities	0.00	GREEN	NO
6.2X Introduced species escape	0.00	GREEN	n/a
Total	70.37		
Final Score	8.80		

OVERALL RANKING

Final Score	8.80
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

Canadian Environmental Assessment Agency. 2011. *Canadian Environmental Assessment Registry*. [Internet] accessed 9 July 2012 from <http://www.ceaa.gc.ca/050/index-eng.cfm>

Fisheries and Oceans Canada (DFO). 2005. *Frequently Asked Questions*. [Internet]. Accessed 9 July 2012 from <http://www.dfo-mpo.gc.ca/aquaculture/faq-eng.htm>

Fisheries and Oceans Canada (DFO). 2009. *White Sturgeon: Species at Risk (Brochure)*. [Internet] accessed 6 July 2012 from <http://www.pac.dfo-mpo.gc.ca/publications/docs/sturgeon-esturgeon-eng.htm>

Fisheries and Oceans Canada (DFO). 2011. *Aquaculture in the Pacific Region*. [Internet]. Accessed 9 July 2012 from <http://www.pac.dfo-mpo.gc.ca/aquaculture/about-ausujet-eng.htm>

Monterey Bay Aquarium (MBA). 2007. *U.S. Farmed Sturgeon. Text by Tzankova, Z.* In: *Monterey Bay Aquarium Seafood Watch Seafood Reports*. Monterey, CA. [Internet] accessed 9 July 2012 from http://www.montereybayaquarium.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_SturgeonReport.pdf

Target Marine Hatcheries. *Northern Divine*. [Internet] accessed 6 July 2012 from <http://northerndivine.com/>

Van Eenenaam, J. P., F. Chapman, and P. Jarvis. 2004. Aquaculture. Pp. 277-311 in Le Breton et al., eds. *Sturgeons and Paddlefish of North America*. Kluwer Academic Publishers, Dordrecht/Boston/London.

Personal Communications

Justin Henry, General Manager, Target Marine Hatcheries, 23 March 2012.

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 fished¹ 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.

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

- Recognize that energy use varies greatly among different production systems and can be a major impact category for some aquaculture operations, and also recognize that improving practices for some criteria may lead to more energy intensive production systems (e.g. promoting more energy intensive closed recirculation systems).

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	2.5	2.5
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			80

C1 Data Final Score	8.89	GREEN
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Criterion 2: Effluents

Rapid Assessment

C2 Score	10
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Criterion 3: Habitat

3.1 Habitat conversion and function

F3.1 Score	10
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3.2 Habitat and farm siting management effectiveness (appropriate to the scale of the industry)

Factor 3.2a – Regulatory or management effectiveness

Question	Scoring	Score
1 - Is the farm location, siting and/or licensing process based on ecological principles, including an EIAs requirement for new sites?	Mostly	0.75
2 - Is the industry's total size and concentration based on its cumulative impacts and the maintenance of ecosystem function?	moderately	0.5

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
		3.25

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)	5.53
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C3 Habitat Final Score	8.51	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 (%)	33
Fishmeal from by-products (%)	60
% FM	13.2
Fish oil inclusion level (%)	14
Fish oil from by-products (%)	85
% FO	2.1
Fishmeal yield (%)	22.5
Fish oil yield (%)	5
eFCR	1.5
FIFO fishmeal	0.88
FIFO fish oil	0.63
Greater of the 2 FIFO scores	0.88
FIFO Score	7.80

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

SSWF	-4
SSWF Factor	-0.352

F5.1 Wild Fish Use Score	7.45
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5.2 Net Protein Gain or Loss

Protein INPUTS	
Protein content of feed	43.5
eFCR	1.5
Feed protein from NON-EDIBLE sources (%)	0
Feed protein from EDIBLE CROP sources (%)	0
Protein OUTPUTS	
Protein content of whole harvested fish (%)	18.2
Edible yield of harvested fish (%)	53
Non-edible by-products from harvested fish used for other food	100

production		
Protein IN		65.25
Protein OUT		18.2
Net protein gain or loss (%)		-72.10727969
	Critical?	NO
F5.2 Net protein Score	2.00	

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 (%)	47
eFCR	1.5
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)	18.34

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

Inclusion level of crop feed ingredients (%)	26.5
Inclusion level of land animal products (%)	26.5
Conversion ratio of crop ingredients to land animal products	2.88
eFCR	1.5
Average yield of major feed ingredient crops (t/ha)	2.64
Land area appropriated (ha per ton of fish)	0.58

Value (Ocean + Land Area)	18.92
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F5.3 Feed Footprint Score	3.00
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C5 Feed Final Score	4.80	YELLOW
	Critical?	NO

Criterion 6: Escapes

Factor 6.1a – Escape Risk

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

Factor 6.1b – Invasiveness

Part A – Native Species

Score	4
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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	2

F 6.1b Score	6
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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