Salmones Camanchaca Water Footprint

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CONTENTS

ABSTRACT

This report estimates the total water footprint to produce one ton of salmon by Salmones Camanchaca during 2022 using information provided by the company. The Water Footprint Network method was used. The results include the company's freshwater, seawater and processing plant fish farming activities and supply chain information.

The results were that 2,315 cubic meters of water is used to produce one ton WFE of salmon. The supply chain water footprint (indirect water footprint) made the largest contribution to the result, as it represented 94.2%, which is higher than the previous period, due to the increase in information from feed suppliers.

1. Introduction

The water footprint is a water use indicator that examines both direct and indirect water use by a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual, community or business (Hoekstra, Chapagain, Aldaya, & Mekonnen, 2011). Water is measured by the volume consumed, evaporated, incorporated into a product and contaminated per unit of time. A company's water footprint is defined as the total volume of freshwater[1] used to directly and indirectly operate a business. The water footprint of a business has two components:

- Direct water used by the producer for production and support activities.
- Indirect water used by the producer's supply chain. A “company's water footprint” is the same as the total "water footprint" of the company's products.

The water footprint is the most comprehensive and complete water accounting method, when compared to other water accounting methods, as it includes both direct and indirect water use and considers water consumption and water pollution. It has been used for various purposes, such as calculating the water footprint for many products worldwide, (Chapagain & Hoekstra, 2004)but so far there have been few corporate accounting applications (Ercin, Aldaya, & Hoekstra, 2009).

[1] Seawater consumption in the salmon production and supply chain is not included in the Hoekstra water footprint measurement method.

2. METHOD

The method measures the water footprint of a ton of Whole Fish Equivalent (WFE) salmon produced in Chile by Salmones Camanchaca's business and its supplier chain.

Green water footprint

The green water footprint refers to the global rainwater consumed to produce goods and services. The company is assumed to consume zero green water, because this is not part of the production process.

$$HHprocess_{green} = Evaporated_{green} + Incorporated_{green}$$

Blue water footprint

The blue water footprint refers to the global surface water and groundwater consumed to produce goods and services. "Consumption" refers to "evaporation" or "incorporation into the product", which occurs in the following situations:

1. Water that is evaporated.
2. Water that is incorporated into the product.
3. Water that does not return to the same catchment area and is returned to another catchment area or the sea.
4. Water that does not return in the same period. For example, it is extracted when water is scarce and returns when water is abundant.

$$HHprocess_{blue} = Evaporation_{blue} + Incorporation_{blue} + Losses_{blue} - Recycled_{blue}$$

The following equation is used to quantify the blue water footprint, as the blue outflow volume leaving the process is known, as is the water incorporated into the product by each business department.

$$HH_{Blue} = Tributary - Effluent$$

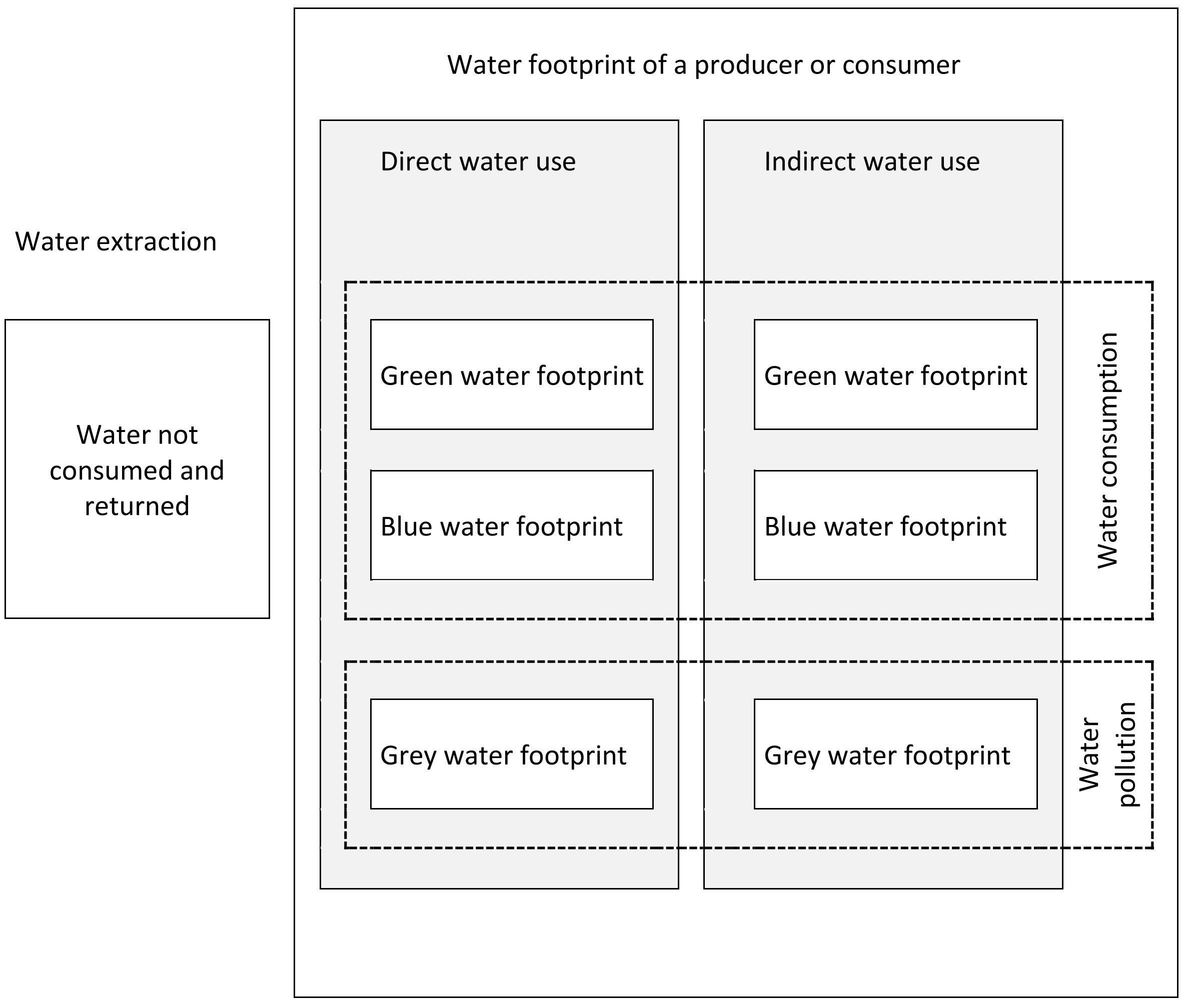
Grey water footprint

The grey water footprint refers to the volume of polluted water associated with producing goods and services. The grey water footprint equation for every situation is:

$$HH_{Grey} = \frac{(Vol_{efl} \times C_{efl}) - (V_{afl} \times C_{afl})}{C_{max} - C_{nat}}$$

The various water footprint concepts are defined in (Hoekstra, Chapagain, Aldaya, & Mekonnen, 2011). See also the glossary at the end of this report. The calculation methods follow (Hoekstra, Chapagain, Aldaya, & Mekonnen, 2011).

FIGURE 1: SCHEMATIC REPRESENTATION OF THE WATER FOOTPRINT.



3. DATA SOURCES AND ASSUMPTIONS

The water footprint evaluation model for Salmones Camanchaca is based on producing one ton of salmon, covering the entire production cycle from the freshwater stage to the processing plant including the company's energy consumption.

3.1. OPERATIONAL WATER FOOTPRINT

3.1.1. THE OPERATIONAL WATER FOOTPRINT IS DIRECTLY ASSOCIATED WITH PRODUCTION.

It includes the following components:

1) Ice and frost
2) Water consumed and not returned to its source during production, water extracted from wells or sewage systems, along with freshwater truck logistics.
3) Water polluted by the production process.

The first two components form the blue operational water footprint, the third component forms the grey water footprint. Green water or rainwater is not used in production, so there is no green water footprint.

Wastewater produced by the processing plant is treated prior to disposal, in order to comply with the regulations in DS90/1998 (Ley Chile, 1998). Laboratory results are published in its monthly reports and bibliographic data.

Wastewater produced by hatcheries is treated prior to disposal, in order to comply with the regulations in DS609 (Superintendencia de servicios sanitarios, 2000). Laboratory results are published in its monthly reports.

3.2. Supply chain water footprint

3.2.1. The supply chain water footprint involves the raw materials used in production.

The supply chain water footprint or indirect water footprint in this report arises from using energy in facilities. It is based on information gathered when measuring the Scope 2 corporate carbon footprint.

4. Results

4.1. Water footprint for one ton WFE of Salmon.

The water footprint of one ton WFE of Salmon including direct and indirect components in freshwater, seawater, feed, transport and processing was 112,444,174 m3 in 2022, equivalent to 2,315 m3/tWFE. All water footprint calculations used average annual flows and inflows/outflows provided by the company.

4.1.1. Water footprint

The total water footprint is the sum of the water footprints of all inputs. The water footprint components are as follows.

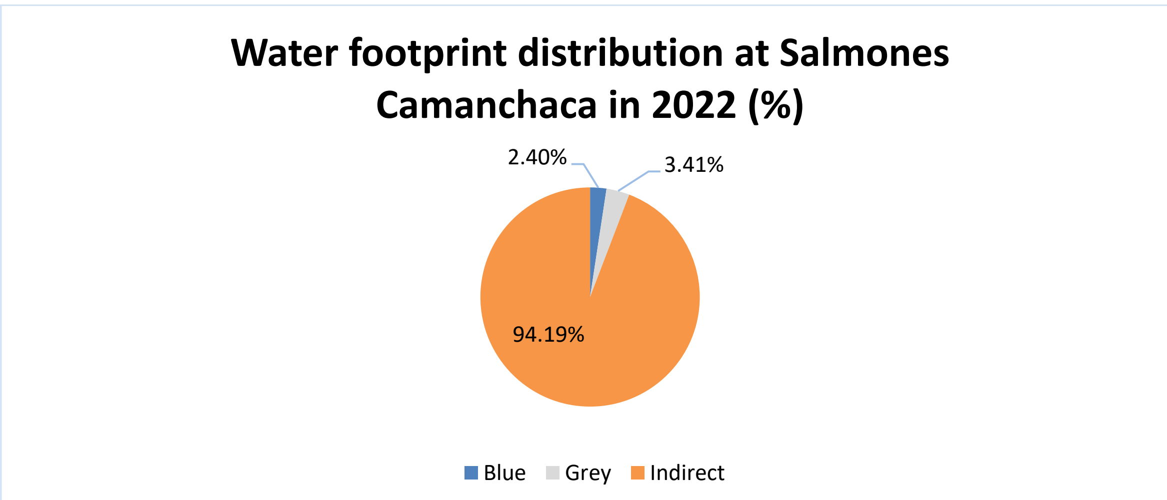
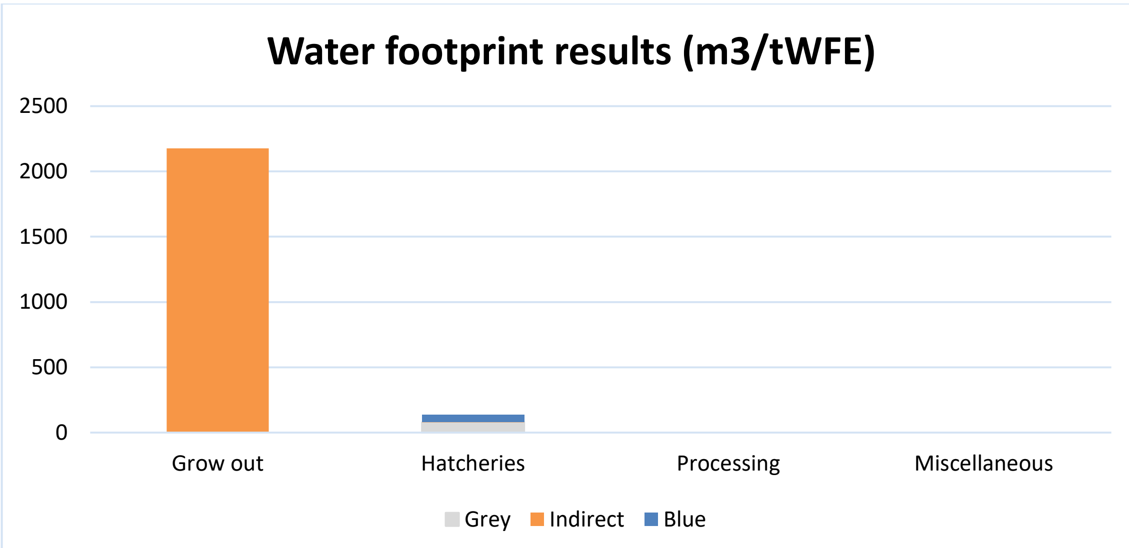


TABLE 3: WATER FOOTPRINT COMPONENTS IN SALMON PRODUCTION BY SALMONES CAMANCHACA IN 2022

Water footprint without feed	Grow out	Hatcheries	Processing	Miscellaneous	Total
Blue	-	2,683,529	14,330	-	**2,697,859**
Grey		3,834,054			**3,834,054**
Indirect	105,681,965	40,688	175,309	14,503	**105,912,464**
Total	**105,681,965**	**6,558,270**	**189,639**	**14,503**	**112,444,376**

TABLE 4: WATER FOOTPRINT COMPONENTS IN SALMON PRODUCTION BY SALMONES CAMANCHACA IN 2022 (M3/TWFE)

Water footprint with feed	Grow out	Hatcheries	Processing	Miscellaneous	Total
Blue	-	55	0	-	**56**
Grey	-	79	-	-	**79**
Indirect	2,176	1	4	0	**2,181**
Total	**2,176**	**135**	**4**	**0**	**2,315**

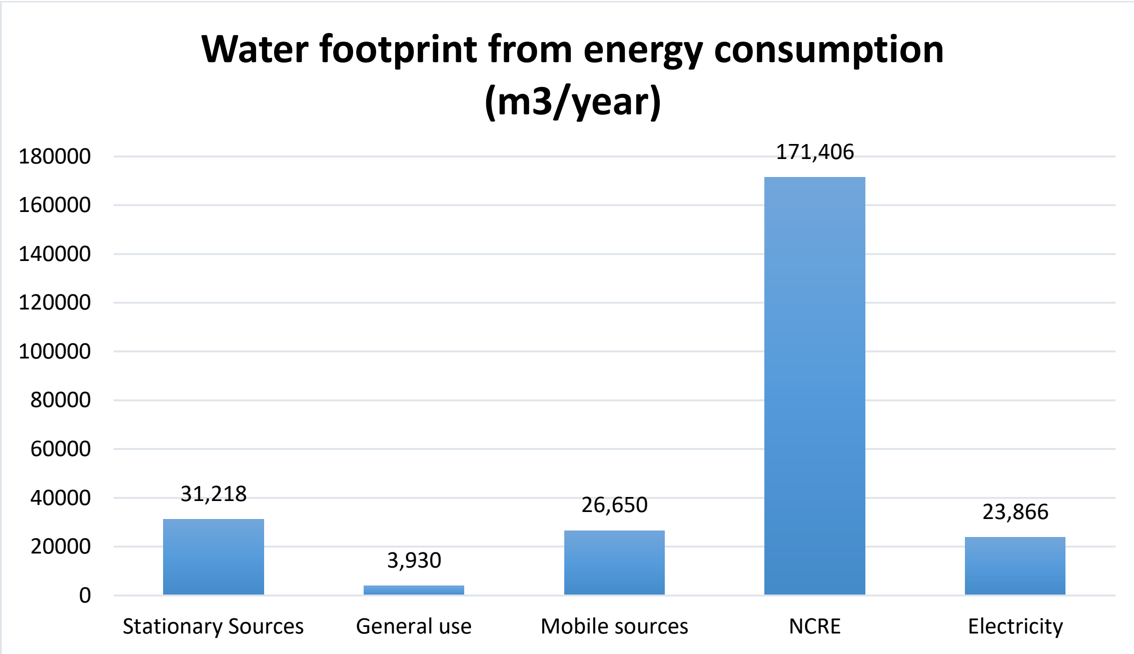


Note: Fish feed is a significant component of the water footprint results. Therefore, each supplier should be encouraged to measure their water footprint for each phase, so that it can be included in future calculations and contribute to the sustainability of the industry.

Other water footprint sources in the supply chain were identified, which arose from the energy used by each facility, and the appropriate conversion factors are in the appendix.

TABLE 5: THE WATER FOOTPRINT COMPONENTS IN THE SUPPLY CHAIN (INDIRECT WATER FOOTPRINT) - ENERGY

Area	Source	Source description	Unit	Annual consumption	Water footprint (m3/year)
Administration	General use	LPG	kg	1,140	7
	Mobile sources	Diesel oil	Liters	149,205	1,351
	Electricity	SEN	kWh	67,097	393
Grow out	General use	LPG	kg	180	1
			Liters	481,759	1,593
		Diesel oil	Liters	4,500	41
	Mobile sources	Diesel oil	Liters	2,783,766	25,199
	Electricity	Los Lagos	kWh	22,064	129
		SEN	kWh	91,727	538
Hatcheries	Stationary Sources	LPG	Liters	955,204	3,159
		Diesel oil	Liters	2,790,239	25,257
	General use	LPG	Liters	52,145	172
		Diesel oil	Liters	100,700	912
	Electricity	SEN	kWh	1,947,499	11,420
Processing plants	Stationary Sources	LPG	kg	2,713	17
		Diesel oil	Liters	280,499	2,539
	General use	LPG	kg	375	2
			Liters	47,229	156
		Diesel oil	Liters	115,500	1,046
	Mobile sources	LPG	Liters	30,400	101
	NCRE	Renewable Energy	kWh	13,631,096	171,406
Frozen	Stationary Sources	Diesel oil	Liters	27,190	246
	Electricity	Electricity	kWh	1,941,711	11,386
Total				**25,523,938**	**257,070**



The water inflow volume at all freshwater facilities was assumed to be equal to the outflow volume, as no evaporation or water losses were identified. However, the water footprint for transferring fry and smolts has been independently measured, see Table 4.

Note: This exercise identified that the company should install instruments to measure hatchery inflows, since there are none.

TABLE 6: FLOW METER MEASUREMENT BY FACILITY

Flow meter	Facility name	Source of supply/discharge
No	Playa Maqui	Underground
	Polcura	Estuary
		Underground
	Rio de la Plata	River
	Río del Este	River
	Río Petrohué	Underground
Yes	Pesca Sur	River
	Polcura	River
	Rio de la Plata	River
	Río del Este	River
	Río Petrohué	River
	Tomé	River
Total		

TABLE 7: WATER FOOTPRINT COMPONENTS - TRANSFERS

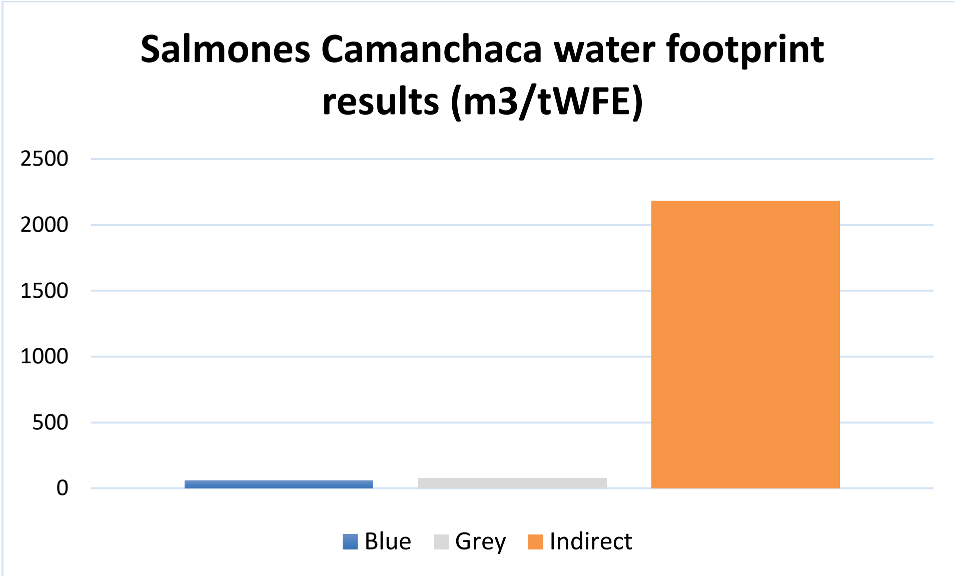
Origin-Destination	Biomass transferred kg	Water footprint (m3/year)
Polcura-Rio del Este	36,450	729
Petrohué-Port	1,801,150	34,560
Río de la Plata-Playa Maqui	71,550	1,431
Playa Maqui-Port	661,500	13,230
Rio de la Plata-El Negro (external hatchery)	21,600	432
Total	**2,592,250**	**50,382**

An average concentration of 50.42 kg of biomass per cubic meter of freshwater was used to estimate the water footprint of the freshwater logistics phase.

TABLE 8: THE WATER FOOTPRINT COMPONENTS IN THE SUPPLY CHAIN (INDIRECT WATER FOOTPRINT) - BOTTLED WATER

Area	Water footprint (m3/year)
Grow out	74.88
Administration	14
Hatcheries	31.2
Processing plants	40.42
Total	**160.5**

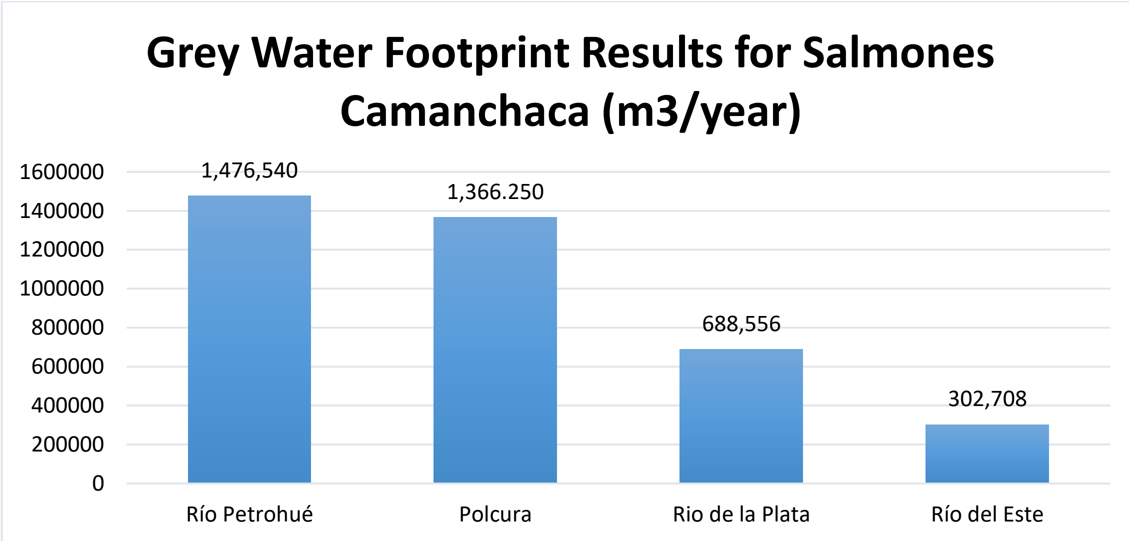
The results are distributed between blue, grey and indirect as follows.



Improvement measures should focus on improving effluent treatment, decreasing the concentration of effluent parameters, and increasing the quality of water extraction.

Note: Water footprint information in natural and inflow conditions are the bibliographic values of basins and sub-basins at the company's facilities. In future, at least the same parameters should be measured for inflows and outflows, in order to reduce data uncertainty.

As previously mentioned, installing inflow and outflow meters will improve the accuracy of water inflow and outflow measurements for each facility. This report is based on water balances that included water supply sources, effluents, groundwater extraction, water use in logistics and ice, as appropriate.



The Grey Water Footprint is the volume of water required to absorb its pollutants and comply with the natural conditions and parameters regulated by law in DS 90 and DS 609.

The natural concentration data was gathered by the Ministry of Public Works from 1980 onwards. It is assumed that these results are the pollutant concentration and natural concentration, and were complemented with laboratory analyses by the company on the outflow water quality at its facilities.

The parameters with the largest water footprint by facility are as follows:

Río Petrohué: Chlorides

Polcura: DBO5

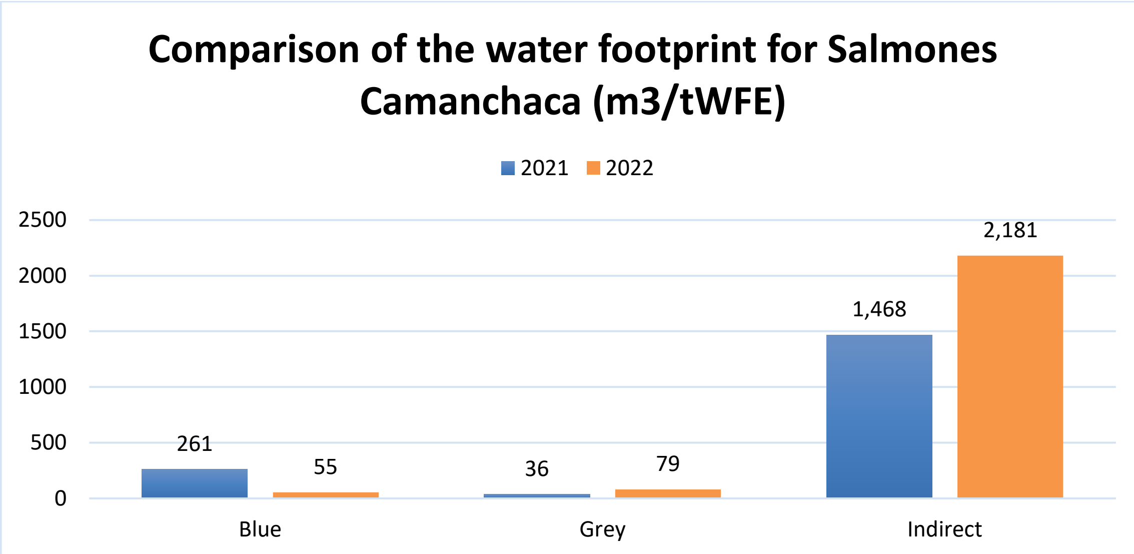
Río de la Plata: DBO5

Río del Este: DBO5

The available data on the quality of water inflows, outflows, natural quality and maximum concentration is limited. In future, measurements should be taken using the same parameters to ensure regulatory compliance, and to track the change in water quality of water inflow and outflow at all water extraction points for each facility.

These baseline results can be used to analyze whether it would be feasible to adopt a zero water pollution strategy for each of the parameters analyzed. Thus, all the water that enters the company's production process would be returned to nature under the same catchment conditions.

5. COMPARISON WITH PREVIOUS YEARS.



A correction was applied to the 2021 blue water footprint, which reduced it to 76 m3/tWFE, due to differences identified in reporting underground water at Playa Maqui.

The increase in the grey water footprint is due to the quantity and quality of water discharged by Río Petrohué hatchery, where polluting chlorides increased the indicator from 36 to 79 m3/tWFE.

Finally, the formulation of salmon feed has a significant impact on the results, as the suppliers Skretting, Salmofood and Cargill were analyzed in 2022, while in 2021 only data provided by Biomar was analyzed.

6. CONCLUSION

Salmones Camanchaca's sustainability strategy measures the water footprint to produce one ton WFE of salmon. These results for 2022 were 2,375 m3/tWFE, which was mainly generated by the indirect water footprint of its supply chain as this represented 94.2%.

We recommend adopting improvement measures, installing flow measurement instruments at each water extraction point to reduce uncertainty regarding measurements of each variable in the water footprint, potential water losses or evaporation during production, and incorporate monthly water quality measurements for both inflows and outflows, to provide primary information on the grey water footprint. Furthermore, it is important to include the raw materials used to make feed used during the freshwater and seawater phases, since globally about 2,422 Gm3 of water is required per year (87.2% green, 6.2% blue, 6.6% grey water), where about 98% of the water footprint is due to animal feed (Mejonnen & Hoekstra, 2010). Therefore, it is critical to analyze this parameter together with feed suppliers to identify solutions, given that water scarcity is increasing every year and that salmon production depends on the quantity and quality of salmon feed. This will support operational and supply chain water footprint management.

Measures that will improve the efficient use of water resources by the supply chain include the following:

- Measuring inflows at each facility by extraction point.
- Identifying suppliers that improve the water footprint of their products, based on their feed conversion ratio, efficiency, ingredient composition and production systems.
- Conducting a freshwater logistics survey to identify the best routes and conditions to reduce water use.
- Implementing treatment systems at every facility.
- Monitoring natural water parameters.
- Monitoring inflow parameters at facilities.
- Analyzing nature-based solutions to treat wastewater from its facilities.

Finally, we recommend collecting information that will help the company to improve its decision making regarding the risks associated with water resources, the importance of involving the company's supply chain, identifying and tracking the main sources of water extraction for salmon production, and communicating to stakeholders the company's measures to improve its environmental performance.

7. REFERENCES

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8. APPENDICES

TABLE 1: ESTIMATED WATER FOOTPRINT BY SOURCE OF ELECTRICITY

Energy source	(m3/GJ)	Conversion factor from (m3/GJ) to (m3/kWh)	m3/kWh	% Normalized energy matrix	m3/MWh
Wind	0	277.777777	0.000	14.09%	0.00
Biomass	61	277.777777	219.600	5.23%	11.48
Coal	0.2	277.777777	0.720	0.00%	0.00
Water energy	0.4	277.777777	1.440	62.27%	0.90
Solar Photovoltaic	0.3	277.777777	1.080	18.41%	0.20
Natural Gas	0.1	277.777777	0.360	0.00%	0.00
Diesel oil	1.1	277.777777	3.960	0.00%	0.00
Total			Factor	100.00%	12.58
Total SEN					5.864

TABLE 2: FUEL PROPERTIES

Fuel	Density (liters/tonnes)	Net CV (kWh/kg)	Conversion factor [kWh/l fuel]	Conversion factor [MWh/l fuel]	Source	Conversion factor [m3 water/kWh]	Conversion factor [m3 water/MWh]
LPG	1,889	13	6.75	0.00675	Defra fuel properties, 2021	0.00	0.49
Diesel oil	1,171	12	10.10	0.01010	Defra fuel properties, 2021	0.00	0.90
Petrol	1,357	12	8.97	0.00897	Defra fuel properties, 2021	0.00	0.49
Electricity				-	Defra fuel properties, 2021	0.01	12.57

9. COLLER FAIRR

1. Water Footprint with feed m3/tWFE

Water Footprint	Grow out	Hatcheries	Processing	Miscellaneous	Total
Blue	-	55	0	0	**56**
Grey	-	79	-	-	**79**
Indirect	2.176	1	4	-	**2.180**
Total	**2.176**	**135**	**4**	**0**	**2.315**

2. Water Footprint without feed m3/tWFE

Water Footprint	Grow out	Hatcheries	Processing	Miscellaneous	Total
Blue	-	55	0	0	**56**
Grey	-	79	-	-	**79**
Indirect	1	1	4	-	**5**
Total	**1**	**135**	**4**	**0**	**140**

3. Water footprint of the food delivered to Salmones Camanchaca.

Total water footprint of food: 105,654,988 m3 and 1.72 m3/kg of food

10. GLOSSARY

Inflow: Volume of water used by the process.

Cafl: Concentration of the parameter chosen to measure the grey water footprint in the inflow.

Cefl: Concentration of the parameter chosen to measure the grey water footprint in the outflow.

Max: Maximum concentration in the receiving water body of the parameter chosen to measure the grey water footprint defined by law.

Cnat: Natural concentration, without anthropogenic alterations, to measure the grey water footprint.

Outflow: Volume of polluted water discharged to public sewers or rivers after being used by the process.

WF: Water footprint

Blue water footprint: Volume of water consumed by and evaporated from a process.

Grey water footprint: Volume of water required to ensure that the pollution produced by an outflow complies with environmental quality regulations.

Green water footprint: Volume of rainwater absorbed by the vegetative layer.

Water use and consumption: Water use is the volume of water billed or extracted. Whereas, water consumption is the Blue water footprint.

WFN: Water Footprint Network, an organization that communicates the Water Footprint and provides technical support for water footprint evaluations.