

Briefing Sept 8, 2022

Salmon Farms & 2022 BC Sockeye Salmon Returns

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Salmon Farms - Sockeye fishing

In 2022 there were more fishing openings on sockeye salmon that were *not* exposed to salmon farms than on stocks that *were* exposed to salmon farms. While the Skeena, Somass and Okanagan sockeye salmon run sizes were significantly upgraded, the Fraser River sockeye salmon were downgraded (Fig 1):

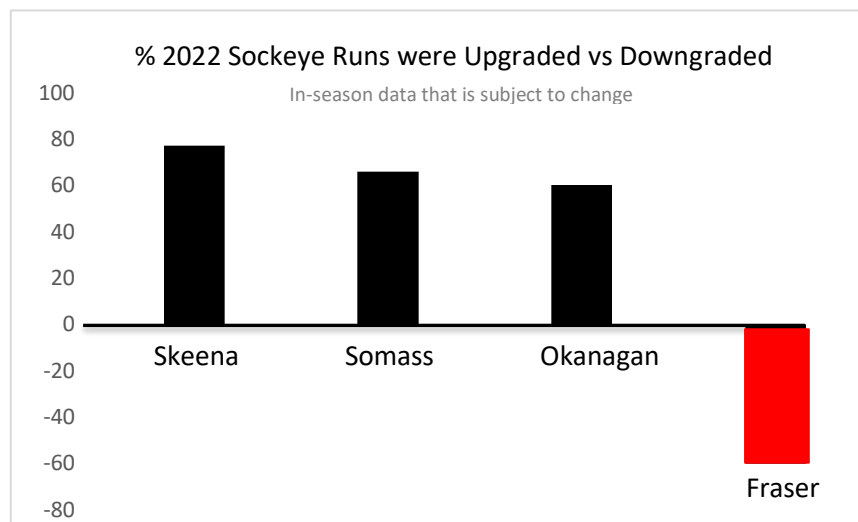


Figure 1: As of Sept 8, 2022, the Skeena, Somass and Okanagan sockeye salmon runs were all upgraded over 50% from the preseason forecast, while the Fraser River sockeye were downgraded by 60%. Only the Fraser River sockeye were directly exposed to salmon farms.

- Skeena River sockeye (north coast) **upgraded** from 965,000¹ to 4,200,000².
- Somass (Barkley) sockeye (SW Vancouver Island) **upgraded** from 400,000 to 900,000³.
- Okanagan sockeye **upgraded** from 200,000 to over 500,000⁴.
- Total Fraser River sockeye **downgraded** from 9,775,000, to 5,944,000⁵

¹ <https://seureservercdn.net/166.62.114.250/b4o.c3b.myftpupload.com/wp-content/uploads/2022/06/NCA-Weekly-Update-1-June-28-2022-1.pdf>

² <https://seureservercdn.net/166.62.114.250/b4o.c3b.myftpupload.com/wp-content/uploads/2022/08/NCA-Weekly-Update-8-August-16-2022.pdf>

³ https://www.ops2.pac.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?pg=view_notice&DOC_ID=263293&ID=all

⁴ <https://www.cbc.ca/news/canada/british-columbia/sockeye-salmon-okanagan-fishery-osoyos-1.6571895>

⁵ <https://www.psc.org/publications/fraser-panel-in-season-information/fraser-river-panel-weekly-reports/>

Sea lice infection – farm salmon

After hatching and rearing in freshwater, the 2022 Fraser River sockeye salmon went to sea as smolts in the spring of 2020. Ten salmon farms were operating in the narrow channels of the Discovery Islands as they migrated through the region. That spring, fish farm companies Mowi and Cermaq reported via their websites that 6 of their 10 active salmon farms in the Discovery Islands were infected with high sea lice numbers that breached the lice limit set by DFO. This limit is DFO’s attempt to keep the number of sea lice on farmed Atlantic salmon low enough so young wild salmon can survive as they pass the fish farms. Most of the Fraser River sockeye migrate to sea through the Discovery islands (Fig 2, red circle).

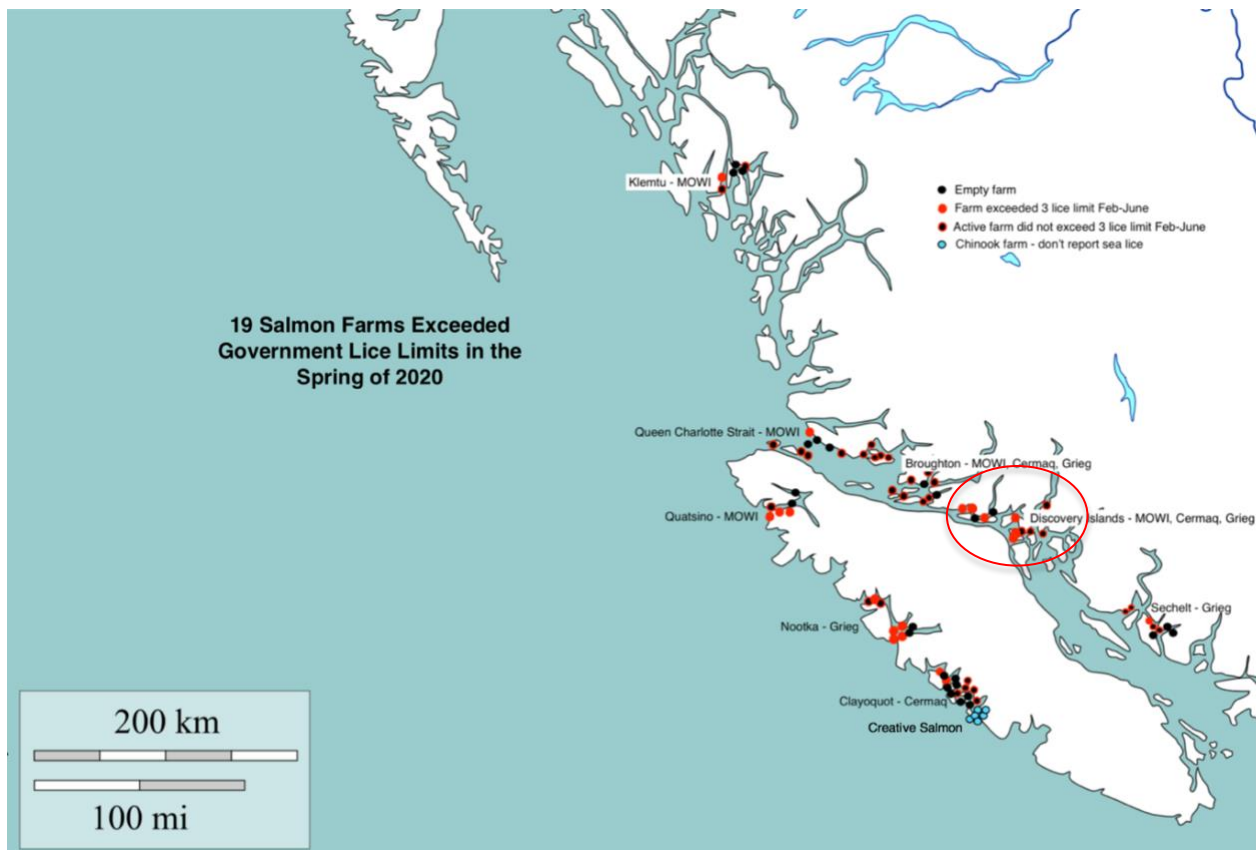


Figure 2: In the spring of 2020, 18 BC salmon farms breached the DFO sea lice threshold (red dots), including six of the active farms in the narrow channels of the Discovery Islands where the majority of sockeye leaving and returning to the Fraser River migrate (red circle).

Sea lice infection - sockeye

One hundred and five juvenile Fraser sockeye salmon were examined for sea lice in the spring of 2020 as they swam past the salmon farms in the Discovery Islands. The fish were collected over 53km (Fig 2, red circle) (See Appendix 1 for Methods, Appendix 2 for data). Smaller

numbers of sockeye were also examined in Port Hardy, Broughton Archipelago and Nootka (Fig 3).



Figure 3: Juvenile sockeye were caught with a hand-purse seine in the Discovery Islands among the salmon farms

The sockeye smolts examined in the Discovery Islands were infected with an average of 9.6 sea lice of all stages (Table 1, Appendix 2).

Area	Number of fish	Length	Weight	Average Lice/fish
Port Hardy	27	98.8	13.7	41.9
Nootka	3	101	12.5	9
Discovery Islands	105	106.5	13.3	9.6
Broughton	16	65.4	Not available	2.75

Table 1: The number, length, weight, and infection of juvenile sockeye examined by area. Fish in the Broughton were examined alive and released which does not allow for weight to be measured.

An attempt was made to examine these young Fraser sockeye again as they continued their migration north along the coast, but after the Discovery Islands no juvenile Fraser sockeye schools were visible. It was unclear whether they had died or were travelling deeper.

The DNA of these young sockeye were identified as predominately Shuswap, Adams, Quesnel, Horsefly, Scotch, Seymour (pers com Pieter VanWill, DFO).

Although not widely communicated, DFO reports that an average of 10 adult stage sea lice cause *acute stress response* and *profound physiological impact* on juvenile sockeye and made the fish *lethargic*⁶ i.e., the young salmon infected with sea lice were unable to keep salt levels regulated and moved slowly (Fig 5b). Sea lice infections are not reported on young wild salmon that are not exposed to salmon farms⁷.

⁶ <https://pubmed.ncbi.nlm.nih.gov/30566268/>

⁷ <https://cdnsiencepub.com/doi/abs/10.1139/f04-016>

Sockeye - farm salmon pathogens

In addition to sea lice infections, we know young Fraser sockeye exposed to salmon farms become highly infected with the bacteria *Tenacibaculum*. This bacteria, reported in most salmon farms, causes mouthrot in Atlantic salmon. These findings led researchers to publish the following warning regarding sockeye salmon exposure to salmon farms:

*“Given the evidence for farm-origin transfer of *T. maritimum* to Fraser-River sockeye salmon, the severity of associated disease in related species, and the imperilled nature of Fraser River sockeye generally, **our results suggest the need for a more precautionary approach to managing farm/wild interactions in sockeye salmon.**”⁸*

In another study, DFO research reported *seven infectious agents were elevated* in young sockeye exposed to salmon farms and this infection was correlated with *lower survival* of the sockeye⁹.

Unpublished data presented to the West Coast Vancouver Island Round Table¹⁰ from research off the west coast of Vancouver Island reported that salmon farm associated viruses and bacteria (PRV and *Tenacibaculum*) were elevated in young over-wintering Chinook salmon in Quatsino, Nootka and Clayoquot Sound, but not Barkley Sound. Of these regions, only Barkley Sound is salmon farm-free. These scientists predicted reduced survival for the infected salmon that had been exposed to salmon farms.



Figure 4: Persistent occurrence of the open sores pictured here in young sockeye in the Discovery Islands in 2015 is a concern. Samples have been provided to DFO but no results.

⁸ <https://cdnsiencepub.com/doi/full/10.1139/cjfas-2021-0164>

⁹ <https://www.frontiersin.org/articles/10.3389/fmicb.2018.03221/full>

¹⁰ <https://www.roundtables.westcoastaquatic.ca/>

Port Hardy 2020

The exceptionally high infection of young sockeye off Port Hardy in Table 1 is notable. These sockeye were from Woss Lake (Nimpkish River). This is the highest average sea lice infection recorded in 21 years of sea lice monitoring of juvenile BC wild salmon. These sockeye smolts were collected near the fish farm company Mowi as their delousing boat, *Aqua Tromoy*, was conducting a sea lice removal treatment. During this treatment farm salmon are pumped into the large vessel, soaked in a bath treatment to remove the lice, then returned to the pen. While there are filters on the vessel, as the treatment water is released into the ocean, elevated numbers of sea lice eggs and larval are found in the effluent. The relationship between release of larval lice from delousing boats and exceptionally high sea lice infections on wild smolts is under investigation.

This raises the concern that the process of removing farm lice to protect wild salmon is elevating, not reducing, the risk to young wild salmon. As well, these findings illustrate the issue of impact of salmon farms sited in one First Nation territory on salmon that spawn in the territory of another First Nation further to the south.

Discussion

The exceptionally good fisheries on Alaska, Skeena, Somass and Okanagan sockeye in 2022 suggest that open ocean survival was very good for this generation of sockeye. However, only sockeye *not exposed* to salmon farms produced strong fisheries. The Fraser River sockeye which were *exposed* to salmon farms when they were smolts were downgraded, severely reducing fishing opportunities. This is only a “correlation”, not “proof” that salmon farms killed a large portion of the Fraser sockeye. However, the condition of these fish as juveniles must be considered. No sea lice outbreaks have been recorded on young wild salmon where there are no salmon farms. The BC Salmon Farmers hired Mainstream Consulting to also collect juvenile salmon in the Discovery Islands in 2020, but they do not provide any data on sea lice infection of sockeye. My team and I were the last people to see this generation of sockeye before they went to sea (Fig 3).

Infection with an average of 9.6 sea lice is a significant challenge for young sockeye salmon that have just left freshwater, are trying to adapt to saltwater, while evading predators, feeding and migrating. The DFO study on impact of sea lice on young sockeye reported that the fish became “lethargic”. This means even if the lice did not outright kill the fish, they made the fish dangerously weak in an ocean full of predators.

Of note, the sea lice numbers reported here include *all life-stages*, from larval to adult, while the DFO study reports only on the impact of *adult* sea lice. Certainly, the impact of adult sea lice is greater than the impact of young lice and we know that a proportion of larval sea lice on

a salmon don't survive to maturity. However, we do know the 2020 young Fraser sockeye were heavily infected with sea lice with, with many more salmon farms to pass off Port Hardy before reaching the open ocean. We know that over half of the number predicted to return did not even though survival of other BC sockeye was very high.

The future of BC salmon farms

Previous Minister of Fisheries Bernadette Jordan closed the salmon farms in the Discovery Islands in December 2020. Because she did this starting in 2021, Fraser sockeye have not been exposed to salmon farms in this region. We will see the impact of this next summer. In June 2022, the current minister Joyce Murray kept these farms closed, but she is actively consulting with First Nations on whether to reopen these farms. This consultation is open to nations outside the Discovery Islands and funding is provided.

This spring, DFO staff reported “close to 40 counts over the sea lice threshold...”¹¹ in the salmon farms still operating outside the Discovery Islands. This means wild salmon coastwide remain unprotected from farm lice levels that DFO considers dangerous. A recent paper reports BC salmon farming companies under-report their lice numbers by up to 50%¹².

First Nations in the Broughton Archipelago, including Namgis (Alert Bay) have an agreement with the Province of BC to close several salmon farms per year. With nine active salmon farms recently closed in the Broughton, they are seeing a dramatic increase in wild salmon returns to local rivers.

Research published in 2007 reports that globally wild salmon decline by up to 50% when exposed to salmon farms:

*“... Meta-analytic estimates of the mean effect are significant and negative, suggesting that salmon farming has reduced survival of wild salmon and trout in many populations and countries.”*¹³

The Minister of Fisheries, Joyce Murray is currently considering whether to reopen the salmon farms in the Discovery and whether this industry will remain in the ocean coastwide. <https://www.canada.ca/en/fisheries-oceans/news/2022/06/government-of-canada-outlines-next-steps-in-transition-from-open-net-pen-salmon-farming-in-british-columbia.html>

¹¹ Email June 8, 2022 from Adrienne Paylor to Brenda McCorquodale, Director of Aquaculture Management (DFO) Access to Information document A-2022-00328

¹² <https://thenarwhal.ca/bc-salmon-farms-sea-lice/>

¹³ <https://pubmed.ncbi.nlm.nih.gov/18271629/>

Gallery of Images



Figure 5a: This is a very recent infection, i.e., the size and shape of several of these sea lice indicate they attached to this fish within hours and days indicating a local source of lice

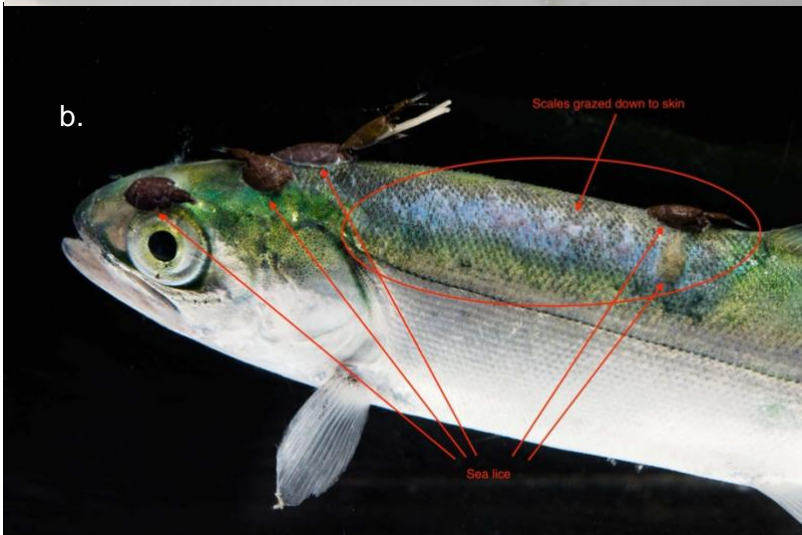


Figure 5b: Sockeye smolt infected with 5 motile sea lice in Knox Bay. The feeding activity of these lice has removed the protective mucus and scales opening this young sockeye to infection and osmoregulatory stress i.e., difficulty to regulating salt levels in its body as well as draining the resources this fish needed to survive.

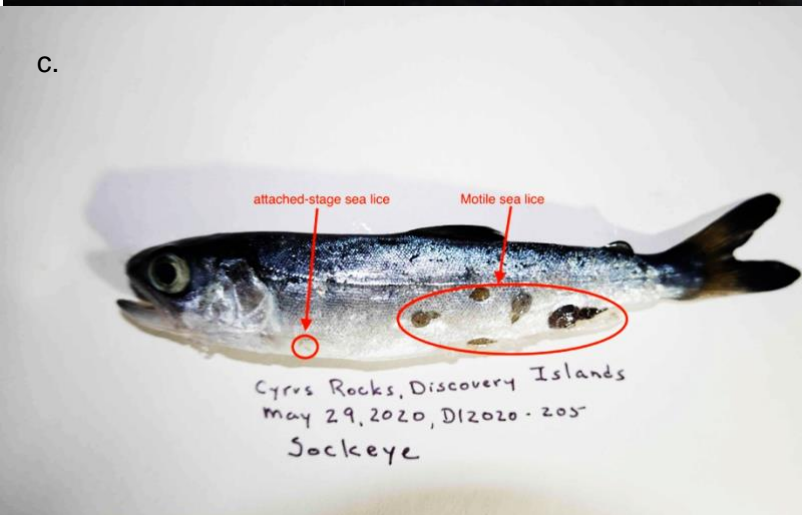


Figure 5c: Infections like this are typical of young salmon that have been exposed to more than one farm. One side of this sockeye smolt is infected with 5 older motile sea lice and 2 younger attached-stage sea lice, evidence that this fish passed two salmon farms.

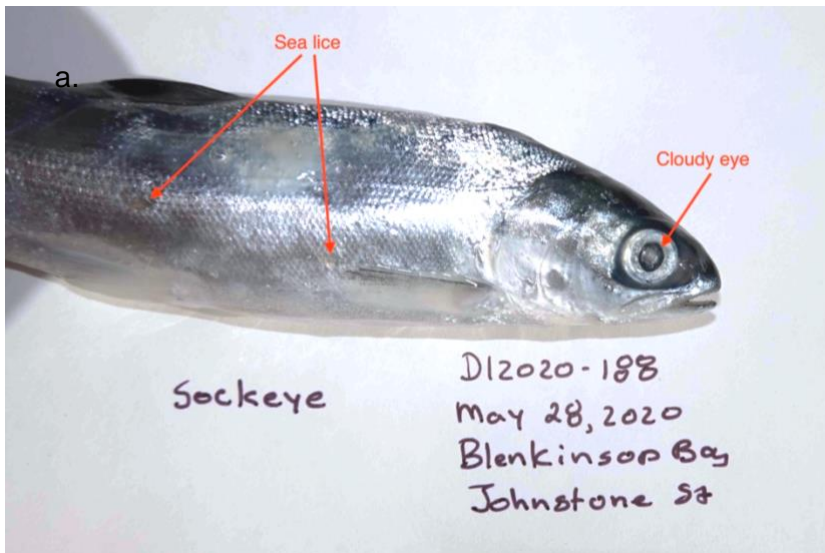


Figure 5d: Cloudy eye syndrome is now common in salmon smolts exposed to salmon farms. The cause is unknown, but farm salmon exhibit a similar appearance. This may reduce ability to catch food and evade predators. DFO has been notified.

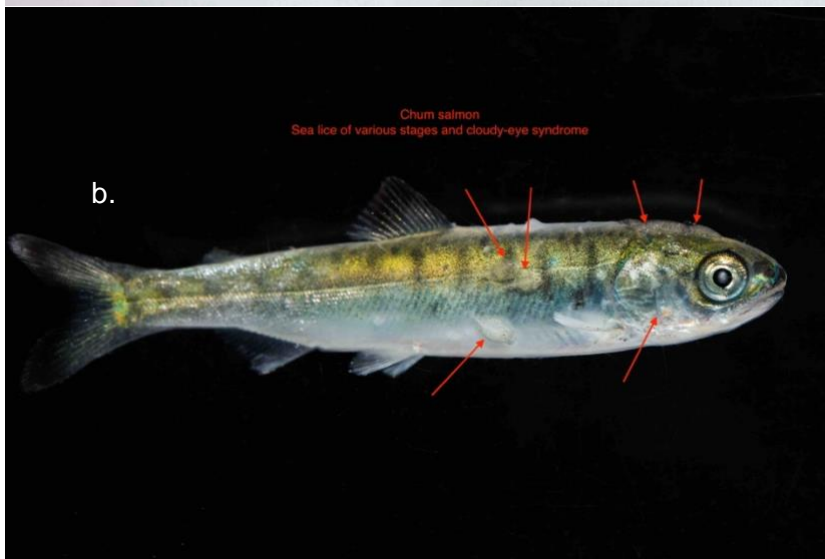


Figure 5e: Cloudy-eye syndrome is also common in other species of Pacific salmon exposed to salmon farms.

Appendix 1

Methods

Two different field protocols were followed. For all samples, juvenile salmon were captured by beach or hand purse seine and transferred to seawater-filled buckets (20 L). In Broughton salmon were individually transferred from buckets into a clear plastic bag for live identification of sea lice. The fish were identified by species and their length was measured. Sea lice were identified with a 16x hand lens to life-stage (copepodid, chalimus A, chalimus b, preadult or adult), the preadult and adult stages or motile-stage lice were further identified to sex and species (*Lepeophtheirus salmonis* or *Caligus clemensi*) and the fish were released as per Krkosek et al (2005). In Nootka Sound, Discovery Islands and Port Hardy the fish were euthanized, placed in individual bags and frozen until they could be examined under a 30x dissecting

Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	105	13.7			2	1					2	5
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	106	14.3		1	7	3			3			14
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	110	14.9			2	4						6
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	112	16.3	1		4	1					1	7
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	121	17.1			5	7		1				13
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	104	13.8		1	9	8					1	19
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	105	12.8			3	2					2	7
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	113	17.9			6	2			2		2	12
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	109	14.3			6	6			1			13
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	107	13		1	4	2						7
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	112	15.1			3	1			1			5
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	113	14.9			6	4			1		2	13
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	108	13.5			7	2						9
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	116	18.8			1	8			2		2	13
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	121	21.5			3	2					2	7
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	111	19		1	4				1			6
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	112	19.5			11	10			2		1	24
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	140	31.1			9	3			2		2	16
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	109	12.8	2		13	1			1			17
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	109	12	1	1	6	1						9
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	108	14.7			8	3						11
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	111	14.2			9	5					1	15
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	116	15.7	1		6	1					2	10
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	113	17.8			4	4						8
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	104	13.7			2	1			2			5
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	108	15			8	2			1		1	12
Discover y Islands	2020	5	28	30.7	10.2	Blenkins op Bay - Johnstone Strait	sockeye	108	15			7	9			2		1	19

Discover y Islands	2020	5	28	30.7	10.2	Blenkinsop Bay - Johnstone Strait	sockeye	119	19.8	1		8							2	11
Discover y Islands	2020	5	28	30.7	10.2	Blenkinsop Bay - Johnstone Strait	sockeye	95	8.9			6	3				1			10
Discover y Islands	2020	5	28	30.7	10.2	Blenkinsop Bay - Johnstone Strait	sockeye	93	8.7	1		4	3							8
Discover y Islands	2020	5	29	29.5	12.9	Cyrus Rocks - Okisollo	sockeye	104	10.8	2	1	15			1	1	1			21
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	100	11.1	2		4	2	1				1		10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	120	19.2			9	4					1	2	16
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	107	12.1	1		4	3							8
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	109	14.2		2	4	4			1			2	13
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	109	14			4	4						1	9
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	109	12.9	1	1	4	3					1	1	11
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	117	15.4	1	1	7	2	1				1	2	15
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	108	13.4			7	2						2	11
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	101	9.6			8	3	2					2	15
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	116	16.3			2	3						1	6
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	89	7.1	2		6	2							10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	95	8.5		2	1	3							6
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	112	13.2			4	3						2	9
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	92	9.4			2	2						1	5
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	104	11.9											0
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	129	22.1			1	2			1				4
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	110	11.9			2	3			2			1	8
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	97	10.3			6	4						2	12
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	88	6.7	1	1	10							2	14
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	102	11.2	1		7							2	10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	98	10.5	2		6	3						2	13
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	107	12.5			7	1						2	10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	105	12.4			3	1		1			1		6
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	106	13			2	3						2	7
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	105	10.9			3	3					1	2	9
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	97	9.8			2	1							3
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	89	6.7			1	2							3
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	86	5.9	1	1	3	1				1			7
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	108	13.3			2	2						2	6
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	100	10.2		1	6	1						2	10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	92	6.8		1	5	2			1				9

Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	102	11.3			3	2						5	
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	108	14.3			6	3						9	
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	105	10.4		1	10	1	1			1		1	15
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	110	13			1	3						1	5
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	93	8.6			5	1						1	7
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	113	14.3			5	5						2	12
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	98	9.9			3	3		1		3		1	11
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	105	13.3			7	2					1	2	12
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	104	10.7	3	4	6	1				2			16
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	101	11.6		1	2	3				1		1	8
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	117	12.5			6	7	1						14
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	102	11.9			1	4				1		2	8
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	104	12.2		7	7	3							17
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	111	15		1	5	6						2	14
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	109	13.5		4	4	2				3		2	15
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	98	10.2			2							2	4
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	105	11.9		1	6	2				1			10
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	95	9.2			3	2							5
Discover y Islands	2020	5	28	30	10.7	Barnes Bay - Okisollo	sockeye	112	15.8			6	7				1		2	16
Johnstone Strait	2020	5	28	30.1	10.3	Knox Bay, Johnstone Strait	sockeye	106	12.6	2	1	7	1				2			13
Johnstone Strait	2020	5	28	30.1	10.3	Knox Bay, Johnstone Strait	sockeye	107	12.4			7	2						2	11
Johnstone Strait	2020	5	28	30.1	10.3	Knox Bay, Johnstone Strait	sockeye	106	13			3	5						2	10