



CENTRAL SOUTH ISLAND REGION

Sockeye Salmon Population Monitoring 2023

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Executive Summary

NZ Sockeye Salmon (*Oncorhynchus nerka*) that reside in the Waitaki lakes were introduced in 1901 from anadromous stocks in British Columbia, Canada to be a sea-running salmon population in the Waitaki River. However they did not run to sea and took residence in the lakes instead. Once the Waitaki dam systems were commissioned Lake Benmore became a stronghold for the sockeye population. NZ Sockeye are a valued sports fish among anglers and sockeye juveniles serve as a reliable forage food for trout. Sockeye are predominantly filter feeders and less likely to compete with trout and chinook salmon for food.

This sockeye salmon monitoring program was developed between 2018 – 2020 and uses a combination of ground surveys and aerial counts to make estimates of the total number of spawning sockeye for the season. For the purposes of this program the peak of the sockeye salmon spawning season is the 15th of March and based on overseas research we estimate the residence time in the spawning streams to be 15 days.

The 2023 sockeye spawning season was estimated to be the largest in the history of the monitoring programme. The 2023 total spawning run was 84,191 individuals which is roughly six thousand more than 2021 and 20,000 up on last year. Notable contributions to this year's total are the high run numbers in the Twizel, Ahuriri and Lower Ohau rivers.

Falstone Creek is a tributary of Lake Benmore and has undergone significant changes in the last year. There is now passage past the Falstone Creek Bridge and access to much more spawning ground resulting in less competition for space. A full survey of the creek will need to be undertaken so that Falstone Creek and its tributaries can be more accurately estimated in the future.

Anglers have reported sockeye spawning in the Jollie River. If time and resources allow investigation into the Jollie River would provide a better understanding of Lake Pukaki's spawning populations.

Background and life history

NZ Sockeye Salmon (*Oncorhynchus nerka*) that reside in the Waitaki lakes were introduced in 1901 from anadromous stocks in British Columbia, Canada to be a sea-running salmon population in the Waitaki River. Some sockeye did not run to sea however, and instead took residence in Lake Ohau. Though these fish were smaller and had lower fecundity (Quinn, et al. 1998) non-anadromy became the naturally selected life history pattern of the NZ sockeye. This population is the only self-sustaining population of sockeye in the Southern Hemisphere. A characteristic of the British Columbian kokanee is to reside in freshwater lakes and spawn in tributaries rather than run to sea like the sockeye from which the NZ stock were sourced from. Despite being genetically dissimilar, the NZ sockeye life history pattern adapted to reflect the life history of the British Columbian kokanee (Quinn, et al. 1998). For the purposes of this report, NZ *Oncorhynchus nerka* will be referred to as sockeye and not kokanee. Like all Pacific salmon, sockeye die shortly after spawning (Couper 2018).

The first of the Waitaki Valley dams was commissioned in 1935, and the last in 1981. These dams resulted in several different lake catchments forming somewhat distinct populations allowing only for downstream migration of sockeye through the power stations.

Sockeye are now established in lakes Pukaki, Ohau, Ruataniwha, Benmore and Aviemore. There are a few individuals sporadically dispersed in the lower Waitaki River as a result of spills but they do not typically reside there. Spawning occurs in most tributaries of these lakes. Lake edge spawning is believed to be minimal (Couper 2019).

NZ sockeye are a valued sports fish among anglers and sockeye juveniles serve as a reliable forage food for trout (Graynoth 1995). Sockeye are predominantly filter feeders and less likely to compete with trout and chinook salmon for food. The most recent sockeye gut samples contained primarily *Daphnia pulex*, an introduced zooplankton (Couper 2021) commonly referred to as the water flea.

The parameters of this sockeye spawning monitoring program are that the estimated peak spawning day is set at 15th of March (Couper 2018) and the residence time of sockeye in the spawning stream is 15 days, based on overseas research of the same species (Foerster 1968).

Methods

For the purposes of this sockeye spawning monitoring programme the Waitaki Lakes were split into 6 Lake catchments. Pukaki, Ohau, Ruataniwha, Benmore, Aviemore, and Waitaki.

Given the size and significance of Lake Benmore to the total Waitaki population, 5 sub-catchments of lake Benmore have been identified (see table 1).

Table 1: Lake Benmore sub-catchment description

Sub-catchment	Waterways
Twizel River	Twizel River and Fraser Stream.
Ahuriri Arm	Ahuriri River and tributaries.
Lower Ohau	Lower Ohau River and Mint Stream.
Tekapo River	Tekapo River, Grays Stream, Fork Stream and Maryburn.
Haldon Arm minor tribs	Falstone Creek, Shepherds Creek and Scrubby Creek

On the 14th of March Fish and Game field officers conducted an aerial survey of key spawning grounds and recorded the number of fish seen. The waterways are broken down into sections between “waypoints” and counts are recorded throughout into a purpose-built tally sheet.

On the 15th of March four ground surveys were undertaken. These being Aviemore Spawning Race in its entirety, 1km of Falstone Creek from “Lake” to “Below Ladder”, sections of Mint Stream and Fork Stream between the Tekapo River and the Tekapo Canal culvert underpass.

The raw data is collated and with corrections for operator visibility and the proportion of the river or catchment surveyed.

The area under the curve (AUC) method outlined in Unwin 1994 is then applied using a residence time of 15 days to obtain the total estimated spawning run in the catchments.

Results

Spawning run estimates

As shown in table 2, 2023 is the highest estimated sockeye run since the development of the monitoring programme in 2018. This year's total run of 84,191 is roughly 6,000 more than the previous highest spawning run in 2021 of which was estimated to be 78,151 sockeye. Notable contributions to this year's data are the high run numbers in the Twizel, Ahuriri and Lower Ohau rivers.

Table 2 Spawning totals from 2018 - 2023 with highest ever run shown in red on the mini-graph.

Catchment/Subcatchment	2018	2019	2020	2021	2022	2023	
Lake Benmore	32,000	36,580	42,770	64,770	44,381	72,177	
Twizel River	19,110	18,420	20,180	21,450	23,756	34,471	
Ahuriri Arm	150	220	11,390	17,330	291	6,265	
Lower Ohau	9,660	9,070	6,100	16,830	3,895	21,139	
Tekapo River	1,830	6,530	4,440	6,700	14,403	7,730	
Haldon Arm minor tribs	1,250	2,340	660	2,460	1,178	2,572	
Lake Aviemore	2,150	-	13,610	10,430	444	874	
Lake Pukaki	4,420	6,880	5,680	2,150	15,249	7,018	
Lake Ruataniwha	300	-	-	600	-	186	
Lake Waitaki	-	-	2,510	100	-	0	
Lake Ohau	110	27,800	9,120	100	199	3,936	
Catchment Total	38,980	71,260	73,690	78,150	60,273	84,191	

Lake Pukaki

The three braids of Glentanner Stream are the key spawning indicators for the Lake Pukaki catchment. The estimated total spawning population of Lake Pukaki in 2023 was 7,018 individuals. This accounted for 8.3% of the total Upper Waitaki sockeye catchment.

Lake Ohau

The total estimated spawning population for the Lake Ohau catchment was 3,936 sockeye. Looking at previous year's data the Lake Ohau spawning catchment shows interesting fluctuations in results. The 2019 season still holds the record for largest spawning run (post construction of Ohau B and C Hydro dams) showing 27,800 spawning sockeye in the catchment. Two years later in 2021 just 100 individuals were estimated to have spawned in the catchment.

Table 3: 2023 Sockeye spawning run breakdown.

Catchment/tributary	Estimated Sockeye
Lake Pukaki	7,018
Glentanner Stream	7,018
Lake Ohau	3,936
Stockyard Stream	1,358
Larch Stream	2,578
Lake Ruataniwha	186
Upper Ohau River	186
Lake Benmore	72,177
Twizel River	31,120
Lower Ohau River	21,103
Mint Creek	36
Fraser Stream	3,351
Mary Burn	2,528
Shepherds Creek	1,606
Falstone Creek	918
Grays River	578
Omarama Stream	386
Forks Stream	27
Scrubby Creek	48
Tekapo River	4,597
Ahuriri River	5,879
Lake Aviemore	874
Otematata River	577
Deep Stream	297
Lake Waitaki	0
Aviemore Spawning Race	0
Estimated catchment total	84,191

In 2021 Larch stream showed a result of zero spawning sockeye whereas this year Larch Stream was the reach accounting for 65% (2,578) of Lake Ohau’s total sockeye spawning population.

It appears that either the sockeye spawning population fluctuates considerably from year to year or the preferred spawning streams are more flexible than we knew and the sockeye sometimes favour different tributaries.

Lake Ruataniwha

Lake Ruataniwha has been identified in the past as supporting a small population of sockeye and this was confirmed this year when it was estimated that 186 spawning sockeye visited the Upper Ohau River. The Upper Ohau River is the principle spawning ground for sockeye in Lake Ruataniwha.

Tekapo River – Lake Benmore

The Tekapo River sub-catchment is comprised of Fork Stream, Mary Burn and Grays River. The total estimated sockeye spawners for the Tekapo River sub-catchments equated to 7,730 sockeye, just over 10% of the total Benmore spawning population for 2023.

Only 205 meters of Fork Stream is accessible to sockeye from the confluence with Tekapo River to the concrete weir where Fork Stream passes underneath the Tekapo Hydro Canal. It was estimated that Fork stream had a run of 27 this year.

The Mary Burn had sections that had thick willow cover and provided little to no visibility from the air in places. Using the calculations outlined it is estimated the Mary Burn contributed 2,528 sockeye to the Tekapo River sub-catchment in the 22/23 season. Approximately 10km of the Mary Burn was flown from Tekapo River confluence to the SH8 Bridge however no sockeye were seen above about 7km upstream.

Twizel River – Lake Benmore

The Twizel River is one of the primary spawning rivers in the Lake Benmore catchment. This season the Twizel River catchment contributed 34,471. This was 40 % of the total Waitaki Lakes spawning population.

Haldon Arm Minor Tributaries - Lake Benmore

Recent flooding in Falstone Creek has significantly improved sockeye access beyond Falstone Road Bridge. Historically a concrete weir impeded fish passage past this point. The large scour hole downstream from the culvert is now filled in with river stones and allows passage through the culvert providing access to an abundance of spawning ground and reducing competition for space.

The total spawning run for Falstone Creek was 918 individual sockeye. Scrubby Creek and Shepherd Creek estimates were derived from Falstone Creek results. The estimated sockeye spawning run in the Haldon Arm minor tributaries was 2,572 individuals.

Ahuriri River – Lake Benmore

On the day of surveying, the Ahuriri River was flowing at 25m³/s at State Highway 8 and the lower reaches were discoloured with no visibility. The first 12km from the mouth to the 4th waypoint was unable to be counted and was estimated from ratios from previous years. Accurate counts were able to be obtained from the subsequent 36km upstream from waypoint 4 (4km upstream of the SH8 Bridge) to Snowy River Junction (47.8km from mouth). From this we concluded that the total estimated spawning population in the Ahuriri River was 5,879 sockeye. Omarama Stream was also surveyed by helicopter and 386 sockeye were estimated to be present in this tributary of the Ahuriri River. Together the Ahuriri sub-catchment contributed an estimated 6,265 total spawners to the Lake Benmore catchment for this season.

Lake Aviemore

Otematata River and Deep stream are the basis of the estimate for the Lake Aviemore catchment. The total spawning population in Lake Aviemore for 22/23 season was 874 sockeye salmon.

Lake Waitaki

No sockeye salmon were present in Aviemore Spawning Race this year which supports the theory outlined in Couper 2020 that Lake Waitaki does not have a self-sustaining sockeye population and that any present are the outcome of spills from Lake Benmore. It is believed juveniles that hatch into Lake Waitaki tributaries are taken by the current or freely migrate downstream.

Future Management

When the current monitoring programme was developed in 2018-2020, Falstone Creek was inaccessible to sockeye past the Falstone Creek Bridge and 100% of the sub catchment was able to be counted. This year is the first year that there has been free passage under this Bridge. It is not known how far up Falstone Creek sockeye are able to progress and whether this extended habitat influences the spawning populations of rest of the Haldon Arm Catchment or Lake Benmore as a whole. A full survey of the creek will need to be undertaken so that Falstone Creek and its tributaries can be more accurately estimated in the future.

CSI Fish and Game have received reports from anglers that the Jollie River has spawning sockeye present. When resources allow, an investigation will be worthwhile to better understand the Lake Pukaki catchment's true spawning population.

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