2022-23 Sea-Run Salmon Escapement Report

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1. Introduction

North Canterbury Fish & Game has been conducting monitoring of sea-run salmon returns since 1993; over the decades a steady decline in escapement has been observed, particularly in the late 90s and early 00s. This information has previously been used alongside angler harvest in setting daily bag limits. Following further declines in the mid-late 2010s, the Adaptive Management Strategy (Webb & Terry, 2020) was developed and resulted in the adoption of a season bag limit for sea-run salmon in the North Canterbury and Central South Island regions at the start of the 2021-22 season. The main aim of the season bag limit was to reduce overall angler harvest, resulting in increased escapement to the headwaters for spawning; limiting harvest is most important in years where total spawning numbers may be low. Historic harvest proportions reached as high as 65% in the Rakaia River and 77% in the Waimakariri River. The season bag limit for each season is determined using the 'Threshold Management Strategy', which depends on the previous three season's escapement estimates for the three 'indicator' rivers (Rakaia River, Waimakariri River and Rangitata River). The 2021-22 season had a season bag limit of two salmon and resulted in a marked decline in the total proportion of the total run estimate being harvested by anglers (12% and 25% in the Rakaia and Waimakariri rivers respectively). The season bag limit for the 2022-23 season remained at two salmon. The expectation was that the harvest proportion for this season remained similarly low compared to previous years with no season bag limit.

2. Sea-run salmon escapement

2.1 Methods

Historically, the 'area under the curve' (AUC) method was used to calculate estimated escapement. The AUC method estimates total escapement based upon multiple periodic spawning counts and the residency time (RT) of the spawning fish (English et al., 1992). This was used from when counts began in 1993 through to 2013, where financial constraints meant multiple spawning counts could not take place (and therefore AUC could not be used). Between 2013 and 2020, the 'peak count' method was used, estimating escapement numbers based off a single count at the time of peak spawning. The resumption of multiple aerial counts in 2021 allowed for the resumption of the AUC method.

Five aerial counts were carried out on the spawning streams of both the Rakaia and Waimakariri rivers in 2023 (Table 1). The Hurunui and Waiau Uwha rivers were not counted this season, as

AUC estimates require at least 3 data points (counts), and an additional 3 flights was not within the budget. Aerial counts follow standardised methods developed by NIWA (Unwin, 1994) on the same known spawning streams each year to maintain consistency. Staff flew over each of the spawning streams, counting all visible salmon in the waterway from the designated starting point. Dead salmon are also counted in the first aerial count. Some streams (e.g., Bush Stream Inner) require staff to do foot counts as it is not possible to count from the air due to vegetation. While a tributary to the Rakaia River, Mellish Stream and Lake Heron are counted by Central South Island staff as it lies within their region. Two aerial counts of the lake and stream are conducted, followed up by a final foot count of the lake edge and stream. Area Under the Curve could also not be performed for Goat Hill Stream/Wilberforce Swamp as there were not enough data points for AUC calculation. Therefore, the Peak Counts for each of these waters were added to the AUC calculations for the rest of the streams. The final Rakaia escapement estimates may therefore be an underestimate.

Table 1. List of spawning streams in the Rakaia and Waimakariri used in aerial counts. Some nearby streams are grouped together for reporting purposes. Mellish Stream lies within the Central South Island region and is counted by their staff.

Rakaia River	Waimakariri River
Double Hill Flats	Bealey Stream
Glenariffe	Bush Stream (inner and outer)
Goat Hill Stream	Cass Hill
Hydra Waters	Cora Lynn
Manuka Point	Lower Casey Stream
Mellish Stream*	Sawmill Stream
Wilberforce Swamp	Thompson Stream
	Turkey Flat
	Winding Creek

Goat Hill Stream (Rakaia River) was unable to be counted for multiple flights as a side braid of the Wilberforce River had cut across into the springhead area and made the stream dirty. The Poulter streams (Thompson Stream, Outer and Inner Bush Stream, and Lower Casey Stream) could not be counted on the 5th Waimakariri flight due to weather conditions.

Once all aerial counts were completed, escapement estimates were made for each spawning stream using the Salmon AUC programme in Matlab (Version 1.0, NIWA).

For each river, estimates for each stream were added together to give the total escapement estimate for both the Waimakariri and Rakaia rivers (See Appendix Figure 7.1 and 7.2 for an example of AUC graph output). It's important to remember that this estimate is a population index and is not intended to represent the total number of fish in the river.

2.2 Results

2.2.1 Rakaia River

The population index for the Rakaia River in the 2022-23 season is 1332 salmon (See Appendix, Table 7.1 for individual stream estimates). This is lower than the 2021-22 season estimate (3217), although still higher than escapement estimates between 2016-2021 (Figure 2.1).

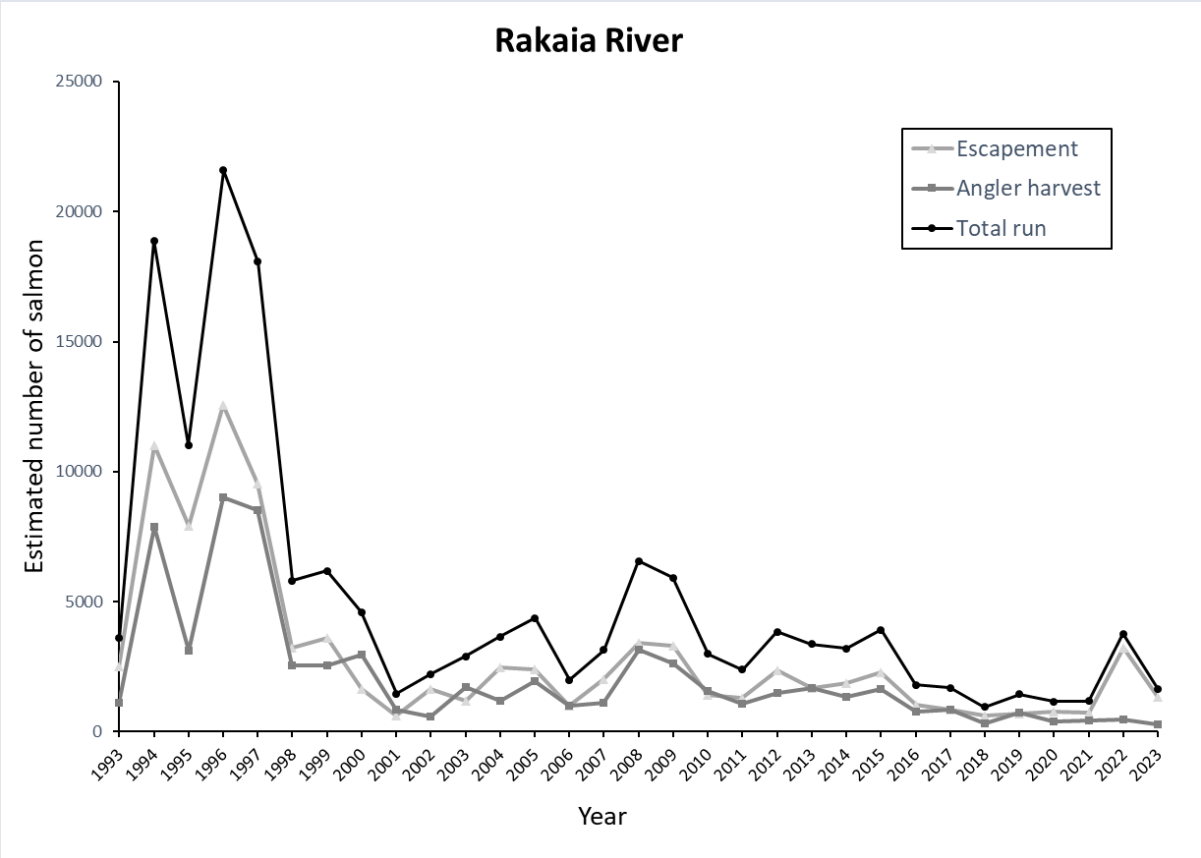

Figure 2.1. Estimated escapement, angler harvest, and total run for sea-run salmon on the Rakaia River from 1993-2023.

2.2.2 Waimakariri River

The population index for the Waimakariri in the 2022-23 season is 671 salmon (See Appendix, Table 7.2 for individual stream estimates). This is the highest escapement estimate since 2017

(Figure 2.2). Due to low population indices, Bealey Stream, Turkey Flat, Railway Springs (Sawmill Stream) were combined for reporting purposes. Likewise, Outer Bush, Inner Bush Stream, Lower Casey and Thompson Stream have been combined into 'Poulter streams'.

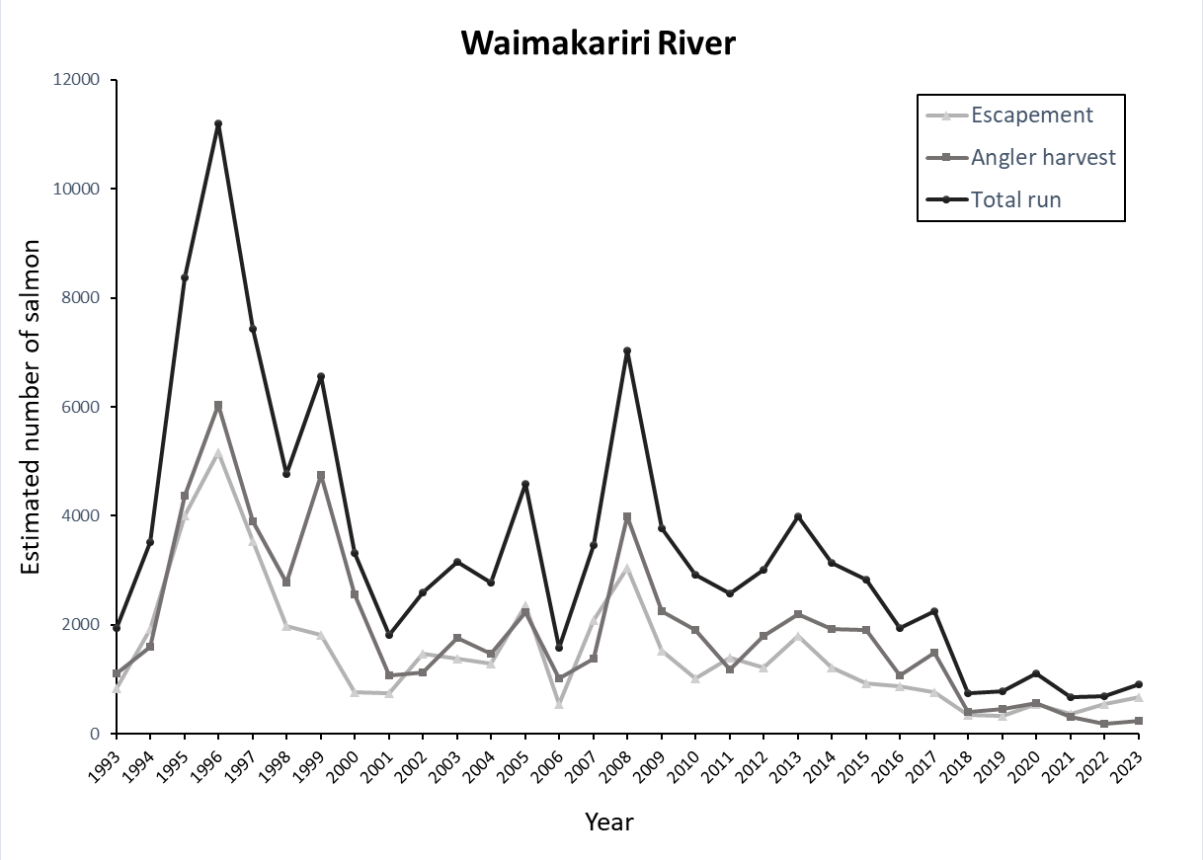

Figure 2.2. Estimated escapement, angler harvest, and total run for sea-run salmon on the Waimakariri River from 1993-2023.

3. Total run and harvest proportion estimates

3.1 Rakaia River

Combining the estimated escapement with the estimated harvest (see the 2022-23 Season Salmon Harvest Report) gives a total run estimate of 1631 salmon for the Rakaia River (Figure 2.1, and Appendix, Table 7.3). Similar to escapement estimates, with the exception of last season's run, this is the highest total run since 2017. An estimated harvest of 299 salmon gives a harvest proportion of 18% of the total run (Figure 3.1. While harvest was lower than the previous season, estimated escapement was also lower on the Rakaia, therefore the harvest proportion is a slight increase on the previous season (12%).

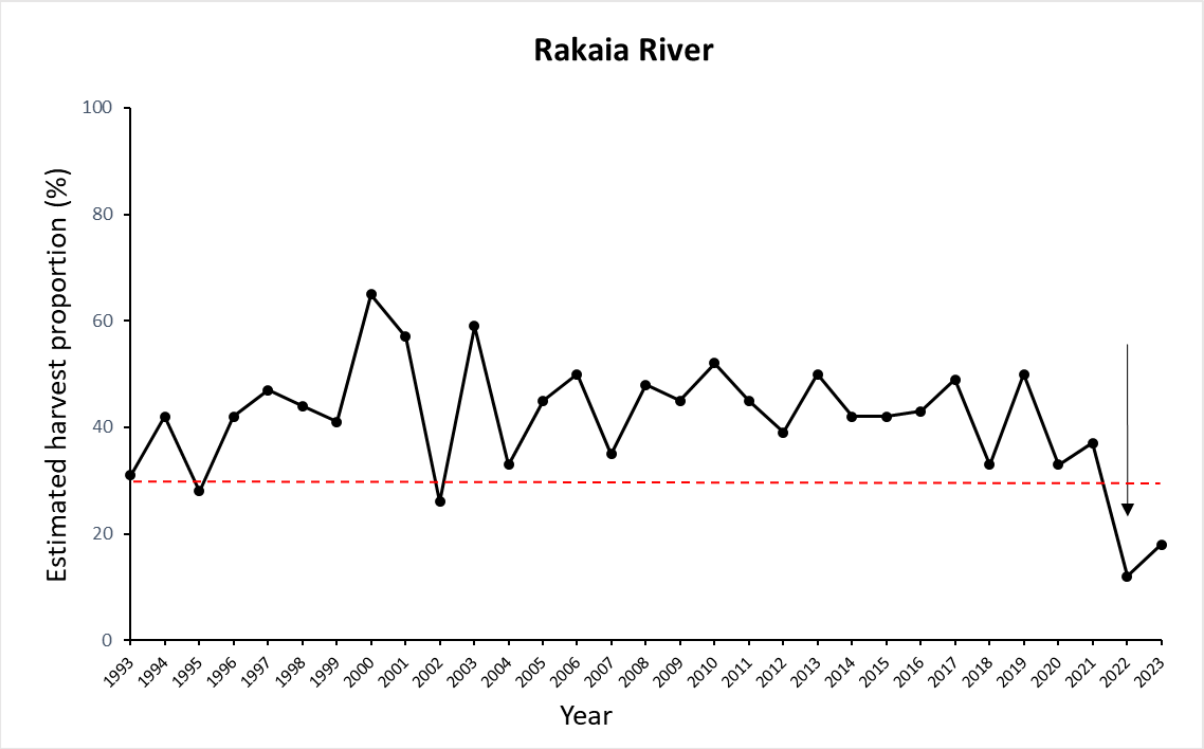

Figure 3.1. Estimated harvest proportion of the total run size in the Waimakariri and Rakaia rivers from 1993-2023. Red dotted line indicates 30% harvest proportion. Black arrow indicates implementation of the season bag limit.

3.2 Waimakariri River

Combining the estimated escapement with the estimated harvest (see the 2022-23 Season Salmon Harvest Report) gives a total run estimate of 917 salmon for the Waimakariri River (Figure 2.2, and Appendix, Table 7.3). With the exception of the 2019-20 season, this is the highest total run since 2017. An estimated harvest of 246 salmon gives a harvest proportion of 27% of the total run (Figure 3.2). While harvest was higher than the previous season, estimated escapement was also higher on the Waimakariri, therefore the harvest proportion is only slight increase on the previous season (25%).

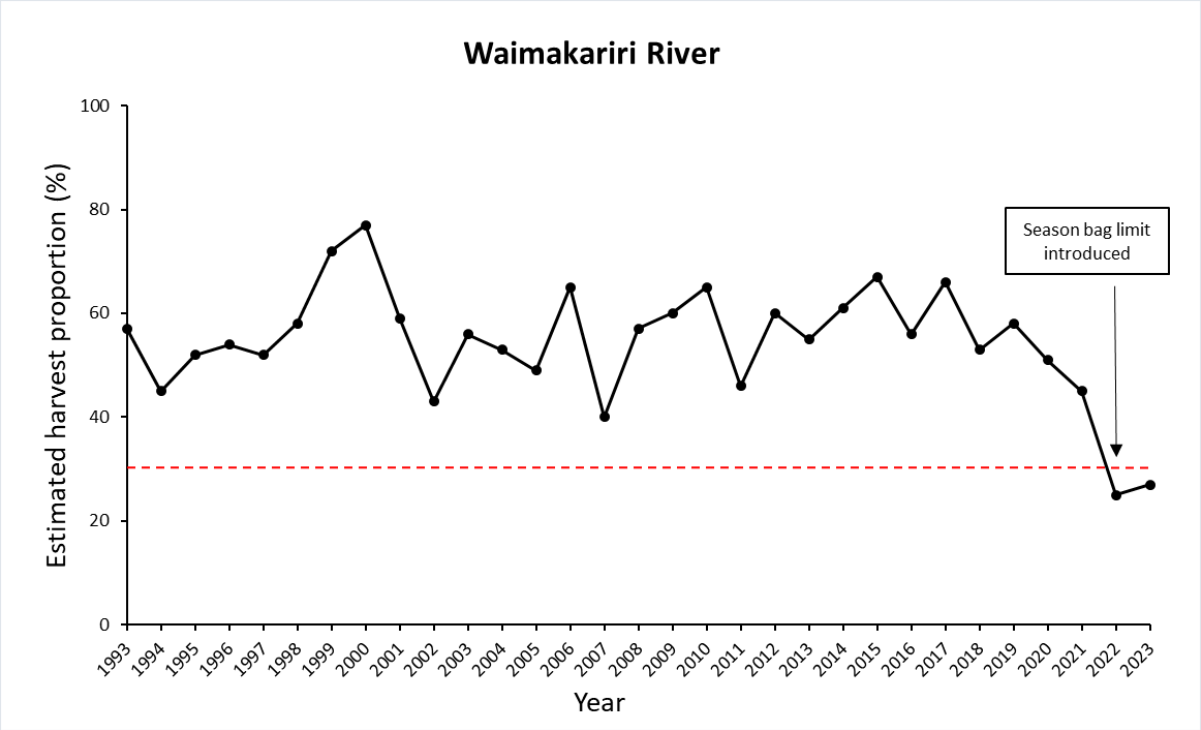

Figure 3.2. Estimated harvest proportion of the total run size in the Waimakariri Rivers from 1993-2023. Red dotted line indicates 30% harvest proportion. Black arrow indicates implementation of the season bag limit.

4. Adaptive Management

The total estimate for the Rangitata River obtained from the Central South Island Region is 552 salmon. Therefore, the combined estimated escapement for the three indicator rivers (Waimakariri, Rakaia and Rangitata) is 2555 salmon (Table 4.1). With the exception of the 2021-22 season, this is the highest total for the three indicator rivers since the 2015-16 season. However, this still places estimated escapement within the 'low' band of the Threshold Management Strategy (Figure 4.1). This is consistent with estimates made at the May 2023 Council meeting for setting the season bag limit in the 2023 Angler's Notice.

Table 4.1 Total escapement estimate for the three indicator rivers used in the Adaptive Management Strategy for setting season bag limits.

River	Est. Pop. Index
Rangitata River	552
Rakaia River	1332
Waimakariri River	671
Total	2555

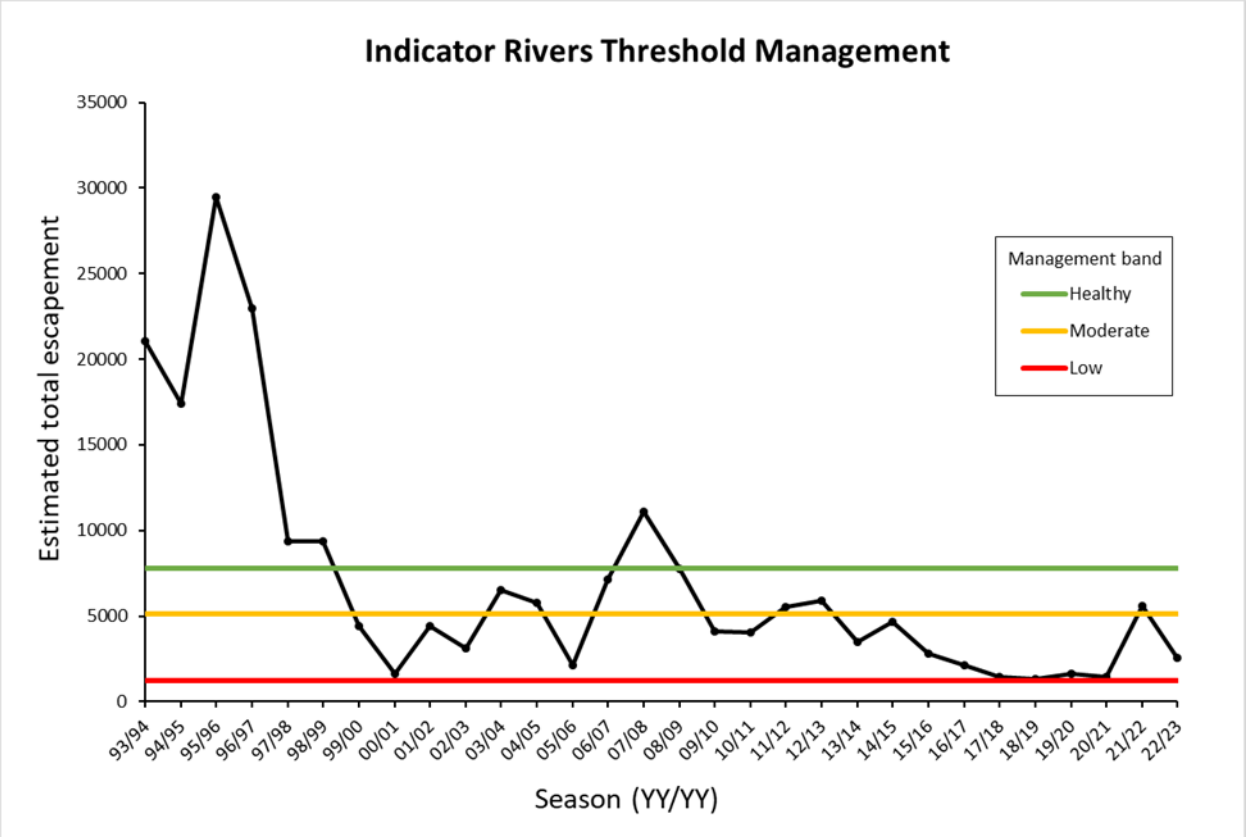

Figure 4.1 Estimated total escapement from the three indicator rivers (Waimakariri, Rakaia and Rangitata) used in the Threshold Management Strategy for setting season bag limits. Green, yellow and red lines show the minimum escapement thresholds for each of the management bands. Black arrow indicates implementation of the season bag limit.

5. Discussion

The lower harvest proportions seen again this season suggest that the season bag limit for sea-run salmon is still working well to keep harvest proportions low. This is evident in the Rakaia River, where this season's escapement estimate was only 41% of the previous season, but the harvest proportion remained fairly similar (only 6% higher harvest proportion). Prior to introduction of the season bag limit, harvest proportions had only dropped below 30% on two occasions for the Rakaia River (1995 and 2002). Furthermore, prior to the season bag limit the harvest proportion on the Waimakariri River had never dropped below 40% since recording began in 1993.

As the Threshold Management Strategy requires the spawning population to remain in a higher band for a minimum of three years before the season bag is increased, the move back to a lower band from the previous season means there now needs to be three seasons in the moderate or

healthy population bands before an increase would be made to the season bag limit. A review of the Adaptive Management and Threshold Management strategies will take place in the coming years and may make changes to the thresholds and suggested bag limits. With a season bag limit of 2 salmon still in place over the coming years until this point, we hope to see continued improvements in the size of the estimated escapements and harvest proportions until such revisions have been completed.

6. References

English, K. K., Bocking, R. C., & Irvine, J. R. (1992). A robust procedure for estimating salmon escapement based on the area-under-the-curve method. *Canadian Journal of Fisheries and Aquatic Sciences*, *49*(10), 1982-1989.

Unwin, M. J. (1994). Salmon populations in the Waimakariri, Rakaia, Rangitata and Hakataramea Rivers: 1994 spawning season. National Institute of Water & Atmospheric Research Ltd.

Webb, M., & Terry, S. (2020). Adaptive Management Strategy for Setting North Canterbury and Central South Island Sea Run Salmon Fishing Regulations. New Zealand Fish and Game.

7. Appendix

Table 7.1. Total population indices of the Rakaia River tributaries calculated using AUC. Asterix denotes waters in which Peak Counts were used to do insufficient data points for AUC calculation.

Stream	Total pop. index
Hydra Waters	410
Manuka Point	288
Double Hill	80
Glenariffe	378
Goat Hill/Wilberforce*	2
Lake Heron/Mellish Stream*	174
Total	1332

Table 7.2. Total population indices of the Waimakariri River tributaries calculated using AUC.

Stream	Total pop. index
Bealey/Turkey/Railway	9
Cass Hill Stream	242
Cora Lynn Stream	80
One Tree Swamp	59
Poulter streams	241
Winding Creek	40
Total	671

Table 7.3 Escapement, harvest & total run estimates and the resulting proportion of the total run harvest by anglers on the Rakaia and Waimakariri rivers during the 2022-23 fishing season.

	Rakaia River	Waimakariri River
Estimated Escapement	1332	671
Estimated Harvest	299	246
Estimated Total Run	1631	917
Proportion harvested by anglers	18%	27%

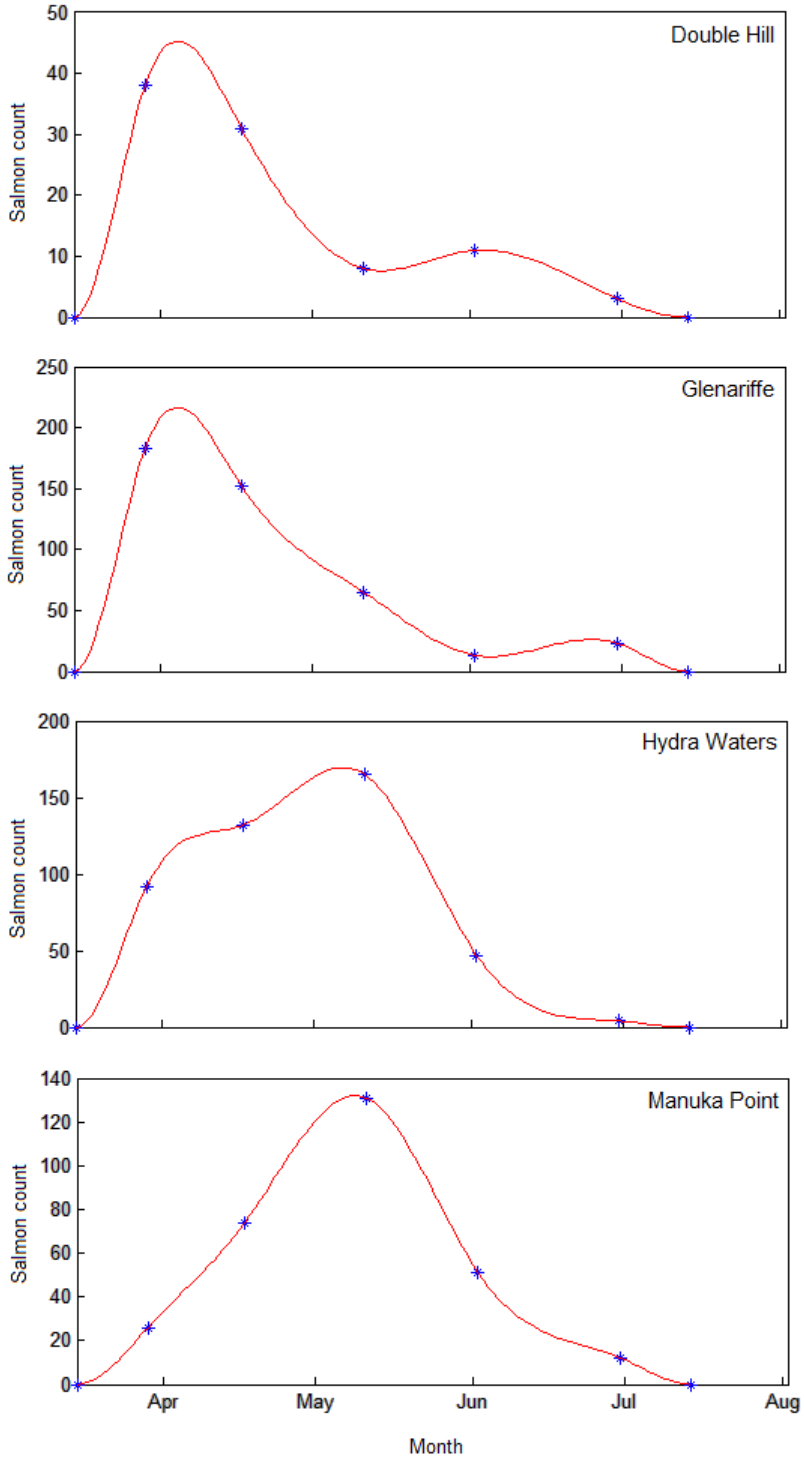

Figure 7.1. AUC graphing for four spawning streams on the Rakaia River, showing how the data is fitted to a curve. The area under the curve is used to calculate the total population estimates when taking residency time into consideration. Each stream has a unique curve, showing peak returns to each of the streams occurs at different times.

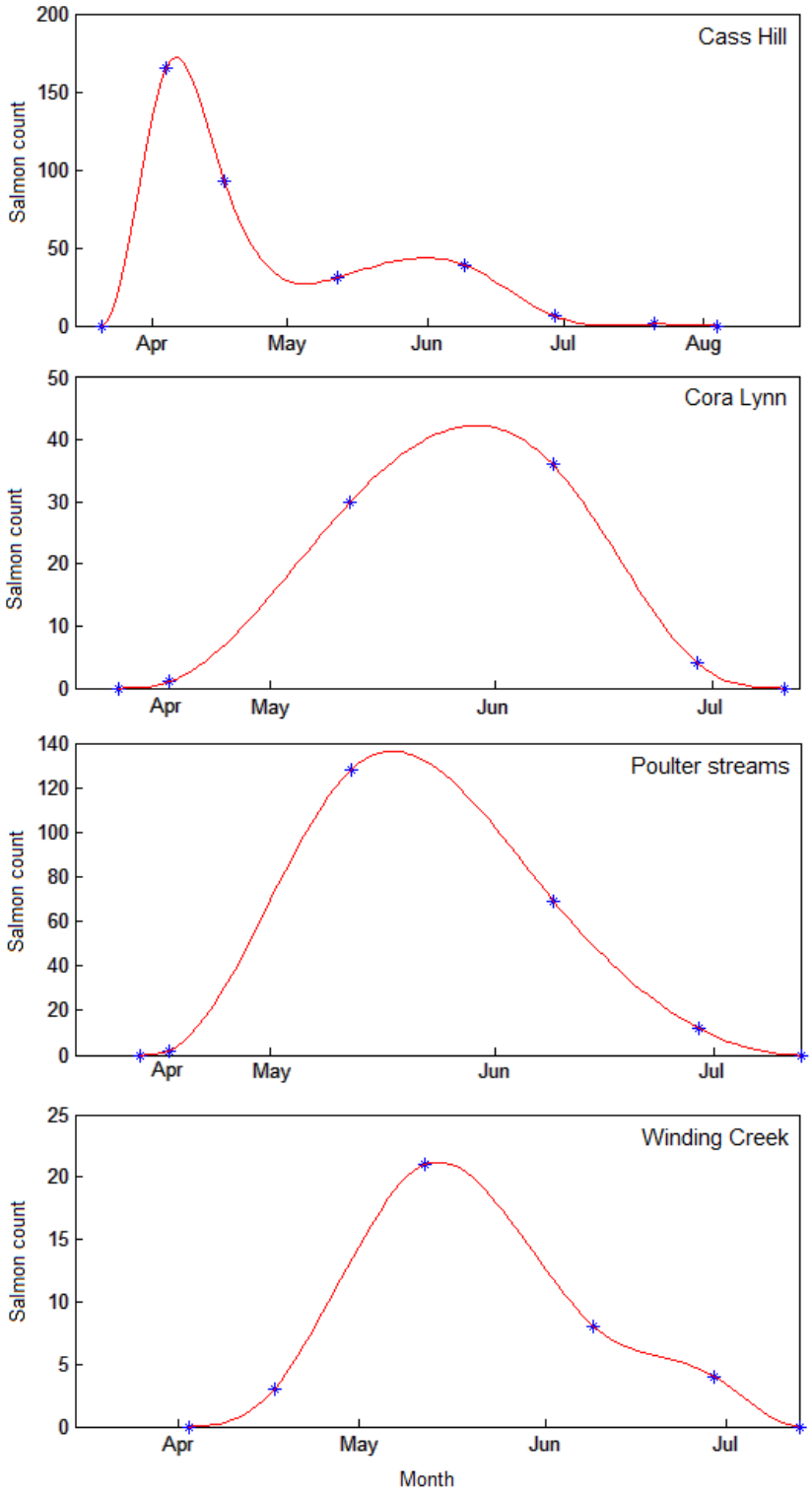

Figure 7.2. AUC graphing for four spawning streams (or combination of streams) on the Waimakariri River, showing how the data is fitted to a curve. The area under the curve is used to calculate the total population estimates when taking residency time into consideration. Each stream has a unique curve, showing peak returns to each of the streams occurs at different times.