Sea-Run Salmon Harvest Assessment and Spawning Counts

2021-2022

PREPARED FOR THE NORTH CANTERBURY FISH AND GAME COUNCIL

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Executive Summary

The main objective of the introduced season bag limit and endorsement for sea-run salmon in the 2021/2022 season was to reduce angler harvest proportions and subsequently rebuild spawning numbers. Each year, salmon spawning counts and a sea-run salmon harvest survey take place to estimate salmon escapement, angler harvest, and an overall total run size for each major sea-run salmon catchment in the North Canterbury region. Overall, 9438 salmon endorsements were issued to anglers, much higher than previous year's estimates for active salmon anglers. Salmon escapement counts were conducted between March and July 2022 in the Rakaia catchment (4 flights), Waimakariri catchment (5 flights), Hurunui catchment (2 flights) and Waiau catchment (1 flight). Escapement numbers were estimated to be 3217 salmon on the Rakaia and 548 salmon on the Waimakariri. Estimates could not be made for the Hurunui and Waiau rivers due to unreliable spawning count numbers. The salmon bag limit harvest card provided a new resource for gathering valuable information on salmon anglers and salmon harvest. However, voluntary card returns of only 11% highlighted the need for the use of email prompts and extra phone surveys to be able to complete harvest estimates. From all harvest returns and estimates, an estimated 453 ±16 salmon were harvested from the Rakaia, and the harvest proportion of the total run is estimated to be 12.3%. This is a 25% drop from the 2020/2021 season (37%), and a 30.7% drop on the 1993-2021 average (43%). An estimated 150 ±3 salmon were harvested from the Waimakariri, and the harvest proportion of the total run is estimated to be 21.5%. This is a 23% drop from the 2020/2021 season (45%), and a 34.5% drop on the 1993-2021 average (56%). Overall, both rivers saw a reduction in harvest by over 20% to the previous season, and a reduction of over 30% from average harvest proportions between 1993 and 2021. With these results we can confidently say that the introduction of the season bag limit has been successful helped in constraining salmon harvest. In addition, the difficulties that arose during this new process has allowed us to make improvements across the board for next season to significantly improve the ease and accuracy of harvest estimates going forward.

1.0 Sea-run salmon endorsement and bag limit harvest card

With the introduction of the 2021/2022 sea-run salmon bag limit for North Canterbury (NC) and Central South Island (CSI) Fish & Game regions, licence holders were required to be endorsed for sea-run salmon fishing and hold a bag limit harvest card to fish for sea-run salmon. Anglers could endorse their licence for sea-run salmon at any time throughout the season. By the end of the sea-run salmon season (30th April 2022), **9438** sea-run salmon endorsements had been issued to anglers. This is a significant increase on previous year's estimates of sea-run salmon angler numbers. The harvest survey for the 2020/2021 season estimated there to be approximately 3600 active sea-run salmon anglers across both the NC and CSI regions, and the 2019/2020 season estimated 4,100 anglers. Anecdotal reports from licence agents suggest that many anglers that wouldn't usually fish for sea-run salmon likely applied for the endorsement on the off-chance that they may go salmon fishing sometime during the season and wanted to be compliant with the new regulations.

Endorsements were issued to anglers from all twelve Fish & Game regions, and NC region had the highest number of endorsements issued (5081), totalling 54% of all endorsements (Figure 1). This was almost twice as many anglers as the CSI region (2603), who had the second highest number of issued endorsements at 28%.

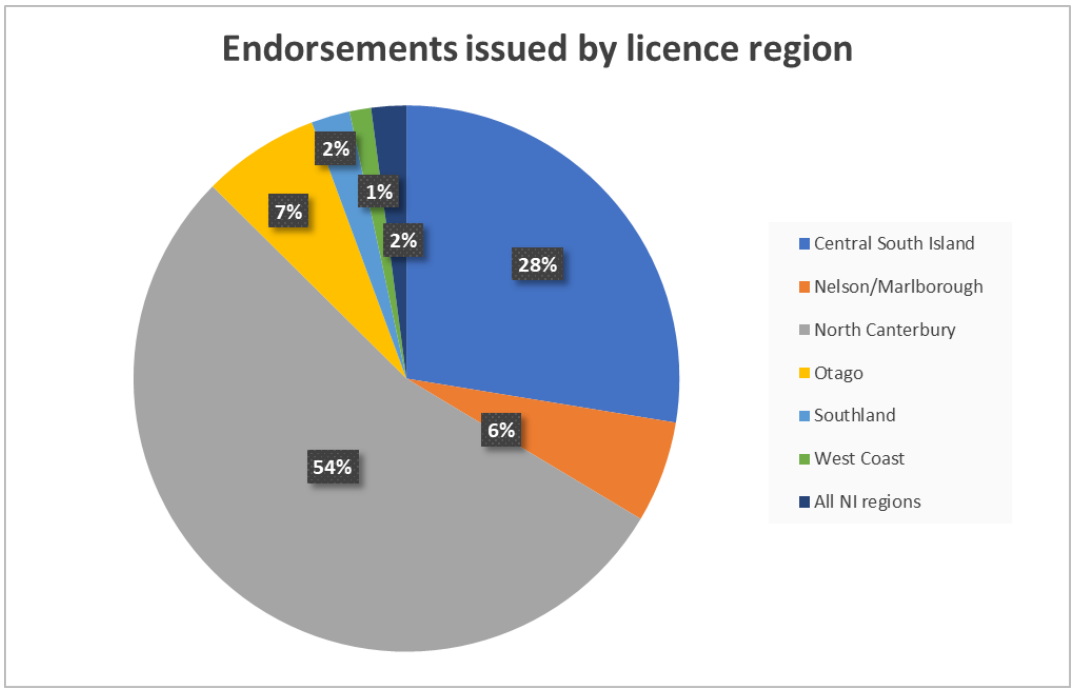

Figure 1. Chart showing each Fish & Game region's percentage of the total issued sea-run salmon endorsements. All North Island regions have been combined into one category.

The sea-run salmon endorsement was available to all anglers who held a whole season licence, including Junior and Child licence holders. Adult licences accounted for almost half of all issued endorsements (4560 endorsements), followed by Family licences (2841 endorsements). Loyal senior licence holders accounted for 14% of all endorsements (1321 endorsements). Junior, Child and Local area licences made up the remainder of the endorsements (Figure 2).

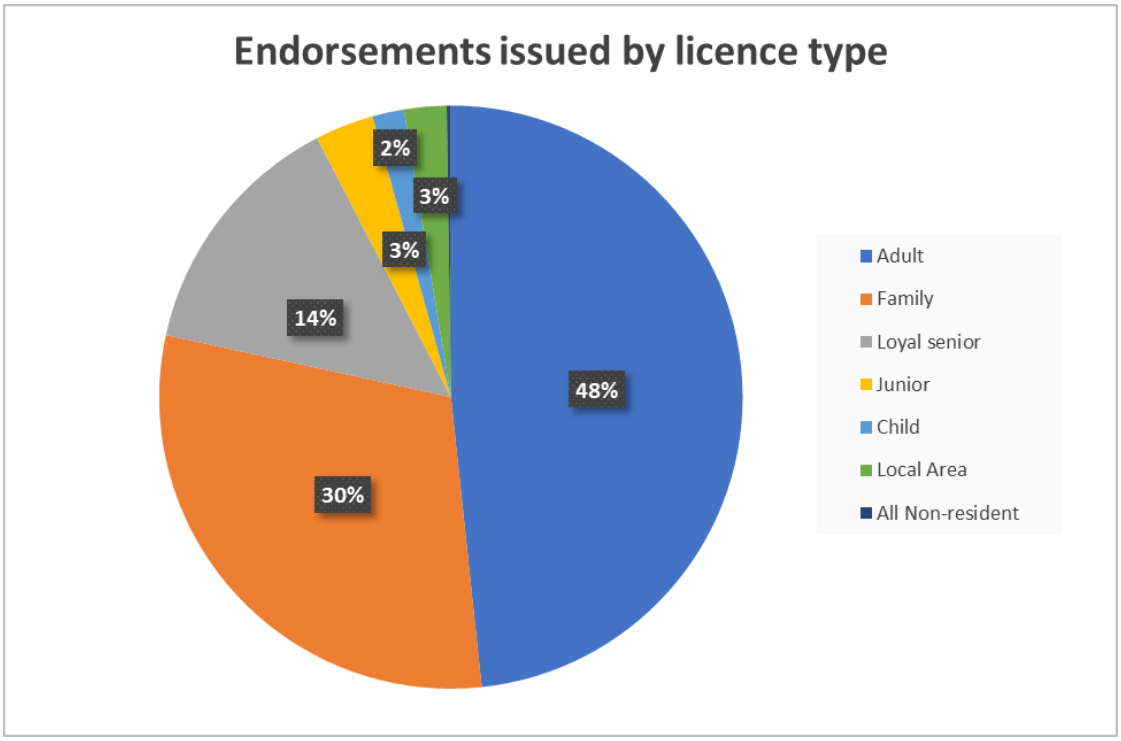

Figure 2. Chart showing percentages of each licence type that made up the sea-run salmon endorsements. All Non-resident licence types were combined in to one category but only accounted for less than 0.3% of all endorsements.

2.0 Sea-run salmon harvest assessment

2.1 Introduction

Since 1993, phone surveys of anglers were carried out at the end of the salmon fishing season to estimate the harvest of sea-run salmon for rivers across the regions. Until 2017, each region completed these independently. In the 2018/2019 season, North Canterbury Fish & Game joined surveys with CSI Fish & Game who had begun utilising email surveys supplementary to standard phone surveys to boost the number of respondents. Otago Fish & Game joined the following 2019/2020 season. These surveys year-to-year could only estimate the number of active salmon anglers. The introduction of the sea-run salmon endorsement and bag limit harvest card for the 2021/2022 season provided a new opportunity for more accurate data collection, as exact numbers of salmon anglers would be known, and assuming all endorsement holders returned their cards, a harvest assessment across the NC and CSI regions could be made with little to no error margins.

2.2 Methods

Bag limit harvest card voluntary returns

The harvest card provided instructions for anglers to return their card or card information (regardless of how many fish were kept). This form of return is referred to as "voluntary" and forms the basis of the "known salmon harvest" strata of the survey.

Four options for return were included:

1. Post (to the CSI office only)
2. Email (to a dedicated harvest card address)
3. Physical drop-off (to either F&G office)
4. Online return form (linked via QR code on card – went live mid-April 2022)

Initial card returns were very low (~5-6% in the month following the close of the sea-run salmon season), prompting further methods to be used in order to increase voluntary reporting. The main online form was closed following the finish of the email prompt periods, leaving only physical options for return.

Email prompts

Due to low card returns in the month following the end of the salmon season it was decided to send out an email similar to previous years' surveys, prompting anglers to fill out the online form. Two random samples of 1000 anglers each were taken from the remaining database (that had not yet returned their card) and were sent an email prompt with a link to the online form. Each random sample was valid for only 7 days and had a unique survey link so responses could be distinguished from the main online form. This return is referred to as "email", and responses from this are included as a sub-stratum in the "known salmon harvest" strata.

Phone Surveys

Following the email, harvest card return rates were still low. Due to the still-low returns and the associated bias of the voluntary return, extra phone surveys were quickly designed and prepared. The phone survey was split into two sub-strata, "expert anglers", and "random anglers". The "expert anglers" list was derived from a list provided by Jayde Couper used in previous years' surveys and consisted of approximately 550 anglers who had not yet returned their cards. The "random anglers" were taken from a random pool of those who had not yet returned their harvest card.

Due to time constraints, these phone surveys were carried out by the Southern Institute of Technology (SIT), who North Canterbury Fish & Game utilise for game bird harvest surveys and can often pick up extra short surveys at late notice. Due to SITs survey schedule at the time, the phone surveys needed to be succinct and therefore the number of questions asked, and number of calls were limited. Error margin calculations suggested a sample size of approximately 300 would be sufficient to generate reliable harvest estimates with approximately 5% margin of error (with a 95% confidence level). A random sample of 300 anglers from each sub-stratum list was therefore taken. To ascertain harvest levels, respondents of these surveys were asked how many salmon were harvested, and if so, which river and on which month were each of the salmon harvested. Respondents were also asked if they actively fished for sea-run salmon during the season, a question that had been asked in previous years but was not an option on the harvest card or the online form this season. This would provide us with at least basic harvest data to allow us to complete the survey and obtain realistic harvest estimates.
Once all the data from all strata had been collected, the phone survey data was scaled up to each of their corresponding population sizes (expert survey to 550, random survey to the remaining

~7500). These figures were then added to the known salmon harvest numbers from the voluntary survey to determine the harvest numbers for each river.

2.3 Results

Harvest card returns

Over the following months, voluntary card reporting continued and increased the initial response percentage from ~5.9% up to 11.2%. As expected, the phone surveys results in much higher response percentages (Table 1).

Table 1. Total sample pools, card returns and response percentages for each of the response strata and sub-strata used in the harvest survey

Strata	Sub-strata	Total survey pool	# Responses	% Repsonse
Known salmon harvest	Voluntary	9438	1061	11.2%
	Email	2000	242	12.10%
Estimated salmon harvest	Expert Survey	300	209	69.67%
	Random Survey	300	196	65.33%

The bias associated with voluntary reporting becomes apparent when looking at the total percentage of successful anglers (successful anglers were deemed to have kept at least 1 salmon). In the voluntary sub-strata, 34.9% of anglers were successful, compared to 10% in the email sub-strata. Because the question "did you actively fish for sea-run salmon" was not asked on either the card or online form, these figures likely included many anglers who did not fish for salmon and therefore contributed to the "unsuccessful" anglers.

In the phone surveys, we had the opportunity to ask anglers if they did actively go fishing for sea-run salmon. In the 'Expert' survey, 80 of the 209 respondents (38%) went fishing. For sea-run salmon This result is surprising considering this list is made up of anglers who have been successful in catching salmon in past seasons. In the random survey, 63 out of 196 respondents (32%) went fishing for sea-run salmon. While these percentages are likely an underestimate (due to the bias in voluntary returns), when applied to the endorsement database numbers, the resulting 'estimated active salmon anglers' is 3000-3500 anglers. This is very close to the estimate of 3600 anglers for the 2020/2021 season.

Rakaia harvest estimates

It is estimated that 453 ±16 salmon were harvested from the Rakaia catchment, including one fish reported caught at the Tentburn outfall. This estimate is made up of 210 salmon from the known strata, and a further 233 ±16 salmon from the estimated strata. Even with the season bag limit in place, this is 19 more salmon than the estimated harvest for the previous season (434 salmon). Figure 3 shows the trend in salmon harvest since 1993, with the trend still declining as sea-run salmon numbers have declined.

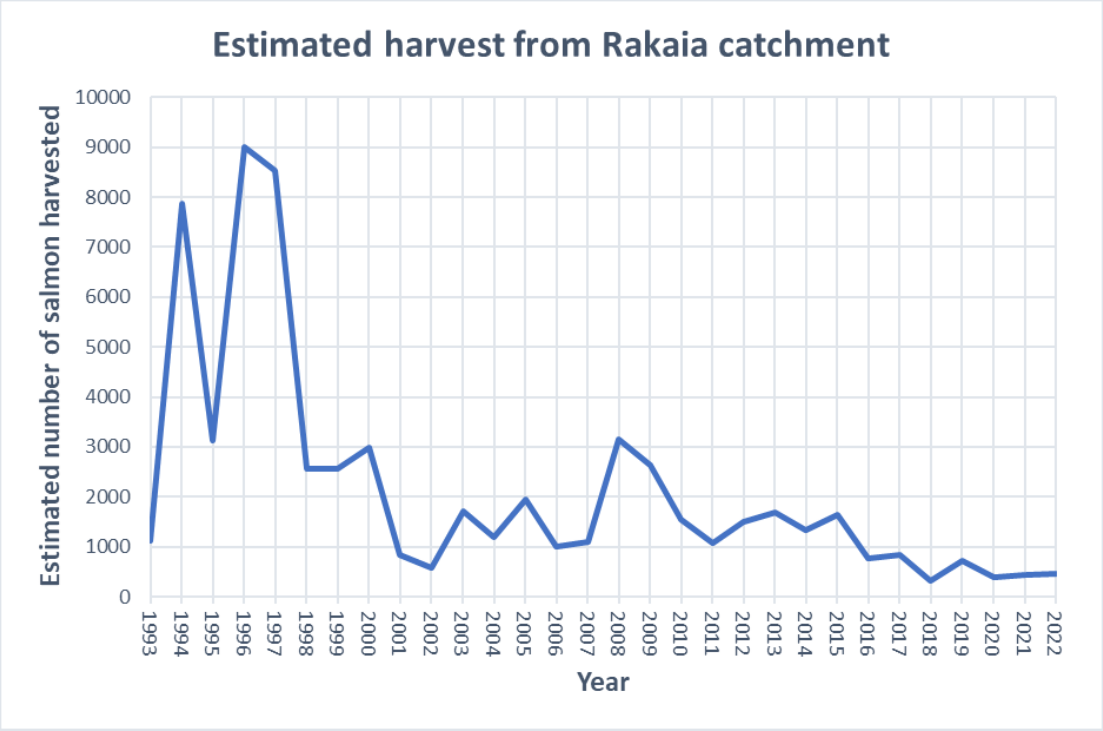

Figure 3. Estimated harvest of sea-run salmon in the Rakaia catchment since 1993.

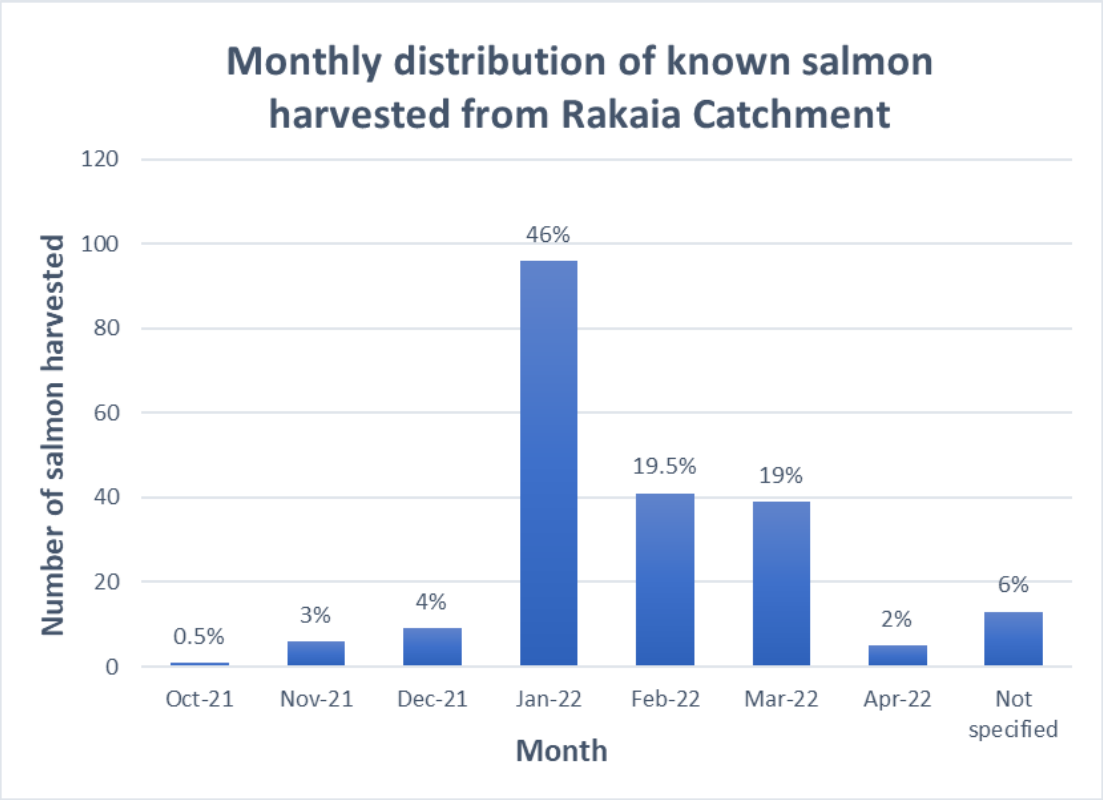

Figure 4. Months in which known salmon harvest occurred in across the sea-run salmon season in the Rakaia River. Percentages of the total are shown above each bar.

From the known harvest numbers, most of the salmon harvested were taken in January, when the first major run was reported occurred (Figure 4). There may be some bias as many anglers that had harvested one fish already continued to catch-and-release throughout the remainder of the season, holding out for the best fish to complete their season bag. Most of the salmon were either harvested from the river mouth and the middle reach of the river. Smaller numbers were caught in the lower and upper reaches. Five salmon in the known harvest strata were reported to be fin clipped.

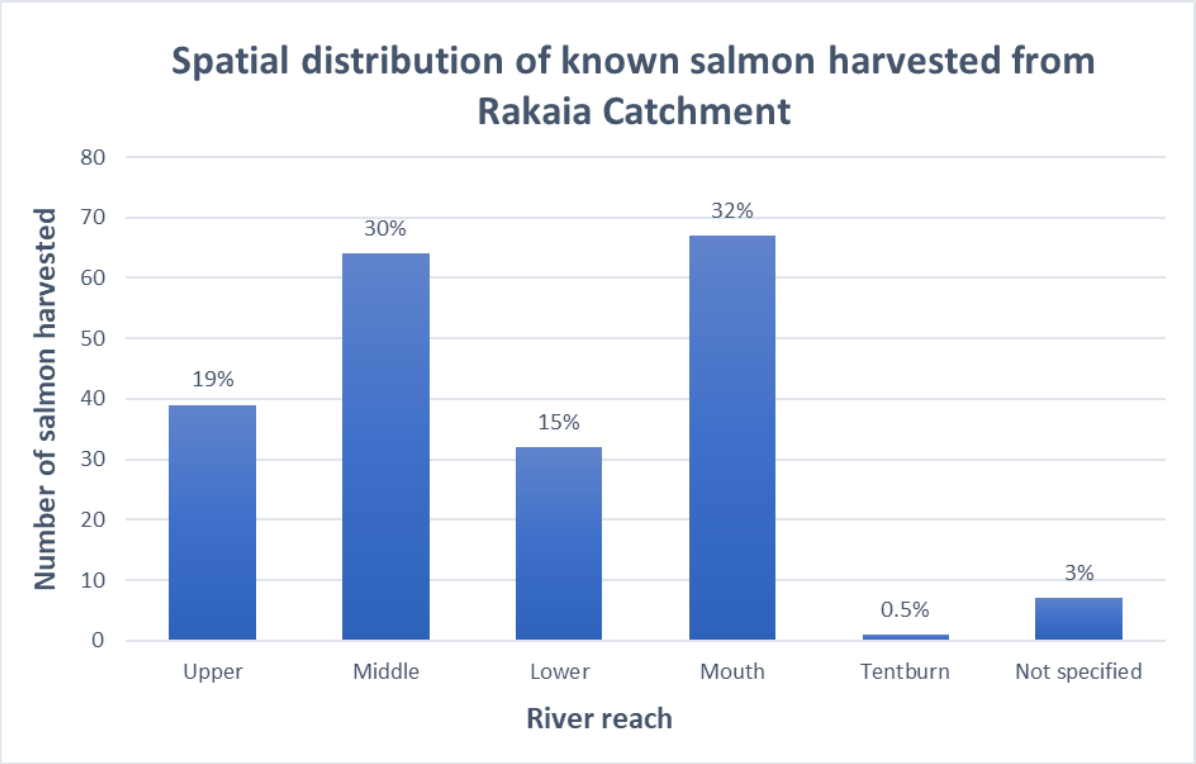

Figure 5. Distribution of known salmon harvest across the river reaches in the Rakaia River, including Tentburn. Percentages of the total are shown above each bar. (Upper = above gorge bridge, middle = SH1 bridge to gorge bridge, lower = SH1 bridge to mouth).

Waimakariri Catchment

It is estimated that 150 ±3 salmon were harvested from the Waimakariri catchment. This includes salmon that were reported to have been harvested in the Kaiapoi river. This harvest estimate is made up of 103 salmon from the known strata, and a further 47 ±3 salmon from the estimated strata. This is half the number of salmon harvested in the previous season (303 salmon), and the lowest harvest since 1993 (Figure 6).

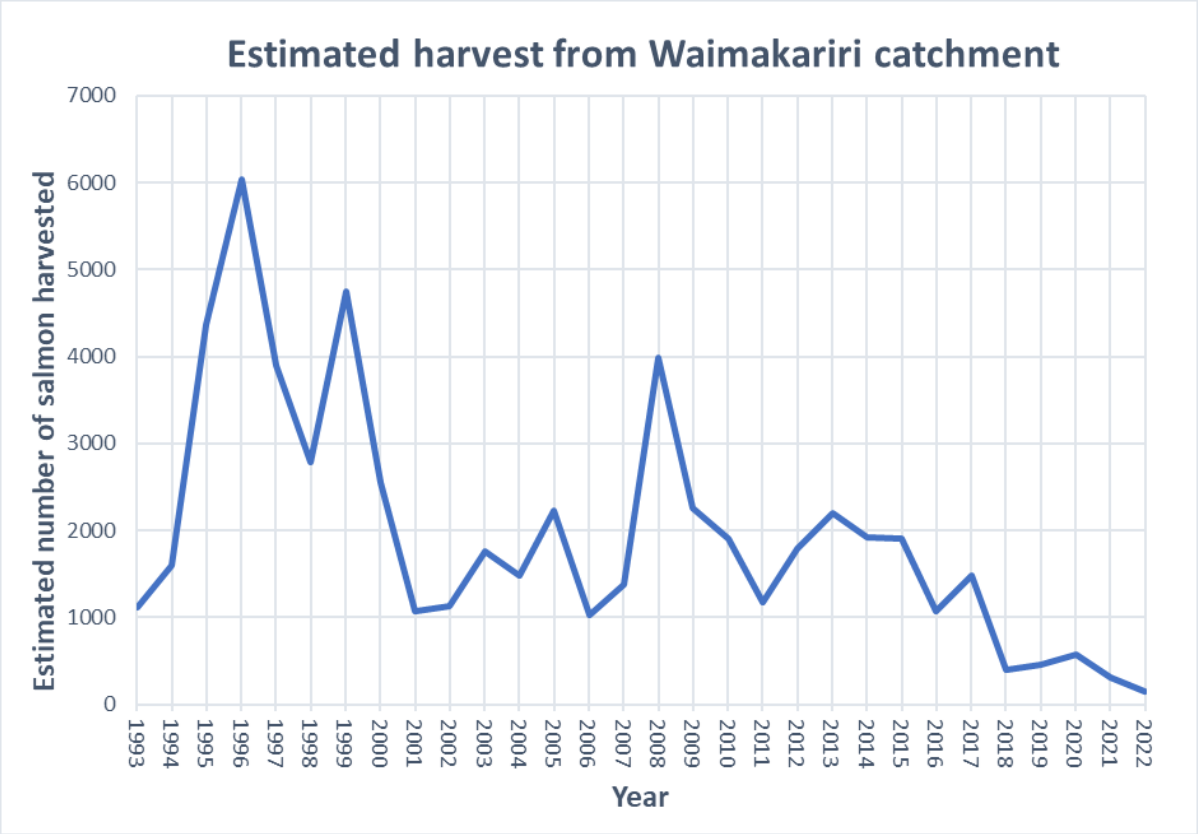

Figure 6. Estimated harvest of sea-run salmon in the Waimakariri catchment since 1993.

From the known harvest numbers, most of the salmon harvested in the Waimakariri were taken in March and April, right at the end of the season (Figure 7), which aligns with the reports of a later run this season. There did not appear to be a major run reported as was observed in the Rakaia. Again, there may be some bias as anglers may have practiced catch-and-release through the season and waited to complete their season bag, waiting towards the end of the season to keep salmon. Unsurprisingly, most of the salmon were either harvested from the river mouth or the lower reaches. Smaller numbers were caught in the middle and upper reaches (Figure 8). Four salmon in the known harvest strata were reported to be fin clipped.

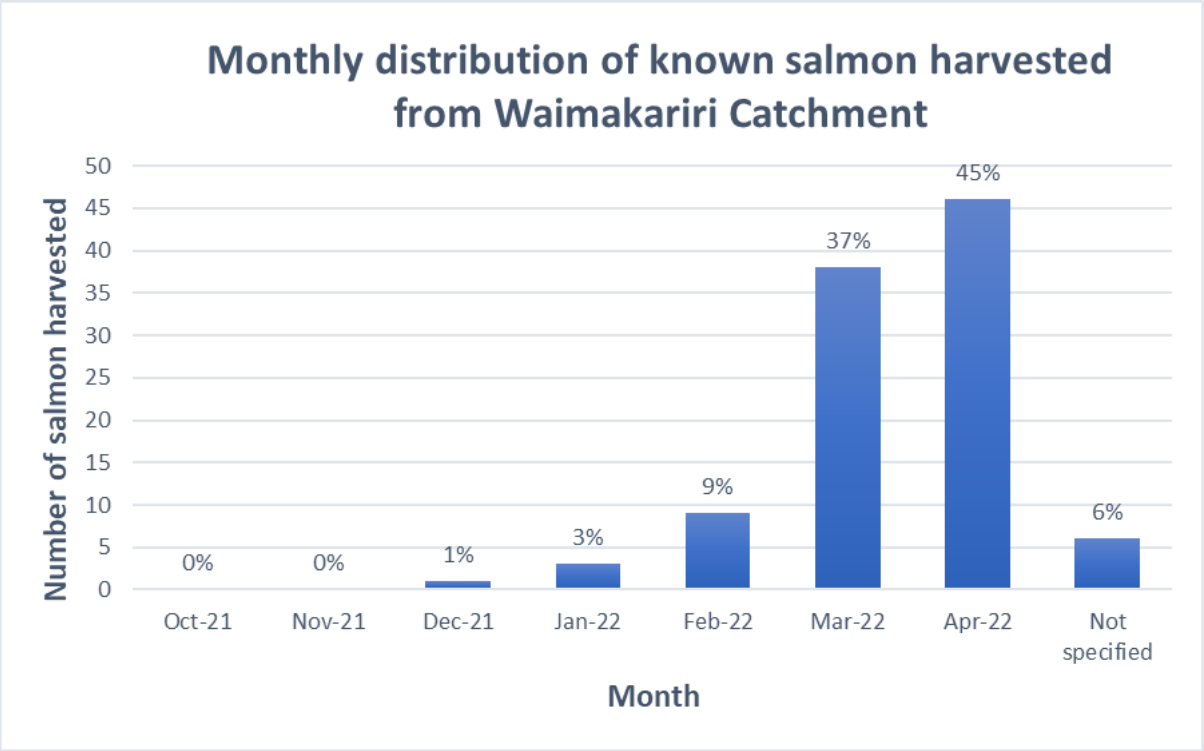

Figure 7. Months in which known salmon harvest occurred in across the sea-run salmon season in the Waimakariri River. Percentages of the total are shown above each bar.

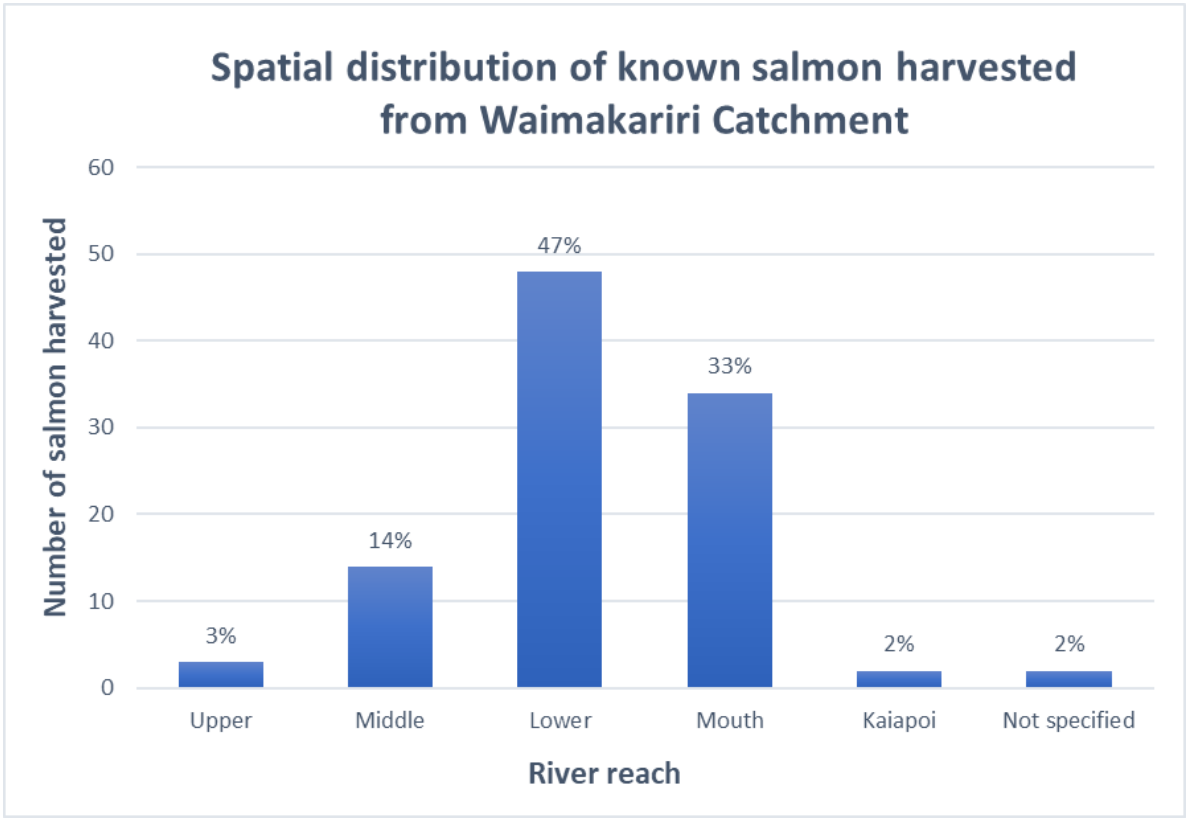

Figure 8. Distribution of known salmon harvest across the river reaches in the Waimakariri River, including the Kaiapoi River. Percentages of the total are shown above each bar.

(Upper = above gorge, middle = between SH1 bridges and gorge, lower = SH1 bridges to mouth).

Hurunui and Waiau Catchments

In the Hurunui, voluntary returns reported 18 salmon harvested. In the random phone survey, 39 ±3 salmon were estimated to be harvested. No salmon were reported in the email returns or in the expert survey.
In the Waiau, voluntary returns reported 3 salmon harvested. No salmon were reported in the email returns or either of the phone surveys.

The non-occurrence of harvested salmon in both the expert and random phone surveys may suggest the sample sizes for each survey were not large enough to encompass reliable harvest estimates in these two catchments, therefore further harvest assessments of these two catchments will not be made.

3.0 Sea-Run Salmon Spawning Counts and Harvest Proportion

3.1 Introduction

North Canterbury Fish & Game has been conducting monitoring of sea-run salmon returns since 1993 and over the decades a steady decline in escapement has been observed. Over the last five years there have been particularly low numbers of returns. Historically, the 'area under the curve' (AUC) methodology was used to calculate escapement numbers. The AUC method estimates total escapement based upon periodic spawning counts and the residency time (RT) of the spawning fish (English et al., 1992). This method was used from the beginning of the counts in 1993 until 2013, where financial constraints meant multiple spawning counts could not take place (therefore the AUC method could not be used). Between 2013 and 2020, the peak count method was used, as escapement could be estimated based on salmon counts at peak spawning. The resumption of multiple spawning counts from helicopters in 2021 allowed for the resumption of the AUC method.

The new season bag for sea-run salmon aimed to limit angler harvest and allow increased escapement to the headwaters where spawning occurs. Our assumption was that the proportion

of angler harvest to total spawning run will have decreased from previous years where no season bag limits were in place.

3.2 Methods

For the 2021/2022 season, we resumed helicopter flights to conduct spawning counts. On all flights, both live and dead salmon numbers were recorded separately.
Appendix 1 shows the table of flight dates and actual counts for each river catchment.

Rakaia Catchment

Four salmon flights were conducted on the Rakaia River tributaries. These included Manuka Point, Hydra Waters, South and East Glenariffe, Double Hill, Goat Hill, and Wilberforce Swamp. Spawning counts at Lake Heron and Mellish stream carried out by CSI Fish & Game were also added to the counts due to these being tributaries of the Rakaia River.

Waimakariri Catchment

Five flights were conducted on the Waimakariri river tributaries. These included Winding Creek, Cass Hill, Poulter Flats, Lower Casey, One Tree Swamp, Cora Lynn, Railway Springs, Bealey and Turkey Flat. Foot counts also took place on Bush Stream as aerial counts are not possible due to tree cover.

Hurunui Catchment and Waiau Catchment

Two of the Waimakariri river flights were extended out to count the Hurunui River and its tributaries. The North branch, South branch, Mackenzie and Landslip streams were counted. One Waiau river flight was conducted, which included a flight of the Clarence River on behalf of Nelson/Marlborough region for their own salmon spawning counts.

3.3 Results

Spawning counts, total run size and harvest proportions

Appendix 1 shows the table of flight dates and actual counts carried out in each of the 4 major catchments.

Rakaia Catchment

Flights appear to have commenced when the spawning numbers were already increasing; by the second flight we were observing peak spawning numbers (1732 live salmon). Following the peak, counts decreased steadily for the remaining two flights. The decision was made to not undertake a fifth flight to save on costs, as escapement estimates using AUC could be made with data from the first four flights.

The AUC calculations for the Rakaia catchment estimate a total minimum escapement of 3217 salmon.

Adding the harvest estimates to the escapement estimates, the estimated total run for the Rakaia River is: **3670 ±16 salmon.** This total run is the highest since 2015 and third highest total run since 2009 (Figure 9).

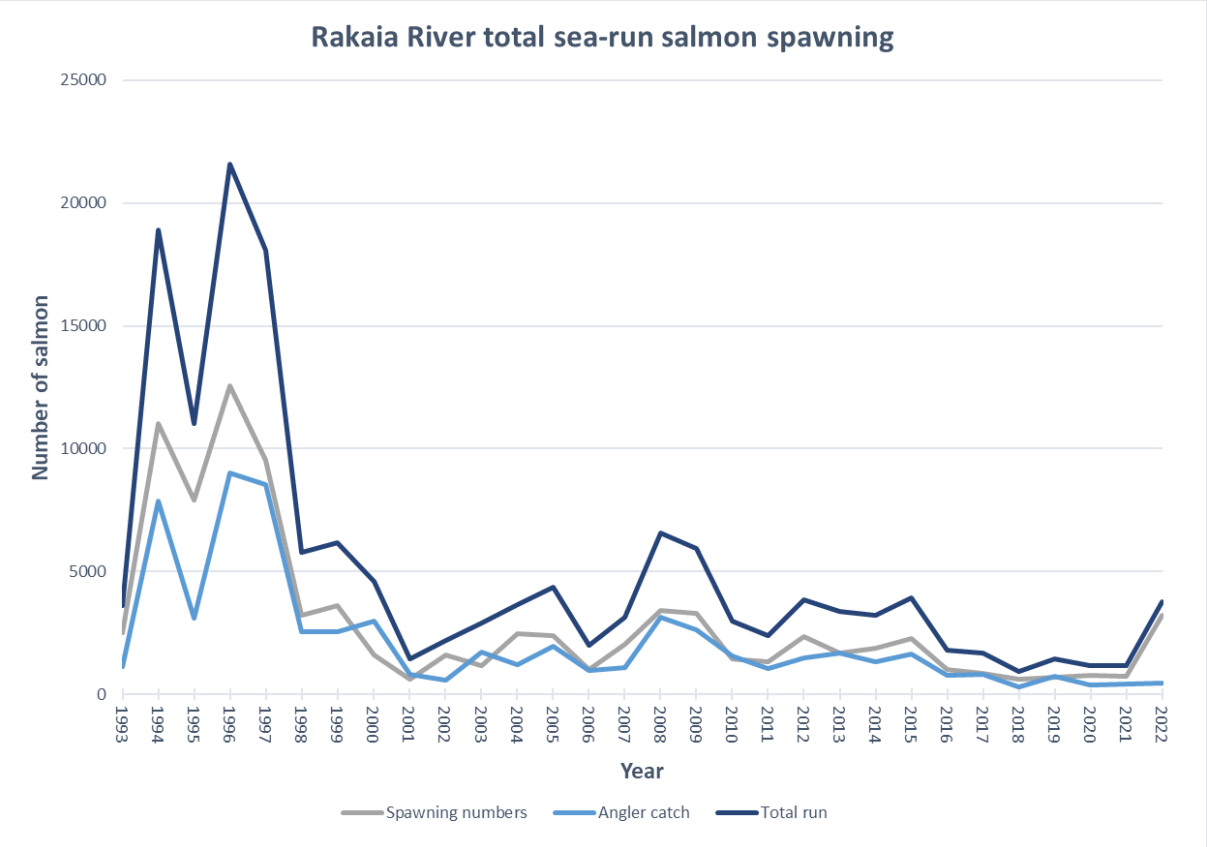

Figure 9. Comparisons of total run size, spawning numbers (escapement) and angler harvest on the Rakaia River since 1993.

Angler harvest remained fairly similar to previous years (estimated 453 ±16 salmon), and when comparing this harvest to the total run, we can assume that the season bag limit kept this harvest to a minimum. Since 1993, harvest proportions reached a maximum of 65% of the total run, with an overall average of 43%. If this average held true for the current season, we would expect approximately 1500 salmon to be harvested from the Rakaia River alone. However, with the season bag limit in place, we achieved a harvest proportion of 12.3% of the total Rakaia catchment run (Figure 10). This is the lowest harvest proportion recorded since monitoring began in 1993 and is a 25% drop from the 2020/2021 season.

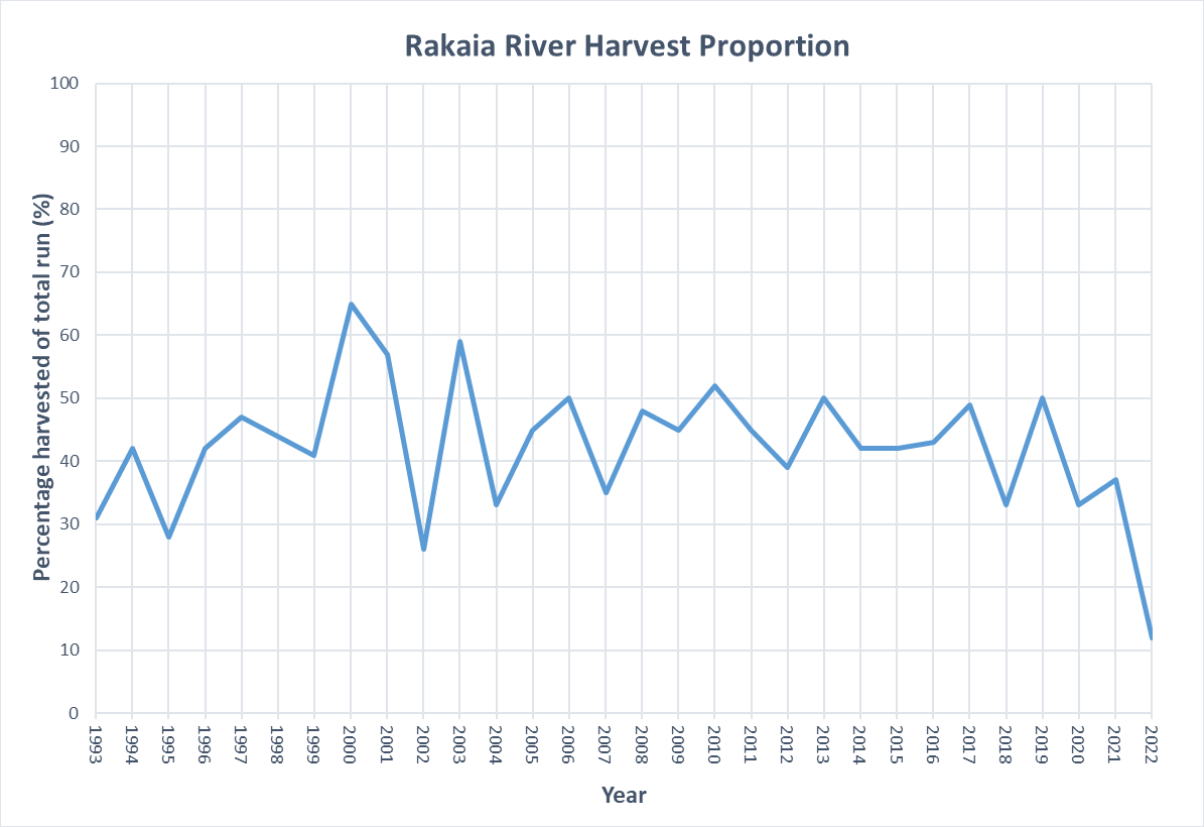

Figure 10. Proportion of sea-run salmon harvested from the total run in the Rakaia River since 1993.

Waimakariri Catchment

The Waimakariri catchment counts dropped between the first and second counts, before increasing to peak at the third count. Fish were still observed in the system at the beginning of July. This could suggest a later spawning run than previous years, and combined with changing river dynamics, could explain the lower incidences of angler catch (including catch-and-release) reported on the Waimakariri River this season.

The AUC calculations for the Waimakariri catchment estimate a total minimum escapement of 548 salmon.

Adding the harvest estimates to the escapement estimates, the estimated total run for the Waimakariri river is: **698 ±3 salmon.** While similar to the 2020/2021 season run, there has been a slight increase but still remains one of the lowest total runs the Waimakariri catchment has seen (Figure 11).

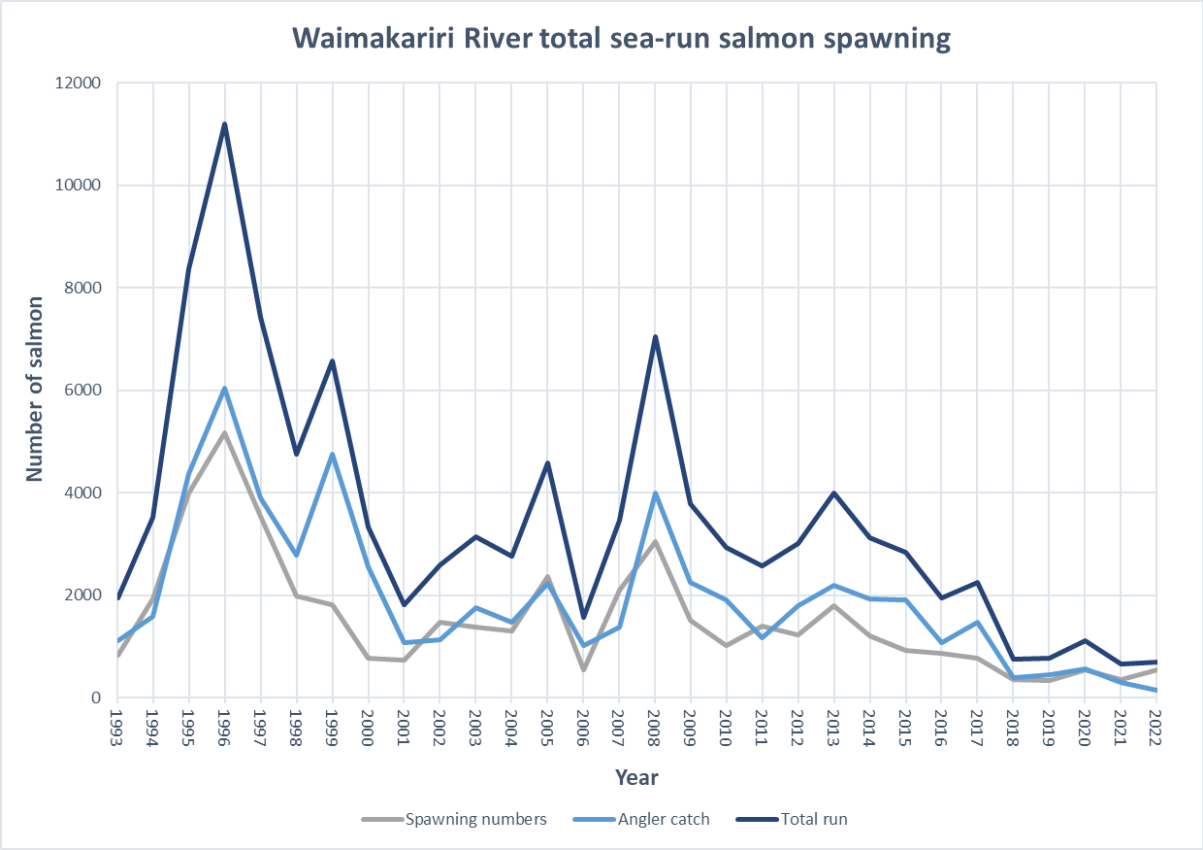

Figure 11. Comparisons of total run size, spawning numbers (escapement) and angler harvest on the Waimakariri River since 1993.

Estimated angler harvest (150 ±3 salmon) was only half of that of the previous season (303 salmon). While the season bag limit may be a largely contributing factor in this reduction, angler reports suggested a poor season on the lower sections of the Waimakariri River in general, which included catch-and-release salmon. This opinion of a poor season could be due to a number of reasons, including long periods of low river levels and high water temperatures, keeping salmon

out to sea and resulting in a delayed run as observed. This delayed run put most of the migrating salmon outside of the sea-run salmon season. In addition to this, historically popular fishing spots (e.g. McIntoshes) did not appear to attract the same number of salmon as previous years. The cessation of salmon releases from the Silverstream hatchery has reduced the number of salmon that would otherwise move through this area and pool before running up the Kaiapoi River. Anecdotal reports also suggest that the flooding events earlier in the season changed the substrate in the McIntoshes area, and salmon may not have pooled in this spot as they once did.

Since 1993, harvest proportions reached a maximum of 77% of the total run, with an overall average of 56%. With the season bag limit in place, we achieved a harvest proportion of 21.5% of the total Waimakariri catchment run (Figure 12). This is the lowest harvest proportion recorded since monitoring began in 1993 and is a 23% drop from the 2020/2021 season.

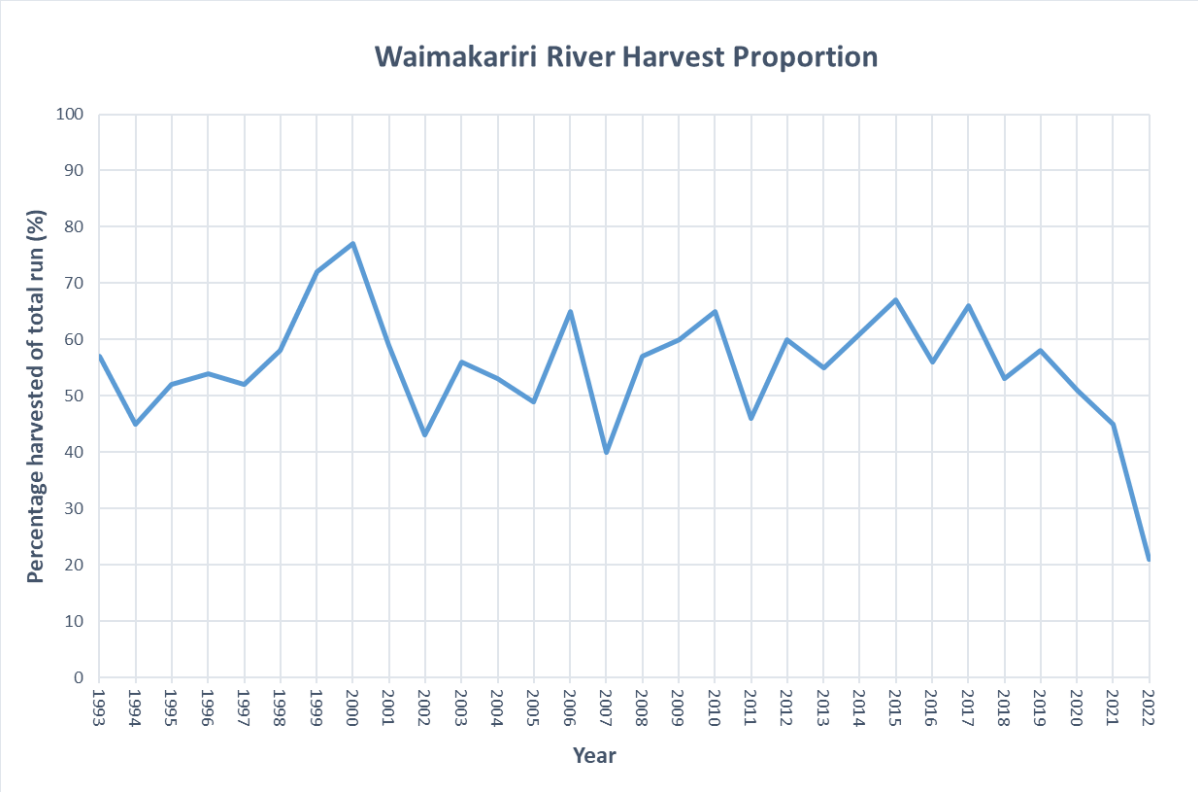

Figure 12. Proportion of sea-run salmon harvested from the total run in the Waimakariri River since 1993.

Hurunui and Waiau Catchments

As only two and one flights were conducted for the Hurunui and Waiau catchments respectively, the AUC method could not be used to estimate total escapement. The peak count for the Hurunui was a total of 13 salmon and occurred on 23rd May (first flight). We suspect actual peak spawning time was missed and therefore these counts are considered unreliable. The count for the single Waiau flight was 117 salmon, although it's not known if this count was carried out at peak spawning. If multiple flights for these rivers are not possible, determining peak spawning time for these two catchments is an important task, as the Peak Count method could be used to estimate escapement using only a single spawning count.

As harvest data for the Hurunui and Waiau rivers were also unreliable, we are unable to determine a harvest proportion for these two rivers for this season. Going forward for future seasons, both spawning counts and harvest surveys need to be adapted and improved to allow more robust and reliable estimates of harvest and escapement for these two catchments.

4.0 Conclusions, Recommendations, and Future Planning

Overall, considering both the Rakaia and Waimakariri catchments saw a reduction in harvest by over 20%, we are confident that the introduction of the season bag limit and salmon endorsement regime has successfully helped constrain harvest, which has allowed improved spawning escapement of wild salmon. As seen in the Waimakariri River, it is particularly important, and encouraging, that the season bag limit harvest management regime appears able to constrain harvest to protect a minimum level of spawning escapement in catchments with poor runs. With the season bag limit in place over the coming years, we hope to see continued improvements in the size of the sea-run salmon escapements and the harvest proportions.

Difficulties experienced with the harvest assessment this season has allowed us to refine features of next season's harvest assessment. This will enable us to manage and collect harvest data more effectively, so that a more accurate assessment can be made. Changes to the harvest card and corresponding online form will make it easier for the angler to convey the correct information. Most importantly, the addition of asking anglers "did you fish for sea-run salmon this season" on the card and online form will improve harvest assessment estimates. Alongside this, we have implemented a deadline for next season's card return and will again utilise email reminders and phone surveys. Phone surveys will include a more comprehensive set of questions (similar to what was asked during phone surveys in the past), and if initial card returns are low, a higher number of anglers will be sampled in order to encompass rivers such as the Hurunui and Waiau for which we could not determine reliable harvest estimates.

5.0 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.

6.0 Appendix

Appendix.1 Actual live salmon counts of spawning numbers in the different key spawning streams and catchments across North Canterbury region. While not shown below the number of dead salmon seen is also recorded and considered when interpreting AUC modelling results.

Rakaia sea-run salmon counts										
Flight Date	Manuka Point	Hydra Waters	Glenariffe	Double Hill	Goat Hill	Wilb Swamp	Total		Count Dates	Heron/Mellish
18/03/2022	55	378	360	27	0	0	820		7/04/2022	0
7/04/2022	212	431	888	182	15	4	1732		20/04/2022	52
26/04/2022	135	242	193	21	31	5	627		11/05/2022	73
25/05/2022	163	141	53	15	11	1	384		4/06/2022	37

Waimakariri sea-run salmon counts											
Flight Date	Winding Creek	Cass Hill	Bush Stream	Poulter Flats	Lower Casey	One Tree Swamp	Cora Lynn	Railway Springs	Bealey	Turkey Flat	Total
13/04/2022	4	126	0	0	4	3	4	0	0	0	141
27/04/2022	7	44	1	0	0	9	0	0	0	1	62
23/05/2022	16	69	34	21	2	25	48	3	11	8	237
16/06/2022	4	35	11	17	7	27	28	0	0	5	134
05/07/2022	1	9	1	0	0	4	15	0	1	5	36

Hurunui sea-run salmon counts					
Flight Date	North Branch	South Branch	Mackenzie	Landslip	Total
23/05/2022	2	10	1	0	13
5/07/2022	0	0	0	1	1

Waiau sea-run salmon counts		
Flight Date	Waiau	Total
25/05/2022	117	117