Report on Sea Run Salmon Harvest by Central South Island and North Canterbury Licenceholders, 2018-2019 Season (1.2.2) (J Couper)

Introduction

The salmon harvest survey is a key tool for managing the salmon fishery of the Central South Island (CSI) and North Canterbury (NC) Fish & Game regions. The survey began in the 2000/2001 season, so it offers a long-term dataset of comparable results. The CSI survey has incorporated an email component since 2015.

This year the CSI and NC surveys were carried out and analysed together using similar methodology. Having the raw data and results from these two surveys in the same format and stored together will help the two councils make informed decisions on the fishery. Another key benefit of combining the surveys means that licenceholders will be allocated to strata based on their fishing history to increase the accuracy of the entire survey rather than that of each region. It will also reduce issues associated with identified experts swapping the region they buy their licence from between seasons.

As each region produces a full salmon report that incorporates harvest and spawning results at a later date, this report will not include discussion on the significance of the results.

Methods

The survey consisted of an email sent to every CSI and NC full season licence holder that provided an email address and a follow up reminder to non-respondents. The results from the email survey are treated as a certainty stratum and do not contribute to survey variance.

Licence holders that did not respond to the email survey are then matched to previous surveys and categorised on their highest harvest season from the previous five seasons (three seasons for NC licenceholders.)

NC licence holders that harvested a salmon in the previous three seasons and CSI licence holders that harvested five or more at least once in the previous five seasons were classed as our top strata, and as many as possible were sampled. CSI also included a stratum for people that harvested between one and four salmon in their highest harvest season of the previous five.

The licence holders who did not respond to the email survey and weren't in the strata outlined above were allocated to the random strata. All strata were further broken down by licence region, whether they had an email or not, and licence type. Licence type was stratified by Family and Adult (includes: adult whole season, loyal senior and local area licences.)

Apart from the email strata and the top strata outlined above, strata were allocated to SIT and private callers using the optimal Neyman Allocation formula (Ackerley, 2001).

$$n_i = n\frac{N_i s_i}{\sum N_i s_i}$$

Where: n is the total sample size
n_i is the sample size for each strata
N is the total population size
N_i is the population size for individual strata
s_i is an estimate of the sample standard deviation (obtained from the previous year's data).

Table 1: Strata breakdown and the proportion of each that was sampled.

Strata	Licence Type	Email Type	Category	Number surveyed	Population Total	Percent Surveyed
A_E	Adult	Respondent	Email	2,603	2,603	100%
A_NE_1to4	Adult	No Email	1 to 4	11	45	24%
A_NE_NCE	Adult	No Email	NC expert	81	98	83%
A_NE_NCR	Adult	No Email	NC random	322	1,528	21%
A_NE_Over4	Adult	No Email	Over 4	21	24	88%
A_NE_R	Adult	Non-respondent	CSI Random	158	1,943	8%
A_NR_1to4	Adult	Non-respondent	1 to 4	6	29	21%
A_NR_NCE	Adult	Non-respondent	NC expert	62	70	89%
A_NR_NCR	Adult	Non-respondent	NC random	599	2,743	22%
A_NR_Over4	Adult	Non-respondent	Over 4	5	9	56%
A_NR_R	Adult	Non-respondent	CSI Random	193	2,129	9%
F_E	Family	Respondent	Email	1,615	1,615	100%
F_NE_1to4	Family	No Email	1 to 4	5	21	24%
F_NE_NCE	Family	No Email	NC expert	26	36	72%
F_NE_NCR	Family	No Email	NC random	144	645	22%
F_NE_Over4	Family	No Email	Over 4	14	17	82%
F_NE_R	Family	Non-respondent	CSI Random	88	1,071	8%
F_NR_1to4	Family	Non-respondent	1 to 4	14	38	37%
F_NR_NCE	Family	Non-respondent	NC expert	39	46	85%
F_NR_NCR	Family	Non-respondent	NC random	428	1,629	26%
F_NR_Over4	Family	Non-respondent	Over 4	5	8	63%
F_NR_R	Family	Non-respondent	CSI Random	114	1,593	7%
			Total	**6,553**	**17,940**	**37%**

Several CSI strata were removed as a trial this season. These strata were licenceholders that had not caught a salmon in the previous five seasons and licenceholders that had not targeted salmon in the previous five seasons. The removed strata were amalgamated into the random stratum but their data were held through the survey so they could be post stratified to look at the effect of removing these strata. The reasons to remove these strata were to reduce the complexity of the survey for the callers, move closer to a unified method for CSI and NC and reduce the difficulties associated with stratum in which nobody caught or targeted salmon.

Analysis was conducted in R (R Core Team, 2014) using the dplyr package (Wickham et al, 2018) for data cleaning and manipulation and survey totals were produced using the survey package (Lumley, 2019).

Results:

Table 2: Results table showing summary statistics and 95% confidence interval for each river and zone (subtotals shown with thicker outline and grey fill).

Region	River	Zone	Anglers			Successful Anglers			Salmon			Finclips		
CSI	Ashburton	A	130	±	55	5	±	2	6	±	4	-	±	-
CSI	Kakanui	A	2	±	-	1	±	-	1	±	-	-	±	-
CSI	Opihi	1	230	±	73	19	±	23	32	±	24	-	±	-
CSI	Opihi	2	59	±	25	2	±	-	3	±	-	1	±	-
CSI	Opihi	3	17	±	6	2	±	1	2	±	1	-	±	-
CSI	Opihi	U	25	±	33	-	±	-	-	±	-	-	±	-
CSI	Opihi	A	271	±	80	22	±	23	37	±	24	1	±	-
CSI	Orari	A	151	±	60	5	±	7	5	±	7	-	±	-
CSI	Rangitata	1	471	±	87	51	±	15	131	±	49	21	±	8
CSI	Rangitata	2	215	±	42	16	±	11	35	±	18	4	±	-
CSI	Rangitata	3	93	±	18	14	±	11	26	±	11	-	±	-
CSI	Rangitata	4	55	±	25	20	±	25	28	±	29	5	±	8
CSI	Rangitata	5	91	±	25	52	±	25	104	±	36	-	±	-
CSI	Rangitata	U	77	±	55	1	±	1	4	±	3	-	±	-
CSI	Rangitata	A	725	±	112	124	±	37	327	±	94	30	±	17
CSI	Waitaki	1	186	±	54	18	±	8	23	±	9	2	±	1
CSI	Waitaki	2	152	±	49	35	±	28	36	±	28	1	±	-
CSI	Waitaki	3	119	±	33	33	±	21	97	±	103	-	±	-
CSI	Waitaki	4	67	±	25	2	±	-	2	±	-	-	±	-
CSI	Waitaki	U	41	±	40	3	±	4	8	±	13	-	±	-
CSI	Waitaki	A	397	±	88	84	±	36	166	±	108	3	±	1
NC	Ashley	A	9	±	-	1	±	-	1	±	-	-	±	-
NC	Avon	A	3	±	-	1	±	-	1	±	-	1	±	-
NC	Hurunui	A	498	±	51	86	±	19	184	±	48	8	±	1
NC	Kaiapoi	A	241	±	41	29	±	14	56	±	43	7	±	-
NC	Rakaia	1	988	±	90	267	±	56	475	±	78	59	±	27
NC	Rakaia	2	440	±	52	80	±	18	106	±	33	27	±	11
NC	Rakaia	3	330	±	58	55	±	12	79	±	20	-	±	-
NC	Rakaia	U	88	±	58	30	±	33	69	±	54	2	±	2
NC	Rakaia	A	1,409	±	121	397	±	67	729	±	106	87	±	29
NC	Selwyn	A	1	±	-	-	±	-	-	±	-	-	±	-
NC	Tentburn	A	19	±	11	8	±	2	17	±	4	-	±	-
NC	Waiau	A	198	±	31	29	±	8	72	±	40	1	±	-
NC	Waimakariri	1	1,473	±	91	156	±	29	254	±	55	31	±	18
NC	Waimakariri	2	732	±	60	62	±	16	102	±	36	5	±	2
NC	Waimakariri	3	223	±	33	40	±	15	40	±	20	13	±	10
NC	Waimakariri	U	12	±	23	-	±	-	-	±	-	-	±	-
NC	Waimakariri	A	1,811	±	98	239	±	34	396	±	84	49	±	21
NM	Clarence	A	15	±	8	2	±	-	2	±	-	-	±	-
NM	Wairau	A	14	±	8	6	±	8	6	±	8	-	±	-
OG	Clutha	A	20	±	22	11	±	21	11	±	21	-	±	-
OG	Taieri	A	4	±	-	-	±	-	-	±	-	-	±	-
WC	Arahura	A	1	±	-	-	±	-	-	±	-	-	±	-
WC	Haast	A	1	±	-	-	±	-	-	±	-	-	±	-
WC	Hokitikia	A	7	±	8	-	±	-	-	±	-	-	±	-
WC	Lake Mapourika	A	2	±	-	1	±	-	1	±	-	-	±	-
WC	Lake Moeraki	A	1	±	-	-	±	-	-	±	-	-	±	-
WC	Mahitahi	A	5	±	8	-	±	-	-	±	-	-	±	-
WC	Paringa	A	19	±	21	4	±	-	4	±	-	-	±	-
WC	Taramakau	A	6	±	-	1	±	-	1	±	-	-	±	-
WC	Waitaha	A	5	±	8	-	±	-	-	±	-	-	±	-
WC	Wanganui	A	5	±	8	5	±	8	5	±	8	-	±	-
WC	Whataroa	A	1	±	-	-	±	-	-	±	-	-	±	-
SI	All	A	3,986	±	206	909	±	96	2,028	±	231	187	±	40

The larger rivers were divided into multiple sections. The sections are shown in Table 3.

Table 3: River zones for larger rivers

River / Zone	Waitaki	Rangitata	Opihi	Rakaia	Waimakariri
1	Mouth and tidal reaches	Mouth and tidal reaches	Mouth and tidal reaches	Below SH1	Below SH1
2	Above tidal reaches to SH1	Above tidal reaches to SH1	Above tidal reaches to junction of Temuka River	SH1 to gorge bridge	SH1 to gorge bridge
3	SH1 to Stonewall	SH1 to Arundel bridge	Whole catchment above Temuka River junction	Above gorge bridge	Above gorge bridge
4	Above Stonewall	Arundel bridge to bottom of gorge			
5		Gorge and above			

Discussion

Strata that were removed from this season's survey were added back in at the end of the survey to see if they made a significant difference to confidence intervals. Margins of error for every fisheries estimate for salmon catch except for the Opihi and Clutha increased when the previous season's strata were included. This should be investigated further before next season's survey.

Even though the CSI and NC surveys were kept mostly separate through stratification, running the surveys together created several benefits. The main benefit is that a higher-harvesting expert can no longer turn up in the neighbouring region's random strata if they swap their licence buying region. This will have reduced the width of the confidence intervals for this season's survey. There will be a further increase in survey accuracy next year when this season's NC email respondents are added to expert lists. Even if future surveys are run separately by each region, there are benefits to both regions if the method is kept consistent between regions.

References

Ackerley, G. (2001). Estimating salmon catch numbers in the Central South Island Fish and Game Region. *Private report for the Central South Island Fish and Game Council*

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Wickham, H, François, R, Henry, L and Müller, K (2018). dplyr: A Grammar of Data Manipulation. R package version 0.7.6. URL https://CRAN.R-project.org/package=dplyr

T. Lumley (2019) "Survey: analysis of complex survey samples". R package version 3.35-1.