Sports fish harvest and angler use dynamics of the upper Tekapo Canal fishery during the 2019 rainbow trout spawning season

Prepared for the Central South Island Fish and Game Council

Rhys Adams, March 2020

Introduction

The Mackenzie Basin hydro canal fishery incorporates the Tekapo, Pukaki-Ohau A, and Ohau canals and according to the 2014/15 National Angler Survey (NAS) is collectively the most popular freshwater sports fishery in New Zealand. The popularity of the fishery has grown dramatically with over a 16-fold increase in angler-use measured between 1994/1995 and 2014/2015 by the NAS. The Tekapo Canal attracted about one-quarter of all canal-based angling activity during the 2014/2015 season in the CSI Region.

Even under the strain of increasing angler use, CSI Fish & Game (CSI) have assessed the fishery to be sustainable and able to maintain the satisfaction of its anglers by providing high levels of catch and harvest. However, in recent years CSI staff (staff) have encountered a concerning perception amongst a relatively small but dedicated part of the angling community that the quality of canal fishing has steadily decreased since about the 2016-2017 sports fishing season until present.

Angler concerns have been expressed to CSI via formal submissions to Angler Notice reviews, angler-staff interaction through meetings, ranging, emails and phone calls. Additionally, non-interactive observations of online fishing community activity like Facebook posts and petitions have been recognised. Although angler concerns and their suggested solutions vary greatly, a notable component of this concern surrounds the sustainability of the increased targeting and harvest of spawning trout in wintertime. Staff have identified the primary area of concern as the upper Tekapo Canal where large numbers of anglers congregate to target known areas of trout spawning where redds are evident. Without doubt, the popularity of this area has skyrocketed over the past three winters along with the use of “egg rolling” methods. This has seemingly been fuelled by promotion of the area and successful methods on social media.

Historically, CSI have considered year-round trout harvest in the canals as sustainable. This approach assumes that most canal trout are recruited via downstream migration from the headwater lakes through the hydro power structures rather than from within-canal spawning as identified by Bloomberg & Graynoth (1991). Although within-canal spawning occurs, CSI has considered that it is likely to only support recruitment rather than being able to sustain the catch and harvest levels experienced. The rationale being that the within-canal spawning and juvenile rearing habitat is suboptimal and that there are high predation levels of trout fry and parr. Faced with the current concerns of anglers, staff have considered it appropriate to re-assess the potential for anglers to affect the sustainability of the Tekapo Canal fishery by targeting trout in the spawning season.

Addressing potential issues of sustainability of the canal fishery is a difficult task for CSI. To date CSI has relied greatly on staff experience and observations and stand-alone research projects to inform the management of fisheries sustainability through the setting of angling regulations and season

lengths. There are currently no regular or comparable sports fish population or harvest monitoring programs in place at the canals to assess changes in the fishery on which to base ongoing reviews of canal fisheries management. Likewise, other than the NAS, which is completed on a seven-year cycle, there is no other regular or comparable angler-use survey in place.

Currently, management decisions are based an accumulation of knowledge including: staff observation of the fisheries establishment and growth, which began with the construction and commissioning of the canals and then the introduction of the first of many salmon farms in 1992; sports fish harvest and angling trends gained by regular ranging efforts and angler interactions; population dynamics observed through the salvage of sports fish during the de-watering of canals and associated parts of the greater hydro scheme; drift dives and sonar surveys; spawning observations; migration and recruitment pathways knowledge gained through salvage and mark-recapture initiatives; a survey of canal angler use and sports fish harvest during the 2015-2016 season; and salmon stocking assessments based on tagged fish releases.

Even with this wealth of observation and knowledge of many of the canal fishery dynamics, many fundamental aspects related directly to the sustainability of the fishery remain unknown. For example, the current angler concerns surrounding the sustainability of targeting spawning fish at the upper Tekapo Canal would be addressed if we could establish the relative value of the two recruitment pathways of trout in the Tekapo Canal, that being either spawning within the canal or downstream migration into the canal from Lake Tekapo. If we could also monitor population levels annually and pair these two sets of information, we could set population thresholds and adjust regulations to maximise angling opportunity.

Staff effort has already gone into establishing the relative contribution of the recruitment pathways at the Tekapo Canal by using otolith microchemistry to identify natal origin of rainbow trout caught by anglers in the canal. However, difficulties have arisen with establishing a viable and cost-effective project design and work continues to establish if indeed this is a viable management tool for CSI. This highlights the challenges faced with an evidence-based management approach at the canals.

Acknowledging the current concerns of anglers and a lack of recruitment pathways and population understanding, an effort was made to initiate an evidence-based review of the angler use and harvest of the upper Tekapo Canal fishery during the rainbow trout spawning season of 2019. The aim of the survey was to capture a ‘snap-shot’ of angling dynamics and sports fish catch and harvest to put some perspective on the angler’s concerns and to assess the need for regulation changes. This report summarises the findings of the survey and assesses regulation change options should the Council wish to pursue a conservation-minded approach to managing the targeting of spawning trout in the upper Tekapo Canal.

Survey Programme

During the months of June to October 2019, inclusive, on the upper Tekapo Canal, CSI’s four Fish & Game Officers collected angler interview and angler counts information spanning 38 days. Survey effort was stratified into 13 strata that were broken down by month, and type of day including weekday, weekend and holiday weekend. Fourteen randomly selected dates were surveyed to capture all strata types and additional data were collected where possible with angler counts occurring on 14 non-scheduled dates, and fishing information collected for 10 non-scheduled dates.

The upper/lower canal was delineated by the State Highway 8 Bridge. The upper canal section makes up 45% or 11.9km of the Tekapo Canal. Four canal sections were identified within the upper canal: Tekapo A Power Station to Tekapo Powerhouse Road Bridge (0.85km), Tekapo Powerhouse Road Bridge to the anglers carpark at the locked road gate (5.78km), angler carpark/locked gate to pine tree block (2.35km), and pine tree block to the State Highway 8 Bridge (2.92km). The section of canal from about the angler's carpark/locked gate down to the pine block incorporated part of the canal that is colloquially known as the "Magic Carpet". This area of canal is a hotspot for fishing and is mainly visited by anglers who park their vehicles at the Magic Carpet carpark.

Angler interviews were undertaken in addition to regular licence and regulation compliance checks by Fish & Game Officers. Anglers were asked if they wished to participate in a survey, which most anglers (~95%) agreed to. Questions were asked at the time of the compliance check and a phone number was collected so that the angler could be interviewed later that day/night or the next day, once their current day's fishing had been completed. The interviewers collected information relating to licence type, the angler's primary method, time spent fishing, and fish species caught (successfully landed), whether each fish was kept (harvested) or released and the estimated weight of each fish. During the field interview anglers were asked if they fished the canal the day prior, if so, a full record of that days fishing information was collected. Not all anglers present on the canal were approached for interview, and of those approached and who provided contact information, not all could be later contacted to provide their catch information.

During individual angler counts of the survey reach, it was noted that not all anglers counted could be subsequently interviewed due to them leaving the survey area. Comparing the number of anglers counted and the numbers of angler successfully interviewed, it is estimated that a range of approximately 50-90% of the angler's present were successfully interviewed any given survey day.

Angler counts were undertaken to estimate the total angler effort at the upper Tekapo Canal on each survey day. 5-9 counts were completed daily during visible light hours on scheduled surveys days. One to three additional counts were completed on non-scheduled survey days. The length of the canal to the locked road gate was driven continuously and all active anglers observed from the road were counted. Binoculars were used at times for assistance and a spotting scope used to count anglers on the lowest section from the locked gate. Each individual angler count was represented by the middle minute of the duration of the count. The angler counts were spread throughout the day to capture variability of angler use as a result of angler behaviour or as a reaction to changing weather or flow. Due to staff resourcing and perceived angler detectability issues, no night-time angler counts were completed. Therefore, the survey only estimated harvest and angler use from approximately dawn until dusk within visible day light hours.

Early in the survey period a trail camera was trialled as a method of counting anglers or their cars to collect data when field staff were not present. Counting congregations of vehicles was considered a viable method whereby simultaneous counts of angler and vehicles undertaken by staff could be used to calibrate the trail camera vehicle counts to estimate angler counts. A trail camera was positioned to capture regular 'time-lapse' images of vehicles at the Magic Carpet carpark from the 13th of June onwards.

It should be noted that this survey effort was considered the minimum required to estimate the angler use and catch of the five-month survey period and the results of this survey should be considered a useful index of the fishery dynamics only.

Results

Over the survey period a total of 300 individual anglers were successfully surveyed based on 14 scheduled survey dates and provided 358 records of daily angling activity. One hundred and nine angler counts were completed spanning 24 dates. On 141 dates, 1,509 trail camera photographs were taken and utilised for counting vehicles.

Angler use of the canal fishery

The highest individual count of active anglers within the total survey area made by staff was 43 at approximately 2:40pm on the Queen's Birthday Holiday Monday in June. The highest individual count of active anglers on the Magic Carpet was 23 on the same day at 8:50am.

Angler use was estimated by calculating representative "angler days" from observed angler counts. An "angler day" represents the effort (hours spent fishing) of one angler over a single day. Angler days were estimated by using an 'area under curve' (AUC) method. This method predicts a pattern or 'curve' of angler counts over a specified day length from actual angler counts recorded at individual times within each stratum. The counts are measured as total AUC minutes/hours. AUC hours were then converted to angler days by dividing them by the actual average number of hours that anglers, fishing within the associated stratum, fished for. The result is a predicted total daily angler days count that represents one day within the stratum and is multiplied by the number of stratum days to get the total stratum angler days.

The trail camera vehicle counts at the Magic Carpet carpark were used to estimate angler counts at the Magic Carpet sections only and were combined with all other non-Magic Carpet sections to estimate total survey area angler counts. The vehicle counts were daily records and were converted to angler counts using a ratio of 1.48 anglers per vehicle, which was established as the average vehicles-to-anglers ratio as observed in the angler counts undertaken by staff. The use of the vehicles-to-anglers ratio was assessed by applying a linear regression to the data. The regression showed that there was a very strong relationship between the numbers of cars in the Magic Carpet carpark and the number of anglers fishing the Magic Carpet (r-squared = 0.925). Therefore, the use of the vehicle counts to estimate angler counts was deemed viable. The same assessment was made to review if the Magic Carpet carpark counts could be used to estimate total survey area angler counts. This only provided very weak evidence of a correlation (r-squared = 0.094), so was not pursued.

As no angler counts were completed in darkness hours the method assumes there were no anglers fishing at night, therefore, angler counts represent visible daylight hours only.

Table 1. Estimates of time (hours) spent fishing and angler days for the total survey period and each stratum. There is distinction made between the section of the survey area including the Magic Carpet and the rest of canal. Some rounding error is included.

Month-Stratum	Average daily hours spent fishing	Average non-Magic Carpet angler days	Average Magic Carpet angler days	Total average angler days	Days in stratum	Total survey angler days
weekday	6.5	9	13	22	19	418
weekend	5.6	35	21	56	8	448
holiday weekend	3.8	37	33	71	3	212
June total						**1,078**
weekday	4.0	17	20	37	23	855
weekend	3.5	28	28	56	8	447
July total						**1,303**
weekday	5.8	3	6	9	22	197
weekend	4.1	38	13	51	9	461
August total						**658**
weekday	2.1	15	10	24	20	490
weekend	4.1	15	10	25	7	177
holiday weekend	1.9	9	16	25	3	74
September total						**741**
weekday	4.0	3	2	5	22	112
weekend	1.4	17	12	29	6	172
holiday weekend	2.1	27	2	29	3	86
October total						**370**
Survey total					153	**4,149**

It is estimated that there was 4,149 angler days during the survey period, with the most popular month being July (1,303 angler days) followed by June (1,078 angler days) (Table 1). The use in August (658 angler days) and September (741 angler days) is a notable reduction from the previous months and October has a distinctly lower use (370 angler days) than August and September. In four of thirteen strata, the magic carpet use is greater than the rest of survey area.

Angler use comparisons with the 2015-2016 canal harvest survey

The 2019 targeted survey and the 2015-2016 canal fishery survey used similar methods; however, the data are not directly comparable as the design of the two surveys are on different scales. The 2015-2016 canal harvest survey was designed to estimate combined fishery use of all the canals over a year and was not considered accurate enough to individually estimate angler use and catch from each canal or any section of an individual canal. To put this in perspective during the 2015-2016 survey the Magic Carpet was considered a secret spot and was only fished by a small but dedicated group. Very few anglers were counted and interviewed specifically at the Magic Carpet during that survey, therefore there is very little data to directly compare with the 2019 survey.

Relationship between angler use and canal flow

Popular fishing techniques like “egg rolling” rely on strong canal current to allow imitation fish eggs and other lures to flow semi-naturally down the canal bed along with a small sinker. Preliminary

analysis was undertaken to compare canal flow records with angler counts to explore the relationship between flow and angler numbers. Statistically, the level of canal flow explained 46% of the variation in angler numbers (correlation coefficient =0.46) suggesting there is some relationship between the presence of anglers and flow. It is likely that with further isolation of other factors that could affect angler numbers, such as weather and section of the canal fished, a stronger relationship may be able to be established. If the survey is to be repeated, then the flow vs. angler relationship should be further explored so data comparisons can be considered in relation to flow variations that may be observed.

Sports fish harvest and catch and release

Angler interviews identified that approximately 60% of daily visits resulted in no fish caught by an angler. 17% of visits resulted in one fish caught and 10% of visits resulted in two fish caught. Approximately 13% of visits resulted in between three and 16 fish caught.

Lake Tekapo and subsequently the Tekapo Canal water clarity was affected by a major headwater flood event in March 2019.There were some suggestions by anglers that water clarity effected catch and that clear water is more productive for the egg rolling method. From the start to the end of the survey period there was a conspicuous improvement in water clarity.

Salmon were present in the survey area occasionally and did get caught. However, Staff did not observe any surveyed anglers successfully landing a salmon and strongly believe, based on interaction with the anglers who reported salmon catch, that some of the salmon recorded were small silver-coloured rainbow trout incorrectly identified by anglers. It must be noted that the catch of salmon within the survey is likely to be an overestimate, and conversely the catch of rainbow trout is likely to be an underestimate.

To estimate total catch and release and catch and harvest (kept) for the individual randomised survey dates, the average rates of fish kept or released were multiplied by the estimated angler days count (Table 2).

Table 2. Estimated total sports fish catch, presented as fish either caught and kept (harvested) or caught and released on individual scheduled random survey dates for the upper Tekapo Canal, June to October 2019.

Month	Strata-day	Rainbows kept	Rainbow released	Brown kept	Brown released	Salmon kept	Salmon released
June	Weekday	1	42	0	12	0	0
June	Weekend	2	80	0	31	0	5
June	Holiday weekend	4	32	1	13	0	1
June	Holiday weekend	2	29	0	8	0	0
July	Weekday	0	37	1	7	0	1
July	Weekend	0	3	0	8	0	0
August	Weekday	2	29	0	16	0	1
August	Weekend	2	41	2	6	0	2
September	Weekday	0	0	2	0	0	0
September	Weekend	1	11	0	4	0	0
September	Holiday weekend	0	0	0	0	0	0
October	Weekday	0	0	0	0	0	0
October	Weekend	0	0	0	0	0	0
October	Holiday weekend	0	14	0	0	0	0

The daily catch and the resulting decision to either catch and release or harvest those fish varies greatly. On three of fourteen survey days, all within the months of September and October no catch at all was recorded as opposed to the estimated highest catch of 82 fish on a June weekend day (Table 2).

There were relatively few fish caught and kept (harvested/killed) and the decision to catch and release dominated the catch. The proportion of daily harvest measured varies from none to approximately 11% for rainbow trout with an average of approximately 3%. For brown trout the daily proportion of fish caught and harvested varies from none to all with an average of approximately 15% harvest. For salmon, on the scheduled survey dates all fish caught were released. One salmon was harvested on one non-scheduled survey date (July weekday) and is incorporated in the month and total catch estimates (Table 3). Because of the misidentification issue regarding salmon it is possible that rainbow trout harvest rates were slightly higher than 3% on average.

None of the 300 individual anglers surveyed throughout the period harvested more than one sports fish per day. This indicates that the true proportion of anglers that harvest their 2-trout daily bag limit is likely to be very small.

For a monthly estimate of catch, the individual catch within each stratum was multiplied by the number of days in that stratum and all stratum totals were combined to give survey period totals (Table 3).

Table 3. Estimates of sports fish catch, presented as fish either caught and kept (harvested) or caught and released on a monthly basis for the upper Tekapo Canal, June to October 2019.

Month	Rainbow kept	Rainbow released	Brown kept	Brown released	Salmon kept	salmon released
June	47	1343	16	461	0	54
July	0	1028	24	241	24	71
August	32	755	10	251	0	31
September	35	140	29	84	0	0
October	0	36	0	0	0	0
Total	114	3302	79	1037	24	156

Total rainbow trout catch is estimated at 3,416, of which 114 were harvested. Total brown trout catch is estimated at 1,116 with 79 of those being harvested. Approximately 4,712 fish, including salmon, in total were successfully, caught. It is likely that some of the fish were caught multiple times and released successfully, therefore the number of individual fish caught is likely to be lower than total of all sports fish caught.

Total catch for the survey period was dominated by rainbow trout at over three-fold levels to brown trout. When considering brown trout catch it is worth noting that the start of the brown trout spawning season was most probably not incorporated in this survey and that a significant amount of brown trout catch may not have been captured by the survey.

Salmon catch is low and is believed to be an overestimate due to rainbow trout misidentification by anglers that staff have experienced. During the survey there was no observations of catch that would suggest that a more than minor escapement of salmon occurred from the salmon farm in the lower canal and migrated upstream to the surveyed reach and affected salmon catch levels.

In some months either zero catch or harvest was captured by the survey, but It is likely that some amount of catch and harvest did occur. It is likely that the true catch or harvest levels would have been relatively low.

The catch of rainbow trout and salmon followed a similar pattern to angler activity and there was a large proportion of the catch achieved in June and July, a notable catch in August and then relatively low level of catch through September to October. For brown trout June had the highest catch with a moderate catch in July and August with the catch tapering off through September and October.

From anecdotal field observations and trail camera observations it was assumed that night-time fishing activity was minimal during the survey period and accordingly catch and harvest during this time is relatively low and unlikely to compromise overall results of this survey.

Fish size

Where an angler could provide the estimated weight of every fish caught on a date, that data were compiled to provide an unbiased index of the size of the fish caught throughout the survey period. (Table 4).

Table 4. Summary data of fish weights in pounds (lb) of 366 fish caught throughout the survey period as reported by anglers.

Species	Min weight	Max weight	Average weight	% < 1.5	% 1.5 - 9.9	% 10+	Total fish count
Rainbow	0.3	34	6.5	18	54	28	267
Brown	0.5	19	4.1	6	90	4	89
Salmon	0.3	7	2.3	40	60	0	10

Fish caught spanned the expected size ranges at the canals from one to two-year-old juvenile fish weighing less than one pound right up to exceeding 30 pounds. Approximately 76% of all fish caught weighed under 10 pounds. A significant proportion of rainbow trout catch (18%) was small fish (although legal size) at less than 1.5-pound. Twenty-eight percent of rainbow trout were considered large in a New Zealand-wide context at 10-pounds or larger. There were few large (4%) or small (6%) brown trout caught.

Eighteen of the 366 fish were harvested, of which 12 were rainbow trout, 5 were brown trout and 1 was a salmon (Table 5).

Table 5. Summary data of the size in pounds (lb) of fish caught and harvested throughout the survey period.

Species	Min weight	Max weight	Average weight	% 10 lb+	Total Fish count
Rainbow	1.5	31	10.6	50	12
Brown	2.5	19	6.6	20	5
Salmon	n/a	7	n/a	n/a	1

The weights of harvested fish spanned the size range of 1.5 to 31 pound. Because of the low sample size (18 fish) it is hard to draw inference about what size of fish it is that anglers preferred to harvest.

Fishing Method

The primary method used by an angler interviewed was recorded against daily angler catch. For analysis the methods were categorised into the three authorised methods: fly, spin and bait and additionally the "egg rolling" technique was recorded as its own method. Technically, an egg rolling assembly, which uses a spin rod rigged with a small sinker and generally 1-2 imitation eggs, is considered to be spin fishing. Some of the imitation egg lures used are scented synthetic soft baits, which then makes the method bait fishing.

'Egg rolling' dominates the catch that means that spin fishing was by far the most successful method used during the survey, possibly accounting for over 80% of fish caught (Table 6). Traditional spin fishing accounted for a small amount (2%) of that catch. Bait fishing, including scented soft baiting, accounted for a small but significant part (12%) of the catch and is an underestimate because an unknown proportion of egg rolling is legally defined as bait fishing. Fly fishing was seldom used during the survey and accounted for approximately 0.1% of total catch. Approximately 2% of the catch could not be attributed to a defined method.

Table 6. The total estimated catch of fish for the survey period according to the successful method. Some rounding error included.

Method	Rainbow	Brown	Salmon	% total catch
Bait	340	189	47	12
Egg rolling	3024	784	132	84
Spin	43	69	0	2
Fly	3	0	0	0
Unknown	5	74	0	2

Additional information

Spawning redds have previously been observed by anglers and staff in the canals, primarily at the upper Tekapo Canal and to a far lesser extent in the Ohau A Canal near the intake from Lake Ohau.

On one occasion, September 19th, 2019, 51 redds were counted in the Tekapo Canal reach between The Tekapo A Power Station and the Fork Stream culvert. The majority of these redds where subject to de-watering during periods where the canal flow was shut off, as was the case on September 19. Reduced flow and zero-flow events appeared to be more common or at least longer in duration during the months of September and October. On September 23 one of the dewatered redds was dug to inspect the health of the eggs contained and all eggs found had died. Spawning redds were also observed but not recorded in the reach between the Magic Carpet and the Fork Stream Culvert. No redds have been observed or recorded below the Magic Carpet.

During the survey period while ranging the Stilling Basin area of the lower Tekapo Canal, staff observed trout fry using the exposed basin wall boulders as refuge. On two occasions staff recovered trout fry using electric fishing equipment (Table 7). Based on the size and life stage, staff deemed them to be of within-canal spawning origin and too small to have been spawned in a tributary of Lake Tekapo and migrated to the lower Tekapo Canal as fry. Although anecdotal evidence of the presence of juvenile trout in the canal previously existed, this is the first recorded sample of juvenile fish that provides evidence of successful spawning within the Tekapo Canal.

Table 7. Trout fry electric fished from the Stilling Basin in the Tekapo Canal in October and November 2019.

Date	Waterway	Location	species	length (mm)	number	comments
31/10/2019	Tekapo Canal	Stilling Basin (farms)	unknown trout	~25-39	6	all fry
26/11/2019	Tekapo Canal	Stilling Basin (farms)	unknown trout	~23-53	11	includes 1 parr

Discussion

This survey has provided insight into the realities of the angler use and catch dynamics of trout in the upper Tekapo Canal in the winter and spring of 2019. The survey has no previous equivalent survey to compare to. It was undertaken in response to angler concerns that the quality of the greater canal fishery has declined and that much of that concern was associated with the dramatic increase of the targeting of trout during the spawning season. This survey informs the reality of angler use and catch of a single rainbow trout spawning season at the upper Tekapo Canal, but it is not appropriate to consider the finding relevant for addressing the sustainability of the greater canal fishery. The upper Tekapo Canal is a unique part of the canal system that has experienced an intense growth in use by anglers who target spawning trout and can be assessed in isolation to other parts of the canal fishery.

Ultimately, annual population monitoring should be used to assess the sustainability of populations in relation to existing management and to monitor effects of any changes to management. At this point in time, with no annual population monitoring in place, the concerns of angler remain unsubstantiated, however it must be recognised in the absence of scientific evidence to the contrary that it is reasonable to take a precautionary approach to managing the perceived issues. To this end, an angler use and harvest survey can provide valuable guidance to options in fisheries management should a conservation-minded approach be taken to the ongoing management of catch, harvest and protection of spawning trout in the upper Tekapo Canal.

Staff believe that currently there is enough recruitment and enough food to sustain a highly valued canal trout fishery and recognise that increasing use and/or the increasing levels of angling expertise could have led to a reduction in opportunity and satisfaction of anglers. This however does not mean that the fishery is in decline or unsustainable; rather it may mean that the quality of fishing previously experienced may be unattainable for some anglers due to an increasing number of increasingly successful anglers targeting the same fish population.

It is accepted that the satisfaction of an angler who targeted spawning trout in the upper Tekapo Canal prior to perhaps the 2017-2018 season, and especially those who fish the Magic Carpet with egg rolling techniques, would have a perception that the fishery has declined or that their satisfaction levels have decreased. Anglers have told us that it was only a few seasons ago that they could have the Magic Carpet to themselves on a weekend and catch multiple exceptionally large trout a day. Now they are likely to be fishing with ten to twenty other anglers and be lucky to catch one of two exceptionally large trout each day. The competition for the same resource has increased dramatically. It is possible that much of the angler's general concern of canal fishery sustainability stems from this unique area of the canal system as anglers fish shoulder to shoulder and witness everything from trout actively spawning to poor handling of fish during photographic sessions. There are many aspects to this

spawning season angling that an individual may take exception to. However, the popularity of the fishing speaks for itself and regardless of some angler's concerns – the opportunity to fish this part of the canal fishery is highly valued by anglers and should be maintained where possible.

It appears to be a common assumption amongst anglers that all recruitment of trout in the canals comes from within-canal spawning. This assumption naturally fuels the questions of the sustainability of fishing for spawning fish. Indeed, some spawning is successful in the canal to at least the parr life stage, but we have no information to say how many of these fish contribute to catch and harvest of adult canal trout. On the other hand, there is evidence that trout migrate into the canal from headwater lakes. Again, we have no information to say how many of those contribute to the catch and harvest of adult trout in the canal. Currently, there is no silver bullet for managing this type of fishing opportunity vs recruitment and the sustainability conundrum that is unique to the canals. For that reason, it is fair to take a conservation-minded approach and assume it is possible both recruitment pathways make a meaningful contribution to the sustainability of the Tekapo Canal fishery.

Should the Council wish to take a conservative-minded approach to managing angling at the upper Tekapo Canal during the trout spawning season, by imposing angling restrictions, in the absence of evidence-based population and recruitment information and monitoring, then there must be recognisable advantages to counteract the loss in opportunity. Any restriction in angler use or methods should ultimately aim to minimise any interference that anglers have on the ability of trout to self-sustain.

In the following discussion the results of the 2019 survey are reviewed with recommendations of options for managing potential restrictions to angling at the upper Tekapo Canal during the rainbow trout spawning season for the purpose of protecting trout spawning.

Options for restricting angler use

The months of June and July were very popular for anglers at the upper Tekapo Canal. August and September had notable angler use levels while the number of anglers in October decreased significantly.

If a closed season was to be used to reduce angling catch and fish disturbance then June and July should be considered priority months, August and September are moderate priority months and October as a low priority month for closure.

If the canal was to be considered a "high-country" waterway then a standard spawning season closure would be from May 1st to the first Saturday in November. The length of the standard high-country closure is not considered appropriate for the upper Tekapo Canal given its unique value to anglers as a year-round fishing destination.

Staff recommend that an appropriate restriction to angler use of the upper Tekapo Canal to protect rainbow and brown trout spawning is a June to August inclusive closure upstream of SH8. A June to August closure restricts high angler use periods in addition to one moderate use period but still maintains "shoulder season" spawning fishing opportunities in May and September and October in the upper Tekapo Canal. This closure should allow a significant proportion of spawning to occur undisturbed, which is likely to result in the full utilisation of the small area of available spawning habitat. There will be no catch or harvest of fish during that period. Additionally, those fish that would have been harvested or died from poor handling during a full open season would be available to

anglers for catch in the lower canal during the closure period or within the entire canal in the normal season.

There is likely to be some angler displacement to other parts of the canal system as a direct result of the suggested closure. The upper parts of Pukaki and Ohau A canals are likely to receive some of the displaced anglers as these are favoured wintertime angling options for anglers that favour the egg rolling technique in fast flowing water.

Options for restricting angler catch

Rainbow trout catch was significant in June and deceases through the months to an insignificant catch level in October. Most of the rainbow catch occurs in June and July, but August is still a significant month. September and October had relatively low catches.

If a closed season is to be used to reduce rainbow trout catch then June and July should be considered priority months, August a moderate priority month and September and October as low priority months for closure.

Brown trout were mainly caught in June and in reasonable numbers in July and August. Low number were caught in September and October.

If a closed season is to be used to reduce brown trout catch then June should be considered a priority month, July and August as moderate priority months and September and October as low priority months for closure.

Any closure aimed at trout fishing has the potential to unnecessarily restrict salmon catch. The worst case would be if many salmon escaped from the farm on the lower Tekapo Canal and migrated up to the top of the canal and competed for the food resources of trout until the season re-opened and they were subject to removal (harvest) by anglers. Although the occasional salmon is caught in the upper canal, no mass migrations of salmon have been observed at the upper canal. If a salmon season was to remain in place while a trout season was closed, anglers would predominantly catch trout and disturb spawning, therefore any closure must be for all species to have the desired effect to protect trout spawning.

A closure of the Tekapo Canal upstream of SH8, for the months of June to August inclusive, is recommended by staff to significantly reduce sports fish catch during trout spawning season.

Options for restricting angler Harvest

As a proportion of total catch, rainbow trout harvest was extremely low at around 3% for the period examined. This is in part believed to be low because anglers are aware that it is spawning season so trout will have reduced flesh quality and anglers want to return them to the water to continue to spawn.

The harvest of brown trout at 15% was still considered low even though it was higher than for rainbows. The higher proportion of browns taken is likely to reflect that more browns are of the preferred size for eating with fewer browns being very small or very large as is the case with rainbow trout.

The total sports fish harvest in this survey is only estimated at around 200 fish across five months. This is not considered to be a significant harvest level in a fishery as productive as the Tekapo canal where there were approximately 4,700 fish successfully landed in total during the survey period.

There is little perceivable conservation value in introducing a reduced trout bag limit from two to one as no surveyed angler harvested more than one sports fish per day. A reduced bag would still allow the catch, harvest and disturbance of spawning trout.

The use of catch and release or a zero-bag limit as a conservation measure is not recommended by staff. Staff believe that the ability for an angler to harvest and utilise any fish not fit for release should be maintained with at least a 1-fish bag limit. It should be recognised that catch and release has the potential to reduce the ability for a trout to spawn successfully and may even cause death. Considering the extremely high levels of catch and release practiced by anglers at the upper Tekapo Canal, there is potential for poor catch and release practice to cause a reduction in the fish population to levels that could affect the opportunity of anglers. Staff recognise that compared to other fisheries there is a high occurrence of poor fish handling at the canals.

Staff recommend that reducing bag limits is not an appropriate tool for protecting trout spawning at the upper Tekapo Canal. It is recommended that pro-active advocacy of best-practice catch and release be targeted to canal anglers in the lead-in and during any spawning season fishing opportunities.

Options for restricting method

Any attempt to regulate catch and harvest levels by way of restricting methods needs to primarily address the high level of catch observed by anglers "egg rolling". By legal definition, egg rolling incorporates both spin and bait angling methods. Although no data were collected on the relative levels of bait or spin lures used by egg rolling anglers, staff believe that bait is used at lower levels compared to lures. There are many technical compliance challenges with trying to restrict "egg rolling" and to restrict both bait and spin methods that it incorporates. To do so would effectively close the fishery for all except for an insignificant number of fly anglers. Restricting season length is considered a more practical compliance tool that can effectively manage a reduction in the catch and harvest of fish at the upper Tekapo Canal during the spawning season.

Staff recommendations

For the 2020-2021 Anglers' Notice review

Recommendation 1: Introduce a closed season for all sports fishing above the SH8 Bridge on the Tekapo Canal from June 1 to August 31, 2021.

Justification summary: This closure represents a conservation-minded measure to address neither substantiated nor disproven angler concerns that the targeting of spawning trout in the upper Tekapo Canal is unsustainable. The three-month closure will allow undisturbed spawning that is likely to result in the full utilisation of the small area of spawning habitat available and will maintain highly valued opportunities for anglers to undertake "spawning season" fishing in the "shoulder season" months of May, September and October. If future research and monitoring establishes evidence that year-round fishing can be sustainable then a year-round season should resume to provide a highly valued fishing opportunity. Any research of this nature should be prioritised where possible.

Recommendation 2: Make no additional spawning season closures at the canal fishery for the 2020-2021 sports fishing season.

Justification: Other than the upper part of the Tekapo Canal, the upper part of the Ohau A Canal is the only other canal section where trout redds have been observed by staff, albeit in very low numbers. Most of the canal system does not appear to offer suitable spawning gravels although congregations of trout do occur in the spawning season at the upper parts of canals. The Ohau B Canal is the only canal with connectivity to river and creek spawning habitat. It is believed to be largely sustained by spawning activity in the upper Ohau River, Lake Pukaki and Lake Ohau.

There is little justification, except perhaps for the upper Ohau A Canal, that any closed season should be introduced to protect within-canal spawning. Although there is some spawning in the Ohau A Canal, the Pukaki-Ohau A Canal fishery is believed to be sustainable based on sufficient downstream migration of trout through the Ohau and Pukaki control gates. There are also other dynamics related to salmon farming changes in the Pukaki-Ohau A Canal that should be considered before any review of regulation change is made. The salmon farm operating in the Pukaki-Ohau A Canal has dramatically reduced its operation to only one raft of pens that will service just the hatchery brood stock and research needs. This in effect has caused a massive reduction in salmon food pellet availability for the wild trout and escapee salmon. It has also decreased the likelihood of salmon escaping from the farm pens into the canals. This change in dynamics will require the Pukaki-Ohau A Canal fishery to essentially "reset" to match the new availability of supplementary salmon pellet food. Staff suggest that the canal should be allowed to reset for several years before any regulation change that reduces season length is reviewed at the Pukaki-Ohau A Canal.

Ongoing upper Tekapo Canal management

Recommendation 3: Repeat this survey during the trout spawning season of 2020 and include the Month of May to better capture brown trout spawning.

Justification summary: The next anglers notice review considers the fishing season starting 1 October 2020. If Council wishes to close or restrict the upper Tekapo Canal fishery in winter as recommended by staff, this will not be applied until winter 2021 at the earliest. The final "unrestricted" spawning season where angler use and catch and other variables could be surveyed is from May to October 2020. It must be recognised that a survey of this nature does take a significant amount of staff time to undertake and report.

Recommendation 4: proactively promote best practice catch and release techniques targeted to canal anglers before and during the spawning season fishing opportunities.

Justification summary: thousands of trout were caught and released at the upper Tekapo Canal during the 2019 winter. The high level of fish handling presents a significant risk for anglers to unintentionally affect "spawning fitness" and kill fish. Best practice catch and release minimises this risk. Catch and release advocacy may need to incorporate compliance and enforcement messaging to be effective by creating a deterrence to poor fish handling by presenting that it is an offence within the CSI Region to cause undue injury to any fish intended for release.

Long-term management of the canal fishery

Recommendation 5: Produce a scoping document that identifies options for long-term management of sustainable hydro-canal trout and salmon populations in the recreational interests of anglers.

Justification summary: The greater Mackenzie Basin hydro-canal fishery is the most fished freshwater fishery in New Zealand. The fishery is unique and dynamic and is a challenge for CSI to manage sustainably with an evidence-based approach. There are many aspects fundamental to its sustainability that have not been researched sufficiently and are not monitored regularly.

Additionally, there is no guiding process or document specifically for the ongoing management of the canal fishery. Should Council wish to take an evidence-based approach to canal management there first needs to be an identification process of all relevant aspects of canal-fishery management and the associated priorities to be investigated and undertaken. This should be a first step to the establishment of a long-term canal fishery management strategy or plan.

Acknowledgements

Genesis Energy kindly facilitated access for staff to undertake the survey work and provided flow records for analysis.

I thank my Fish & Game Officer colleagues for assisting with this labour-intensive survey, streamlining the statistical analysis and reviewing the survey report.

References

Unwin, M.J. (2016) Angler usage of lake and river fisheries managed by Fish & Game New Zealand: results from the 2014/15 National Angling Survey. *NIWA Client Report* 2016021CH.

Bloomberg S, Graynoth E 1991. Trout stocks in the Pukaki and Ohau hydro canals. Prepared for MAF Fisheries. Freshwater Fisheries Centre. 18 p.