July 2022

14.0 Items to be Received or Noted

1230 Assisted Habitat – Native Fish Project

Introduction

The Cardrona River catchment provides important habitat for the non-diadromous Clutha flathead galaxias (Galaxias "species D") which has a conservation status of Threatened – Nationally Critical (Dunn et al. 2018). Over the last decade, approximately 35% of known Clutha flathead galaxias populations have disappeared (Kavazos, 2022).

The Cardrona River is also an important sports fishery and spawning tributary of the Upper Clutha River. Salmonids are the biggest threat to populations of Clutha flathead galaxias (Ravenscroft, 2014). Much of the decline in Clutha flathead galaxias populations over the past decade has been attributed to the spread of salmonids into their habitats and most of the remnant populations of non-diadromous galaxias only occur in isolated tributaries in the absence or low numbers of salmonids.

Very little survey work on native freshwater fishes in the Cardrona catchment has been completed since 2013. In 2021 the Department of Conservation, Otago Regional Council, Wai Wanaka and Fish & Game have been working together to plan work that will ensure the protection of the galaxias populations in the Upper Cardrona River. Work have focussed on surveys and management options of the Clutha flathead galaxias. Fish & Game have completed fieldwork and been consulted throughout this entire project.

Methods

Tyre Gully is a second order stream in the upper Cardrona Valley (44.974824°S, 168.950379°E). Environmental DNA (eDNA) was collected using a passive drogue eDNA sampler in December 2021 (Kavazos, 2022). Subsequent electric fishing survey work by Dr Richard Allibone (Waterways Consulting) and Ash Rebel (WAI Wanaka) was carried out in May 2022. Further electric fishing was undertaken in May and June 2022 by Ash Rebel and Chris Kavazos (DOC).

Results

Clutha flathead galaxias DNA was detected in this catchment (NZFFD 123618) in December 2021. Electric fishing identified a Clutha flathead population inhabiting a reach of Tyre Gully above a small series of waterfalls at 44.977777°S, 168.951473°E in May 2022. The presence of brown trout was also established to be in the immediate vicinity.

Based on the results obtained the group decided to install a temporary fish barrier (Figure 1) into Tyre Gully and begin a process of removing trout from the reach between the fish barrier and upstream waterfalls. The electric fishing surveys undertaken have removed approximately 100 brown trout since the barrier was installed.

Figure 1. Temporary Fish barrier installed in Tyre Gully, Cardrona River catchment.

Discussion

The Tyre Gully tributary is transported under the Crown Range Road through a long culvert which does not provide a barrier to trout migration. A longer-term solution is to install a barrier at the culvert under the Crown Range Road. Once completed this work will extend the available habitat for Clutha flatheads by approximately 400m and enhance the security of the population into the future.

The feasibility of removing trout from this catchment needs to be fully assessed. Tyre Gully is a confined stream with an abundance of riparian vegetation making electric fishing and trout removal challenging. Nevertheless similar trout removal work has been successfully carried out on several streams throughout Otago and Canterbury. In each situation the response and recovery of the galaxiid species in these streams has been phenomenal (Ravenscroft, 2014). The use of eDNA sampling will also be used to confirm the success of the trout removal.

Recommendation
That the Report be received

Paul van Klink
July 2022
Fish & Game Officer

References

Dunn, N.R.; Allibone, R.M.; Closs, G.P.; Crow, S.K.; David, B.O.; Goodman, J.M.; Griffiths, M.; Jack, D.C.; Ling, N.; Waters, J.M.; Rolfe, J.R. 2018: *Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24*. Department of Conservation, Wellington.

Kavazos, C. 2022. *Cardrona Valley Fish Survey – An update on the status of the Cardrona Valley freshwater fish, December 2021*. DOC 6938095, Department of Conservation

Ravenscroft, P. 2014. *Clachanburn Station – Restoration project of Stony Creek.* Unpublished report prepared for Department of Conservation.

Greenstone River Drift Dive Survey, October 2021

Introduction

The intention of the 2021 survey was to replicate the October drift dive survey in the week prior to the opening of the sports fishing season on 1 November 2021. Drift dive surveys in the Greenstone River were conducted in 1987, 1994, 2002 and 2003. Previous surveys were completed in late October and again in December the same year to look at the differences in numbers before and after the outward migration of spawning trout (Kroos, 1987).

Survey Method

Three sections of the Greenstone River were surveyed by two divers and two bank spotters on the 27th and 28th of October 2021. The timing of the survey and the survey methods were closely aligned to what had been completed in past Greenstone River drift dive surveys.

The three sections of the Greenstone River have previously been described in drift dive surveys as Stations 1, 2 and 3. A Garmin handheld GPS was used to locate the start and end points of each Station. Station 1 starts where many small meandering channels converge into a main river channel and goes downstream to the Greenstone Walkways smoko shed which is approximately 2.93km (Appendix 1). Station 2 starts at the Greenstone Walkways smoko shed and ends at the top of the gorge upstream from Steele Creek (5.83km) (Appendix 2). Note that in 1987 survey the survey ended at the confluence of Steele Creek but in 1994 it ended at the top of the Steele Creek gorge. Station 3 starts at the confluence of Steele Creek and goes downstream to the top of the gorge at Greenstone Hut (4.65km) (Appendix 3). Note that in 1987 divers counted several pools into the gorge and in 1994 divers stopped at the confluence of the Pass Burn which is upstream of this point.

Water temperature was taken using DeltaTrak handheld thermometer and flow conditions were based on the number of days since the last rain and the general river conditions observed on the day. Underwater visibility was measured horizontally by one diver and the use of a 200mm black secchi disk. Weather conditions were recorded using the Weather Bureau codes for sky and Beaufort wind codes for wind speed. Medium fish sizes were recorded as being 250mm – 400mm and large fish were fish > 400mm. Small fish < 250mm were not included in the count.

Additional information recorded for each drift dive section is shown in Appendix 4.

Results

A combined total of 68 medium and large rainbow trout and ten large brown trout were recorded in drift dive stations 1 and 2 during the 2021 survey of the Greenstone River. The drift dive results shown below in Figure 1 for all years only include data from Stations 1 and

2. Station 3 data has not been included in the graphed results for 1987 to 2001 but is included in Appendix 5 for 1987 and 2021. All station 3 results have been omitted from previously graphed data and the exact reasons for this are unknown.

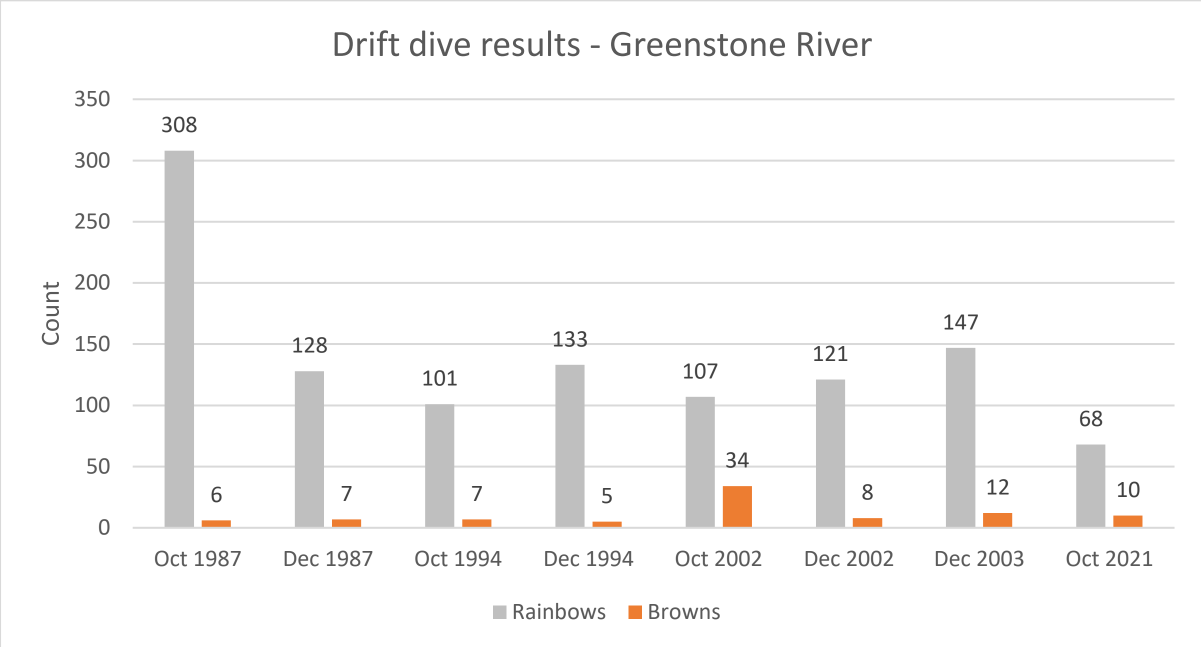


Figure 1. Greenstone River drift dive combined results for Station 1 and 2 from 1987 – 2021. Station 3 data has not been included in this graph due to incomplete data for 2002 and 2003.

Discussion

The 2021 drift dive survey found that fish numbers were much lower than expected. Fish were less abundant in the upper reaches of Station 1 and in station 3 compared to previous survey results despite good conditions for the survey. Anecdotally anglers have been observing lower fish numbers in the Greenstone particularly since the 2016 / 2017 season (van Klink, pers. Obs).

As a result of an incomplete reporting of past surveys there are data gaps in the survey records, particularly for the surveys in years 1994 (part), 2002 and 2003. These could not be located or resolved despite efforts to gather information from previous employees. This has somewhat hindered the analysis of the Greenstone River drive dive survey across all years and the accuracy of the data in Figure 1 should be treated with caution.

The 2021 drift dive results for rainbow trout numbers are the lowest recorded for an October count (Figure 1). The average number of rainbow trout counted in the drift dive survey during October over all years (n=4) is 146.

Drift dive results are often highly variable with previous studies identifying visibility, drift dive technique and fish behaviour as all important factors (Jowett & Hicks, 1985). Despite their limitations but they do provide us with a population estimate for that survey and that time of year. There were difficulties keeping the two divers in a line during the drift dive survey and this meant that the count was probably not as accurate as it could have been (ie the rear diver could count fish that had already been counted by the diver in the lead). Future surveys should make more of an effort to brief the divers and ensure the line is held. The water visibility reduced significantly (from 6.1m to 3.1m) at the bottom of Station 3. No fish were observed in the section where the water was noticeably discoloured due to a slip on the true left.

With only four repeated October drift dive surveys over 34 years this is a long-term dataset which would benefit immensely from more regular monitoring to provide better confidence around how the fishery is performing. Consideration should be given to repeat surveys at five yearly intervals as a minimum. Even with the limitations of drift dive survey technique the results in the 2021 survey show there is a likely decline in the numbers of rainbow trout in the Greenstone River.

A lot has changed in the Greenstone fishery and Lake Wakatipu over this period. The introduction of didymo (*Didymosphenia 7eminate*) and *Lindavia intermedia* which can cause lake snow are just two the biological variables which contribute to the health of the fishery. Flood events are a key influence of fishery population dynamics. Events such as the floods of February 2020 are expected to increase in frequency and severity into the future as a result of global climate change.

Acknowledgements

Otago Fish & Game wish to thank Southland Fish & Game staff Cohen Stewart and Erin Garrick for participating in the drift dive survey. Thanks also to Glacier Southern Lakes Helicopters for aerial access to and from the survey and Southern Lakes branch of the New Zealand Deer Stalkers for use of the Greenstone hut.

Recommendation

That the Report be received

Paul van Klink
Fish & Game Officer
June 2022

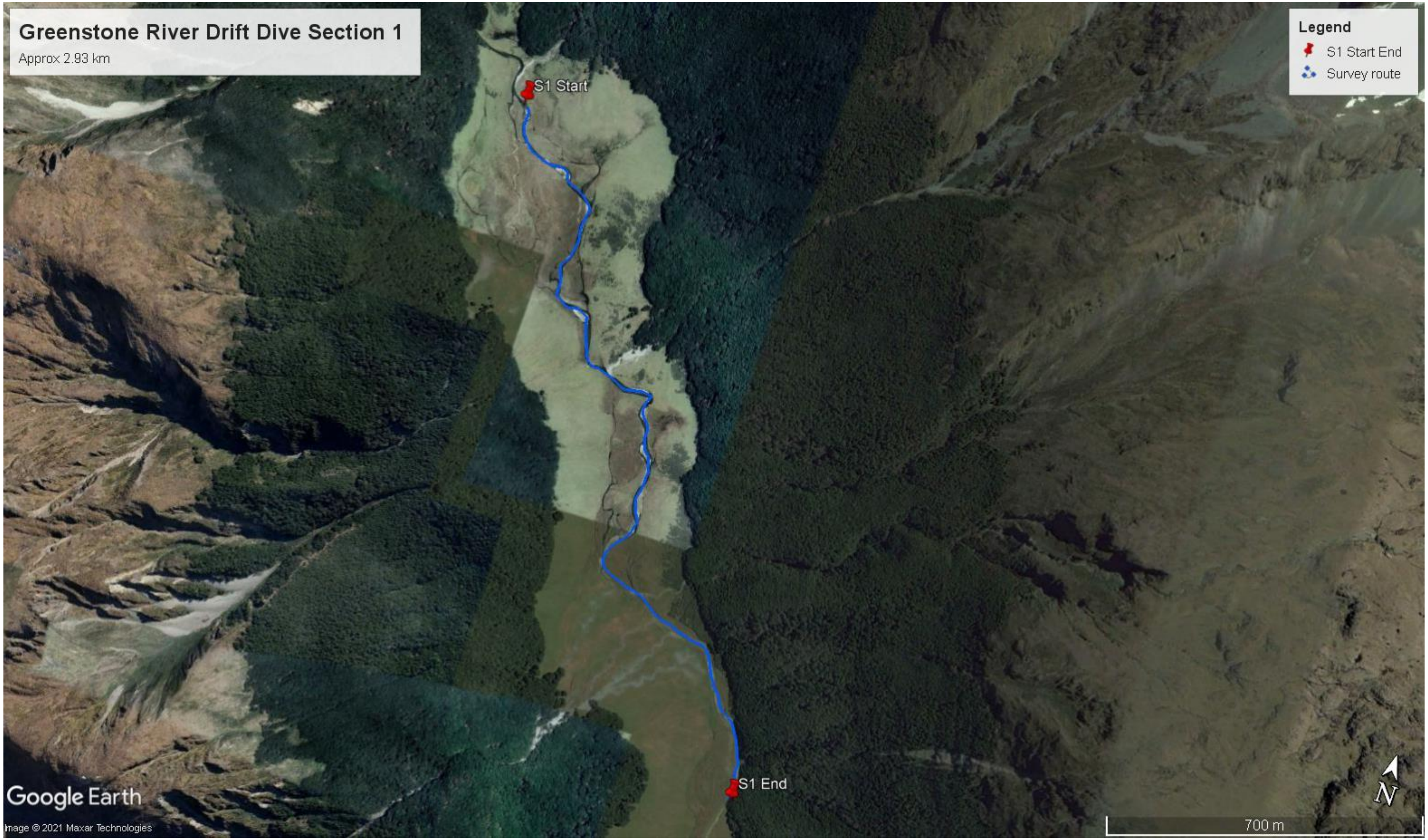
References

Jowett, I., Hicks, B. 1985. Estimation of comparative trout abundance in New Zealand rivers by drift diving. Spring 1985, Freshwater Catch 28. Freshwater Fisheries Centre MAF Fisheries Christchurch.

Kroos, T. P. 1987. *Greenstone River Survey*. Progress Report 1 & 4. Unpublished Field Reports, Department of Conservation, Lakes District, Queenstown.

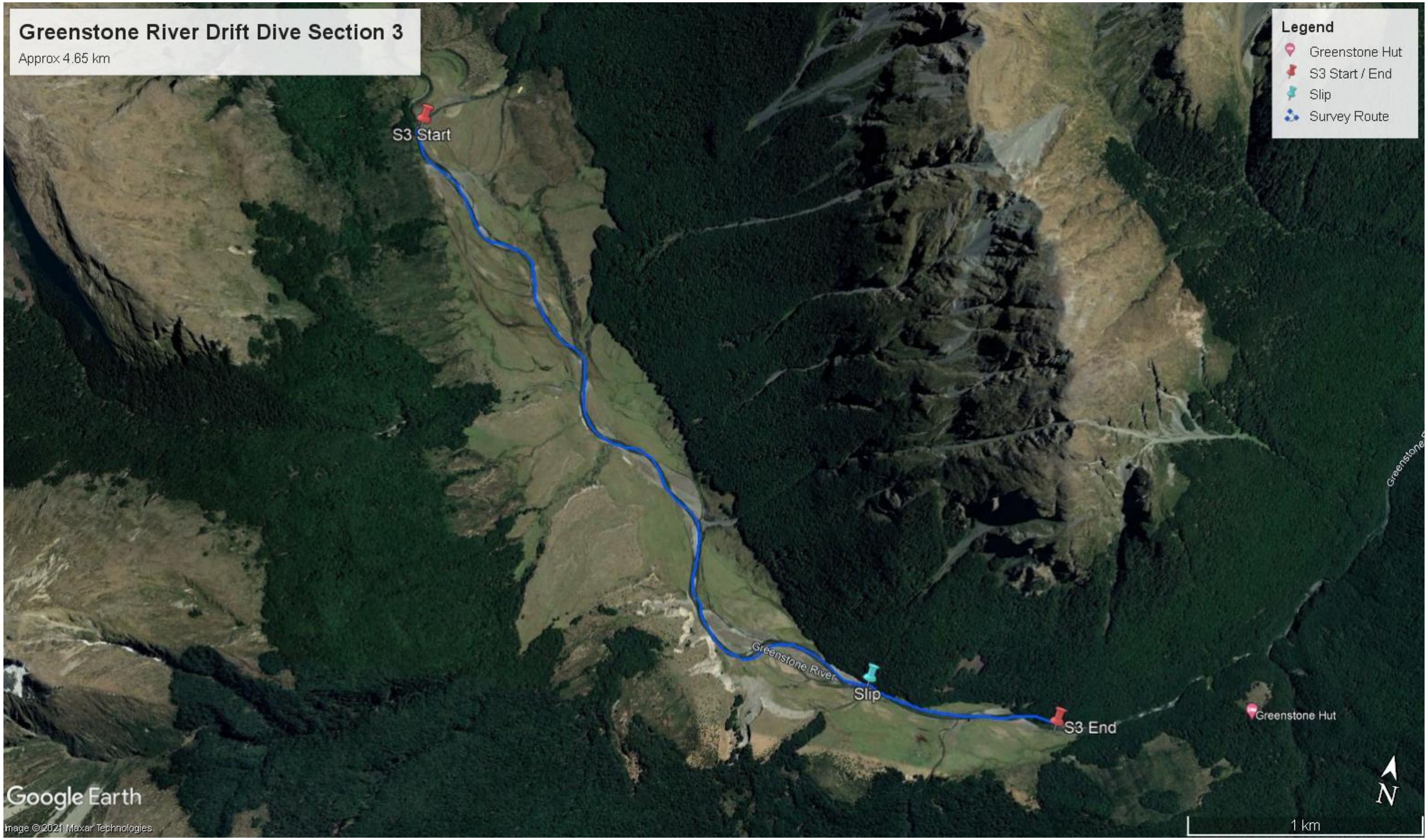
Van Klink. P. A. 2022. Personal observations from angler contacts 2015 – 2022. Fish & Game Officer, Cromwell.

Appendix 1 Greenstone Drift Dive Station 1 (2.93km)



Appendix 2 Greenstone Drift Dive Station 2 (5.83km)

Appendix 3 Greenstone Drift Dive Station 3 (4.65 km)



	Station 1		Station 2		Station 3	
Date	27/10/2021		27/10/2021		28/10/2021	
Divers	Ben Sowry, Cohen Stewart		Ben Sowry, Cohen Stewart		Ben Sowry, Cohen Stewart	
Bank spotters	Paul van Klink, Erin Garrick, Bruce Quirey (comms / media)		Paul van Klink, Erin Garrick, Bruce Quirey (comms / media)		Paul van Klink, Erin Garrick, Bruce Quirey (comms / media)	
Physical description of stations	Narrows to GSVW lunch spot		GSVW lunch spot to gorge u/s Steele Creek		Steele Creek confluence to gorge u/s of Greenstone Hut	
Start GR	1217259 5016975		1218818 5015075		1222116 5009826	
End GR	1218818 5015075		1221471 5010730		1225582 5008050	
Approx distance (km)	2.9		5.8		4.6	
Start time	1045		1253		0938	
End time	1210		1508		1048	
Time to DD (hrs)	1 hour, 30 minutes		2 hours, 15 minutes		1 hour, 10 minutes	
Species	BT	RT	BT	RT	BT	RT
Medium	0	6	0	12	0	11
Large	4	17	6	33	1	17
Water temperature (°C)	9.8°C		11.1°C		7.4°C	
Underwater visibility (m)	Not measured till Station 2		6.1 M		3.1 M at bottom of section	
Weather conditions	Sky 1, Wind speed 2		Sky 1, (Sunny then clouded over to 2), Wind 2		Sky 0 (changed to 2 later in am), wind 0	
Hazards identified	Rocks, logs and debris, cold water, walking in flippers		Rocks, logs and debris, cold water, walking in flippers		Rocks, logs and debris, cold water, walking in flippers, poor visibility in lower part of station 3	
Flow	Normal, clear		Normal, clear		Normal, clear then coloured in lower section	
Comments	3 fingerlings seen		Exited the river for a gorgy section. 1440 exit river 1220666 5011567, 1450 enter river 1221032 5011244		1034 river became coloured from slip 1224712 5007969 to end of survey 1048 1225582 5008050	

Total no. of fish counted	Brown	Rainbow
107	11	96

Appendix 5 Station 3 drift dive survey data recorded for October 1987 and October 2021. Data for October 1994 and October 2002 has not been located

	Station 3		Station 3	
Date	31/10/1987		28/10/2021	
Divers	Tom Kroos, Rob McLay, Rudi Hoetjes		Ben Sowry, Cohen Stewart	
Bank spotters	None recorded		Paul van Klink, Erin Garrick, Bruce Quirey (comms / media)	
Physical description of stations	Steele Creek confluence to the gorge u/s of Greenstone Hut		Steele Creek confluence to gorge u/s of Greenstone Hut	
Start GR	NZMS 159-769		1222116 5009826	
End GR	NZMS 201 - 748		1225582 5008050	
Approx distance (km)	4.0 km		4.6	
Start time	1010, 1310		0938	
End time	1130, 1330		1048	
Time to DD (hrs)	1 hour, 40 minutes		1 hour, 10 minutes	
Species	BT	RT	BT	RT
Medium	1	5	0	11
Large	34	118	1	17
Total	**158**	**123**	**1**	**28**
Water temperature (°C)	9°C		7.4°C	
Underwater visibility (m)	7.4M		6.1M down to 3.1 M at bottom of section	
Weather conditions	Sky clear and sunny with light winds		Sky 0 (changed to 2 later in am), wind 0	
Hazards identified	Not recorded		Rocks, logs and debris, cold water, walking in flippers, poor visibility in lower part of station 3	
Flow	Not recorded		Normal, clear then coloured in lower section	
Comments	4 small rainbow trout seen		1034 river became coloured from slip 1224712 5007969 to end of survey 1048 1225582 5008050	

Backcountry Fishery and Controlled Fishery Report for the 2021/2022 Season

Introduction

The 2021 / 2022 season marked the second year of the post COVID-19 pandemic which meant there was an absence of non- resident anglers and fishing guides on backcountry rivers in Otago. Compliance checks were performed on back country fisheries over the season with many of these checks being performed by honorary rangers. This report covers the backcountry fishery monitoring programme including the Greenstone Controlled Fishery for the 2021/2022 season.

Backcountry Ranging

Planned ranging was undertaken in the Nevis River as part of signage inspection trips after several signs were vandalised at the start of the season. Staff were also in the Greenstone River completing a drift dive survey prior to the start of the Backcountry opening and the upper Pomahaka River was checked as part of the ranger training programme in December 2021. All other licence checks completed in the Wilkin, upper Lochy, Dingle Burn, Greenstone and Caples and were not planned backcountry ranging trips but were undertaken by staff and / or honorary rangers who were in the area undertaking recreational activities.

Greenstone Controlled Fishery

A limited amount of data was collected from the online booking system. This data is presented in the results.

Compliance

Compliance monitoring was undertaken to enforce the Sports Fishing Regulations. Additionally, Fish and Game rangers gathered information on guided fishing operators on behalf of the Department of Conservation. Pre-season backcountry fishery information letters and/or presentations were given to a number of user groups including;

- accommodation providers i.e. fishing lodges,
- fishing guides (including NZPFGA members),
- New Zealand Deerstalkers Association (Southern Branch),
- New Zealand Jet Boat Association (Otago Branch),
- Central Otago aircraft operators,
- All successful hunting parties in the Wanaka Roar Ballot and the Greenstone / Caples Ballot
- Department of Conservation hut wardens based at Glenorchy with an emphasis on the wardens working in the Caples and Greenstone Valleys.

Timing of ranging

Backcountry fishery monitoring was undertaken throughout the 2021/2022 season (01 October – 30 April and 01 November - 31 May).

Results

Greenstone Controlled Fishery

Table 1: GCF angler effort and demographics 2008-2022

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
No. of anglers						40	43	55	66	55	38	38	21	22
Total capacity allocated	51%	46%	46%	61%	27%	27%	25%	26%	39%	29%	22%	29%	19%	21%
NZ Res anglers	31%	36%	31%	41%	37%	48%	42%	29%	38%	31%	45%	34%	90%	91%
NR anglers	69%	64%	69%	59%	63%	52%	58%	71%	62%	69%	55%	66%	10%	9%
Guided anglers	21%	20%	34%	32%	43%	10%	16%	36%	33%	18%	6 %	*	*	*

NB: Following a review of past booking records some adjustments were made to these results for past seasons and this table varies from those previously reported. Due to inaccuracies and inconsistencies with angler details reported (particularly prior to the introduction of the non resident licence) some judgements were required regarding the interpretation of results (Helen Trotter 2018).

** This figure could not be ascertained as an angler survey was not completed for the CF period in 2019, 2020 or 2021.*

Total capacity in the Greenstone River controlled fishery period (Beats 1 – 3) was on par with the 2020 / 2021 season with 21% occupancy (Table 1). Resident anglers made up 91% (n=20) of the angling effort and non-resident anglers the remaining 9% (n=2) during the controlled fishery period. The occupancy rate has been quite low (20 – 30%) over the past decade although the 2016 season was slightly higher (Table 1).

Sports Fishing Regulations Compliance

Rangers completed 15 licence checks in 24 ranging days (Table 2) which is less than last season with a similar amount of effort (23 licences in 25 days ranging). Ranging effort was considerable this season due to the efforts of honorary rangers although the effort did not translate to a higher number of licence checks due to the COVID-19 pandemic. Twelve anglers were resident (80%) and three anglers were non-resident (20%) all of which were compliant with back country licence requirements (Table 2).

Table 2: Backcountry Ranging Effort 2021 /2022

Location	**Person**	**Dates**	**Days Ranging (incl access)**	**Guides**	**Licence checks**	**Offences detected**
Nevis River	Jakub Kanok	03 October 2021	1	0	0	na
Nevis River	Ben Sowry	21 October 2021	1	0	2	0
Wilkin River	Paul van Klink	23-24 October 2021	2	0	0	na
Greenstone River	Paul van Klink	27-28 October 2021	2	0	0	na
Caples River	Jakub Kanok	30-31 October 2021	2	0	0	na
Nevis River	Ben Sowry	29 October 2021	1	0	1	0
Nevis River	Ben Sowry	16 November 2021	1	0	0	na
Nevis River	Ben Sowry	20 November 2021	1	0	0	na
Lochy River	Jakub Kanok	29-30 November 2021	2	0	0	na
Dingleburn	Fraser Hocks	30 October – 02 November 2021	3	0	0	na
Pomahaka River	Jakub Kanok, Jason Kelly, Santillan de Pinto	05 December 2021	1	0	4	0
Nevis River	Ben Sowry	13 December 2021	1	0	0	na
Wilkin River	Paul van Klink	12 February 2022	1	0	0	na
Nevis River	Ben Sowry	15 February 2022	1	0	2	0
Nevis River	Paul van Klink	25 February 2022	1	0	2	0
Caples River	Jakub Kanok	2 May 2022	1	0	1	0
Greenstone River	Jakub Kanok	21 May 2022	1	0	2	0
Caples River	Jakub Kanok	22 May 2022	1	0	1	0
Totals			24	0	15	0

Department of Conservation concessionaire compliance

No fishing guides were encountered during the 2021/22 season in back country fisheries however two guides were checked during routine ranging. A total of 39 different fishing guides that have been interviewed in Otago fisheries over the past seven seasons and all have had a valid concession.

Discussion

The low number of anglers fishing Backcountry Rivers in the 2021/2022 season is a reflection of down-turn in tourism due to the COVID-19 pandemic. The Greenstone Controlled Fishery received the second lowest number of bookings since the system was implemented. The observed decrease in angling effort in the Greenstone over the past four or five seasons is possibly in part due to the quality of angling itself. Anecdotal reports and observations have noted that trout numbers in the river are far less than they used to be. This evidence is supported by the recently completed Greenstone Drift Dive survey which observed the lowest numbers of adult rainbow trout since monitoring began in 1987 (van Klink, 2022).

Angler compliance with the backcountry fishery regulations has been 100% this season. Compliance of fishing guides with valid concessions is also very high with no detection of illegal guiding occurring over the past seven seasons.

Planned work for 2022 - 2023

- Continue to communicate and liaise with backcountry fishery user groups.
- Complete Sports Fishing Regulation training with Department of Conservation staff hut wardens (October 2022).
- Further develop a backcountry fisheries / designated waters monitoring programme across all of the Otago backcountry fisheries.
- Continue to liaise with Department of Conservation on concession monitoring and reporting.
- Install new Controlled Fishery Beat signage in the Greenstone River by November 2022.

Recommendation

That the Report be received

Paul van Klink
Fish & Game Officer
July 2022

References

Trotter, H. 2016. COUNCIL REPORT AUGUST 2016. Backcountry Rivers Online Satisfaction Survey 2015-2016 Season. Fish & Game, Otago

van Klink, P. A. 2022. COUNCIL REPORT JUNE 2022. Greenstone River Drift Dive Survey, October 2021. Fish & Game, Otago

Project 1122 – Creel surveys of Lake Wanaka

Executive Summary
27 randomised creel surveys were undertaken on Lake Wanaka over the months of September to May during the 2021 – 2022 fishing season to gather angler and fisheries information, and compliment previous data. 211 anglers were interviewed totaling 233.92 hours of angling effort for a catch of 32 fish, which equates to one fish for approximately 7.3 hours fishing. Trolling, both deep and shallow, was the most popular method accounting for 69.2% of the overall angling effort and 65.6% of the total catch.

Fly fishing is still popular at 20.7% of the angling effort and 25% of the catch. Spinning was at 9%, with 9.4% of the total catch. Six bait anglers made up the remainder of the anglers, with no fish caught. Only one salmon was recorded during surveys, although there were many reports of salmon catches recorded during this season, particularly at the mouth of the Makarora River during Autumn.

1. Introduction

Lake Wanaka is located in the Otago region of New Zealand, at an altitude of 278 meters. Covering an area of 192 km^2 (74 sq. mi), it is New Zealand's fifth largest lake. The lake holds populations of brown and rainbow trout and landlocked chinook salmon and is highly valued nationally and internationally for its sports fishing opportunities.

Creel surveys were undertaken from 1998-2001 and summarised (Scott & Wright, 2007). Additional angler and fisheries information has been gathered in recent years during random creel surveys and ranging days over peak holiday periods.

This report summarises the Lake Wanaka Creel survey results for the 2021 – 2022 season starting in September 2021 and finishing at the end of May 2022.

2. Survey Methodology

The survey was a randomised creel survey with a frequency of at least two surveys per week and two weekend days per month, with randomised starting times. The survey methodology meets the requirements of a randomised stratified roving creel survey (Pollock, et al. 1994).

Two weekdays and two weekend days were selected each month and morning and evening starting times were randomly selected.

Start times.

Creel survey start times were either 0900 hours or 1300 hours.

A full schedule of survey days and start times was compiled. Surveys had to be completed within the four- or five-hour survey period. Volunteers were often used to support staff on the boat. Lake locations and times were recorded (Appendix 1).

Creel survey sheets and a questionnaire were developed to document all the relevant information (Appendix 2).

Surveys were conducted using the Otago Fish and Game boat (OFG7), a 5.5-meter Kiwi Kraft with a 115hp four stroke Suzuki. Surveys circumnavigated the lake from a selected boat ramp. The direction of the trip was randomly selected.

On the lake all anglers were approached. Extra care and consideration was given when approaching shore anglers to ensure that they were not overly interrupted. This was achieved by beaching the boat a fair distance from their fishing position around the shoreline. It was difficult at times in Paddock Bay when lake levels were low.

Some boat angler interviews were conducted while anglers continued to fish with the Fish & Game boat pulling alongside. Fenders were deployed from the Fish & Game boat, and boats were approached on from our starboard side onto their port side to mitigate damage to either vessel.

In windy conditions, the surveys were cancelled or postponed, due to difficulty in approaching other vessels and safely mooring alongside.

Anglers were asked about their angling activity for the day along with a standard set of creel questions (Appendix 3). In addition, anglers were asked whether they had experienced lake Snow (*Lindavia intermedia) on their trip, their years of experience on the lake and how many days a year did they commonly fish the lake. Their fishing location was recorded (Appendix 2).*

All fish harvested were weighed and measured (Appendix 4) and data collected was entered onto an excel data base where it has been analysed for reporting.

3. Results and Discussion

A total of 211 angler interviews were obtained from 32 sampling periods. There were five survey days during the duration of the creel programme for the 2021 – 2022 season were no anglers interviewed. A further four survey days were not completed early in the season due to poor weather conditions.

Most of the survey effort was in the lower third of the lake where anglers were located which was very similar to 2019 - 2020 and 2020 - 2021 seasons and where our monitoring effort was focused.

Matukituki Bay, Paddock Bay and Stevenson’s Arm continued to be popular angling areas where fish were commonly caught.

The total catch from the 211 anglers was 32 fish for an overall 233.92 hours of angling effort. Anglers returned 14 fish which was 43.75% of the total catch, a similar percentage to previous years.

187 (88.6%) anglers caught no fish during survey periods, which is the lowest catch rate over the four-year survey records. Nineteen anglers had caught one fish when interviewed, three anglers caught two fish each, two anglers caught three fish. None of the surveyed anglers caught more than three fish.

4. Catch Rate

The Total Catch Rate (TCR) is calculated from the number of fish caught over the length of angling time. 233.92 divided by 32 fish = one fish for 7.31 hours angling effort or (.14) as fish per hour caught.

Of the 32 fish caught 15 were brown trout and 16 were rainbow trout. One salmon was recorded. The harvest rate (HR) is calculated from fish kept divided by total angling effort and shown as fish per hour.

Table 1. Total catch rates (TCR), return rates and harvest rate (HR) for each species.

Season	Species	Fish caught (TCR)	Fish released (TCR) and % returned	Fish kept and (HR)
Sept 2020-May 2021 (inc)	Brown	58 (0.13)	36 (0.08) 62%	22 (0.05)
Sept 2021-May 2022 (inc)	Brown	15 (0.06)	8 (0.03) 53.3%	7 (0.03)
Sept 2020-May 2021 (inc)	Rainbow	43 (0.09)	13 (0.03) 30.2%	30 (0.07)
Sept 2021-May 2022 (inc)	Rainbow	16 (0.07)	6 (0.03) 37.5%	10 (0.04)
Sept 2020-May 2021 (inc)	Salmon	2 (0.005)	0 (0.0) 0%	2 (0.005)
Sept 2021-May 2022 (inc)	Salmon	1 (0.004)	0 (0.0) 0%	1 (0.004)

During the 1998-2001 seasons Scott & Wright (2007), recorded (TCR) for brown trout at 0.14, 0.14 and 0.10, respectively. For rainbow trout it was 0.10, 0.16 and 0.08 and for landlocked salmon TCR was 0.04, 0.01, and 0.04 for the respective years.

The catch rate for both trout species for 2021 - 2022 shows a marked decrease on previous seasons.

5. Catch Rate by Method

Table 2. Fish Caught and Catch Rate (CR) by method as fish per hour.

Year	Fish caught Fly and (CR)	Fish caught Spin (CR)	Fish caught Surface Trolling (CR)	Fish caught Deep Trolling (CR)
Sept 2020-May 2021 (inc)	33 (0.07)	9 (0.02)	5 (0.01)	56 (0.12)
Sept 2021-May 2022 (inc)	8 (0.03)	3 (0.01)	2 (0.008)	19 (0.8)

Deep trolling including down rigger, lead line and paravane was the most productive method accounting for 19 fish, and 59.4% of the total catch which was similar to the 2020 – 2021 season at 54.4%, and the 2019 - 2020 season at 59.2%. Fly fishing was next then spinning and surface trolling. Only four bait anglers were interviewed in the 2021 – 2022 season.

Table 3. Total Angling effort for each Method

Year	Angler Numbers and (%) Time Fly fishing	Angler Numbers and (%) Time Spinning	Angler Numbers and (%) Time Surface Trolling	Angler Numbers and (%) Time Deep Trolling
Sept 2020-May 2021 (inc)	42 (19%)	43 (12%)	46 (12%)	117 (57%)
Sept 2021-May 2022 (inc)	48.4 (20.7%)	21.1 (9%)	43.2 (18.5%)	118.5 (50.7%)

For the past three seasons trolling was the most popular method (Table 3) and most productive (table 2) with deep trolling the standout. Scott & Wright (2007) reported similar findings with trolling being the most popular method and between 57-68% of the angling effort for the three survey years from 1998 - 2001.

Surface trolling was slightly up from the past two seasons from 12% to 18.5% of the total angling effort.

Fly fishing is still popular at around 20% of total angling effort for the past four seasons with popular fly fish areas continuing to be Paddock Bay and Stevenson's Arm.

Spinning around the shoreline or from boats was slightly down from the 2020 – 2021 season at 9% of total angling effort.

Bait anglers made up the remaining 1.1% of the total angling effort percentages for the 2021 – 2022 season.

6. Catch Details

Table 4. Provides the average length, weight and condition factor of each trout species recorded.

Year	Average Length (mm)		Average weight (Grams)		Average condition factor	
	Brown	Rainbow	Brown	Rainbow	Brown	Rainbow
Sept 2020-May 2021 (inc)	519	465	1510	1268	41.1	47.1
Sept 2021-May 2022 (inc)	485	475	1173	1177	37.1	39.7

In the 2021 – 2022 season eight rainbow trout were weighed and measured, another one rainbow was not recorded due to the fish being gutted and decapitated. Seven brown trout were weighed and measured. Only one salmon was caught, but not weighed or measured during the surveys as it too had been gutted and decapitated.

In the 2021 – 2022 season brown trout were generally larger than rainbow trout which was following the trend of previous seasons. Last season brown trout on average were significantly smaller with the average being 485mm. Rainbow trout, however, were longer than the previous two seasons with the average length 10mm longer than last season, but significantly smaller in average weight. The condition factor in both species has dropped this year.

These results may be caused by a smaller sample, with some of the sampled fish harvested being of particularly poor condition, bringing down the average weight and condition factor significantly.

7. Angler information

Anglers were again questioned on lake snow (*Lindavia intermedia). Anglers experienced levels of lake snow occurrence, mostly while trolling. Fly anglers and shore spin anglers experienced no issues. Stevensons Arm and outer Glendhu Bay were the main areas in the lake where lake snow was causing issues.*

Due to the noticeable increase of salmon catches in the lake these last two seasons, anglers were no longer asked when they had last caught salmon from the lake.

Similarly, salmon sample collection for DNA analysis in lake Wanaka has halted as adequate samples were collected last season.

8. Summary

Many anglers were concerned with the lake Wanaka fishery this season. During the field contact during surveys, angler feedback has been variable with occasional reports of good fishing. Most reports were of very poor angling, with many anglers making comments during the surveys like: “are there any fish in this lake?”.

Both species of trout were in poorer condition this season than the previous season, and catch rates were also extremely low. Anglers' effort was also reduced compared to previous years, with anglers spending less time fishing per session, with only 63.8% of time fishing in the 2021 – 2022 season compared to the 2020 – 2021 season.
Angling effort may have been influenced by high fuel prices during this season, possibly discouraging anglers from putting in the same amount of time into fishing as previously. The fuel price increase of late February coincided with a marked drop in angler encounters on the lake, however this also aligns with the usual holiday season ending.

The past four seasons of monitoring angling on Lake Wanaka has provided valuable current fisheries information.

9. References

Pollock, K.H., Jones, C.M. and Brown, T.L. 1994. *Angler survey methods and their applications in fisheries management.* American Fisheries Society Special Publication 25.

Scott, D., Wright, M. 2007 *Thirty Years of Creel Surveys.* Otago Fish and Game Council.

Recommendation

The report be received.

Ben Sowry
Field Officer
June 2022

Appendix 1

Lake Wanaka Creel Survey 2021/2022 Schedule of Activity

Start Time
Finish Time

Season	Date	Weather	Boat Ramp Site	Survey Team
2021/2022				

Lake Survey Zones

Zone															
Start Time															
Finish Time															

Comments

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GB = Glendhu Bay
PB = Paddock Bay
MM = Matukituki Bay

RBurn = Rumbling Burn
MBurn = Minaret Burn
Mbay = Minaret Bay

WF = Wanaka Faces
SA = Stevensons Arm
DB = Dublin Bay

CO = Clutha Outlet
RB = Roys Bay
SB = Snag Bay

AB = Albert Burn
Mak = Makarora Mouth
BC = Boundary Creek

CC = Camp Creek
Pen = Peninsula

Appendix 2

WATER : LAKE WANAKA **DATE**

ANGLER DATA						SPORTS FISH DATA						Experience		Lake Snow	Salmon Caught	
ZONE	LICENCE NUMBER	LICENCE CATEGORY	HOMETOWN	HOURS FISHED	METHOD	FISH KEPT			*FISH RETURNED*			# Seasons	Days / season		When	Where
						B	RB	S	*B*	*RB*	*S*					

Appendix 3

Lake Wanaka Survey - Angler Questionnaire

1. **How many hours have you fished today?**

2. **What fishing method are you using?**

3. **Have you caught any fish today?**

4. **Is this your first fishing trip on Lake Wanaka?**

5. **Or how many seasons have you fished Lake Wanaka?**

6. **How many days per season do you fish the lake?**

7. **Have you had your line fouled with lake snow on this trip?**

   Answer should be yes or no, but they may not know what lake snow is.

Appendix 4

Lake Wanaka Fish Data Sheet

DATE	Brown		Rainbow		Salmon	
	Length	Weight	Length	Weight	Length	Weight

05/07/2022

Otago Regional Council
Private bag 1954
Dunedin

Dear Sir/Madam

Re Consent reporting associated with Takitakitoa Wetland Restoration Project

The information below is presented to satisfy the conditions of consent **RM14.043.03** granted to Otago Fish & Game Council to restore and enhance the Takitakitoa Wetland.

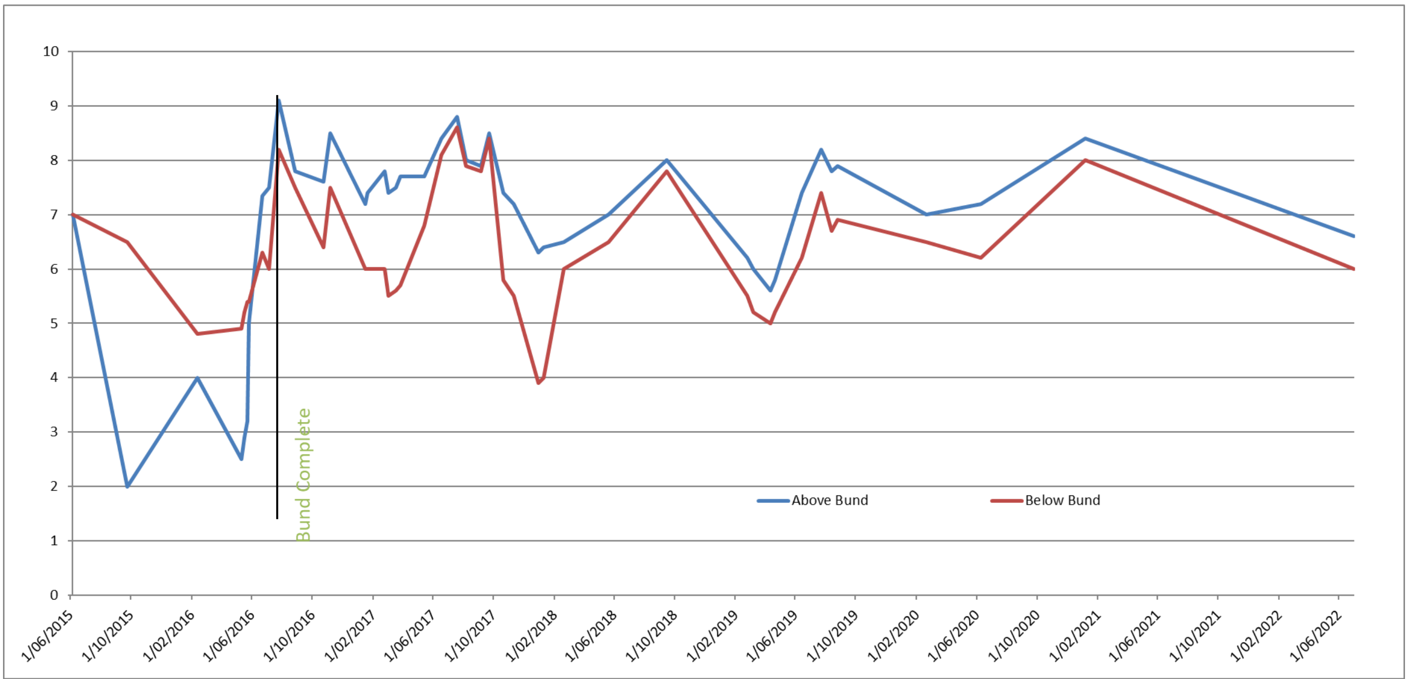
Both Condition 4 and 5 of the consent are being answered under each subheading

1. ***Water Levels***

Staff gauges above and below the bund wall are being used to monitor water levels in the wetland. Units are in decimetres.

The bund, and the blocking of the deep drains which dissected the upper part of the wetland has resulted in much improved hydrological regime. Water levels are higher than the lower part of the wetland and are much more consistent.

Manually read staff gauges are the most cost effective and efficient way to measure water levels in the wetland so this monitoring will continue at least quarterly (or better) for the next twelve months.



2. ***Flow through fish pass***

The fish pass was modified in late February to give better water flows for fish migration. The ladder can be adjusted to keep constant water flow throughout the migrating season. Mussel rope was also added to assist climbing fish. (Photo 1&2 taken 01/03/22).

Fish Pass Check	Flowing?	Depth	Dam WL	Video
24/10/2016	yes	+35mm	7.6	
3/03/2017	Yes	+30mm	7.4	
19/03/2017	yes	+30mm	7.4	Yes
08/03/2019	No	0mm	6.0	
10/04/2019	No	0mm	5.6	
08/06/2020	Yes	+5mm	7.2	
06/01/2021	yes	+20mm	8.4	
02/07/2022	No	0mm	6.6	

Fish pass flowing data

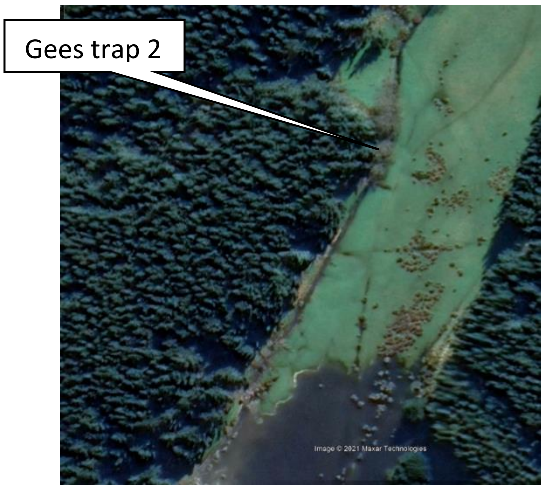
3. ***Eel abundance***

No fyke nets were set this year due to limited access to the bund wall because of a City Forests logging operation.

4. ***Inanga abundance above the dam***

Inanga were in very low abundance in the upper part of the wetland before it was enhanced. Electric Fishing surveys in Surprise Stream (near the maximum upstream extent of the wetland) recorded a single fish, and even then, it was not captured.

Two minnow traps (baited with vegemite) were set on the 02/07/2022, one on the upstream side of the bund wall & one at the upper part of the wetland. (Figure 2 & 3). The traps were checked the next day and were found empty.



5. ***Vegetation Changes***

Seven monitoring sites have been established and from these the vegetation is photographed annually. This photo monitoring is going to continue annually. No alteration to the methodology is proposed. A photo monitoring summery attached to this report.

City Forests has begun harvesting pine trees on the Eastern boundary of Takitakitoa wetland. The photo below shows the wetland looking towards the West.

6. ***Effectiveness of plant pest control***

- Crack willow control – two trees within the F&G boundary have been killed (summer 2021). Several trees were sprayed on the neighbouring property this summer 2022.

- Broom, gorse, and blackberry has been sprayed where possible along roadsides and bund wall and follow up knapsack spraying will be conducted again in Summer 2023.
- Glyceria - it was noted a few small plants appearing downstream of the western culvert last year, these have been sprayed with ongoing monitoring.

7. ***Gamebird Harvest***

The monitoring method for gamebird harvest is simply to record the opening day harvest from each allocated mai-mai of which there are five. **Note:** in 2016 only mai-mai 5 had any water near it as the impoundment had not filled at that point in time.

Opening day results	Mai-mai #1	Mai-mai #2	Mai-mai #3	Mai-mai #4	Mai-mai #5
7th May 2016					11 Mallards
6th May 2017	1 Mallard 5 Parries 2 Shoveler	16 Mallards 12 Parries 2 Shoveler	7 Mallards 12 parries 1 Shoveler	25 Mallards 5 Parries	33 Mallards 2 Swans 6 Parries
5th May 2018	6 Parries 1 Mallard	6 Swans 20 Parries 12 Mallards	3 Mallards	1 Parries	115 Parries
4th May 2019	1 Mallard 6 Parries 2 Shoveler	25 Mallard 5 Parries	0 birds shot	2 Parries	34 Mallard 46 Parries 2 Shoveler 2 Swan
23rd May 2020	5 Parries	1 Mallard	Not shot	Not shot	2 Mallard 6 Parries
1st May 2021	3 Parries	Not shot	0 birds shot	10 Mallard	25 Mallard 2 Parries
7th May 2022	6 Parries 13 Mallards	1 Mallard	Not shot	0 birds shot	Not Shot

No changes to this monitoring approach are proposed. There is not a better-known monitoring tool for harvest and the results can depend a lot on the conditions, and the ability of the hunter.

8. ***Shoveler abundance***

Takitakitoa is counted as part of the “National Shoveler Survey” conducted in the first week of August 2021 - there were 252 noted on that survey. This number is well above the 58 that was counted last year which shows Takitakitoa wetland has ideal habitat for this species.

9. ***Biodiversity plantings***

Last year 400 native shrubs were planted in the margins of the wetland near Surprise Stream outlet, and a further 500 + are proposed to be planted this spring.

10. ***Small Dam Inspection Report***

An updated Small Dam Inspection Report is attached to satisfy **Condition 6**.

11. Abundance of native avifauna

A combination of observations and counts have been used to note changes in abundance of all avifauna present in the wetland. The table below shows the relative changes over time.

*Denotes 'gamebirds' as defined by the Wildlife Act 1953

Species	***Pre bunding***	***Post Bunding***	**June - 2022**
Pukeko*	Rare	Common	10 seen
Mallard*	Occasional	Common	Large numbers
Black Swan*	Not recorded	Occasional	6+ they come and go
Grey Teal	Rare	Abundant	1000+
Scaup	Not Recorded	Occasional	20 sighted at the bund
P. Shelduck*	Rare	Common	Not many seen this season
Shoveller*	Rare	Common	62 counted
Harrier Hawk	Rare	Common	Seen often
Fernbird	Common	Common	Still present on edges
Bittern	Not Recorded	Not Recorded	Unseen
Pied Stilt	Not recorded	Occasional	Not seen this season
Royal Spoonbill	Not Recorded	Rare	2 noted this season
Canada Goose	Not recorded	Rare	12 were seen before gamebird opening
Spurwing Plover	Not recorded	Rare	
Fantail	Not recorded	Common	20 + seen
Welcome swallow	Not recorded	Common	6 birds seen

It will be noted that there has been a significant improvement the diversity of species and their relative abundance (shaded green) since the wetland has been restored.

Ongoing monitoring will most likely involve annual (or better) checking to see if there are any changes to the post bunding abundance above and recording numbers where possible.

Takitakitoa was not recognised for its gamebird values under the RWP at the time of consenting but policy 10.4.2(c) of the plan allows for those values (A8) to be enhanced. It is our view, based on the monitoring above, that F&G has been successful with this project in achieving a regionally significant habitat for waterfowl (Ref A8 under wetlands in RWP).

Please let me know if any further reporting is required to satisfy these consent conditions.

Thank you

Steven Dixon
Fish & Game Officer
July 2022

14.6

An Investigation Into Lake Onslow Spawning Habitat Availability

At Increased Lake Heights

Photo 1: Ian Hadland surveys the upper reaches of Armstrongs Creek. (B. Quirey)

Executive Summary

An investigation into the effects on spawning habitat availability for Lake Onslow at increased lake levels was conducted during the 2022 brown trout spawning run. The investigation found that at the level proposed, the spawning area available would only be approximately 0.38 percent of what it is currently.

The survey found low gravel quantity and quality in the tributaries above the proposed lake level. A considerable number of barriers to upstream trout migration were also identified, both within and above the proposed lake footprint.

Introduction

Lake Onslow is high elevation lake formed by the damming of the Teviot River in 1890. The lake was raised by five metres in 1982. When full the lake surface is approximately 1,100 hectares (Figure 1) and 684 meters above sea level. Brown trout are the only sports fish present in the lake. The tributaries of the lake contain prolific brown trout spawning areas as well as significant juvenile rearing habitat consisting of healthy riparian vegetation cover, large macrophyte beds, ideal diversity of habitat including run riffle pool combinations and areas of cobbles to provide instream cover and invertebrate production. The high spawning and rearing potential in the tributaries means the lake has abundant adult trout and excellent angling.

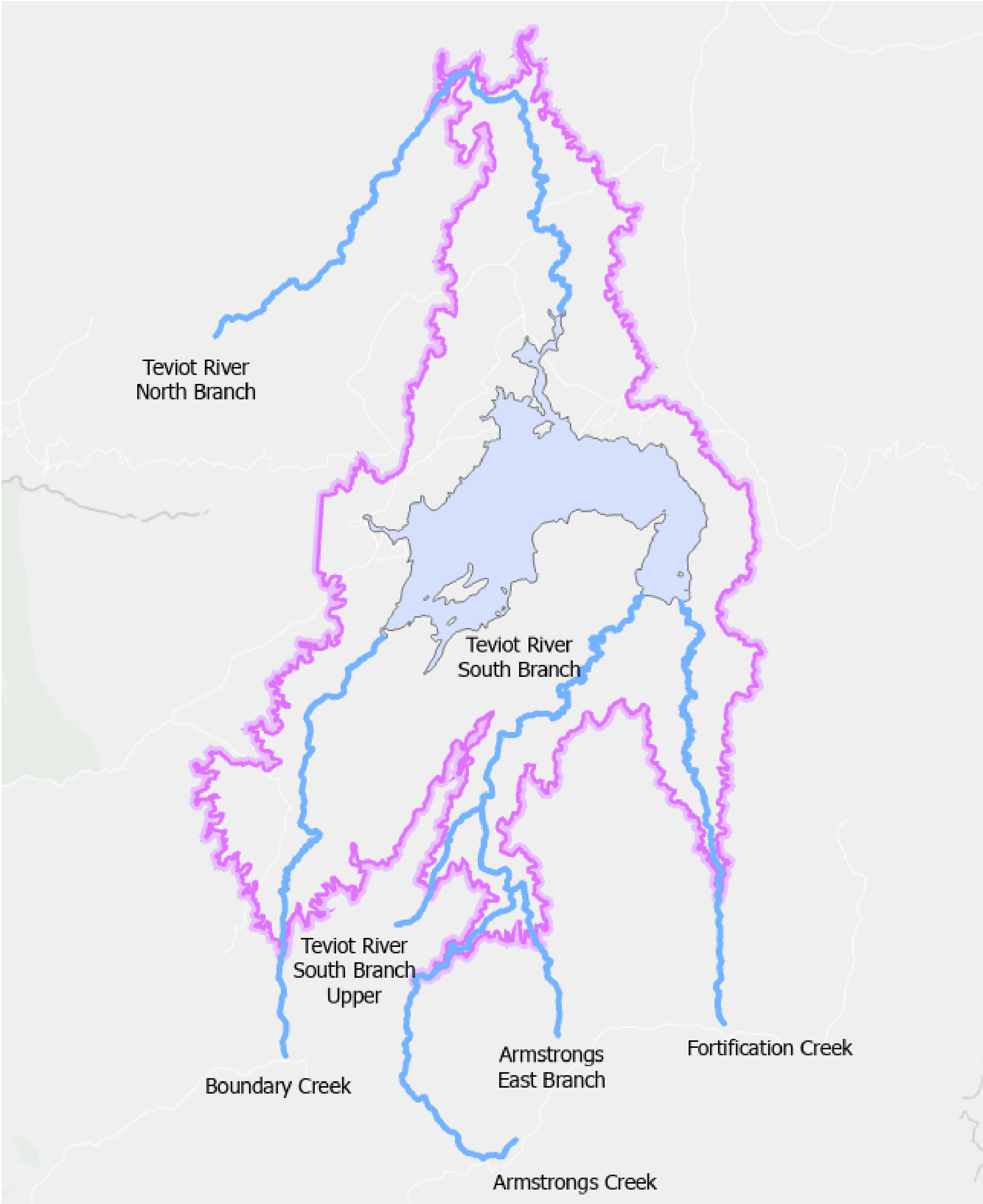


Figure 1: Lake Onslow and tributaries, current full lake footprint shown in blue, proposed lake footprint shown in purple.

Trout spawning occurs in the tributaries of the lake and requires multiple environmental factors to be correct including suitable gravel sizes and stream velocities. Typically, the correct velocities for spawning are only found in relatively low gradient areas of the stream. Trout from the lake need to access these areas so unpassable drops (hydraulic barriers) and shallow water (critical riffles) also limit the amount of spawning potential of the lake.

Battery Project

The Ministry of Business, Innovation and Employment (MBIE) is currently investigating turning the lake in to a hydro battery. This would significantly increase the maximum area of the lake and substantially inundate tributaries (Figure 1). The depth of the lake is expected to raise by approximately 76 metres, bringing the full level up to 760 metres above sea level. Based on Fish & Game calculations the lake is expected to be approximately 6,900 hectares at this level.

To investigate the effects of an increase in lake depth and footprint, staff designed a project to look at the amount of spawning area available to lake resident trout at varying lake heights.

Methods

Field Work

Staff were flown to the headwaters of streams expected to contain the majority of trout spawning. Staff made a quick assessment of spawning suitability from the helicopter and were dropped off at the upper extent of feasible spawning habitat. Above the drop off points, the streams were deemed to be unsuitable for spawning due to being too steep, too small or having substrate consisting almost entirely of bedrock.

Staff walked downstream for a significant proportion of the tributaries, recording spawning gravel availability and GPSing and estimating the height of hydraulic structures that they thought would prevent the upstream migration of trout.

Photo 2: Fish & Game Officer Bruce Quirey assessing spawning gravel suitability (I Hadland)

The percentage of each section suitable for spawning was estimated using two methods: estimating the percentage at the end of each section, and by counting the linear metres and calculating the percentage from GIS section lengths. The first method was typically used in sections with high amounts of gravel. If both methods were implemented, the higher value was chosen for analysis.

While surveying, staff also recorded adult trout and GPSed trout redds. Staff walked up sections of two less significant tributaries; Armstrongs East Branch (the Armstrongs Creek tributary sourced by the Teviot Swamp) and the Teviot River South Branch Upper (the Teviot River South Branch above the confluence with Armstrongs Creek).

Modelling

Topographic contours were sourced from a LINZ Topo50 dataset. The intersection of the contours with each stream bed was mapped using ARCgis pro. The distance of each contour along each stream was then calculated, to give a two-dimensional model of the tributaries. Distances were calculated along the tributary from the mouth of each stream and from the edge of the lake.

The hydraulic trout barriers were then placed on the model, their horizontal position on the line was sourced from their gps coordinates, their vertical position was estimated by assuming the streams steepness was constant between contour marks.

The height of the hydraulic trout barriers were then incorporated to the model, it was assumed that the barriers were .5m in horizontal length, their height was sourced from staff estimates from the day.

The two-dimensional model was then recalculated with the barriers included, once again it was assumed that the gradient of each stream was linear between the estimated points. The final two-dimensional model is shown below in Figure 2.

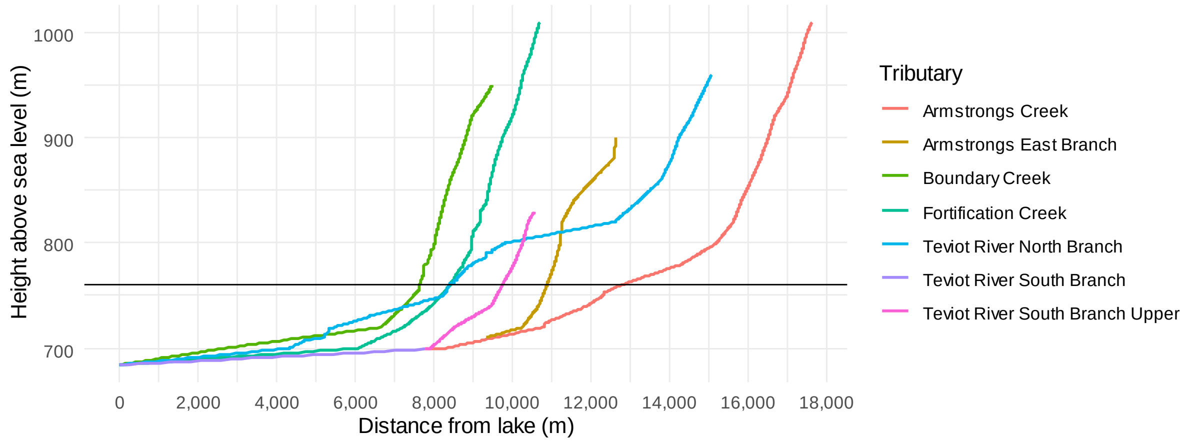


Figure 2: Two-dimensional model of each tributary. Proposed lake level (760m) shown by black line.

After the final two-dimension model of each stream was set up, it was broken down in to 0.5-metre height sections and the percentage of available spawning was added to each section. The percentage of available spawning was assumed to be constant between each contour point.

The linear amount of gravel in each stream was then calculated for varying lake heights. Only gravel between the modelled lake height and the lowest trout barrier was included in the calculations.

Limitations and Assumptions

Largely due to time restrictions and data availability the following assumptions were made:

- That the LINZ contour dataset was accurate
- That the stream gradient did not change between calculated points
- That the percentage of gravel available was constant between each contour
- That hydraulic barriers were all 0.5-metres in horizontal length
- That hydraulic barriers were not traversable by trout at any flow
- That hydraulic barriers were not traversable by trout until entirely submersed by the lake
- That each linear metre of gravel has the same value, meaning we did not take in to account the width and flow of the streams or the quality of the gravel. It was noted that gravel near the top of some tributaries that appeared suitable often held a lot of entrained sediment making it less valuable for spawning
- That the spawning activity of stunted river-resident trout is not a significant contributor to catchment spawning

Due to the lengths of the streams, we were unable to survey all the way to the lake on all streams, this meant that:

- The gravel availability in the lower end of the Teviot River South Branch had to be estimated partly by helicopter
- The gravel availability in the lower end of Boundary stream had to be estimated by comparing to other streams by a staff member familiar with each stream

Results

The tributaries were very steep at higher levels and levelled out towards the lake (Figure 3). This meant that on average higher sections were shorter in length.

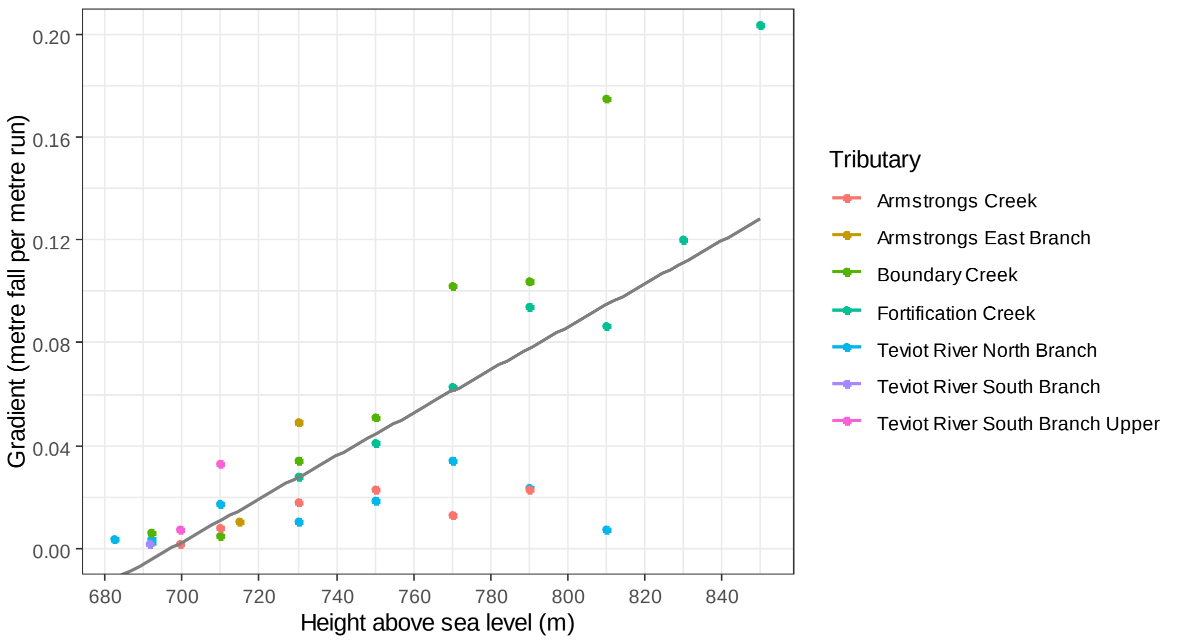


Figure 3: Gradient of section vs altitude. Linear trend shown in black.

Staff recorded that the high gradient of the upper reaches meant the hydraulic trout barriers (Photo 3) were more common and larger hence more likely to prevent trout migration.

Photo 3: Hydraulic trout barriers in the upper reaches of Armstrongs Creek (B. Quirey).

There were some examples of trout barriers low in the tributaries that meant that some sections will be opened up to lake resident trout dependant on how much the lake level is increased (Photo 4). Trout barriers were far less abundant in the lower reaches although there were some present below the 700m contour in the Teviot River North Branch.

Photo 4: Hydraulic trout barrier in Armstrongs creek within the proposed footprint, around 720m altitude. Walking stick on image right for scale (I. Hadland).

The estimated percentage of spawning gravel available showed a negative relationship with altitude (Figure 4).

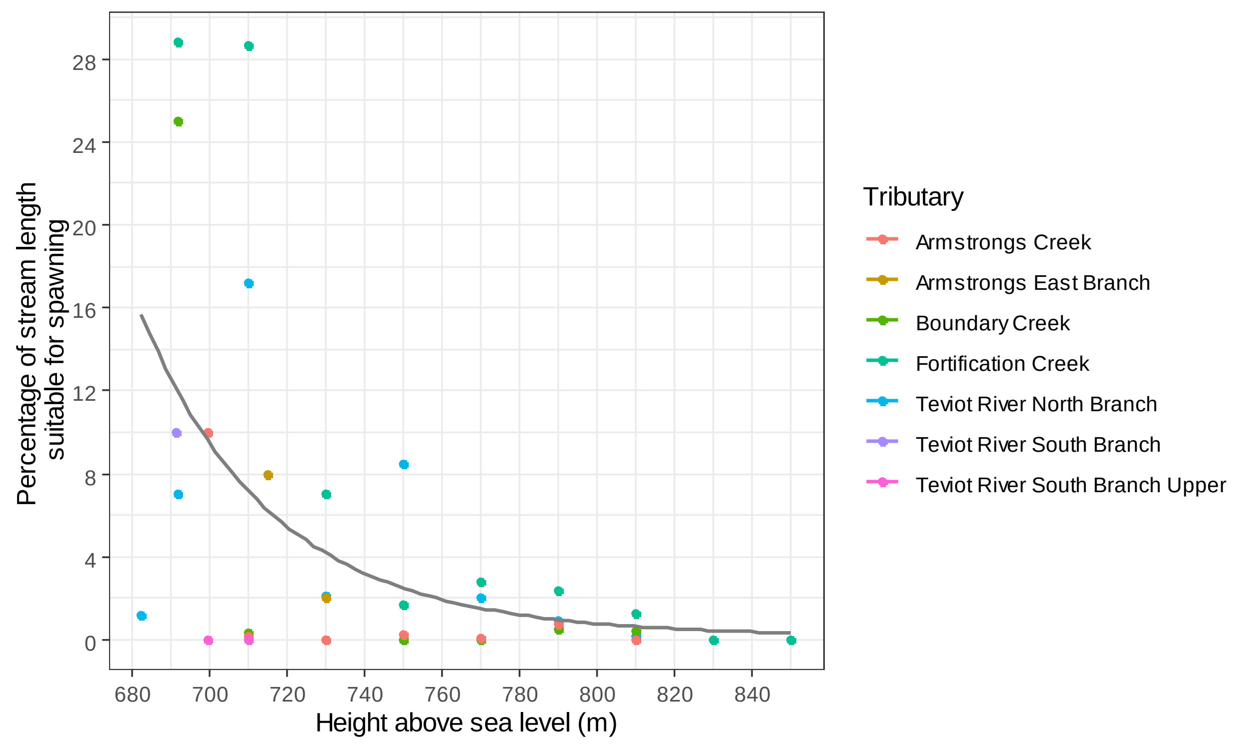


Figure 4: Percentage of stream length suitable for spawning vs altitude. Trend shown in black.

At the top end of the streams, staff found very little gravel, with bedrock dominating the substrate. Staff did not see evidence of suitable spawning habitat above the 860-metre contour on any tributary.

As the streams got closer to the lake they started to level out (Figure 2 & Figure 3) and accumulations of gravel became more common. The bottom section of the North Branch (bottom left point) was an outlier as it was deemed unsuitable for spawning due to the substrate consisting of almost entirely fine quartz sand.

Photo 5: Gravel accumulation and trout redd in the lower reaches of the Teviot River South Branch (I Hadland)

Figure 5 shows the total amount of spawning available at different lake levels relative to the currently available amount. It shows that the vast majority of available spawning gravel is only available when the lake is at the current height, even a lake height increase of 20 meters to 700 metres above sea level would result in a reduction of spawning gravel by approximately 84 percent. This is largely due to the shallow gradient of the tributaries near their confluence with the lake; a small lake height increase can inundate huge lengths of the tributaries.

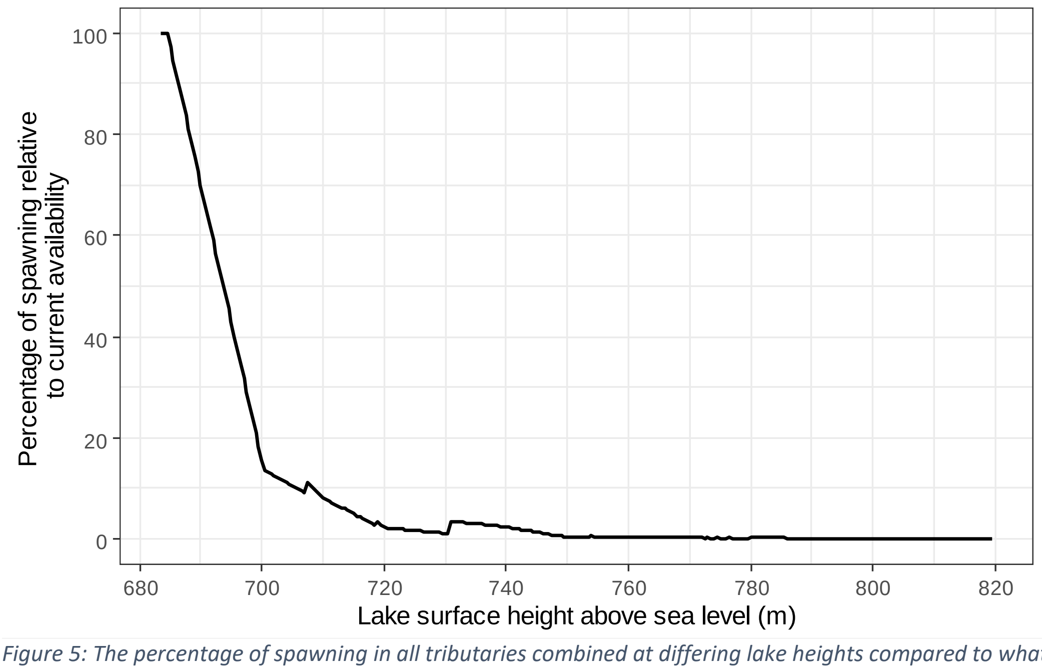


Figure 5: The percentage of spawning in all tributaries combined at differing lake heights compared to what is currently available.

The upwards bumps in the chart are due to hydraulic trout barriers being inundated, opening up new areas of spawning gravel upstream.

If the lake is increased to 760 metres, it is expected that the amount of spawning gravel available to lake resident trout would be around 0.38% of the amount currently available (Appendix 1).

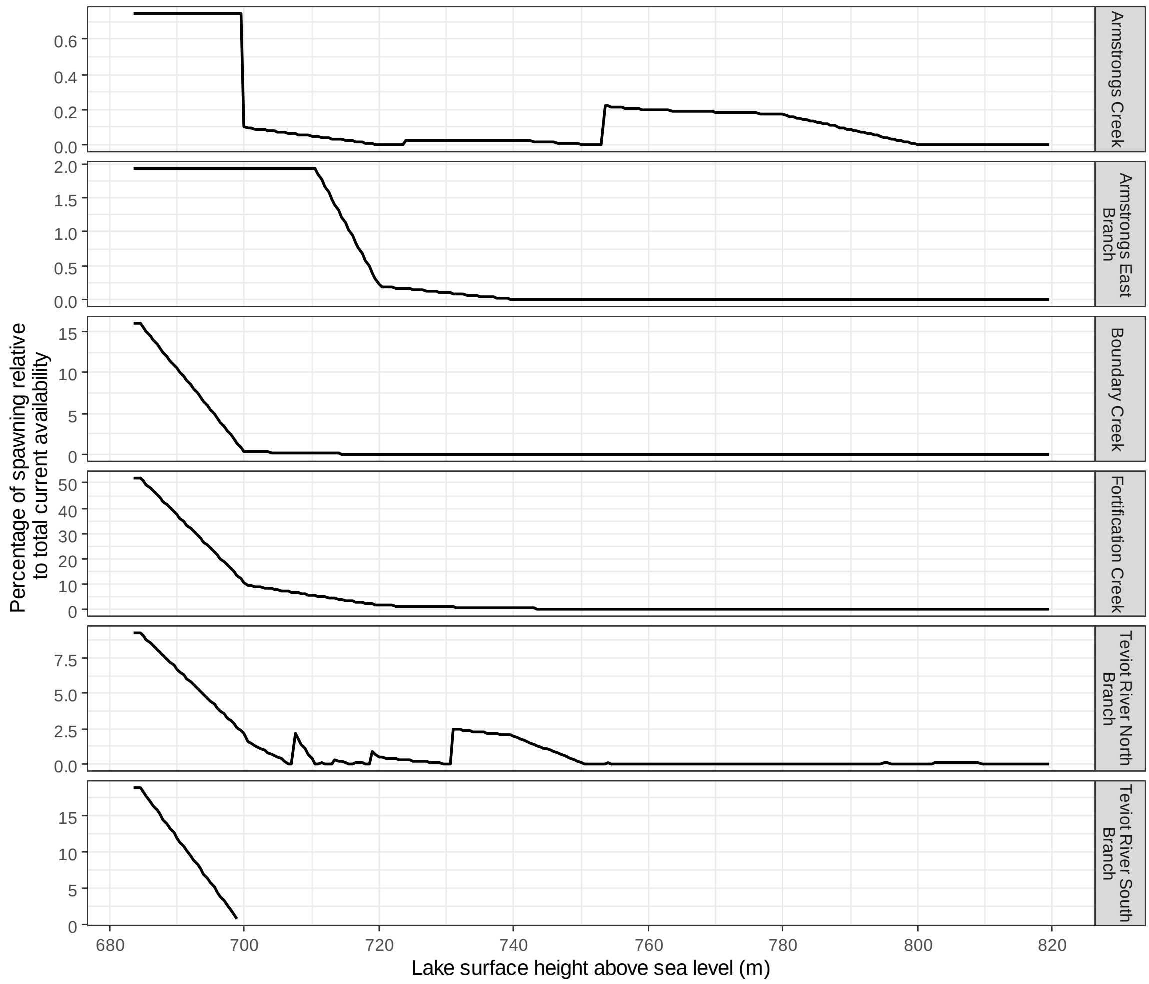


Figure 6: The percentage of spawning in each tributary at differing lake heights compared to the current total availability. Please note the scale up the y axis is inconsistent between tributaries.

Figure 6 shows gravel availability in each tributary at different lake heights expressed as a percentage of the total available gravel in the catchment. Note that the upper reaches of the Teviot South Branch are not included as staff found it did not contain enough suitable spawning gravel or flow to sustain successful spawning.

The chart shows that current lake levels the majority of available spawning gravel is in Fortification Creek with very little available in Armstrongs Creek due to poor substrate and hydraulic trout barriers in the stream.

Figure 7 shows a zoomed in view of Figure 6, however the y axis has been made consistent to better show the relative importance of each stream if the lake was raised to 760 meters or above.

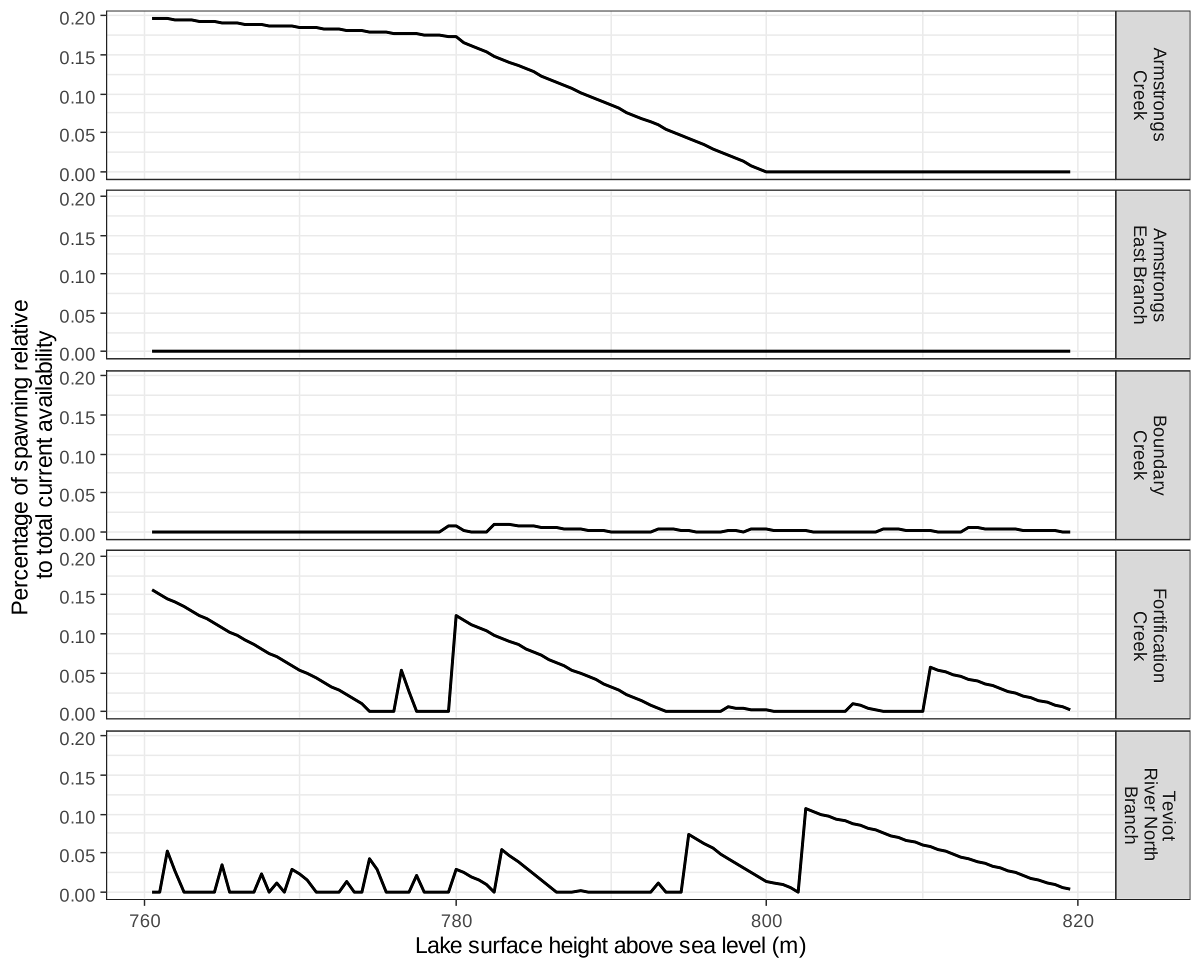


Figure 7: The percentage of spawning in each tributary at differing lake heights compared to the current total availability.

When the lake is modelled at 760 metres or above the largest available area of spawning gravel is in Armstrongs Creek despite its poor spawning substrate. Armstrongs East Branch is very steep between the 740- and 820- metre contour and is unsuitable for spawning at these heights.

There is very little gravel present in the streams above the 760-metres contour. An exception to this is the North Branch of the Teviot River which had some gravel above 760 metres, however it was of poor quality and there were a significant number of hydraulic barriers to fish access.

Discussion

The investigation into Lake Onslow spawning showed there would be a dramatic reduction in spawning area with even a small rise in lake level. At the proposed new upper lake level (760 metres), we estimate that the lake would be six times larger in area, and significantly more than that in terms of volume. The far larger lake would only have around 0.38% of the lakes current spawning area and the gravel that is available is likely to be of a poorer quality than the gravel currently available.

Although not directly measured in this investigation, staff noted excellent rearing habitat for juvenile trout throughout the tributaries (Photo 6), this essential nursery habitat will also be decimated with an increase in lake height. The reduction in both spawning and rearing area means there is unlikely to be enough production of juveniles to support the fishery in a much larger lake.

Photo 6: An example of excellent rearing habitat in Armstrongs Creek (I Hadland)

The proposed Lake Onslow battery is expected to supply power when there is a prolonged dry period. This means that the lake is likely to fluctuate significantly over extended periods of time and that the lake levels could be highly variable between spawning seasons. The lake was approximately three metres below full when staff conducted this investigation. Staff walked the Teviot River North Branch between the current maximum level (684m) and the lake level on the day(~681m). Staff found that the stream that was running through the footprint of the lake had extremely poor spawning potential due to high sediment load from inundation from the lake (Photo 7). It is expected that spawning within the lake footprint in years where that lake is low will be largely unsuccessful.

Photo 7: The North Branch of the Teviot River within the lake footprint showing extremely poor ecological values.

Without mitigation, the proposed lakes trout fishery will be severely limited by the reduction of spawning and rearing habitat. Mitigating this will be difficult. The introduction of spawning gravel to the tributaries is likely to be unsuccessful as the streams at higher levels are smaller, steeper and have more frequent trout barriers than the streams near the lake. There is also a chance that lake will be at low levels during spawning season meaning that introduced gravels might not be reachable by trout. Above the 760-metre contour there is insufficient flow to support large areas of introduced spawning gravel.

The construction of a spawning race has potential to mitigate the loss to spawning however it would need a significant area of gravel to provide enough spawning area for the increased lake size. s. A spawning race sourced from Clutha water would need groomed regularly to prevent didymo build-up. It is unlikely that large quantities of suitable spawning shingle is available anywhere near the site. A spawning race is unlikely to mitigate the losses to rearing habitat, consequently it would need a large area of rearing habitat (stream length or macrophyte beds) to provide grow-on space for juveniles.

Although not included in the calculations, staff noticed small, stunted trout spawning throughout the tributaries, it is unknown how significant these are to juvenile production. It’s probable that there are stream resident trout spawning higher up in the catchment. Electric fishing of tributaries has been conducted by other agencies, but results are not yet available.

Analysing the effects of the proposal on the whole of the Lake Onslow and Clutha River sports fisheries will require significant future work and research.

Acknowledgments

Thank you to the landowners who allowed access to their land to carry out this investigation. Thanks also to Cohen Stewart, Khalym Marshall and Nick Van de Vlierd who helped with field work on short notice.

Jayde Couper
Fish & Game Officer
July 2022

Appendices

Lake Height (metres)	Spawning Available (linear metres)	Percentage of spawning relative to current availability
684	4074.2	100.00%
685	3963.1	97.27%
690	2851.8	70.00%
695	1740.6	42.72%
700	628.7	15.43%
705	427.4	10.49%
710	335.0	8.22%
715	202.8	4.98%
720	95.0	2.33%
725	70.3	1.73%
730	45.0	1.11%
735	123.9	3.04%
740	98.6	2.42%
745	56.5	1.39%
750	14.9	0.37%
755	17.7	0.43%
760	15.5	0.38%
765	13.8	0.34%
770	10.8	0.26%
775	8.6	0.21%
780	13.7	0.34%
785	9.7	0.24%
790	4.8	0.12%
795	4.8	0.12%
800	0.8	0.02%
805	3.8	0.09%
810	2.6	0.06%
815	2.6	0.06%
820	0.0	0.00%

Appendix 1: The percentage of spawning in all tributaries combined at differing lake heights compared to what is currently available.

Photo 8: Significant natural habitat in the lower reaches of the Teviot River North Branch

14.7

Thomsons Creek Brown Trout Spawning and Proposed Fish Barrier July 2022

1. Abstract

Thomsons Creek is sourced from the Dunstan Mountains and flows in an easterly direction and enters the Manuherekia River, near the township of Omakau.

Thomsons Creek has a remnant population of Central Otago roundhead galaxias, which are declining due to many factors, including the presence of trout. A fish barrier is proposed by the Thomson Creek Catchment Group to prevent upstream migration of brown trout into the galaxiid habitat.

Thomson's Creek is used as a spawning stream by brown trout from the Manuherekia River.

Otago Fish & Game staff have been assessing the extent of spawning in Thomsons Creek to assess how much spawning habitat will be lost with the construction of a fish barrier.

2. Galaxiid Population and Fish Barrier

Thomsons Creek was considered to hold a healthy population of the threatened Central Otago roundhead galaxias. However much of the data was old (>5yrs) and therefore was considered to be unreliable by the Thomson Creek Catchment Group.

A fish survey was conducted by several key stakeholders in early 2021 to obtain up to date understanding of the distribution of galaxias. The design of the survey was to inform the following management objectives:

-Maintain the existing distribution of the galaxiids in Thomson's Creek

-If possible, improve the health and extent of the population by undertaking fencing, revegetation, and willow removal

-Ensure the continued exclusion of exotic fish species

-Where appropriate conduct removal of exotic fish species.

The survey results showed a vast decline in the distribution of galaxiids, with most populations occurring in side streams and seepages feeding into Thomsons creek. There is only one population of central Otago roundhead galaxias still present in the mainstem of Thomsons Creek (Figure 1).

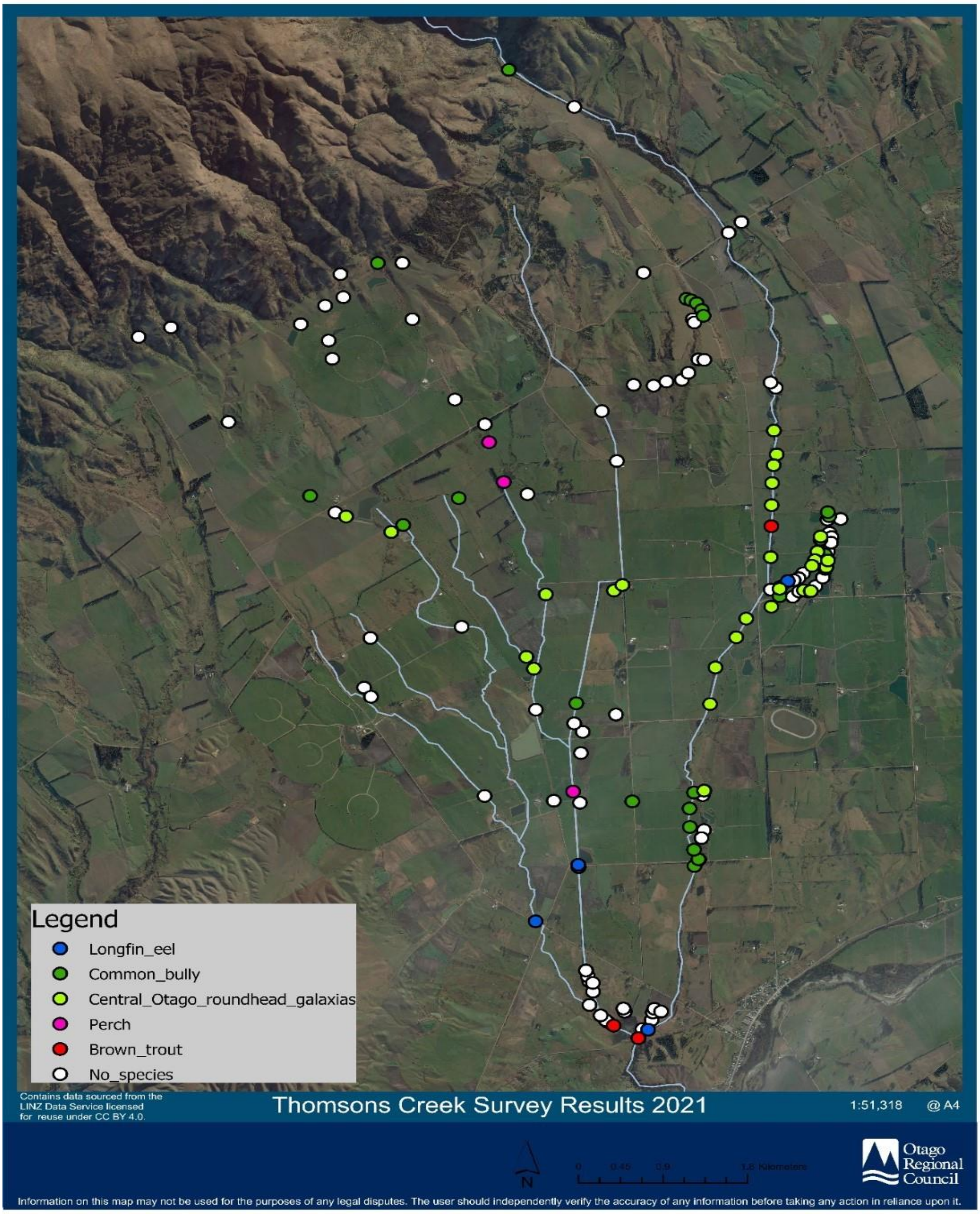


Figure 1. Survey locations and results in the Thomsons Creek catchment from early 2021.

It is proposed that a weir of 1.0 to 1.2m in height be installed in Thomsons Creek at a suitable site downstream of the main galaxias population to prevent upstream passage of trout (figure 2). Immediately downstream of the barrier a concrete floor extending 4 – 5m below the barrier will be installed to prevent a pool forming below the barrier that trout could utilise to jump and move upstream.

Figure 2. Thomsons Creek showing the distribution of Central Otago roundhead galaxias (blue dots), the proposed location of the fish barrier as well as the presence trout (red dots), common bully (green dots) and longfin eel (purple dots).

The purpose of the weir is to prevent introduced sports fish moving upstream past the weir and preying upon on galaxias. The proposed barrier will exclude migratory trout entering Thomsons Creek from the Manuherekia River from accessing the creek above the barrier. From a trout fishery perspective Thomsons Creek is a spawning and rearing stream, the location of the barrier will mean there is approximately 5 Km of stream length between the proposed fish barrier and the Manuherekia River for spawning and rearing to continue to occur.

The Thomsons Creek mainstem galaxias population has trout both above and below them. It is expected that the proposed downstream barrier would prevent large adult trout from the Manuherekia entering the reach containing galaxias during their annual spawning run. It is expected by preventing large spawning trout entering the section of Thomsons Creek above the weir it will significantly reduce the trout load in this reach over time.

Currently there is a trout population in the upper reaches of Thomsons Creek, especially in Thomsons Gorge above the Matakanui Race where flows are permanent. It is expected that the population of trout above the Matakanui Race weir is a self-sustaining stunted adult population as such they are less likely to move downstream. Often juvenile trout will move downstream as available habitat decreases and competition increases which usually occurs in summer and autumn. This downstream migration is impeded significantly by the presence of the currently unscreened Matakanui race which takes the majority of flow during low flow periods (and probably the majority of trout migrating downstream at this time) and the presence of a naturally intermittent reach (which is extended by water taking upstream). The combination of the unscreened take and the dry reach are likely to significantly inhibit downstream migration of trout and trout establishing in high numbers in the reach to be managed for galaxias.

It is expected for the barrier to be successful there will need to be ongoing monitoring and as necessary removal of trout from the galaxias management reach. ORC have allocated funds as part of their work program to do this at least over the next five years under their long-term plan. F&G will probably have to consider being part of this management of sports fish.

2a. Fish Barrier Summary

The Thomsons Creek catchment has traditionally been a stronghold for Central Otago roundhead galaxias, though a significant survey of the catchment in early 2021 by stakeholders indicates their range continues to decline.

Central Otago roundhead galaxias are considered nationally vulnerable and a compulsory value to protect under the National Policy Statement for Freshwater Management 2020. Central Otago roundhead galaxias range has significantly reduced due to the impacts of competition and predation by trout, though changes in land and water use is likely to be adding pressure to this species.

Given the key threat to Central Otago roundhead galaxias is predation from sports fish to ensure their continued existence active management is required. Active management requires steps to exclude sports fish from galaxias habitat with the proposed fish barrier.

3. Brown trout Spawning

As a tributary of the Manuherekia, Thomsons creek is known as a spawning site for brown trout. Adult brown trout commonly enter Thomsons creek between March and June, with the peak of spawning occurring during May.

Otago fish and game staff contacted landowners for access to Thompsons Creek, to conduct spawning surveys between April and June in 2021 and 2022. Staff would walk along the banks of the stream, looking for adult fish or redds. During 2022 surveys, a drone was also used to fly over parts of the stream, again looking for redds and adult fish.

3a. Brown Trout Spawning Methodology

Walking Survey
Surveys are conducted from late April through until early June which was based on previous anecdotal records of when brown trout have been observed present or spawning at these

locations. Most surveys were a single walk-through survey focusing on covering as much spawning habitat as possible within the trout spawning season.

Drone Survey

During 2022 surveys, a drone was used to survey stretches of Thomsons creek. The drone was equipped with a polarized lens. Visibility was reduced with low light angles during the surveys, making redd identification difficult. Drone surveys did not have the same efficiency as walking surveys

3b. Brown Trout Spawning survey results and discussion

Thomsons Creek had various sections of its catchment surveyed for spawning. Despite areas with appropriate spawning gravels and habitat, it seems that most of this spawning habitat is not utilised by brown trout. Results from spawning surveys showed exceptionally low numbers of both fish and redds compared with other spawning locations on Otago. There is no definitive reason for the low representation of spawning in Thomsons Creek.

It appears that Thomsons Creek is a minor contributor to the recruitment of brown trout to the mainstem Manuherekia River. It is believed that a fish barrier preventing upstream spawning migration would not have any significant changes to the Manuherekia trout population or fishery.

4. Recommendations

The report be received

Ben Sowry
Fish and Game Officer
July 2022

5. Appendix: Spawning survey results

Appendix 1: 2015 results.

A spawning survey was completed in two sections of Thomsons Creek in early June 2015. The lower site was surveyed upstream from the confluence of the Manuherekia River to the Omakau – Chatto Creek Road bridge. In this section the in-stream substrate was coarse cobbles with few gravel areas suitable for spawning. No fish or spawning activity was observed.

The second section was surveyed upstream from White Road to Donnelly Road. Access permission was gained via The Terrace farm. The stream was relatively open, and the flow was low and clear which made conditions ideal to observe spawning activity. No fish were observed however 9 spawning redds were noted over the section surveyed.

Way Points	Date	Time (24 hr)	Altitude	Easting	Northing	Redds	Fish	Site	Comments
Start S18	02-JUN-15	11:47	297	1331858	4999143	0	0	18	Start survey
End S18	02-JUN-15	12:03	304	1331587	4999556	0	0	18	End Survey
Start S19	02-JUN-15	12:36	316	1331543	5000827	0	0	19	Start survey
End S19	02-JUN-15	13:35	324	1331770	5002534	0	0	19	End Survey
001	02-JUN-15	12:38	308	1331546	5000829	1	0	19	
002	02-JUN-15	12:41	309	1331565	5000921	1	0	19	
003	02-JUN-15	12:41	309	1331565	5000925	1	0	19	
004	02-JUN-15	12:44	309	1331586	5001005	1	0	19	
005	02-JUN-15	12:56	313	1331572	5001429	1	0	19	
006	02-JUN-15	12:56	311	1331567	5001461	1	0	19	
007	02-JUN-15	13:13	317	1331566	5001702	1	0	19	
008	02-JUN-15	13:20	318	1331587	5001960	1	0	19	
009	02-JUN-15	13:31	320	1331715	5002394	1	0	19	

Table 1: Thomsons Creek Spawning Survey Data 2015

Appendix 2: 2019 results.

Aerial spawning survey conducted in 2019

Date: 04 July 2019

Personnel: Ross Dungey, Paul van Klink (Observers), Simon Spencer-Bower (Pilot)

Helicopter: Squirrel, Wanaka Helicopters Ltd

Thomsons Creek

Start Time: 1345 hrs

End Time: 1424 hrs

Start GPS: E 1331821 N 4999100

End GPS: E 1329257 N 5012589

Thomsons Creek was surveyed from the confluence of the Manuherekia River upstream. A wind shift part way upstream meant that rotor wash began interfering with visibility. Consequently, the helicopter was relocated to the end survey GPS point and the survey continued back downstream. Visibility was good and six redds were seen in the upper reaches. A small slip further downstream coloured the creek which challenged observation for some distance

Appendix 3: 2021 results.

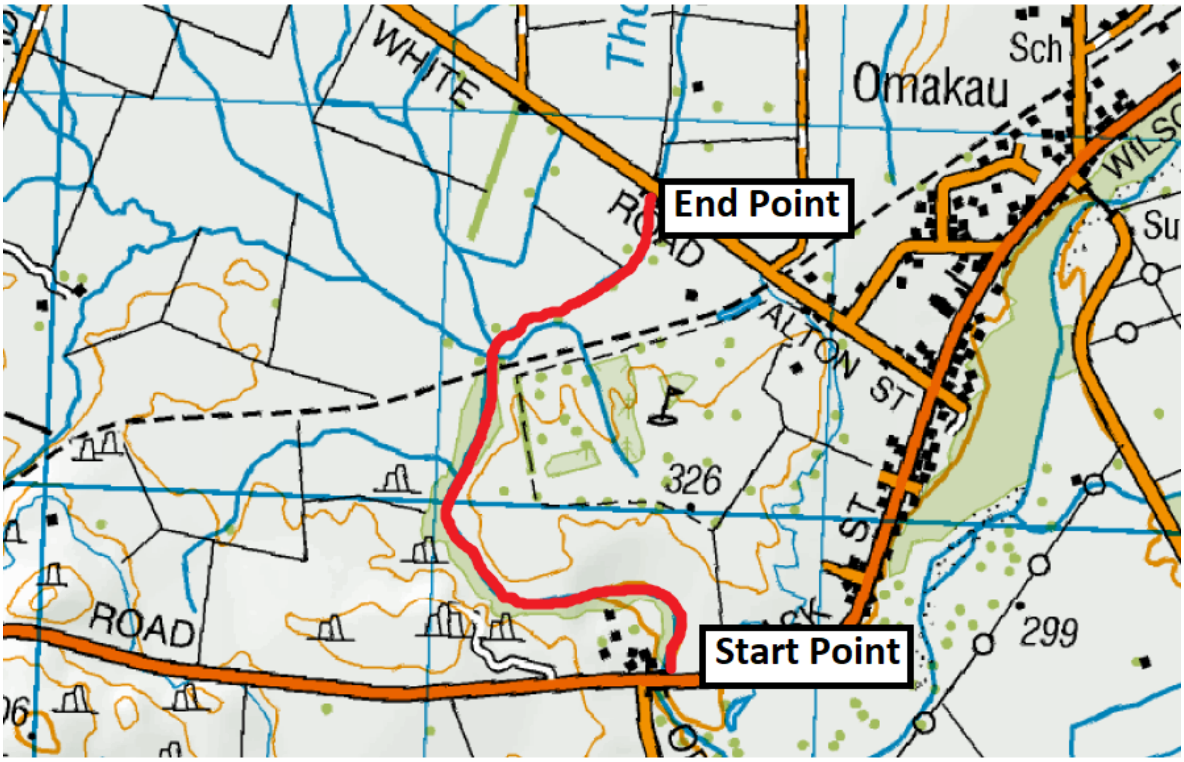
SPORTSFISH SPAWNING SURVEY FORM

Date: 30/04/2021
River: Thomsons Creek
Section: Lower Section
Start Point: E1331642 N4999574 **End point:** E1331524 N5000825
Distance: 2km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	1	
Totals		1	**Redds/km:**

Map:



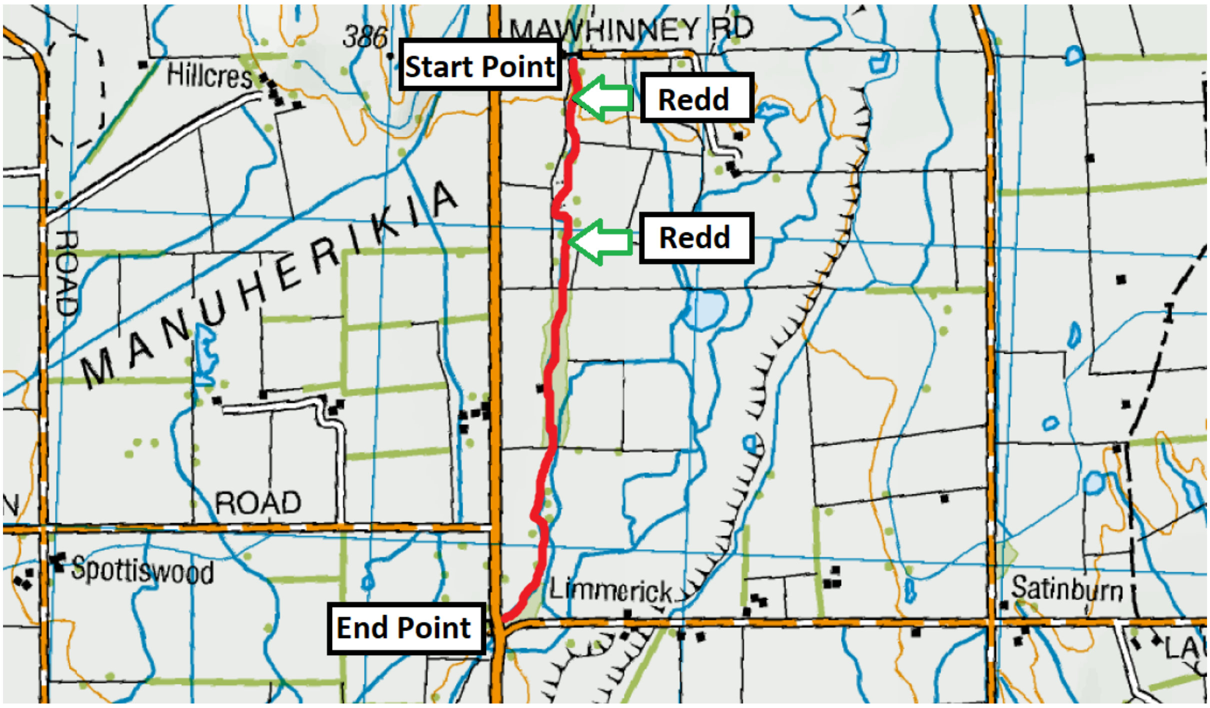
Comments: Extremely difficult spotting conditions, with overcast skies and discoloured waters

Date: 13/05/2021
River: Thomsons Creek
Section: Mid-Section
Start Point: E1332394 N5005594 **End point:** E1332992 N5006834
Distance: 1.9km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	2	5	One fish on redd
Totals	2	5	**Redds/km:**

Map:



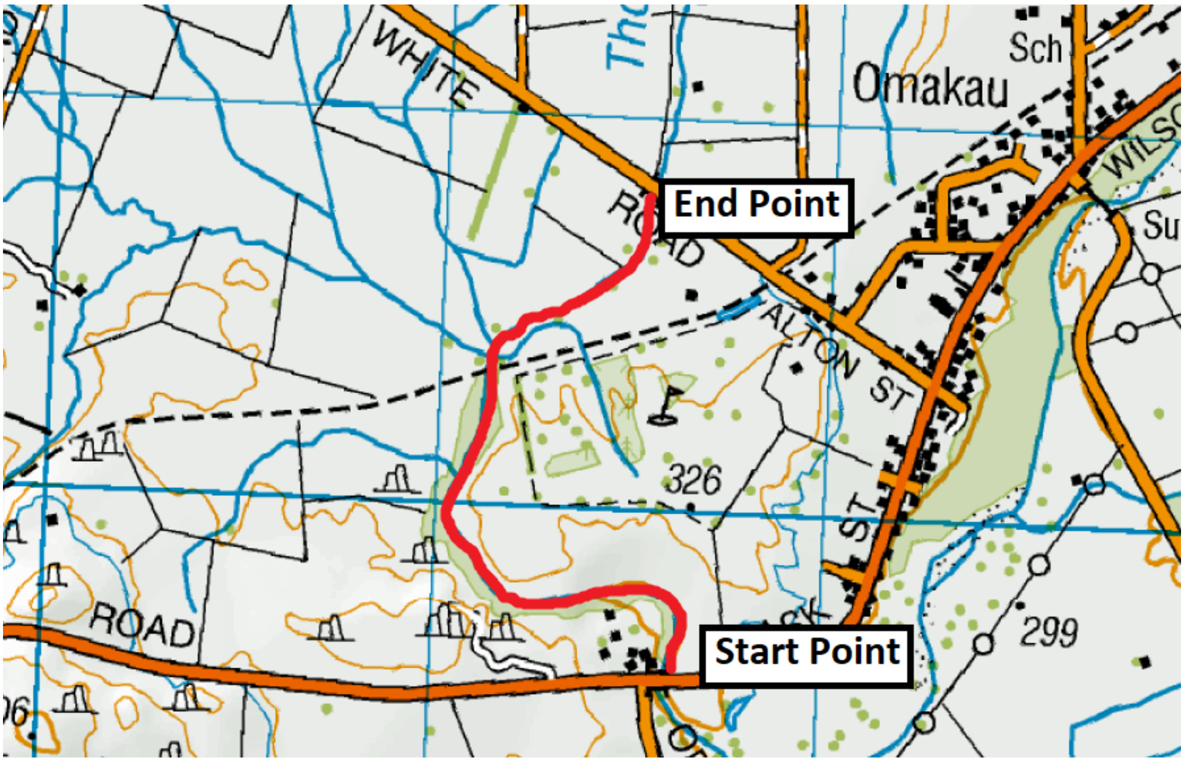
Comments: One fish observed on upstream redd

Date: 13/05/2021
River: Thomsons Creek
Section: Lower Section
Start Point: E1331642 N4999574 **End point:** E1331524 N5000825
Distance: 2km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	8	
Totals		8	**Redds/km:**

Map:



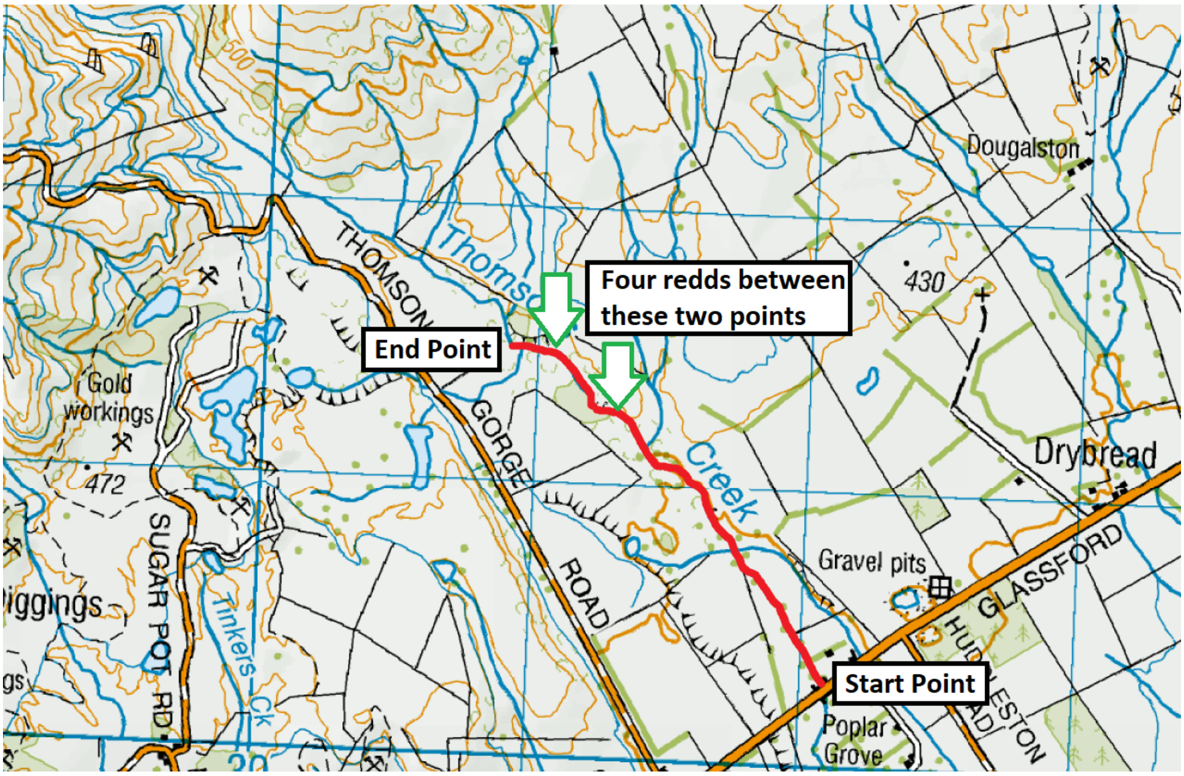
Comments: Same section as previous month, repeated due to better conditions.
No signs of spawning activity. Some fish present, but looking like they were in the process of running upstream (sitting in pools etc)

Date: 04/06/2021
River: Thomsons Creek
Section: Upper Section
Start Point: E1332074 N5010308 **End point:** E1330928 N5011478
Distance: 1.7km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	4	7	Redds were in a section as marked on map
Totals	4	7	**Redds/km:**

Map:



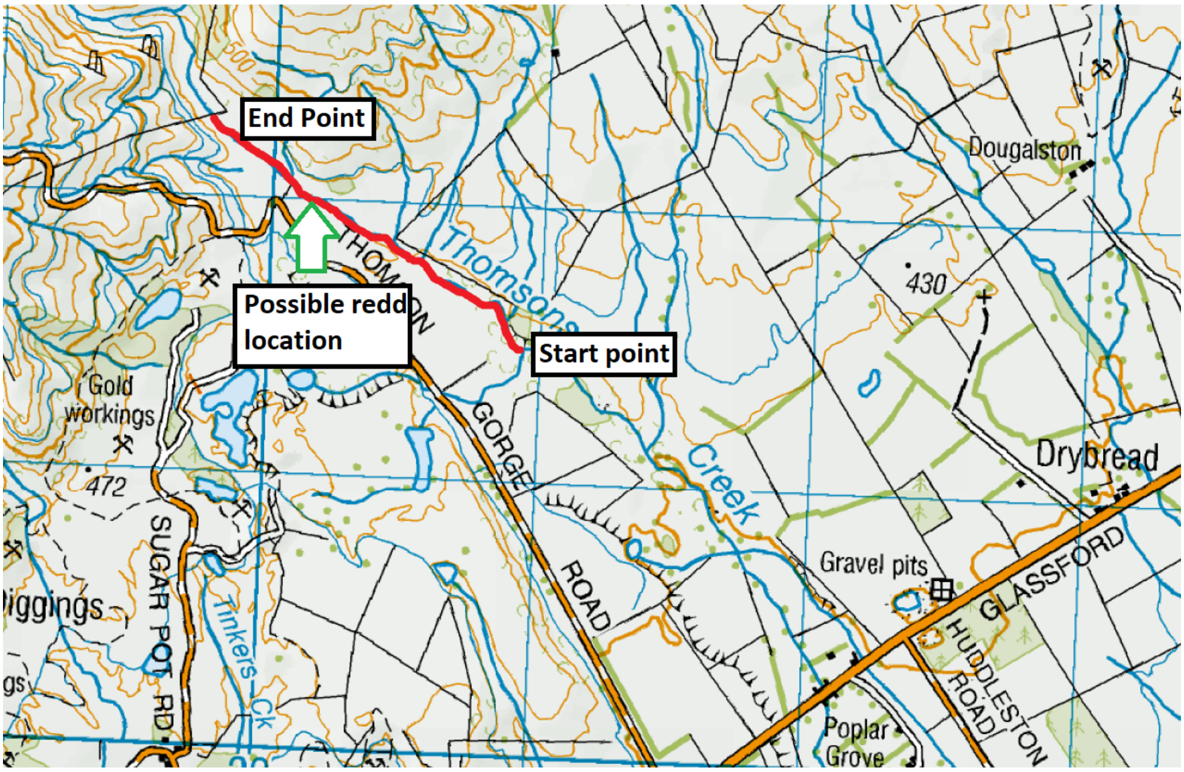
Comments: Four redds in section marked

Date: 09/06/2021
River: Thomsons Creek
Section: Upper Section
Start Point: E1330928 N5011478 **End point:** E1329773 N5012279
Distance: 1.8km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	1	4	One possible redd
Totals	1	4	**Redds/km:**

Map:



Comments: Reasonable spawning locations throughout. Might have been more obvious activity earlier in season.

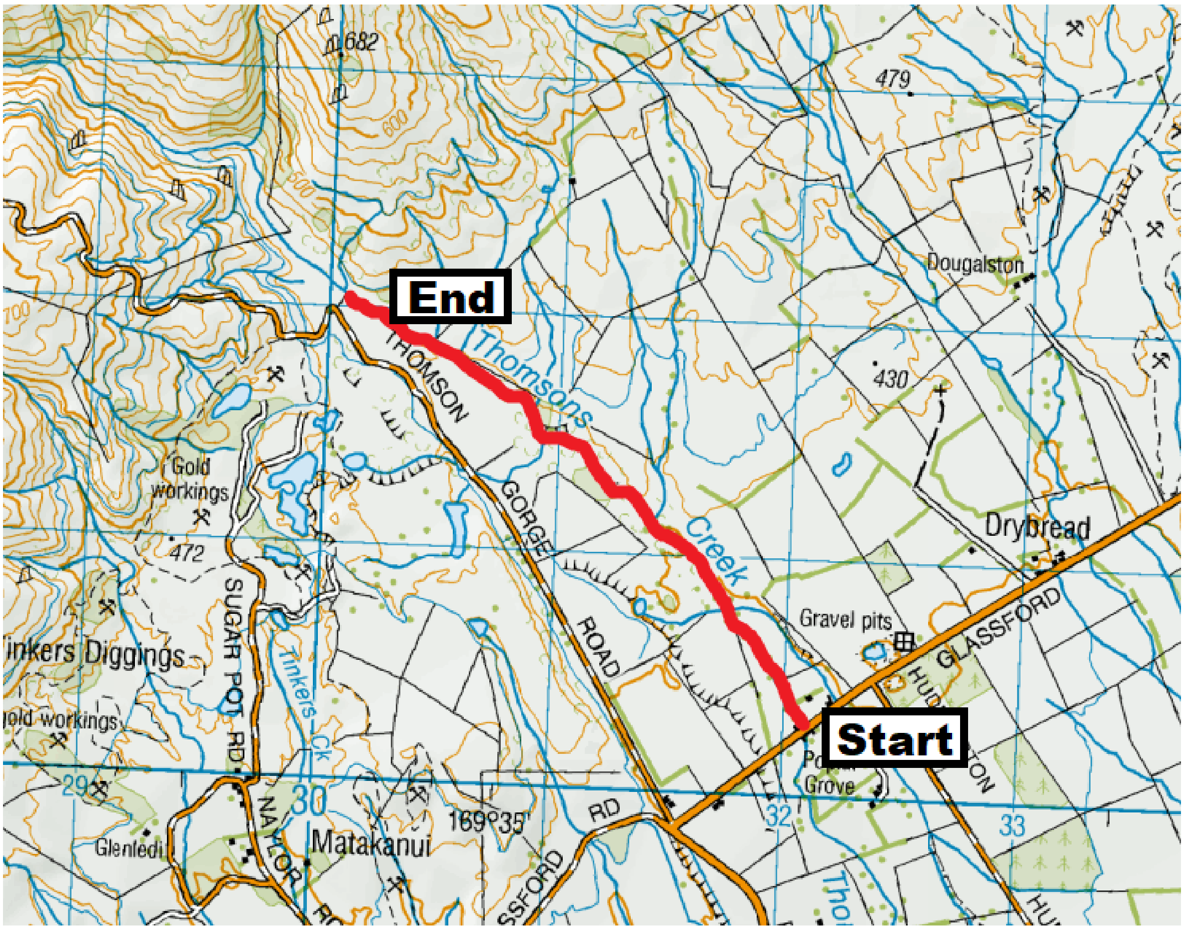
Appendix 4: 2022 results.

Date: 29/04/2022
River: Thomsons Creek
Section: Upper Section
Start Point: E1332039 N5010307 **End point:** E1329970 N5012132
Distance: 3.2km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	0	
Totals		0	**Redds/km:**

Map:



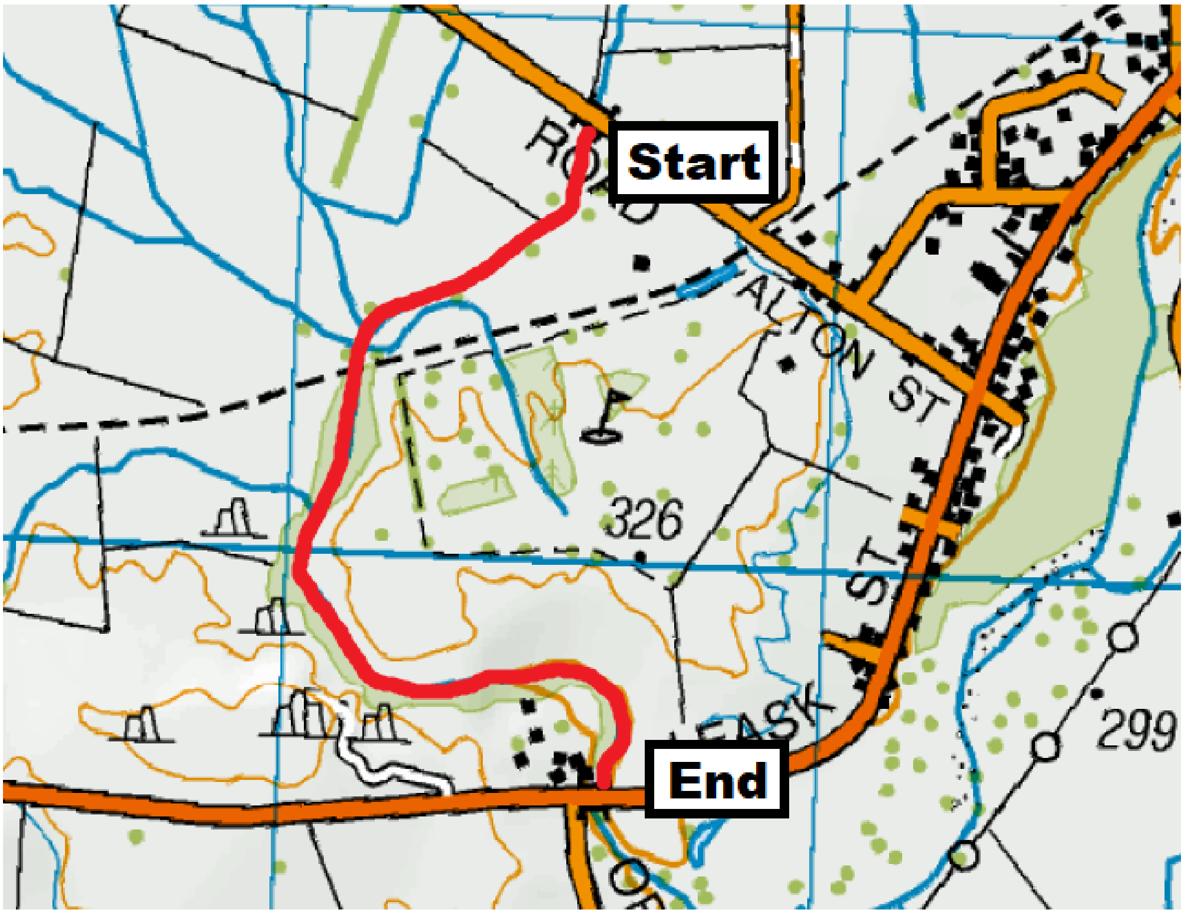
Comments: No wind, Overcast

Date: 06/05/2022
River: Thomsons Creek
Section: Lower Section
Start Point: E1331552 N5000871 **End point:** E1331619 N4999583
Distance: 2km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	3	
Totals		3	**Redds/km: 0**

Map:



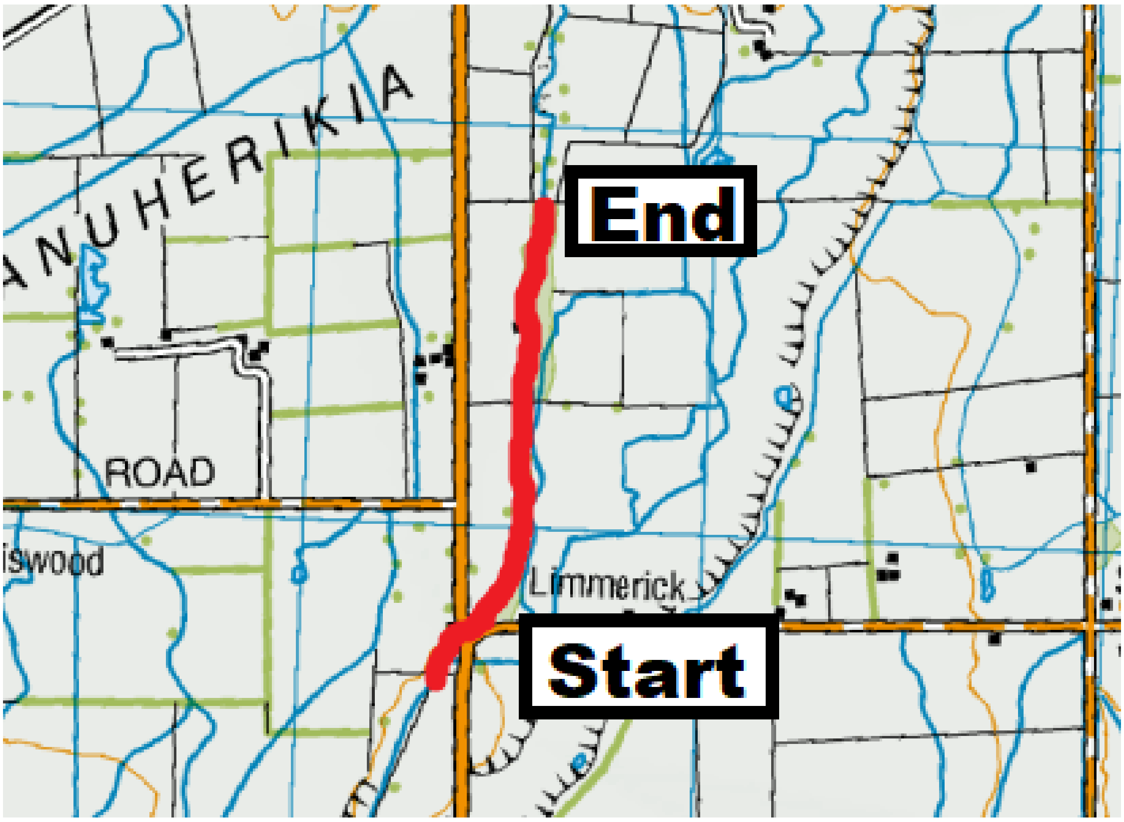
Comments: Three single fish

Date: 10/05/2022
River: Thomsons Creek
Section: Middle Section
Start Point: E1332354 N5005630 **End point:** E1332566 N5006845
Distance: 1.4km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	1	5	Possible redd at E1332532 N5006077
Totals	1	5	**Redds/km:**

Map:



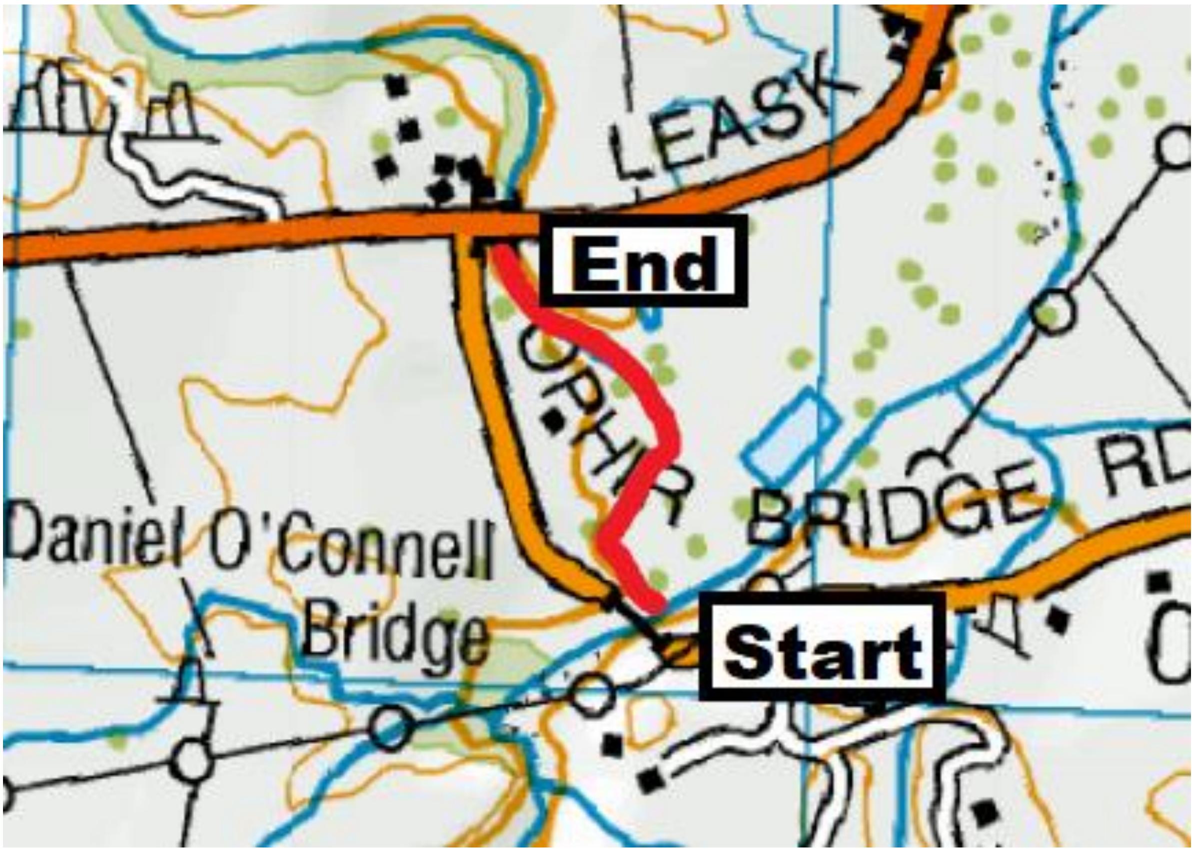
Comments: Not a strongly defined redd. Two fish just upstream of redd. Sunny, light breeze

Date: 11/05/2022
River: Thomsons Creek
Section: Lower Section
Start Point: E1331815 N4999099 **End point:** E1331588 N4999542
Distance: 0.9km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	0	
Totals	0	0	**Redds/km:**

Map:



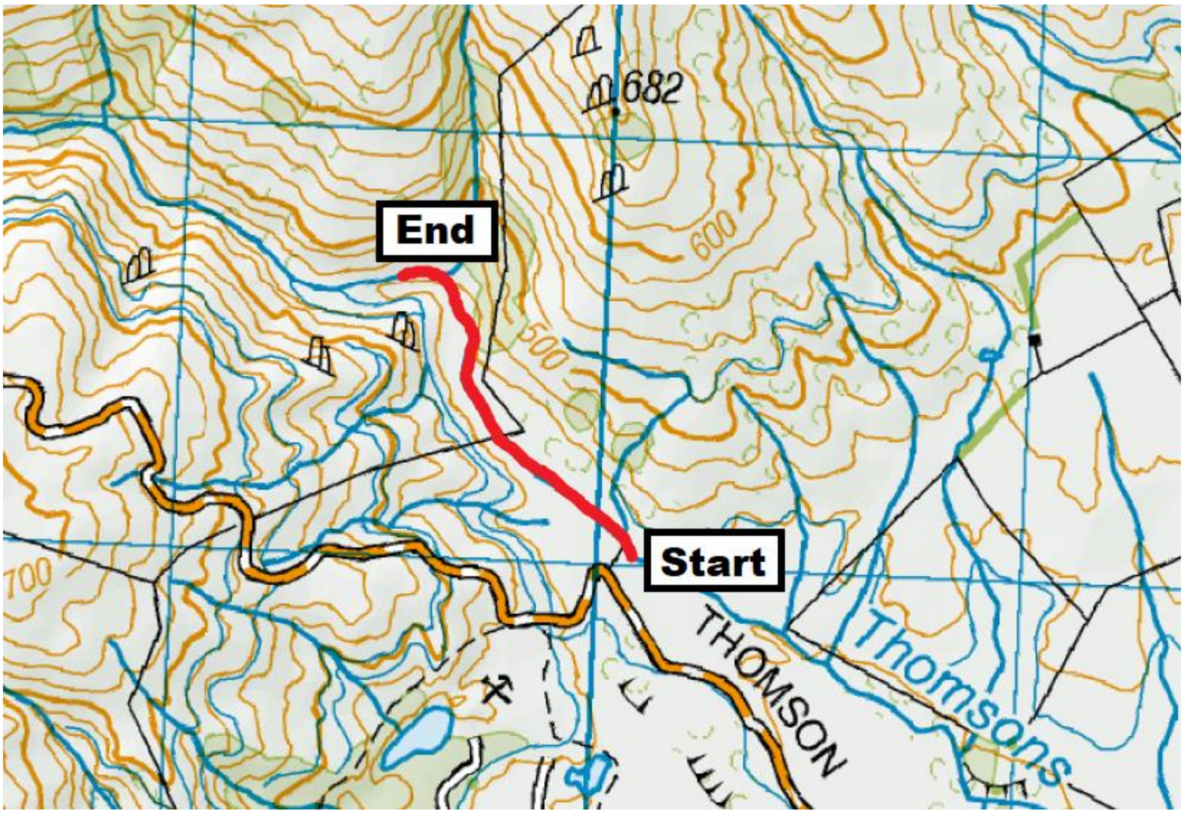
Comments: Some fish in Manuherekia downstream of confluence. Sunny, calm

Date: 09/06/2022
River: Thomsons Creek
Section: Upper Section
Start Point: E1330070 N5012059 **End point:** E1329595 N5012657
Distance: 1.1km

Species: Brown trout **Observer:** B. Sowry

Description	Redds	Fish	Comment
.	0	0	
Totals	0	0	**Redds/km:**

Map:



Comments: Good spawning locations, but no definitive redds seen. Calm, overcast

Non-Resident Anglers' Survey 2022

Background

As part of ongoing work on how Fish & Game can best manage pressure sensitive and backcountry fisheries, a survey of non-resident anglers was undertaken to obtain information on key aspects of non-resident angler fishing behaviour. The data collected will be used to inform and provide further evidence in support of the proposed pressure sensitive fisheries management regime.

The objectives of the survey were to:

i. Describe the frequency and length of trips non-resident anglers make to New Zealand.
ii. Estimate the number of days non-resident anglers spend fishing while visiting New Zealand, including the number of regions fished and days spent fishing designated backcountry fisheries.
iii. Describe other key aspects of non-resident angling activity including use of guides, aircraft, hiking and camping activity.
iv. Investigate the aspects of trip planning and the relative importance of some key motivators for non-resident anglers.
v. Determine future interest in fishing in New Zealand.

Methods

The survey sample was comprised of adult non-resident whole season licence holders for the three seasons prior to the COVID-19 pandemic (2017-18, 2018-19 and 2019-20). For this period a total of 19,664 licence records were available. As the survey was to be distributed via email, duplicate email addresses were removed from the database (i.e., anglers who had multiple licences during the 3-year period) giving a sample size of 11,521 anglers, for which 9,717 had valid email addresses. The survey was sent via Survey Monkey and a reminder email was sent after approximately 1 week to prompt additional responses.

Results

Angler demographics

Non-resident anglers originated from 91 different countries. Australians made up the largest proportion of non-resident anglers (30 %), followed by the United States of America (USA) (22 %). Anglers from Canada, Germany, France and United Kingdom comprised approximately 3-5 % of non-resident anglers respectively, with the other countries each represented by <1-2 % of anglers.

A significant proportion of non-resident anglers (19 %) had New Zealand listed as their country. The country of origin for these anglers was unclear. Approximately two thirds of these anglers had another country (outside New Zealand) associated with their licence record i.e., a country listed with a previous 24-hour licence, while the remainder had only New Zealand listed. These licences could be explained by incorrect selection at the time of purchase, changes to the definition of non-resident, anglers using a New Zealand based address, or guides and/or other service providers entering their own addresses when purchasing licences for clients. For the purposes of this survey, these licences were included in the total non-resident sample. A small number of anglers responded to the survey who were not non-residents. This included some anglers whose residency status had changed in the last 5-years.

The median age of non-resident anglers was 45; 90 % were male and 10 % were female. Interestingly, 42 % of female anglers came from the USA whereas only 20 % of male anglers were from the USA. This likely reflects the trend of increasing participation in fishing by women in the USA. Women are the fastest growing demographic in fly-fishing in the USA making up approximately 30 % of fly anglers there. A 2020 study reported by The Recreational Boating and Fishing Foundation found that female fishing participation increased 3 % on average annually since 2017.

Response rate

A total of 1,364 responses were received representing a total response rate of approximately 15 %. Respondents were representative of licence holder country of origin with responses received from 47 countries, and proportional participation from the main countries where non-resident anglers originate: 27 % Australia, 21 % USA, 8 % UK, 6 % Germany, France 3 %.

Experience fishing in New Zealand

Non-resident anglers had a range of experience levels fishing in New Zealand; 29 % of anglers had fished in New Zealand only once, 30 % more than once, 25 % had fished more than five times and 15 % of non-resident anglers said they fished in New Zealand every year or nearly every year.

Based on the frequency of their visits and experience fishing in New Zealand, anglers were asked how long their last trip to New Zealand was (for one-time and more than one-time visitors) or how long they typically stayed in New Zealand (for >5-time visitors or every year/nearly every year visitors). For both groups the distribution of trip length was similar, with a trip of about two weeks being most popular (30-35 % of anglers) and most anglers visiting New Zealand for four weeks or less (73-68% of anglers) (*Figure 2*). A small number of anglers reported longer term stays in New Zealand (>2 months to >1 year). Approximately 8 % of anglers who were frequent visitors in New Zealand (>5 times or every year/nearly every year) also said they stayed for longer than 1 year; it is thought some of these anglers might be non-residents living in New Zealand.

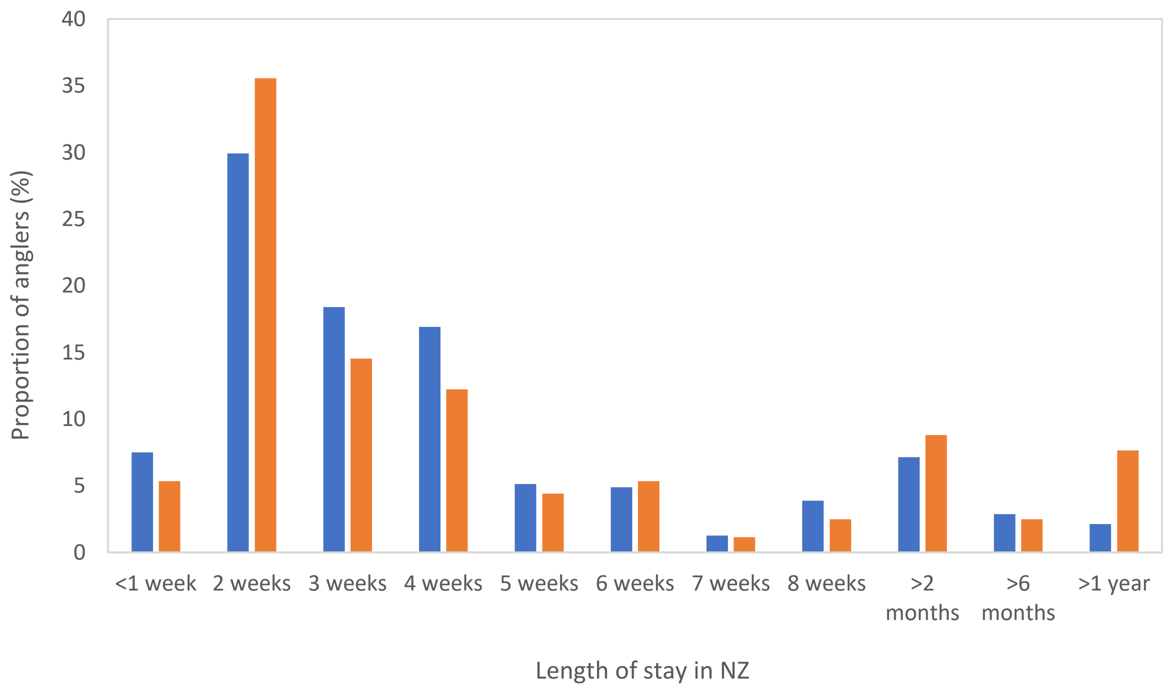


Figure 2. Length of stay in New Zealand for non-resident anglers who visited once or more than once (blue) or visited more than 5 times or every year/nearly every year (orange).

Fishing activity in New Zealand

Anglers who were higher frequency visitors (>5 times or every year/nearly every year) fished more days on average than anglers who had visited New Zealand fewer times (once or more than once). The mean days reported by high frequency return visitors was 14.82 days (±SD 13.0) and the median was 10 days, compared to a mean of 10.92 days (±SD 9.86) and a median of 7 days for less frequent visitors (Figure 2). These estimates are comparable with the most recent data from the National Angling Survey (2014-2015) which estimated the average days fished for non-residents was 7.5 days (±SD 18.90) (Unwin 2016). It is expected that the estimates from this survey will include response bias as a result of more active anglers self-selecting (compared to random sample selection used in the National Angling Survey). Also, a small number of anglers from both groups said they fished >60 days[i] and these anglers generally had made longer-term visits to New Zealand (often >1 year); this should be kept in mind when considering the angler activity of more typical, shorter-term visitors.

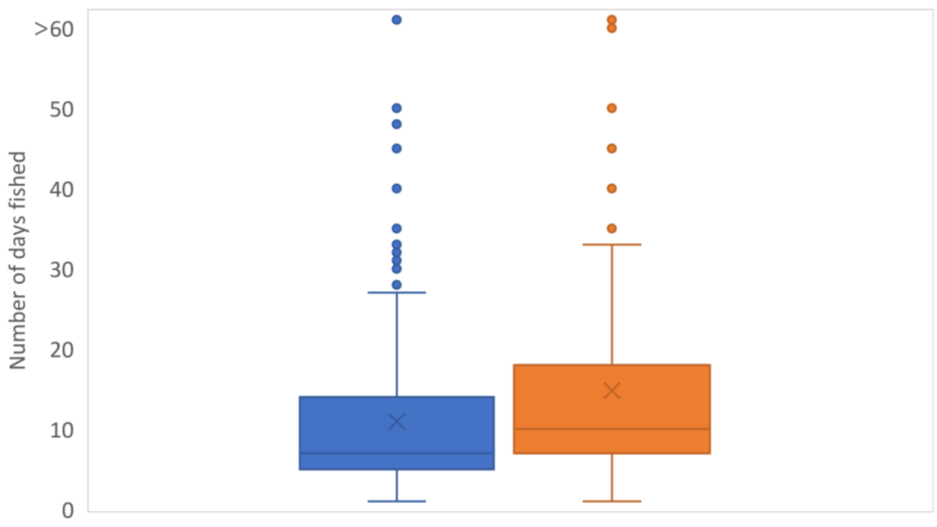


Figure 3. Days spent trout fishing while visiting NZ for non-resident anglers on their most recent visits for anglers who had visited NZ once or more than once (blue) and days spent trout fishing on a typical visit to NZ for non-resident anglers who visited NZ more than 5 times or every year/nearly every year (orange).

Most anglers (52 %) didn't fish a designated backcountry fishery and a further 15 % didn't know or couldn't recall if they did. About 20 % of anglers fished backcountry fisheries for four or fewer days, 9 % fished 5-10 days and just 3 % of anglers fished backcountry waters for more than 10 days. Non-resident anglers generally fished in 1-3 regions during their stay, but a smaller number fished more extensively across the New Zealand with some visiting 10 or more regions during their visit (*Figure 4*). The most popular regions were Central South Island, Otago and Southland (*Figure 5*). It should be noted as total fishing days per regions were not reported the results do not indicate which region received the most fishing pressure. About a quarter of anglers also reported fishing the Taupo region.

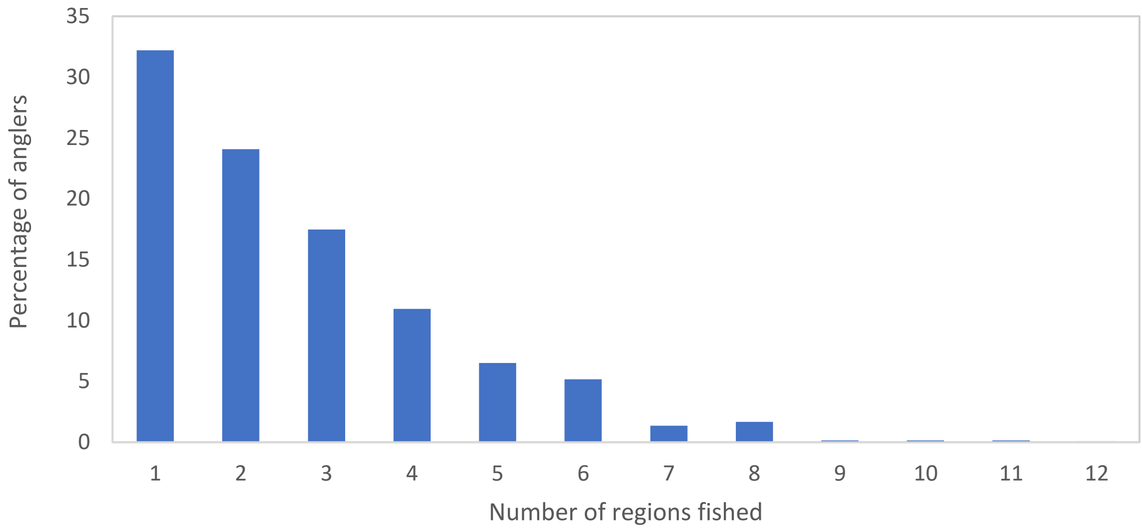


Figure 4. Number of regions (12 FGNZ regions and DOC Taupo fishery) fished by non-resident anglers while visiting New Zealand.

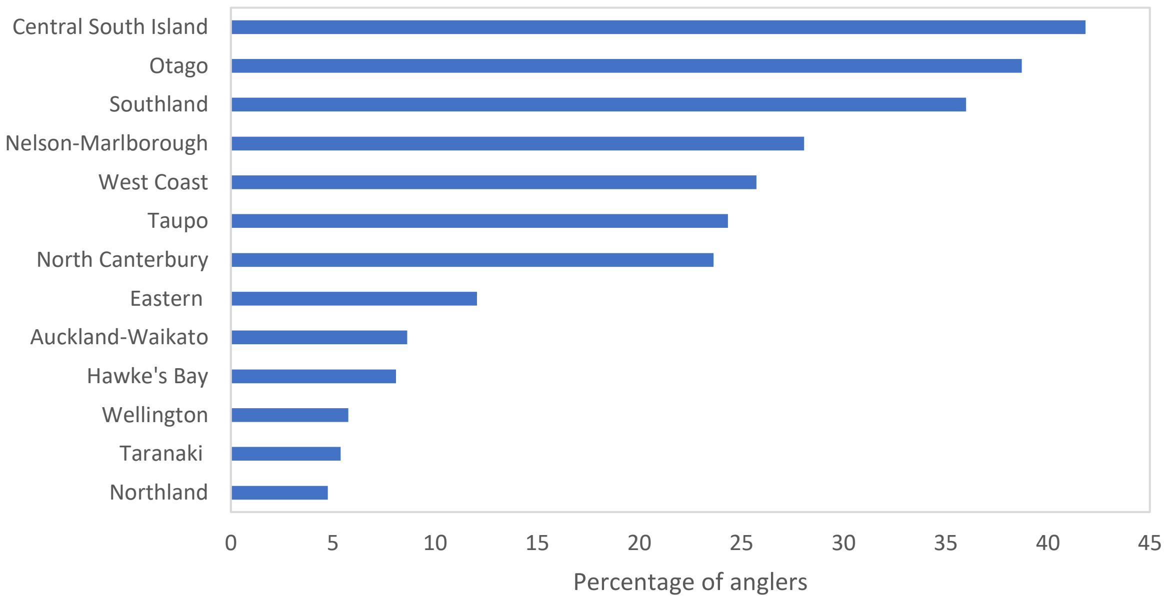


Figure 5. Regions fished by non-resident anglers while fishing in New Zealand

Use of guides was reported by 36 % of non-resident anglers, while just 11 % reported flying-in to a fishery while in New Zealand. About half of non-resident anglers (48 %) said they hiked more than 1 hour to access a fishing location and 32 % of anglers said they camped overnight (either tent or hut) on a river. The maximum number of nights spent on an individual fishery was three or fewer for 80 % of anglers, while 3 % of anglers reporting staying >10 nights on a single fishery (*Figure 6*).

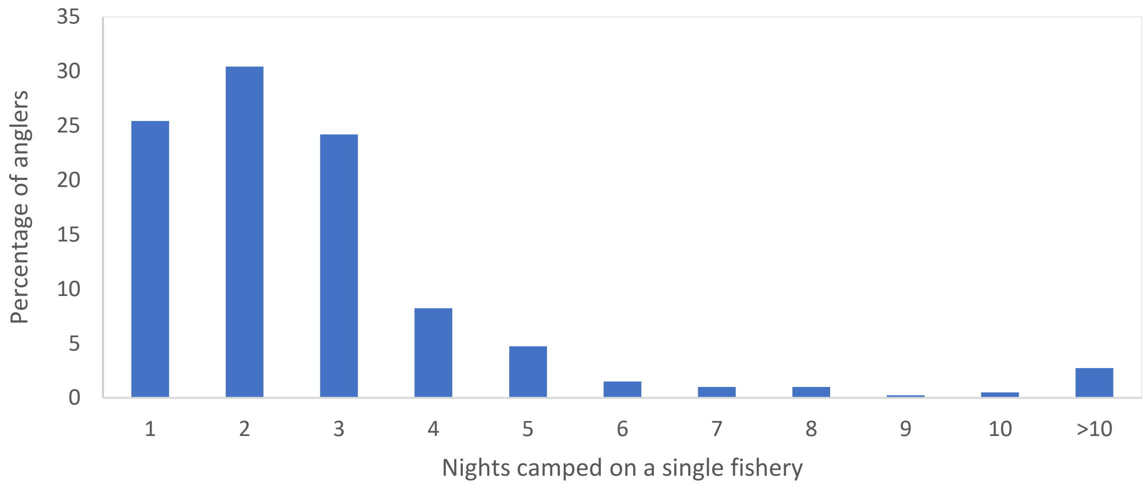


Figure 6. Maximum nights spent camping (tent or hut) on a single fishery by non-resident anglers fishing in New Zealand

Fly-fishing was the preferred method for >80 % of non-resident anglers. Spin-fishing was preferred by about 15 % of anglers. Anglers were interested in fishing a range of fishery types, particularly small streams, backcountry and headwater fisheries and lowland rivers (*Figure 7*). It should be noted that lowland rivers cover a diverse range of fisheries, and previous studies have identified some lowland fisheries are very popular with non-residents (e.g., Oreti, Mataura) because they offer characteristics similar to a backcountry fishing experience (i.e., scenic qualities, less intensive development). Lowland fisheries in more intensively developed and modified catchments/reaches are less preferred by non-resident anglers (Unwin 2016). The use of small stream and backcountry fisheries by non-resident anglers is likely due to their strong preference for clear water sight-fishing opportunities which has consistently rated as a key characteristic valued by non-resident anglers (Unwin, 2016).

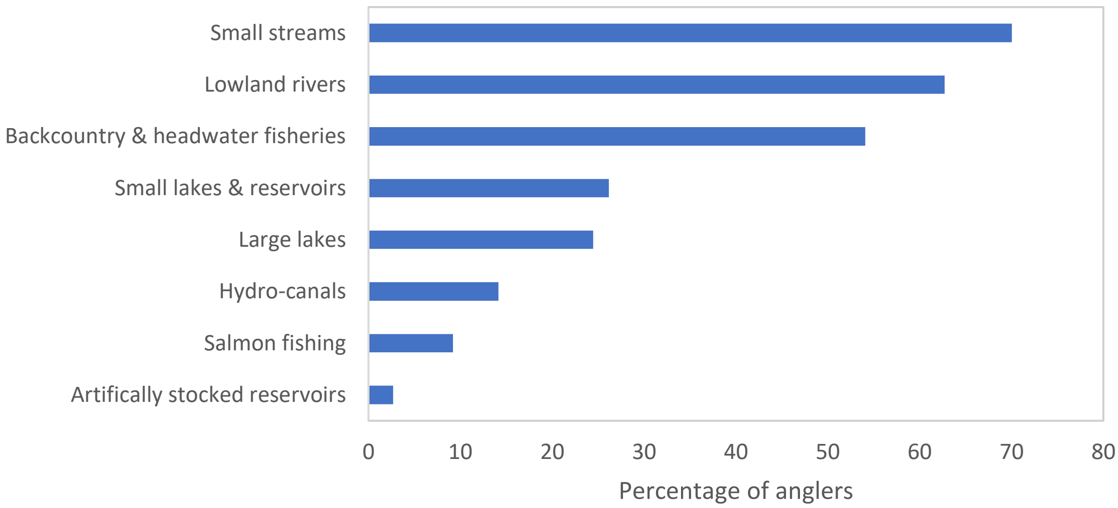


Figure 7. Preferred fishery types for non-resident anglers visiting New Zealand.

Around 73 % of anglers identified specific waters they wated to fish prior to visiting New Zealand. Anglers rated lack of crowding/few other anglers, sight fishing opportunities/clear water, and scenery as the most important factors influencing where they chose to fish in New Zealand (*Figure 8*). Other attractions in the area was rated as the least important.

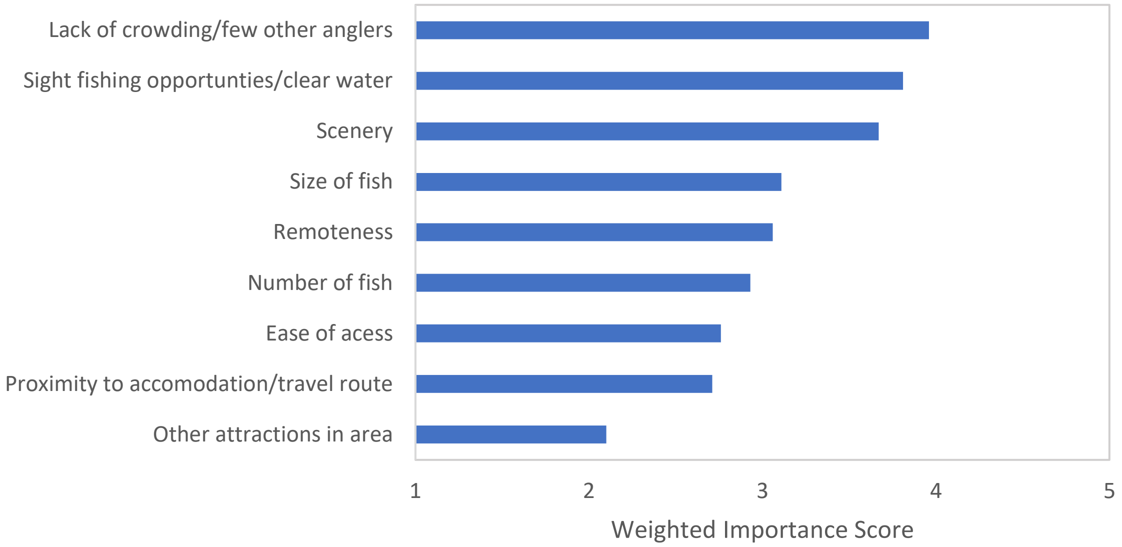


Figure 8. Weighted important score for some key factors influencing choices of fishing location for non-resident anglers (1=not at all important, 2=somewhat important, 3=moderately important, 4=important, 5=very important).

Anglers utilised a range of information sources when planning their fishing trip in New Zealand. Recommendations from friends, the Fish & Game New Zealand website and fishing guide recommendations were among the most popular ways to obtain information (*Figure 9*).

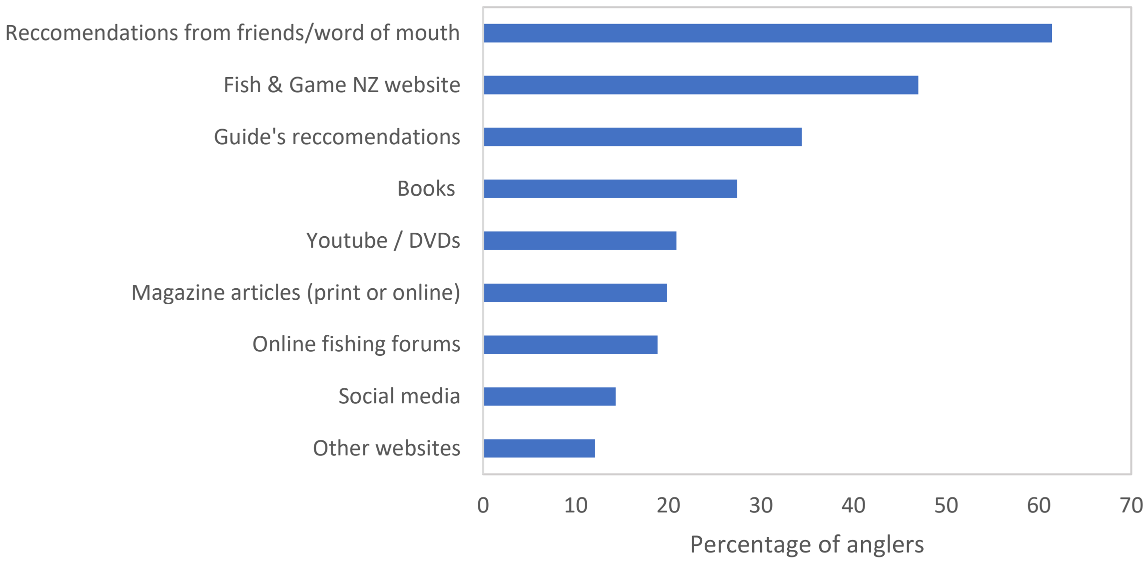


Figure 9. Preferred information sources accessed by non-resident anglers when planning their fishing trip to New Zealand.

When selecting an international fishing destination, water quality was rated as the most important factor for anglers, followed by lack of crowding/few other anglers, sight fishing potential, scenery and number of fisheries available (*Figure 10*.) Cost of licences was the least important factor.

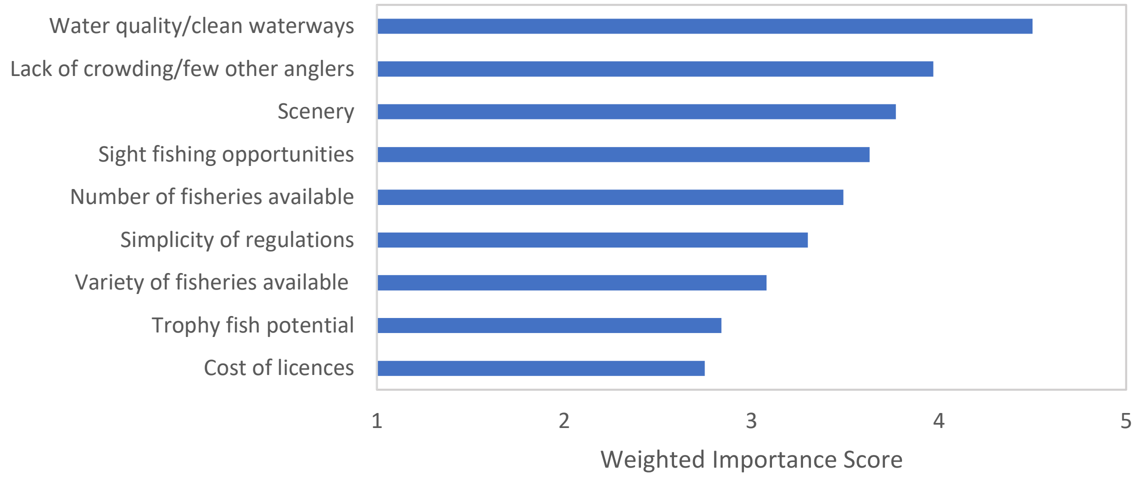


Figure 10. Weighted importance score for key factors influencing choice of international fishing destination for non-resident anglers (1=not at all important, 2=somewhat important, 3=moderately important, 4=important, 5=very important).

Future intentions

There was a high level of interest in returning to New Zealand to fish with 55 % of anglers saying there were very likely to visit in the next two years and 20 % indicating they were likely to visit again in the next two years. It should be noted that the survey responses may have been biased towards anglers who were already considering returning to fish in New Zealand, although response biases were not specifically investigated in this study.

General comments

Anglers were asked to provide any additional comments about fishing in New Zealand or freshwater fisheries management in New Zealand and 633 anglers entered comments. Several key themes were apparent – positive comments about the fishing experience and fisheries management in New Zealand, concern about environmental degradation and the need to protect fisheries, importance of preserving access, concerns about crowding/tourism growth and comments relating to licencing and regulations. Approximately 5 % of anglers commented that the cost of licence was too high; three-quarters of these anglers were from Australia. The limited range of licence options for non-residents was also an issue for many of these anglers who expressed frustration at being required to purchase a season-length licence despite only making a short-term visit to New Zealand.

Summary

Most non-resident anglers who purchased a non-resident season licence in the three seasons prior to the COVID-19 pandemic (2018-2020) visited New Zealand for 2-4 weeks and fished around 7-10 days during their stay. It should be noted that this survey did not include anglers who purchased 24 hr/day licences only[1]. Most anglers preferred fly fishing and were most interested in small streams, headwater and backcountry fisheries and lowland fisheries, with lack of crowding, sight fishing opportunities and scenery the most important factors influencing where they chose to fish.

[1] The angling behaviours of 24 hr licence holders was considered by Hayes and Lovelock (2016).

About 30 % of anglers said they fished a designated backcountry fishery during their trip and most of these fished designated fisheries for four or fewer days. Understanding existing levels of use is important when considering proposals to limit use. The results of this survey suggest a proposed limit of four days represents somewhat of a 'status quo' level of use and would not significantly impact most non-resident anglers. However, approximately 10 % of non-residents anglers would be restricted by such a limit. Therefore, a four-day limit is considered to be a reasonable starting point for introducing restrictions to manage pressure on these waters. Effects might differ depending on whether limits are applied at a fishery, catchment, regional or national scale.

Changes to licencing options and pricing can have effects on angler perceptions of value and intentions to revisit (Lovelock and Hayes, 2020; Hayes and Lovelock, 2016). It is important that any proposed changes be considered in the context of overall fisheries management objectives and are supported by appropriate evidence. While differential licence pricing has been in place for almost a decade, opposition has persisted among a minority of non-resident anglers (apparently overrepresented by frequently visiting anglers from Australia). Targeted communication and education about the rationale for non-resident licencing and additional licencing requirements for pressure-sensitive fisheries would help address such views, improve perceptions of value, and encourage support for any future changes.

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[i] Exact angler days >60 days were not collected i.e., anglers selected >60 days instead of entering a number. This was considered to be at the upper limit of reliable recall of fishing days and represented by only a small number of very active anglers.