Before Environment Canterbury Regional Council

In the matter of	of the Resource Management Act 1991
And	
In the matter of	the Rangitata Diversion Race Consents

Statement of evidence of Mark Webb for Central South Island Fish and Game Council

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Qualifications and experience

1. My name is Mark Whitby Webb.

2. I am a Senior Fish and Game Officer for Central South Island Fish and Game Council, a position I have held since 1984.

3. I graduated from the University of Canterbury with a BSc in 1979 and have since worked in freshwater fisheries for the Ministry of Agriculture and Fisheries, the former South Canterbury Acclimatisation Society and subsequently the Central South Island Fish and Game Council.

4. I have more than 30 years' experience in sports fish and game bird management, most of that in Mid Canterbury, South Canterbury and North Otago. With that experience I have acquired a sound understanding of habitat requirements of sports fish and game birds, the recreation based on these species and conflicts associated with water allocation and use.

5. In preparing this evidence I have reviewed:

   (a) The reports and statements of evidence of other experts giving evidence relevant to my area of expertise, including:

      (i) Klondyke Storage Proposal – Hydrology Assessment (July 2016);

      (ii) Rangitata Diversion Race Fish Screen – Hydrology Assessment (November 2017);

      (iii) Klondyke Water Storage Facility Fish Screen Verification Management Plan (revised September 2017);

      (iv) Proposed Fish Screen for the RDR: Assessment on Rangitata River Water Quality and Aquatic ecology (November 2017);

      (v) The evidence of Gregory Ian Ryder prepared for this hearing;

      (vi) The Section 42A Officer's Report prepared by Natalia Ford, Canterbury Regional Council, March 2018;

      (vii) The evidence of Darryl Murray Hicks prepared for this hearing; and

      (viii) The evidence of Alistair John Keane prepared for this hearing;

   (b) I have contributed to the Joint Witness Statement of Greg Ryder (RDRML), Paul Morgan (RDRML), Adrian Meredith (Canterbury Regional Council), Marty Bonnett (Central South Island Fish and Game), and Mark

Webb (Central South Island Fish and Game) on water quality and aquatic ecology, dated 19 March 2018.

6. I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

7. I have been asked by Central South Island Fish and Game Council (**CSIFG**) to prepare evidence in relation to Rangitata Diversion Race Consents. This includes:

   (a) Freshwater fishing in New Zealand

   (b) Angler use of the Rangitata River salmon fishery

   (c) Distribution of salmon angling – time and space

   (d) Influences on salmon angling amenity – river flow, turbidity, and catch

   (e) Influences on salmon angling amenity – flow variability

   (f) Rangitata River salmon population dynamics

   (g) Rangitata River juvenile salmon

   (h) Sediment

Executive summary

8. In 2006, New Zealand and Central South Island Fish and Game Councils were successful in their application for a Water Conservation Order on the Rangitata River in recognition of its outstanding recreational, amenity, natural characteristics and fishery values, among other things.

9. Freshwater sports fishing in Canterbury is an important recreation and up to almost one-third of all river fishing in New Zealand occurs on the four big salmon rivers. On the Rangitata about 70% of all fishing is for salmon.

10. Salmon anglers are very dedicated and passionate sports people by necessity – on average anglers need to fish for 50 hours to catch a fish and on average 70% of anglers do not catch a fish each season.

11. The area of the river that will be most affected by the proposed 10 m³/s abstraction is the area where 90% of salmon angling takes place and where 94% of salmon are caught during the salmon fishing season.

12. Annually, about 1,500 salmon anglers fish the Rangitata River with about half of angler activity occurring around the river mouth. Almost all fishing is done using spinning gear with an assortment of shiny, coloured metal lures. Upriver fishing requires considerable skill and experience to read the surface currents and bed shape to identify likely places where salmon lie. Contrary to trout fishing, almost never are salmon able to be seen and cast to, instead the river angler needs to visualize the salmon "lies". Also salmon are not induced to bite a lure thinking it is food since they do not feed from the time they enter the river until they die after spawning up to 6 months later. The river angler's chances of success are greatly enhanced by changes in river flow that induce salmon to migrate upriver en masse called a "run", with a result being that more of the salmon lies contain fish and the flow variation helps the angler to identify more lies.

13. Salmon angler activity targets Klondyke flows between 70 m³/s and 110 m³/s and natural variation in flows in this range. Activity declines rapidly in flows over 110 m³/s as water clarity deteriorates. The applicant's proposed additional 10 m³/s take is sourced from flows between 132.6 m³/s and 142 m³/s. The net effect of this and other takes will be to reduce the lower river flow to 77 m³/s and at times this flow will have the clarity of the river above Klondyke and be unsuitable for angling. Natural flow variability will also be reduced.

14. Over the last 20 years annually on average 1.1 million salmon fry moving seaward from spawning grounds above the Rangitata gorge must negotiate the RDR intake. It is estimated between 5% and 25% of these fry enter the RDR intake and the current BioAcoustic Fish Fence (**BAFF**) fish screen returns only about one-third of these back to the Rangitata River. This loss of salmon and any further loss resulting from the applicant's additional 10 m³/s abstraction is contrary to the requirement of Clause 10(2) Water Conservation (Rangitata River) Order 2006, to prevent fish from being lost from the Rangitata River.

15. Salmon fry of three to six months of age and 35mm to 100mm in length leave the upriver spawning grounds on their seaward migration largely from August through to April, with a small percentage spending more than a year in freshwater before migrating in the following spring at 120mm to 180mm in length. About 80% of salmon spend two and a half years at sea, returning as three-year olds, with the remainder turning one year younger or one year older. The returning adults are either caught by anglers or continue upriver to spawn and die.

16. I expect salmon migration occurs in the 132.6m^3/s to 142.6m3/s range that RDRML have sought to take water, and that the flow variability in this range,

which will be removed by the proposed take, is advantageous to salmon migration .In addition, increased fine sediment (<2mm particle size) deposition in the Rangitata River, as a result of reduced flows generally and particularly during sand trap flushing, may impact on the amount and quality of trout and salmon habitat present by shallowing of water depths and smothering of food producing habitat.

Freshwater fishing in New Zealand

17. Annually throughout New Zealand, approximately 190,000 anglers fish our lakes, rivers and estuaries for sports fish. Fishing occurs primarily for brown and rainbow trout and Chinook salmon all of which were first introduced to New Zealand waters between about 1875 and 1910.

18. New Zealand anglers are extremely fortunate to have the only self-sustaining sea-run Chinook salmon fisheries outside of their native Northern Hemisphere range. The Rangitata is one of the four main salmon fishing rivers so it has both national and international significance. The other three salmon rivers are the Waitaki, the Rakaia and the Waimakariri. The Waimakariri River due to its close proximity to Christchurch, receives the most angler attention followed in order by the Rakaia, Rangitata, and Waitaki rivers.

19. Since 1990 management of sports fish angling in New Zealand has been jointly undertaken by the Department of Conservation (**DOC**) and Fish and Game New Zealand (**FGNZ**). Functions of the two organisations are separated by regional boundaries. DOC is responsible only for the Taupo Conservancy in the Central North Island under s53 Conservation Act 1987, while 12 Fish and Game Regions cover the remainder of the country.

20. FGNZ has statutory responsibility for freshwater sport fishing and gamebird hunting. While the sports fish and gamebird populations are a public resource and belong to all New Zealanders they are managed on the Crown's behalf by FGNZ. This management is not a burden on the taxpayer as Fish and Game is funded almost entirely by the sale of fishing and hunting licences. Management of a public resource by the principle user group rather than a department of the state is unique on a world scale.

21. Every person legally fishing for sports fish in freshwater must do two things. They must have a current sports fishing licence issued by a Fish and Game Region and they must comply with the Anglers Notice in force at the time. The only exception to these requirements is the concession made to landowners who may fish on their own land without a licence although they must still comply with the Anglers Notice.

22. The most recently published census figures are those from 2013. At that time there were estimated to be 1,581,300 adult male residents in New Zealand. In total 58,900 whole season adult fishing licences were held by this age group in the 2014/15 season or 3.7% of the male population. The distribution of adult whole season licence holders was not even over the country but clearly favoured the South Island. On average 1.5% of adult males in the North Island held whole season licences in 2014/15 compared to 10.2% of South Island adults. In the CSI Region approximately one adult male in every 5.4 held a fishing licence and this was the highest incidence of fishing activity on a regional basis (Figure 1). Clearly freshwater sports fishing is an important recreation for South Island adult males and particularly for those in the CSI Region.

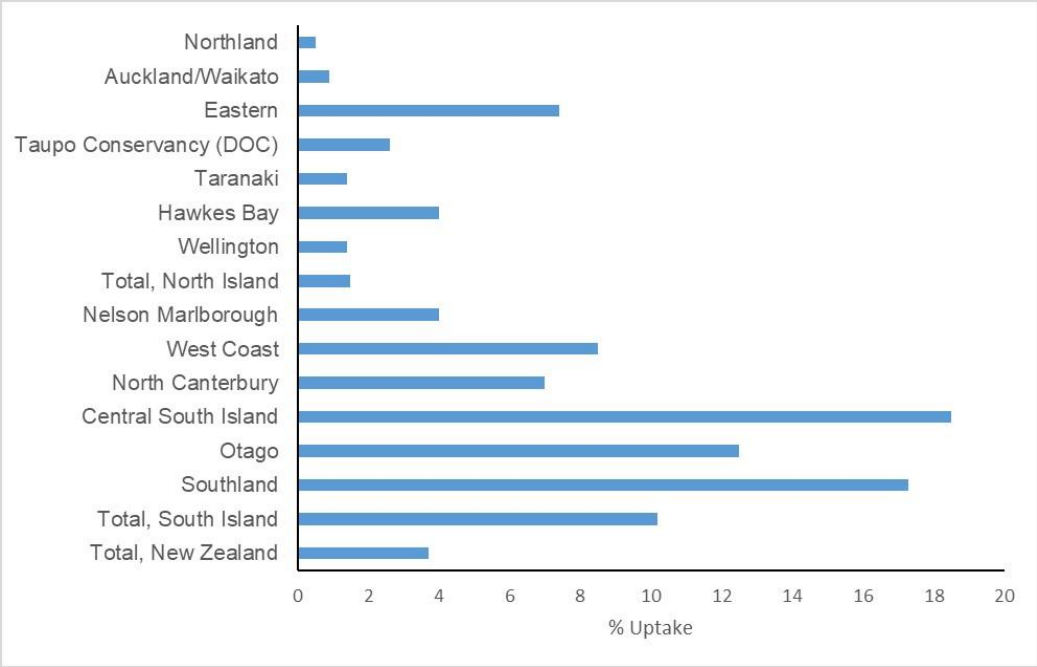

Figure 1. Sales of FGNZ whole-season adult male fishing licences for the 2014/15 season in relation to population figures from the 2013 Census, by FGNZ region. (From Unwin 2016)

23. The sports fisheries of the Canterbury Region are managed by Central South Island and North Canterbury Fish and Game councils (CSIFG and NCFG respectively). In the last five years these regions combined have licenced 33,000 to 37,000 anglers annually to fish for sports fish.

24. Fishing licences are issued by all Fish and Game New Zealand regions and any Region's licence can be used in any other Fish and Game Region. There is no residency or use requirements for anglers living in a Fish and Game Region to be licensed by that Region or to only fish in that Region.

25. The number of fishing licences issued by a Fish and Game Region is not a measure of the fishing activity undertaken in that Region since the number of fishing trips made by that Region's anglers and by anglers with other region's licences is not known. A survey of national angler effort that samples angling throughout the country can account for straying of anglers away from their home regions and more accurately reflects angler use of individual fisheries and their relative value.

26. At approximately seven-year intervals FGNZ contract the National Institute of Water and Atmospheric Research (**NIWA**) to undertake a survey to assess New Zealand-wide angler effort in terms of total angler-days for each fishery from random interviews of up to 35,000 sports fish anglers. The first National Angler Survey (**NAS**) was for the 1994/95 season followed by surveys in 2001/02, 2007/08 and 2014/15. Across those surveys New Zealand wide effort put into freshwater angling has averaged approximately 1.3 million angler-days per season of which 57% was directed to river angling and 43% to lake angling (Unwin 2016).

27. Across the four NAS between 18% and 29% of all river angling effort in New Zealand has occurred on the four major salmon rivers in the central South Island east coast.

28. The Rangitata River is consistently one of the top five rivers fished in New Zealand across the four NAS alongside the Waimakariri, Rakaia, Mataura and Clutha rivers.

Angler use of the Rangitata River salmon fishery

29. The NAS records angler effort as an angler-day, where an angler-day is one angler fishing on one day. Exact effort in terms of hours or minutes, and catch are not requested from survey respondents due to likely bias in this information over a two-month recall period.

30. NAS estimates of angler use of the Rangitata River are as follows –

    1994/95 season – 35,960 ± 2,550 angler-days
    2001/02 season – 12,710 ± 1,930 angler-days
    2007/08 season – 33,230 ± 3,560 angler-days
    2014/15 season – 28,330 ± 3,690 angler days

31. Fish and Game annual salmon catch surveys undertaken since 1993/94, indicate the 2001/02 season to have been the worst in that period with only 150 salmon caught from the Rangitata River. The poor catch is reflected in low angler effort recorded in the NAS that season. Of the four NAS surveyed seasons the 1994/95 season had the highest angler use and the highest angler catch with 2,500 Rangitata salmon estimated to have been caught. Angler catch

in the 2007/08 and 2014/15 seasons was similar with recorded catch of 1,390 and 1,060 Rangitata salmon respectively.

32. Based on NAS and annual harvest survey results it is estimated that in an average year the Rangitata River sustains approximately 30,000 angler-days of fishing effort.

33. The 2014/15 NAS was the first NAS survey to identify angler effort attributable to trout or salmon fishing in the Rangitata River. Approximately 70% of angler effort, or about 20,000 angler-days was sustained by the salmon fishery alone.

34. End-of-season angler interviews conducted by stratified random telephone interviews of up to 1,500 CSIFG whole season licence holders each season since 1993/94 indicate the average salmon angler fishes for approximately 12 days per season and has a catch rate of about one salmon for 50 hours fished. In the last five seasons on average 70% of salmon anglers fishing the Rangitata each season did not catch a salmon.

35. The number of CSIFG whole season licenced anglers fishing the Rangitata salmon fishery and their catch of salmon estimated from end-of-season surveys are as follows -

    2011/12 season - 1,180 anglers, 980 salmon
    2012/13 season – 1,190 anglers, 1,280 salmon
    2013/14 season – 1,270 anglers, 1,110 salmon
    2014/15 season – 1,230 anglers, 1,130 salmon
    2015/16 season – 1,000 anglers, 410 salmon
    2016/17 season – 710 anglers, 320 salmon

36. In addition to these estimates of angler use and catch by CSIFG whole season licenced anglers, ranger interviews of 1,760 anglers fishing the Rangitata over 12 seasons identified local licenced anglers represented 77% of anglers present. The other 23% held NCFG (16%), Otago Fish and Game (4%), or other Fish and Game region's licences (3%).

37. I believe it is reasonable to assume that on average about 1,500 anglers fish the Rangitata River for salmon, annually. They spend about 20,000 angler-days on the river for a season catch of between 300 and 1,500 salmon.

38. On a day-to-day basis what dictates whether salmon anglers will fish or not is largely determined by:

    (a) The knowledge that salmon are likely to be present, that is the time of the season and any recent reports of salmon landed, and

    (b) River flow in terms of its colour, size and variation in the previous few days.

39. The exact combination of environmental conditions that trigger salmon to run from the sea into the Rangitata River are unknown; however, river flow, temperature, barometric pressure, and sea conditions, are implicated in most anglers' theories. Once salmon are in the river, flow, temperature and water clarity largely dictate angler catch of salmon.

40. Many anglers fish for hundreds of hours in a season and catch no fish at all while the average catch rate across all anglers is around 50 hours per fish. Expert anglers who have gained the experience to read the river to identify where fish will most likely "lie" and who have gained other knowledge to know when the fish will be in those places, can have season average catch rates as high as 5 hours per fish. The environmental conditions that expert anglers seek are declining flows after a flood or fresh and water clarity sufficient that they can just see the toes of their waders in water that is knee deep. In the absence of declining flows after a flood or fresh then small variations in flow of the order of 1 or 2 m^3/s over 24 hours are targeted.

41. The exact reasons why these conditions result in higher salmon catch rates are unknown. What is known is that if there is a run of salmon they tend to be moving up the river after a fresh, so a procession of fish can be expected to be moving into and out of the identified "lies", and the fish are more disposed to bite at an angler's lure. At higher flows salmon lies are too difficult for anglers to identify and the water is believed to be too discoloured for salmon to detect lures. Salmon may well be present in the river at higher flows but our only gauge on salmon presence is angler catch and this is limited to the flows that anglers fish. At lower flows water is often too warm and clear to induce salmon to move, and fish will school-up in pools and be difficult to motivate to bite.

42. I address the timing and location of angling effort, and conditions considered favourable to angling, in further detail below.

Distribution of salmon angling – time and space

43. Adult salmon returning to the Rangitata River after one and a half to three and half years at sea generally make their first appearance at the river mouth in November. Increasing angling success and upstream extent of angling indicates these fish move upstream through the lagoon to the gorge reach through to March. It is not until January and February that angling picks up above the gorge.

44. Salmon do not begin to spawn in the headwaters of the Rangitata until late March so the reason why adult fish turn up at the river mouth five months earlier is unknown; however, the early runs of salmon are almost always associated with the period of decreasing flows after a fresh or flood. Later in the fishing season when the river is in its summer lower flow band smaller day to day

variation in flows are an important cue for increased angler activity when floods and freshes are less common.

45. As part of the end-of-season telephone interviews of randomly selected CSIFG licence holders, salmon anglers are also asked what reaches of the rivers they fished and their catch in each reach. While anglers are usually able to describe where they fished in terms of local landmarks or well-known access points, for the purpose of categorising angler distribution in the Rangitata River four reaches have been identified. These are:

(a) River mouth – includes surf, mouth and lagoon

(b) Mouth to SH 1 – top of the lagoon (start of the river) to SH 1 bridge

(c) SH 1 to Klondyke

(d) Above Klondyke

A fifth category records the response of anglers who were unable to recall the specific area they fished – this is recorded in the 'unidentified' category.

47. From the RDR intake at Klondyke downstream to the river mouth, approximately 89% of salmon fishing takes place and a similar proportion of total salmon catch is taken (Table 1). This is the river reach where flows will be diminished by consent CRC170654 if granted as applied for.

Table 1. Average annual distribution of fishing effort and season salmon catch in reaches of the Rangitata River in the five seasons between 2011/12 and 2015/16 for CSIFG whole season licence holders who were interviewed during end-of-season random surveys.

	Proportion of whole river salmon angler activity (%)	Proportion of whole river salmon catch (%)
Mouth, surf & Lagoon	48	39
Top of lagoon to SH1	24	34
SH1 to Klondyke	17	13
Above Klondyke	5	8
Unidentified	6	6

Influences on salmon angling amenity – river flow, clarity and catch

48. In this section I present information regarding preferred flows and clarity conditions for angling. The assessment is based on information obtained from

    (a) A three-year Rangitata salmon angler diary scheme from 1990 to 1993,

    (b) The 15-minute Rangitata River flow record at Klondyke from 1980 to 2000 that was the flow data agreed for use by the hydrology experts during the WCO process,

    (c) 15-minute turbidity records for the Rangitata River at State Highway 1, and 15-minute river flow records at Klondyke from May 2000 to January 2001 that was the period during which CSIFG operated their turbidity meter.

49. In the 1990/91 fishing season CSIFG commenced an angler diary scheme specific to angling for salmon in the fisheries it manages. This scheme ran for three seasons until its replacement with the end of season telephone interview of randomly selected anglers which continues today.

50. Over the three seasons from 1990/91 to 1992/93, between 24 and 42 Rangitata River salmon anglers took part annually with 15 anglers contributing every season and a further 12 contributing in two of the three seasons. Diaries recorded a total of 1,739 anglers visits to the Rangitata River for 7,500 hours fished and 407 salmon landed.

51. Anglers who have the enthusiasm and conscientiousness to maintain diaries cannot be regarded as 'average' anglers. These qualities are also among those needed to become expert anglers and if diarists apply these skills to their fishing they are likely to have a higher catch rate and a higher season tally than the average angler. Angler diarists can be considered as a group to be expert anglers.

52. Information obtained from angler diaries generally contains more information on the catch of salmon than might be expected from a random sample of salmon anglers. These anglers have acquired the knowledge to read the conditions that promote successful angling and these conditions are likely to be a more common thread in their records. The collective information on times, dates, fishing effort and success is important for revealing environmental conditions that encourage anglers to fish and accordingly, what the conditions are that change fish behaviour and make them more available to anglers. I believe the expert angler information indicates that flow variation and the level of flow that anglers assess by clarity, are triggers for salmon movement.

53. Experienced salmon anglers do not simply look up the ECan flow site to see what the flow is on the day and then decide whether they will go fishing. Indeed, during the time of the expert angler diary scheme the only access anglers had to river flow information was in the local newspaper from the day previous which itself was out of date at the time of printing. Instead keen anglers predict river conditions based on how river flow and clarity have changed in the last few days. They will read the weather in terms of recent nor'west rain in the headwaters and relate their flow, clarity and flow change predictions to other times they have fished and achieved success.

54. As fishery managers, CSIFG need to unravel the key conditions that influence salmon angling and its success in order to seek protection for recreational fishing and the environmental conditions that maintain the Rangitata as a salmon river. Angler catch information is the only information CSIFG has that can be used to identify what are the river conditions that are important to salmon migration. Of course a significant downside to this is that when anglers are not fishing – when the river is high and dirty, we have no angler information yet we know salmon are present and moving. So while certain flows are important for angling I believe there is a wider range of flows, particularly in the high flow range that are important cues for adult salmon migration.

55. Most angler effort by the expert diarists, just under 1,200 visits, was attributed to fishing in the lagoon, river mouth, and surf. Five hundred and forty-two diary entries recorded fishing in the river above the lagoon and upstream to Klondyke (RDR intake). Only eleven entries recorded fishing in the gorge or above.

56. Review of the flow preferences for angler diarists who fished the Rangitata River between the RDR intake and the top of the lagoon over the 1990 to 1993 seasons indicates good correlation between mean daily flow at Klondyke and angler activity.

57. Preferred flows for salmon fishing in the river below the RDR intake are those corresponding to a Klondyke flow range of between 70 and 110 m^3/sec. This is matched by a similar flow range within which salmon catch peaks.

58. In reality anglers fishing downstream of the RDR intake were not fishing river flows recorded at the Klondyke flow recorder. The RDR intake is immediately below the Klondyke flow recorder and the RDR take (which was operational at the time the diaries were kept) must be subtracted from the Klondyke record to generate the residual flows for the river. . Flow sharing rules are contained in Table 1, Rangitata River Water Management Plan 1986, and repeated in s9(4) and s9(5) Water Conservation (Rangitata River) Order 2006. Since 2013 the additional abstraction by RWL also impacts on flow in the river below Arundel.

59. During the three-season period when angler diary records were maintained the preferred flows for salmon angling in the Klondyke flow range of 70 m^3/s to 110 m^3/s corresponded to a residual river flow downstream of the RDR intake of approximately 40 m^3/s to 80 m^3/s.

60. Across the three fishing seasons 76% of salmon taken by diarists were caught below the RDR intake when the Klondyke flow was recorded as being between 70 m^3/s and 110 m^3/s. Flows were in this range 39% of the time during the fishing season and diarists expended 64% of total effort within that flow band. Approximately 14% of total diarist effort was expended in flows above 110 m^3/s and up to 190 m^3/s for a return of 5% of total catch.

61. Angler activity between Klondyke and the lagoon increased over the 50 m^3/s to 90 m^3/s Klondyke flow range, peaked in the 90 m^3/s to 110 m^3/s range and then rapidly declined as flows approached 145 m^3/s. Some angler activity is recorded through to flows of 190 m^3/s. I believe the rapid decline over 110 m^3/s is caused by deteriorating water clarity in high flows producing conditions where salmon are uncatchable.

62. Expert angler diaries indicate that following a period of river flow below the preferred angling minimum of 70 m^3/s at Klondyke during the salmon fishing season, a rapid rise in flow preceding a flood or fresh peak will provide a short period of time when flow and clarity are within the preferred fishing flow band. After the flood peak, as flow gradually recedes, the period of time the river spends in the preferred fishing band is longer and heralds concerted angler effort if this occurs during peak salmon fishing periods. The post-flood peak fishing band is that which is most commonly used by anglers because it is easier to predict and it is longer in duration. That angling success is higher also indicates that salmon abundance and behaviour are more likely to favour angler catch.

63. Salmon anglers consider water clarity is ideal for salmon fishing when they can just see the toes of their boots when standing in knee-deep water. If water is crystal clear or it is filthy dirty these conditions are less favoured by anglers. In between these extremes there is a narrower preferred band where water clarity changes as flow increases, from slightly too clear to ideal to slightly too dirty.

64. The automatic turbidity meter installed at State Highway 1 over the winter to mid-summer of 2000/01 provided a means to identify the water clarity range corresponding to preferred fishing flow band between 70 m^3/s and 110 m^3/s identified in paragraph 59. Below 10 Nepthelometric Turbidity Units (**NTU**) the river was too clear for good salmon angling and above 30 NTU it was too dirty. This does not mean that outside this range angling ceases and no salmon are caught, only that it is not preferred and is less likely to result in success.

65. When considering possible impacts of the RDR high flow take (CRC170654) on salmon fishing, the avoidance shown by anglers for flows above 110 m³/s at Klondyke brought about by experience with poor angling success in dirty water, is a significant threat to the outstanding salmon fishing values of the Rangitata River.

66. The applicants AEE, Klondyke Storage Proposal – Hydrology Assessment pages 26-28, presents information on the increased time that the Rangitata River downstream of the RDR intake will be at a residual flow of 77 m³/s as a result of the additional 10 m³/s being taken by the RDR. This increase appears to be in the order of 5%, being the difference between the 20th percentile and the 15th percentile when the existing plus RDR proposed take will result in flows of 77.3 m³/s to 77.4 m³/s (Table 10, Klondyke Storage Proposal – Hydrology Assessment). The AEE concentrates on the extra time the lower river will spend at 77 m³/s and does not consider the quality of the water in terms of clarity/turbidity that will result. The extra time the lower river will spend at 77 m³/s will be a result of the additional proposed RDR take which would occur when the flow at Klondyke is between 132.6 m³/s and 142.6 m³/s. The residual river flow at these times will be 77 m³/s but will be sourced from flows that were 132.6 m³/s to 142.6 m³/s. So while the lower river flow volume is within the preferred angling residual flow range the quality of the water due to low water clarity will be poor for angling. To anglers these are considered too high for fishing and expert anglers with many years' experience identify these are not flows fished successfully.

Influences on salmon angling and salmon migration – flow variability

67. Over the 70 m³/s to 110 m³/s flow range in the Rangitata River at Klondyke, change in flow from day to day is equally important to anglers as a cue for angling as the flow rate on any particular day. If the river were to be held at a steady flow within the range even though salmon would likely be present, anglers would lose the opportunity to target the particular conditions that produce salmon angling “lies” they can identify that normally occur for only a short period of time as river flow changes.

68. Data from the 1990 – 1993 angler diary scheme established that a feature of the increased angling effort and success in the preferred flow range was the tendency for the flow to be in this range over short periods of five to ten days duration as flow generally decreased through the range. The periods are short because during the preferred fishing months of January to March the flow is on average in that range only one day in five. On occasions freshes in river flow of 5 to 15 m³/s during these periods prolonged good angling conditions.

69. In the three-season diary record 10 short periods of intense angler activity and salmon catch were identified. These periods totalled 72 days in duration, or

about 13% of the November to April fishing season days available to anglers. Almost half (47%) of all angler visits to the river over the three seasons were made during the ten periods and 70% of all salmon were caught.

70. These intense events averaged 7 days in duration with a peak flow at the Klondyke recorder of 122 m³/s and low flow of 64 m³/s, and an average change in flow of 23 m³/s over the 7 days.

71. In reference to the reduction of natural flow variation in the lower river as a consequence of the proposed 10 m³/s RDRML take, the evidence of Alistair Keane at paragraph 39 is that overall the river flows are held steady at about 80 m^3/s for an additional 2% of the time or on average about 7.3 days per year.

72. While the increased time the river below Arundel is held at around 77 m³/s due to the additional RDRML 10 m³/s abstraction, the extra time is derived from flows above Klondyke of between 132 m³/s and 142 m³/s and these can be considered to be too dirty for salmon angling. However, the angler records above demonstrate the importance of flow variability to salmon migration cues. While anglers consider these high flows are unproductive for fishing, I expect salmon migration is maintained in this flow range and enhanced by flow variation through the range just as it is in the preferred angling flow range.

Rangitata River salmon population dynamics

73. The Chinook salmon has a life cycle with critical components in both freshwater and marine habitats. Salmon spend their first three to twelve months and their last six months, in freshwater. In between they can spend one and a half to three and a half years growing at sea.

74. On returning to freshwater adult salmon are either caught by anglers and removed from the river or they avoid anglers and continue upriver to spawn. The total run of salmon in any season can be estimated from the sum of its two components – angler catch and spawning population. The run can be further divided into components that are salmon returning as almost two, almost three, or almost four year olds most simply on the basis of size and more accurately by identifying growth rings on salmon scales. Angler catch is estimated annually by random survey of licenced anglers and the spawning population is estimated by repeat aerial counts of fish present on the spawning grounds.

75. Robust and consistent estimates for the size of the annual salmon in the Rangitata River are available from 1994 when annual surveys of live fish on the spawning grounds and angler harvest surveys commenced. Prior to this redd (salmon nest) counts and occasional angler surveys provide broad estimates of salmon run size back to the 1950's.

76. Since the 2000/2001 season returning salmon runs to the Rangitata River have been consistently poor and the five lowest runs on record have occurred in this period. Since the year 2000 the Rangitata salmon run has averaged 2,170 fish and ranged between 730 and 4,310 fish. In the decade prior to this the average run was 7,640 fish and ranged between 2,910 and 12,830 fish.

77. Understandably Fish and Game New Zealand and anglers are concerned for the future of the fishery. While the salmon fishery has always been characterised by two- to six-fold changes in run size from year to year, never has it been so low and so consistently low as it has been in the last 20 years.

78. While the similarity of salmon population trends across the four major East Coast South Island salmon fisheries suggest a significant component of the poor survival of salmon occurs where salmon from all of these populations are in the same environment – at sea, there is no single cause that can be identified and it is more likely that in its current state the fishery is less resilient to other influences. These include intensified agricultural development around spawning streams, commercial by-catch of salmon at sea, hydroelectric development, and large-scale water abstraction with ineffective or no fish bypass.

79. Fish and Game New Zealand has recognised these threats and is directing additional resources toward understanding and protecting the salmon fishery. These initiatives include more advanced monitoring programmes, research into marine climatic factors which affect run size, research into the impact of irrigation on salmon migration, monitoring of the effectiveness of fish screens and bypasses, and proactive measures to protect salmon habitat from degradation, such as took place with the application for a Water Conservation Order on the Rangitata River.

Rangitata River juvenile salmon

80. In the Rangitata River 93% of known salmon spawning occurs in Deep Stream (Mesopotamia) and Deep Creek (Mt Potts). These are spring fed gravel bedded systems in the upper reaches of the Rangitata River above the gorge. Other known spawning sites include a handful of much smaller springs above the gorge, Ealing Springs at State Highway One, and McKinnons Creek about 4km above the river mouth. All of these streams are named in the Water Conservation (Rangitata River) Order 2006, Schedule 2 as waters to be protected for their outstanding salmon spawning characteristics, among other things.

81. Average annual production of salmon fry from Deep Stream and Deep Creek since 2000 is estimated to be approximately 1.1 million fry and ranging from 375,000 to 2.77 million. These figures are derived from annual spawning

population estimates from repeat count of live spawners, an average 50:50 sex ratio, 3,000 eggs per female, and 50% survival from egg to fry (Unwin, 1986).

82. Without exception all of these juvenile salmon must migrate down the Rangitata River to the sea to complete their life cycle. Before reaching the sea there will be natural mortality due to predation, competition for food, and natural attrition. In addition, the RDR currently diverts approximately 30% of the mean flow of the Rangitata River at Klondyke during the irrigation season and the loss of juvenile salmon into the RDR is a significant issue for CSIFG and anglers.

83. The Water Conservation (Rangitata River) Order 2006, Schedule 2 identifies all of the Rangitata River between the spawning streams above the gorge and the coast as waters to be protected for their outstanding salmon passage characteristics, among other things.

84. In a concerted effort to estimate juvenile salmon diversion from the Rangitata River into the RDR intake, Rangitata Diversion Race Management Limited (**RDRML**) and CSIFG undertook a joint project running the length of the 1998/99 irrigation season. Juvenile salmon diversion for that season was estimated at 204,200 fish with 95% confidence limits = 127,100 and 326,700 (Unwin et al., 2005).

85. The 204,200 salmon estimated to have been diverted into the RDR in 1998/99 was believed to represent at least 5% and possibly up to 25% of all juvenile salmon migrating downstream passed the RDR intake that season (Unwin et al., 2005).

86. When RDRML resource consent applications to operate the RDR Scheme were heard in 2003, the Rangitata Water Conservation Order had not been gazetted and the requirements for preventing fish from being diverted came from the Freshwater Fisheries Regulations 1986. Given the significant extent of salmon losses into the RDR identified in 1998/99 RDRML accepted as a condition of consent that it would take such measures as are appropriate to ensure that, as far as is reasonably practicable, juvenile salmon are excluded from the body of the diversion race and are returned to the river.

87. RDRML commissioned a Bioacoustic Fish Fence (**BAFF**) and bypass in the RDR in August 2008. Between 2008 and 2017, during annual monitoring of the efficiency of the BAFF in diverting salmon from the RDR and into the bypass back to the river, on a minority of occasions an efficiency of 80% or greater was achieved. Most often the BAFF efficiency was less than 20% and across all trials an average estimated efficiency of 33% has been reported (Ryder 2015).

88. If the objective is to protect the various fish species, particularly salmon, from the adverse effect of the RDR take, the efficiency of the BAFF is unacceptable.

At recorded levels of spawning in the Rangitata River headwaters above the RDR intake it is estimated that since the BAFF was commissioned, each year on average 1.14 million fry have been exposed to the RDR intake on their passage down the Rangitata River, between 57,200 (5%) and 285,900 (25%) of those have been diverted into the RDR and between 18,900 and 94,300 of those diverted into the RDR have been returned to the river by the BAFF. Despite the operation of the BAFF on average 38,300 to 191,600 juvenile salmon have perished in the RDR each year since 2008.

89. This loss could have been as high as 376,000 fish in the 2013/14 season when over 3,000 spawners were counted in the upper reaches and if 25% were diverted in to the RDR.

90. Clause 10 of the Water Conservation (Rangitata River) Order 2006, prevents granting of a resource consent for an intake from the Rangitata River unless there is a fish exclusion or a fish bypass system to prevent fish from being lost from waters specified in Schedule 2. In reference to our statutory responsibilities for sports fish, Fish and Game interpret this to mean that all sports fish diverted into the RDR from the Rangitata River will be returned to the Rangitata River unharmed.

91. Assessment of the proposed rotary fish screen is contained in the evidence of Mr Marty Bonnett.

Sediment and sandtrap flushing flow

92. Any abstraction of water from the Rangitata River reduces river flow downstream from the intake and potentially increases silt dropping out of the water column and settling along margins and pools in the river downstream from the intake.

93. It is the conclusion of Dr Murray Hicks in his evidence at paragraph 28, that extraction of more Rangitata River flow (such as the proposed additional 10 m^3/s) at conditions when the river carries significant concentrations of fine suspended sediment is indeed expected to result in increased rates of fine sediment settling into dead zones.

94. I believe there are two issues associated with this increased settling of fine sediment in the river downstream of the fish bypass outlet. Firstly, increased sedimentation carries greater risk to productive algal and invertebrate habitat that is needed to sustain current trout and juvenile salmon growth and survival. Secondly, the infilling and shallowing of adult trout and salmon deep water habitat. These issues could have adverse effects on the recreational fishery of the Rangitata by reducing the food and space currently available to trout and salmon.

95. Salmon anglers have learned that fishing is unsuccessful in areas of the river that have a silty bed – regardless of depth or flow there are no salmon lies there. It follows that adult salmon do not like silt laden substrate and any increase in the accumulation of silt on the bed reduces habitat available for migrating salmon.

96. The continuous bypass discharge will not only contain silt from the additional 10 m^3/s applied for, it will also discharge sediment from the current 30 m^3/s take. Suspended sediment in the Rangitata River downstream of the RDR bypass return will be directly affected since the concentration of particles in suspension will be higher than upstream of the RDR intake.

97. RDR return as much sediment as possible through routine flushing of the sand trap. That RDR only flush the sand trap in flows above 140 m^3/s assists with dispersion of the sediment, however at these flows all abstractions can be occurring. This means that the river will be subject to both the additional silt load and a reduction in flows.

98. The South Canterbury Catchment Board and Regional Water Board 1986-1996 Rangitata River Water Management Plan (Scarf and Waugh 1986), identified that at that time "the operation of the RDR sandtrap was governed by Crown Water Right authorising the Ministry of Works and Development, who owned and operated the RDR Scheme at that time, to discharge water and sediment into the Rangitata River subject to certain conditions and routine operation of this facility is controlled to minimise the impact of "flushing" on the river and on recreational fishing."

99. Appendix 4 to the 1986-1996 Rangitata River Water Management Plan contained operating conditions for the sandtrap. Condition (a) states "That this right may be exercised at any time provided the flow at the Klondyke recorder is greater than 140 m^3/s, or any such other figure as the Board may determine from time to time after consultation with the Grantee and representatives of local fisheries and recreational organisations."

100. Clearly the potential for the sandtrap discharge to adversely affect Rangitata River fisheries and recreation was acknowledged by the addition of that condition in 1986 and this is further supported by the evidence of Dr Hicks which indicates a possibility that sand trap flushings could at times be more conspicuous in the river than anticipated by Pattle Delamore Partners Ltd

101. I refer to the evidence of Dr Hicks and his assessment of the sand trap flushing and the effect that an additional 10m3/s take would have on sediment deposition downstream of the discharge site. I consider Dr Hicks' evidence supports the raising of the minimum flow for discharge events by 10 m^3/s to a Klondyke flow of 150 m^3/s, to take account of additional abstraction.

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