BEFORE THE SOUTHLAND REGIONAL COUNCIL

IN THE MATTER OF the Resource Management Act 1991

AND

IN THE MATTER OF Hearings of Application – APP-20171566 by Alliance Group Ltd (Applicant)

AND Fish & Game New Zealand – Southland Region (submitter)

STATEMENT OF EVIDENCE OF ZANE NIGEL MOSS ON BEHALF OF SOUTHLAND FISH & GAME COUNCIL

Dated: 28 November 2018

Southland Fish & Game Council
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Contact: Jacob Smyth

1. My name is Zane Nigel Moss.

Qualifications and experience

2. I hold a Bachelor of Science from Lincoln University majoring in Applied Biology (1993) and a Master of Science with Honours (First Class) from Lincoln University in Wildlife Management (1997).

3. I have approximately 22 years of experience in the environmental field with the Department of Conservation (West Coast Conservancy) and most recently Fish & Game New Zealand – Southland Region[1] (Fish & Game).

4. I have been continually employed by Fish & Game based in Invercargill since 1997, initially as a Fish & Game Field Officer with responsibility for the Mataura catchment and subsequently as Operations Manager for the Southland Region. Since 2016, I have been employed as the Regional Manager of Fish & Game for the Southland Region.

5. The Southland Fish & Game region encompasses the lower South Island, extending from the Mataura catchment across to Fiordland and South to Stewart Island. I am familiar with sports fish and game bird habitat and populations, including their life cycles, in the Southland Region.

6. My role entails managing and reviewing Fish & Game's game bird and sports fish population monitoring programmes, undertaking population assessments, compliance monitoring, field work and management and administrative work in relation to the sustainable management of sports fish and game birds in Southland.

7. I am an experienced and active trout and salmon angler and game bird hunter. I have hunted gamebirds and fished for trout and salmon intensively in Southland for the past 20 years and more extensively throughout the South Island for the past 35 years.

8. In preparing my evidence I have reviewed the following:

    a. The application and accompanying information provided by Alliance Group Ltd ('Alliance');

    b. The May 2018 report 'Review of Fish Screening Monitoring Provisions at Mataura Meatworks Hydro Intake' by Joe Hay, Cawthron Institute prepared for Department of Conservation, Ngai Tahu and Fish & Game;

    c. The s 42A report prepared by Stephen West on behalf of Environment Southland;

    d. Evidence filed on behalf of the Alliance, including the evidence of Doyle Richardson, John Kyle and Mark James; and

    e. Evidence of Tony Hawker on behalf of Fish & Game.

9. As referred to above, I am employed by Fish & Game – Southland Region, a statutory body whose function under s 26Q(1) of the Conservation Act 1987 is to manage

[1] Otherwise known as the 'Southland Fish & Game Council'.

sports fish and game and their habitats in the Southland Region in the recreational interests of anglers and hunters. This includes in relation to planning:

a. To represent the interests and aspirations of anglers and hunters in the statutory planning processes – 26Q(1)(e)(i); and

b. To advocate the interests of the Council, including its interests in habitats – s 26Q(1)(e)(vii).

In this case, I am providing evidence on behalf of Fish & Game – Southland Region in relation to the consent application by Alliance Group Ltd ('Alliance'). I am aware of, and in preparing this evidence have complied with, my overriding duty to assist the Hearing Commissioner impartially with matters within my area of expertise.

10. I confirm I have read and agree to comply with the Code of Conduct of Expert Witnesses in the Environment Court Practice Note. This evidence is within my area of expertise, except where I state that I am relying on what I have been told by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

11. My evidence will, from an ecological perspective, cover the following matters so far as they relate to Fish & Game's submission on the Alliance application:

a. The Mataura brown trout fishery values, including:

i. Angling season;

ii. Angling usage;

iii. Brown trout life cycle in the Mataura River, including patterns of movement;

iv. Brown trout growth and size in the lower Mataura River, i.e. below Gore;

v. Brown trout numbers in the lower Mataura River.

b. The monitoring programme proposed by Alliance.

12. I am familiar with the Water Conservation (Mataura River) Order 1997 (the Mataura WCO), which was granted around the time I began employment with Fish & Game. I acknowledge at the outset of my evidence that the prohibition of dams on the Mataura River from its source to the sea does not apply to weir at the Mataura Falls that is currently used by Alliance and Mataura Industrial Estate to divert water for hydro-electric generation if *" . . . the water permits are granted or renewed subject to similar terms and conditions to which the former permits were subject."*[2]

[2] See Clause 6(1) and 6(3) of the Mataura WCO.

EXECUTIVE SUMMARY

13. The Mataura River is best known as a brown trout fishery and is recognised by the Mataura WCO as being outstanding for its brown trout fishery and angling amenity features.

14. Notwithstanding the reputation of the Mataura River, angling survey data shows overall angling effort on it upstream and downstream of Gore has declined over the last 20 years. There is evidence that this is driven by changes in perceived angling quality, which is primarily related to brown trout abundance and arguably decline in rising trout. Further, there is evidence that anglers perceive that the angling experience on the Mataura River is better above Gore than below it.

15. Adult and juvenile brown trout can be encountered throughout the Mataura River system. That said, the migratory behaviour of brown trout in the Mataura River is not fully understood. It is known, however, that the brown trout population of the Mataura River is mobile and that there are both upstream and downstream movements associated with their life cycle, including spawning and juvenile recruitment.

16. Passage through Alliance's Francis turbine is likely to result in mortality for some fish, particularly for larger brown trout of the size found in the lower Mataura River. However, it is not currently known what numbers of fish, including brown trout, are physically diverted from the mainstem of the Mataura River through Alliance's Francis turbine.

17. The monitoring methodology proposed by Alliance is limited by the fact that any conclusions about the downstream fish passage in the lower Mataura River or mortality / damage rates can only be taken from fish that are entrained during the January – May period. Employing additional monitoring approaches would produce a more complete understanding of Alliance's hydro activity and how it can best be mitigated.

18. The monitoring methodology proposed by Alliance is likely to result in high mortality of brown trout unless they are impinged uninjured and appropriately handled prior to gentle release to the Mataura River downstream of the Mataura Falls.

Background

19. The Mataura catchment is the Southland region's second largest. It extends from the southern tip of Lake Wakatipu to the Toetoes / Fortrose Estuary. The Waikaia River is the main tributary, contributing approximately half the flow of the catchment above its confluence with the Mataura, east of Riversdale.

20. The Mataura River, including its tributaries, support an extensive range of aquatic habitats from its mountainous headwaters to the tidal / estuarine habitat in its lower reaches. These habitats combine to support an extensive range of fish faunas.

21. Three sports fish[3] species are present in the Mataura River waters: Brown trout (*Salmo trutta*), Chinook salmon (*Oncorhynchus tshawytscha*) and Perch. For the purposes of this evidence I discuss Alliance's application with respect to brown trout,

[3] *"Sports fish"* mean those freshwater fish described in the First Schedule of the Freshwater Fisheries Regulations 1983.

which are the major sports fish in the Mataura catchment and are spread throughout its river and streams.

22. All river and most still water sports fisheries in Southland, including the Mataura fishery, are wild and self-sustaining through natural spawning rearing and the recruitment of juvenile trout into the adult trout population. No artificial stocking is undertaken by Fish & Game, including in the Mataura catchment. It is the standing of adult trout that provide the recreational trout fishing amenity and fishery productivity is related to habitat quality and ecosystem health.

23. Management of trout fisheries by Fish & Game is largely to sustain suitable habitat to enable thriving populations of these species, and, where appropriate to regulate harvest to ensure this is undertaken sustainably.

Mataura brown trout fishery values

24. The Mataura is best known as a brown trout fishery and is recognised by the Mataura WCO as being outstanding for its brown trout fishery and angling amenity features.

25. Historically, the most renowned feature of the Mataura River was its hatches of mayfly that stimulated the resident brown trout to rise and feed, traditionally known as the "Mataura rise". The combination of mayfly hatches and rising trout were the ingredients for high quality nymph and dry fly fishing, which have made the Mataura well known locally, nationally and internationally.

Angling season

26. The fishing season on the Mataura River upstream of Gore and on all its tributaries (e.g. Otamita Stream, Waimea Stream, Waikaka Stream and tributaries, Waikaia River and tributaries, Mimihau Stream and Mokoreta River) runs from 1 October each year until 30 April in the following year . The fishing season on the Mataura River below Gore to Gorge Road runs from 1 October each year until 31 May in the following year, excluding the first weekend in May which coincides with the opening weekend of the annual game bird hunting season. The reach of the Mataura River below Gordge Road to the sea is open all year round. The purpose of the closed season is to protect trout spawning, including adult trout seeking to reproduce, and trout egg incubation.

27. The Mataura provides a range of angling opportunities from bait and spin fishing in the tidal / estuarine – mid reaches to very challenging fly fishing in the upper reaches. Water clarity in the upper reaches is generally good, and the relatively clear water provides ideal conditions to sight-fish for adult brown trout. These wary fish are generally difficult to catch, especially when the river is low and clear.

Angling usage

28. Fish & Game New Zealand nationally coordinates and funds research on sports fish and gamebirds, and anglers' and hunters' success and satisfaction. To this end, Fish & Game coordinates both regional and national surveys of, and research into, both the sports fish and game bird resource and the recreational activities and aspirations of anglers and hunters. This includes the National Angler Survey at seven year intervals.

29. The most recent national angler survey was undertaken during the 2014 - 2015 fishing season (Unwin (2016)). Similar surveys were undertaken prior to this in 1994 - 1995, 2001 – 2002 and 2007 - 2008.

30. Each survey involves a telephone survey of part and whole season resident anglers in each region throughout the country undertaken at two-monthly intervals for the entire fishing season from 1 October until 30 September the following year. Anglers are asked which rivers or lakes they have fished over the preceding two month period, where the unit was an 'angler day', being any time spent fishing on a particular water body during a particular day. Usage of rivers from 'out of region' anglers is noted.

31. Changes in angling use between surveys can be noted for some waters and not others. In short, the overall angling effort across Southland at large has declined between the four surveys. Specifically, there has been a trend from fishing in rivers, particularly lowland rivers, toward fishing in lakes, particularly larger lakes between the four surveys.

32. The reduction in angling effort in lowland fisheries in Southland is a source of major concern to Fish & Game and is reflected in major concerns by anglers to Fish & Game and to the community at large about the state of these lowland rivers and streams as habitats for trout and locations to go fishing.

33. The evidence of Mark James for Alliance provides at paragraph 33 that:

"National angling survey results are collated and reported by NIWA. In the 2014/15 season 19,100 ± 3,000 angler days were spent fishing the lower Mataura River (below Gore) with the Mataura River recording the greatest number of angler-days in the Southland Region (36% of regional total) (Unwin 2016). In Southland the Mataura River was ranked 4th out of 25 recreational locations (including coastal, lake and river locations) in a 2015 survey."

In response, I do not dispute the above figure quoted by Mark James from the 2014 – 2015 angling survey, however, it does need to be understood in context, particularly with reference to previous angling surveys in 1994 - 1995, 2001 – 2002 and 2007 - 2008. Specifically, between the four surveys:

a. Overall angling effort in the Mataura catchment at large, including the Mataura River above and below Gore, has declined; and

b. Overall angling effort on tributaries of the Mataura River located both above and below Gore has declined.

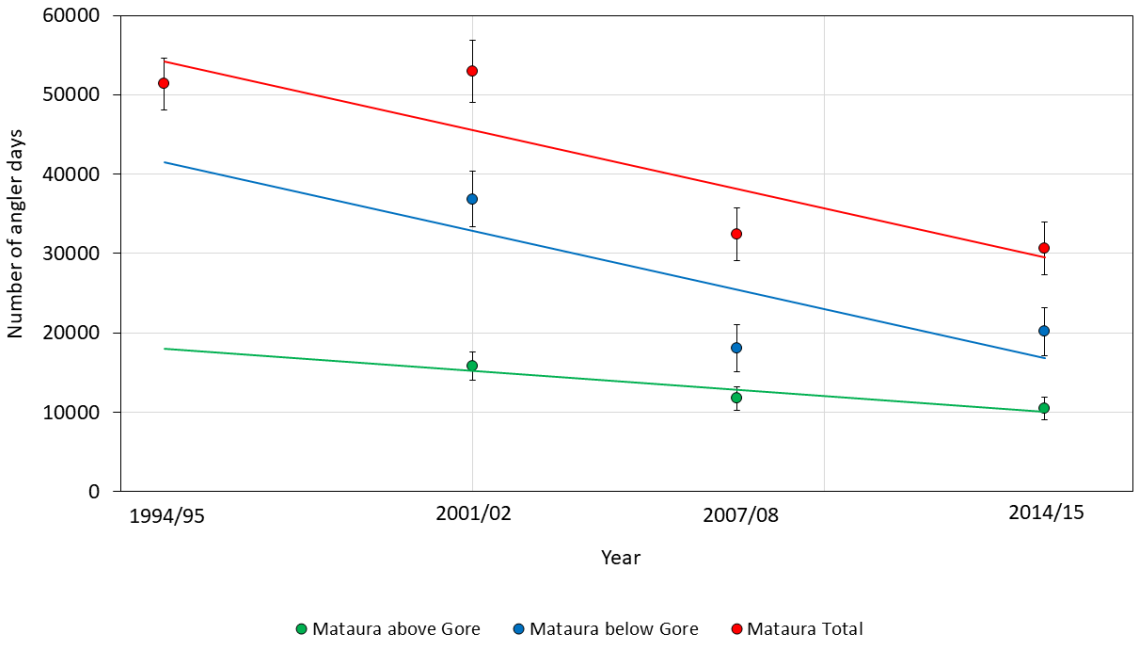

Figure 1 – Angling effort on the Matura River

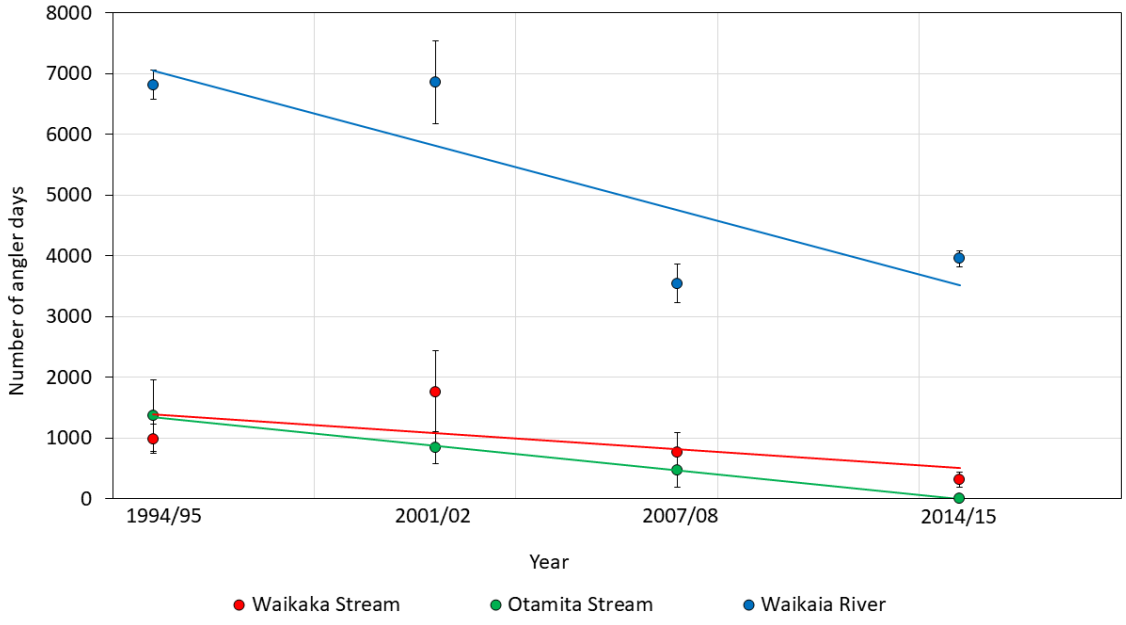

Figure 2 – Angling effort on the Waikaka Stream, Otamita Stream and Waikaia River, i.e. tributaries of the Mataura River located above Gore)

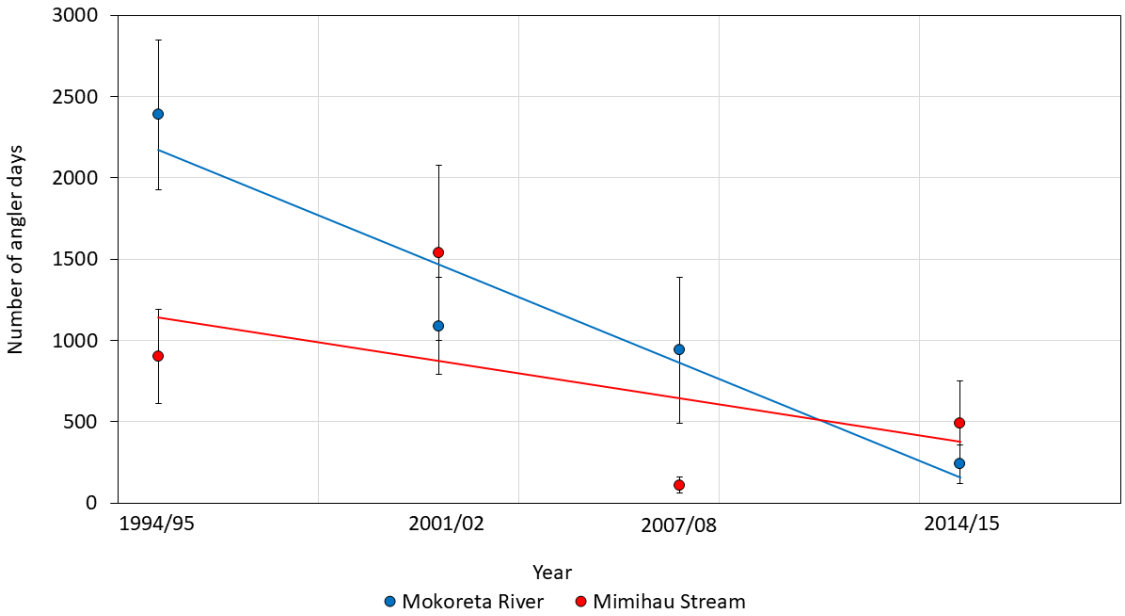

Figure 3 – Angling effort on the Mokoreta River and Mimihau Stream, i.e. tributaries of the Mataura River below Gore

The above angling usage figures and graphs do not address the cause of the decline in angling usage of the Mataura fishery above and below Gore. There is, however, evidence in Southland of the displacement of anglers from the lower reaches of rivers, including the lower Mataura River, due to a perceived and / or measurable decline in water quality associated with intensified farming practices (McAuliffe (2010).

Jellyman et al (2003) undertook a postal survey for Fish & Game between December 2000 – June 2001 of angler perception of long-term changes in lowland fisheries, based on the premise that anglers are natural observers. The survey targeted anglers throughout New Zealand who had fish for at least 20 years and asked them to rate the extent to which angling quality, trout abundance and size had changed in rivers they were familiar with. Despite its qualitive nature, the survey found that:

a. Changes in perceived angling quality appeared to reflect changes in fish abundance rather than fish size, suggesting for lowland rivers availability of fish rather than fish size was the main determinant of angling quality; and

b. Surveyed anglers (47 participants) perceived decline of the Mataura River in relation to angling quality, number of fish and size of fish.

   Similarly, surveyed anglers perceived decline of the following tributaries of the Mataura River in relation to angling quality, number of fish and size of fish: Mimihau Stream (12 participants), Mokoreta River (18 participants), Otamita Stream (9 participants), Tomogalak Stream (1 participant), Waikaia River (12 participants), Waikaka Stream (3 participants) and Waimea Stream (8 participants). The only exception being the Redan Stream (1 participant) where the angler surveyed did not perceive any change in relation to angling quality, number of fish and size of fish.

In my experience, a common concern voiced by anglers is the decline of rising trout or the ‘Mataura rise’, which is linked to mayfly hatches.

34. In 2013 NIWA conducted an angler survey of river fisheries managed by Fish & Game (Unwin (2013)). The work was commissioned because of the realisation that specific fishery attributes or values for individual fisheries had not been assessed since the 1970's. Randomly sampled respondents were asked to identify rivers that they had fished over the last 3 – 5 years, to rate their enjoyment of the fishery on a scale from 1 (least enjoyable) to 5 (most enjoyable) and to identify up to three reasons, from a list of 10, why they fished each river. These 10 reasons were:

    a. Close to home;

    b. Close to holiday home;

    c. Ease of access to river;

    d. Area of fishable water;

    e. Scenic beauty;

    f. Wilderness feeling;

    g. Angling challenge;

    h. Anticipated good catch rate;

    i. Anticipate large fish; and

    j. Other.

    431 rivers that had at least 10 responses were analysed.

35. The results for fishing the Mataura River (above Gore) were ranked as follows in order of importance.

    a. Area of fishable water – 60%;

    b. Ease of access – 50%;

    c. Anticipate good catch rate – 40%;

    d. Angling challenge – 25%

    e. Close to home – 23%;

    f. Anticipate large fish – 10%;

    g. Scenic beauty – 9%;

    h. Close to holiday home – 7%;

    i. Wilderness feeling – 5%; and

    j. Other – 3%.

These results suggest that the Mataura River (above Gore) is valued by anglers for its area of fishable water, ease of access, catch rates, angling challenge and proximity to home.

36. The results for fishing the Mataura River (below Gore) were ranked as follows in order of importance.

    a. Area of fishable water – 58%;

    b. Ease of access – 47%;

    c. Anticipate good catch rate – 42%;

    d. Close to home – 27%;

    e. Angling challenge – 19%

    f. Close to holiday home – 7%

    g. Anticipate large fish – 6%;

    h. Scenic beauty – 4%;

    i. Other – 2%; and

    j. Wilderness feeling – 1%.

    These results suggest that the Mataura River (below Gore) is valued by anglers for its area of fishable water, ease of access, catch rates, proximity to home and angling challenge.

    It is not surprising to me that area of fishable water and ease of access were ranked as the two leading factors for the Mataura River above and below Gore given that mainstem excluding tributaries is approximately 220km from its source to the sea and relatively easy to access. Good roads run parallel with the Matura River, and close to it, in all areas except the Nokomai Gorge. The banks are generally open and much of the river, especially upstream of Gore, is wadable.

37. The mean enjoyment score or 'overall importance' ranking on scale of 1 – 5 was:

    a. 3.03 for the Mataura River (above Gore) – based on 188 respondents. This score falls within scale point 3 – "The fishery consistently provides enjoyable angling".

    b. 2.71 for the Mataura River (below Gore) – based on 171 respondents. This score falls within scale point 2 – "The fishery often provides enjoyable angling but is not exceptional".

    The above results suggest that anglers on the Mataura River perceive some difference in the angling experience on the Mataura River above and below Gore. For completeness, none of the tributaries of the Mataura River that were surveyed exceeded scale point 2 with regard to the mean enjoyment score or 'overall importance' ranking: Mokoreta River – 2.40 (10 respondents), Mimihau Stream – 2.71

(17 respondents), Waikaka Stream – 2.36 (11 respondents), Otamita Stream 2.61 (23 respondents), Waimea Stream – 2.50 (24 respondents), Waikaia River – 2.88 (33 respondents), Nokomai River – 2.50 (14 respondents) and Eyre Creek – 2.00 (17 respondents).

Brown trout life cycle in the Mataura River

38. Brown trout spawn from mid-April to September (McDowell (1990); Graynouth et al. (2003)). Most trout begin spawning in their third or fourth year of age, but fast growing trout can spawn at age two (Hayes and Hill (2005)). When plenty of food is available, brown trout may spawn year after year, however they may skip a year when food is scarce (Hayes and Hill (2005)). To spawn successfully, brown trout require relatively clean, unsilted stream / river bed comprised of suitably sized and aerated gravels. Water depth must always be adequate to cover the redd and the intra-gravel water velocity must be enough to service the developing embryos.

39. Adult brown trout generally live in medium to larger sized rivers and lakes and are adapted to feed over the summer period to put on condition to enable spawning in the autumn or early winter in smaller spawning tributaries. Spawning tributaries can on occasion be quite small, and brown trout run up them during freshes and minor floods in autumn to early winter to get as far upstream as possible. This reduces the risk of later floods disturbing the vulnerable developing eggs or fish larvae in gravels and means that the location of spawning can vary from year to year depending upon flows at the time of spawning. Maintaining the habitat of suitable spawning areas is crucial to the on-going survival of wild stocks of brown trout.

40. The female brown trout digs a nest or 'redd' in suitably gravels at the head of riffle sections which have clear, cool, well oxygenated water running through the gravels with low levels of fine sediment. Streams with more stable flows are favoured as these are less likely to suffer flood damage and the loss of developing eggs or larval fish. Female trout lay 2,000 – 3,000 eggs that are then fertilised by the male. Depending upon water temperature, the eggs incubate for a period of about 6 weeks. The hatching larval fish or 'alevins', which are about 20mm in length, retain a yolk sac and remain in the gravels for a further period of about four weeks before emerging as fry about 25-30mm long. The average size of fry increase from about 25-30mm in September to 70-80mm in February. Young fry are highly vulnerable to disturbance, predation and other factors, with around only 1% surviving to adulthood.

41. Retention and access to suitable high-quality spawning waters is therefore crucial to the survival of wild stocks of brown trout, including in the Mataura catchment. Many spawning tributaries also provide habitat for developing brown trout, which may remain in those spawning tributaries for up to 18 months after emergence from the spawning gravels before venturing into the larger waterbodies.

42. Most adult brown trout spawn multiple times and may live up to 12 years, although commonly adult brown trout only survive half this time. Brown trout generally spend much or all their life in freshwater, including the tidal zone of rivers, although a proportion may live in estuaries or enter salt water and subsequently return to freshwater and are commonly known as 'sea run trout' or 'sea runners'. Research using radio tagging and chemical analysis of fish otoliths (inner ear bone) shows that most undertake migratory movements occur in response to floods, low flows, elevated water temperatures, to find suitable food or for reproduction, i.e. spawning. Some

individual brown trout show high site fidelity and can move considerable distances seasonally[4], but often return whence they came.

43. Maintenance of wild brown trout fisheries and recruitment of juvenile fish is dependent upon maintaining the unimpeded upstream 'migration' of sexually mature males and females and suitable spawning habitat.

44. In the Mataura catchment, adult brown trout are usually approaching sexual maturity by the end of the fishing season (April). Throughout May there is increasing amounts of spawning, which tends to peak in June – July. A few late spawners are still active over the August – September period (Witherow and Scott (1984)).

45. Brown trout spawning occurs throughout the Mataura catchment, however significant spawning tributaries are found in the mid – upper reaches, i.e. upstream of the Mataura Falls, for example: Waikaka Stream, Otamita Stream, Waimea Stream, Dome Burn, Meadow Burn, Gow Burn, Tomogalak Stream, Nokomai Stream and Eyre Creek. Fish & Game spawning surveys show consistent patterns of widespread spawning activity in these tributaries. Most tributaries in the mid reaches of the Mataura River, such as the Meadow Burn in the Riversdale area, are stable and derive a substantial portion of their flow from groundwater, which has a buffering effect on spawning productivity insofar as it avoids the peaky hydrology associated with rain fed streams that can have a significant effect on juvenile mortality.

46. Spawning tributaries downstream of the Mataura Falls are comparatively limited, for example Mokoreta, Redan and Mimihau Streams. These streams are rainfed, which results in a peaky hydrology, and there is a predominance of exposed bedrock and limited availability of suitable spawning gravels. Generally, the Mataura River downstream of the Mataura Falls is unsuitable for mainstem spawning due to the bed being comprised of comparatively large gravels, which cannot be readily mobilised by adult female brown trout, predominance of exposed bedrock, a lignite bed overlaid by a comparatively thin layer of large gravels, relatively long 'runs' of deep water and the tidal influence in the lower reaches.

47. Whilst brown trout spawning occurs upstream and downstream of the Mataura Falls, I consider that the bulk of productive spawning habitat utilised by brown trout in the Mataura catchment is likely to be upstream of the Mataura Falls.

48. There is general upstream migration of adult brown trout associated with spawning in the Mataura catchment, which is evidenced by adult brown trout congregating at the base of instream features that present a physical barrier to upstream passage. For example, congregations of adult brown trout numbering in the hundreds are known to form at the base of the Mataura Falls and congregations of adult brown trout form at the base of the falls in the Nokomai Stream, which is a recognised spawning tributary of the upper Mataura River. At the peak of the spawning run upstream migrating adult brown trout will throw themselves repeatedly at the rock walls in an endeavour to pass upstream.

49. Migration of juvenile brown trout from spawning grounds downstream to the main stem of the Mataura is likely to occur all year round. That said, research suggests that peak downstream juvenile migration occurs during September – January (Fox et al (2003)). Brown trout fry and fingerling migration is significantly higher during

[4] For example, up to 41km in the Motupiko river (Young et al, (2010)), up to 70km each way in the Wairau River and 150km in the Waikato-Waipa Rivers (Gabrielsson and Knight (2014)).

freshes and high flows and occurs mostly during the night and more so on moonless nights. Trout fry and fingerlings have a strong preference for bank side movement and keep to the edges of main channels, near to the banks of stream and river.

50. Downstream migration of adult brown trout can occur post spawning through autumn, winter and early spring. In addition, changes in flow, such as flood events and low flow events, can cause adult brown trout that are resident in upstream reaches and tributaries to move downstream.

51. I agree with the evidence of Mark James for Alliance that brown trout are found throughout the Mataura River and that they do not have an obligate marine phase to their life cycle. However, I disagree with the evidence of Mark James that:

    a. It seems unlikely that there is significant downstream migration of brown trout or loss through the turbines;[5] and

    b. The movement of adult brown trout in the Mataura River is limited to upstream movement.[6]

    In my opinion:

    a. It was agreed during witness conferencing that eels (short and long fin), brown trout (juvenile and adults), lamprey, and koaro are present in the area around the Mataura Falls and will pass through and other native species may be carried through this area. Alliance has not undertaken any on site monitoring to determine the effects of its hydro-generation activity on fish populations in the Mataura River. Specifically, it is not currently known what proportion of fish, including brown trout, are being physically diverted from the mainstem of the Mataura River into the Alliance intake channel and through its Francis turbine. In this regard, I note the comments of Hay (2018) and evidence of Tony Hawker for Fish & Game that it is generally accepted that the proportion of fish lost to unscreened (or poorly screened) water intakes is proportional to the flow diverted from the river. Alliance has provided a table of predicted mortality associated with entrainment in the intake and passing through its Francis turbine.[7] This shows that passage through the turbine is likely to result in mortality for some fish, particularly for larger individuals.

    b. Due to the patterns of spawning and migration of brown trout in the Mataura River, both adults and relatively small fish can be encountered throughout the river system. Any discussion of brown trout movement in the Mataura River, including upstream and downstream of the Mataura Falls, needs to take account of the fact that the population is mobile, and likely to be passing downstream in the vicinity of the Alliance intake with a frequency consistent with that characteristic. In this regard, the *'Best Practice Guidelines for the Passage of Fish at Hydroelectric Dams in New Zealand: Part 2 – Downstream Migrants'*[8] provide that:

[5] Evidence-in-chief of Mark James - paragraph 45
[6] Evidence-in-chief of Mark James – Table 1 'Migratory periods for migratory fish found in the Mataura River catchment.
[7] Golder (2016). Mataura River – Ecological Summary and Assessment. Report prepared for Alliance Mataura – Table 3: Predicted mortalities for fish passaging through Alliance's Francis turbine.
[8] Paterson, C. and Boubee, J. (2010). Best Practice Guidelines for the Passage of Fish at Hydroelectric Dams in New Zealand: Part 2 – Downstream Migrants. NIWA Report HAM2010-89 – Prepared for Generator Environmental Forum.

i. Downstream migration of juvenile brown trout typically occurs from October – April annually, i.e. mid-spring – mid-autumn; and

ii. Downstream migration of adult brown trout typically occurs from March – September, i.e. early Autumn – early spring, which in my opinion is likely to occur post-spawning.

Brown trout growth and size in the lower Mataura River

52. Fish & Game consider the threshold for 'very large trout' to be 600mm caudal fork length. Generally, the Mataura River does not produce brown trout in this size range nor does it often produce brown trout of 'trophy' size.[9]

53. Brown trout in the Mataura fishery are not particularly large. Otolith data from angler caught brown trout caught in the Mataura River upstream and downstream of the Mataura Falls in 2008 – 2009 was analysed for Fish & Game by Cawthron in 2010. This research shows that:

a. Brown Trout in the lower Mataura River (below Gore) generally reach maximum size at approximately 4 – 5 years of age; and

b. Brown trout in the lower Mataura River do not generally grow beyond 550mm in length, irrespective of age.

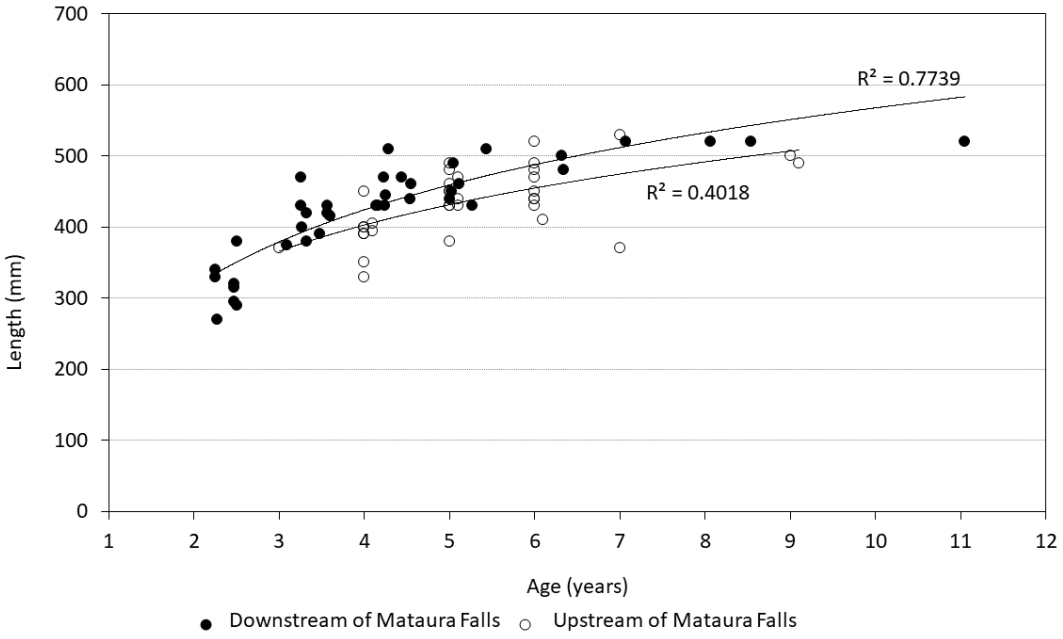

Figure 4 - Mataura River trout size upstream and downstream of Mataura Falls

54. I consider that the limiting factor for trout growth in the Mataura River system is likely to be insufficient high-quality large food to enable further growth.

55. Applying Alliance's predicted mortality rates (Golder (2016)) to trout in the above size classes that were found in the Mataura River, i.e. 300 – 500mm, suggests there will

[9] The bench mark for trophy sized trout is generally considered by most anglers to be 10lb (4.5kg).

be approximately 37.5% - 61.1% mortality depending upon the individual size of the brown trout passing through the turbine. What is unknown is the actual numbers of brown trout that are physically passing through Alliance's Francis turbine.

Brown trout numbers in the lower Mataura River

56. An aspect of the Mataura fishery is the number of fish known to inhabit the river, as evidenced by the angler perception data referred to for the Mataura River upstream and downstream of Gore (Unwin, (2013)). Quantitative sampling of adult trout populations in rivers is, however, difficult particularly for large river systems. This is problematic in terms of assessing the effects of the Alliance diversion and take.

57. The most frequently used method in New Zealand has been drift diving. Drift diving is conducted annually on approximately 10 rivers in the Southland region as a method of counting fish which can enable some comparison with other sites and record changes in fish numbers and size distribution over time. This is undertaken by a number of divers set out across the river counting fish by size class and species over a length of river, usually between 1 and 2 km at each site. This technique was first used extensively in New Zealand during the '100 Rivers' investigations of 158 river sites in 88 rivers throughout the country during the late 1980's (Tierney and Jowett, (1990)).

58. The difficulty with using the technique of drift diving in the lower Mataura River is that water clarity[10] of at least 4m is required, which simply does not occur. In this case, the Mataura River at Gore has a 5-year median for visual clarity of 1.115m[11] and the Mataura River 200m downstream of the Mataura Bridge has a 5-year median for visual clarity of 1.11m.[12] In addition, issues exist with respect to the suitability of water in the lower Mataura River for swimming involving full immersion. Conversely, the upper Mataura River in the vicinity of Garston can be drift dived as the water is significantly clearer and is done so on an annual basis in mid – late December.

59. From a quantitative point of view trout numbers in the lower Mataura River, including upstream and downstream of the Mataura Falls, are unknown. It is crucial for maintaining fish numbers and growth rates, however, that fish are freely able to move and thrive in different parts of the catchment at different times of year. The fishery is dependent upon the ability of fish to use different parts of the river, such as tributaries for spawning, at different times.

Proposed monitoring programme

60. I have reviewed the monitoring programme proposed by Alliance. In response:

    a. I agree with Hay (2018) and the evidence of Tony Hawker that:

        i. The monitoring is limited by the fact that any conclusions about the downstream migration potential in the lower Mataura River or mortality / damage rates can only be taken from fish that are entrained,

[10] As measured by the black disc technique, in which a black 200 mm disc is viewed horizontally through the water column until it becomes indistinguishable against the background water colour, at which point the distance to the viewing point is measured.
[11] https://www.lawa.org.nz/explore-data/southland-region/river-quality/mataura-river/mataura-river-at-gore/ - Accessed 26 November 2018.
[12] https://www.lawa.org.nz/explore-data/southland-region/river-quality/mataura-river/mataura-river-200m-ds-mataura-bridge/ - Accessed 26 November 2018.

physically impinged on the modified trash screen and subsequently captured either alive or dead. As such, the monitoring:

- Will not provide any information on the proportion of fish, including species and age classes, that are diverted from the main mainstem and either impinged on the screen or pass through the turbine;
- Will be biased toward larger fish that are physically impinged on the modified trash screen, i.e. it will not provide information on smaller fish that pass through the trash screen and turbine;
- Will not provide information on the number of fish passing through the turbine outside of the downstream eel migration period (January – May); and
- Will not provide any information on the fate of fish that pass through the trash screen and turbine.

ii. Employing the following approaches would produce a more complete understanding of the effects of Alliance's activity and how it can best be mitigated:

- Extension of PIT tagging to include brown trout upstream of the intake;
- Use of DIDSON in the intake channel; and
- Monitoring of the fate of fish that physically pass through the trash screen and turbine.

b. It is, however, unclear to me:

i. Whether the trash screen can be physically modified as intended to be fit for purpose; and

ii. Whether brown trout impinged on the trash screen can be successfully removed from the trash screen without pressing / crushing and / or grinding injuries. If so, I agree with Hay (2018) that impinged brown trout are likely to experience high mortality rates unless they are rapidly removed from the trash screen and gently released into a cool aerated holding tank prior to a transport site for release. In my opinion:

- The holding tank should be shaded and covered to provide as low stress environment for impinged brown trout as possible;
- Water within the holding tank should be continuously refreshed with a constant supply of cool well oxygenated water from the Mataura River; and
- Impinged brown trout should not be dropped or placed in a largely de-watered sluice along with screened trash. Ideally, the top of the holding tank and water level in it should be the

same height as the trash screen so fish are not dropped from height into it.

In addition, the proposed monitoring methodology is likely to underestimate the mortality of impinged fish unless they are observed for approximately 24 hours to determine suitability for release back to the Mataura River. Any impinged brown trout should be gently released into flowing water in the Mataura River, i.e. they should not be dropped or thrown.

In my opinion, the proposed monitoring methodology is contingent upon human intervention to gather / record information and safely return any uninjured fish to the mainstem of the Mataura River. As such, it will require ongoing availability of suitably trained staff to gather / record information and handle fish. Unexpected numbers of fish should be considered likely at any time and should not be allowed to overwhelm the capacity of the infrastructure used or the operator.

Zane Nigel Moss

Date: Wednesday, 28 November 2018

References

Fox, S., Unwin M. J. and Jellyman, D. (2003). The Migration of Brown Trout in the Rakaia River System. NIWA – report prepared for Fish & Game New Zealand.

Gabrielsson, R. M. and Knight, B. R., (2014). Natal origin and life time movement patterns of brown trout in the lower Waikato River. Cawthron Report 2585 – report prepared for Auckland / Waikato Fish & Game Council.

Golder (2016). Mataura River – Ecological Summary and Assessment. Report prepared for Alliance Mataura. Report Number: 1656011.

Graynoth, E., Hayes, J. and Bonnett, M. (2003). Project Aqua: Environmental Study Aquatic Ecosystems: Salmon and Trout. Report for Meridian Energy Ltd. NIWA.

Hay, J. (2018). Review of Fish Screening Monitoring Provisions at Mataura Meatworks Hydro Intake. Report No. 3171 for Department of Conservation, Ngai Tahu and Fish & Game New Zealand. Cawthron Institute, Nelson.

Hayes, J. and Hill, L. (2005). The Artful Science of Trout Fishing. Canterbury University Press. Christchurch.

Jellyman, D. J., Unwin, M. J. and James, G. D., (2003). Anglers' perceptions of the status of New Zealand lowland rivers and their trout fisheries. NIWA Technical Report 122 ISSN 1174-2631 prepared for Fish & Game New Zealand.

McAuliffe, T. (2010). Angling and Dairying: Local Anglers' Perceptions and Responses to Dairying in the Mataura River Catchment. A dissertation submitted for the partial fulfilment of the Bachelor of Commerce with Honours in Tourism at the University of Otago, Dunedin, New Zealand.

McDowell, R. M. (1990). New Zealand Freshwater Fishes: A Natural History and Guide. Heinemann Reed. Auckland.

Tierney, L. D. and Jowett, I. G. (1990). Trout Abundance in New Zealand Rivers: An assessment by Drift Diving. NZ Freshwater Fisheries Report No. 118 MAF Fisheries Christchurch ISSN 0113 – 2504.

Unwin M. (2013). Values of New Zealand angling rivers – Results of the 2013 National Angling Survey. NIWA report CHC2013-120 – report prepared for Fish & Game New Zealand.

Unwin M. (2016). Angler usage of New Zealand lake and river fisheries - Results from the 20014 / 15 National Angling Survey. NIWA – report prepared for Fish & Game New Zealand.

Witherow, W. D. and Scott, D. (1984). The Mataura Trout Fishery. Published by the Acclimatisation Societies of Southland and Otago.

Young, R. G., Wilkinson J., Hay J., Hayes, J. W. (2010). Movement and mortality of adult brown trout in the Motupiko River, New Zealand: effects of water temperature, flow and flooding. Transactions of the American Fisheries Society 139(1): 137-146.