BEFORE THE HEARING PANEL

IN THE MATTER OF	The Resource Management Act 1991 ("the Act")
AND	
IN THE MATTER OF	applications for resource consent by various applicants to take and use water from the upper Waitaki River catchment

STATEMENT OF EVIDENCE OF RICHARD MARK ALLIBONE ON BEHALF OF THE DIRECTOR-GENERAL OF CONSERVATION

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STATEMENT OF EVIDENCE OF RICHARD MARK ALLIBONE

INTRODUCTION

1. My full name is **Richard Mark Allibone.**

2. I am a senior ecological consultant at Golder Associates (NZ) Ltd. I have been in practice as a freshwater and terrestrial scientist and manager for 16 years.

3. I have previously been employed as the National Services Manager for the Queen Elizabeth the Second (QEII) National Trust; Species Protection Officer at the Biodiversity Recovery Unit of the Department of Conservation; Fisheries Scientist and Post Doctoral Fellow at the National Institute of Water and Atmospheric Research (NIWA); and a Freshwater Fisheries Specialist for the Department of Conservation in the Nelson/Marlborough and Otago Conservancies.

4. I have a BSc (Geology and Zoology), an MSc (Zoology) and a PhD (Zoology) from the University of Otago. My University research centred on the biology, taxonomy and population structure of New Zealand's migratory galaxiids (whitebait) and non-migratory galaxiids. For my Masters thesis I carried out one of the first investigations of the population structure of whitebait and non-migratory galaxiids in the South Island and Stewart Island. My PhD study investigated the biology and distribution of non-migratory galaxiids in the Taieri River system. This was the first research to study the biology of four species of non-migratory galaxiid found in the Taieri River. This research included determining their distribution, the diet of the species, their spawning ecology,

growth and populations structure and determining the conservation status and threats to the populations remaining today.

5. Over the past 20 years I have been involved in research that has led to the recognition of six new non-migratory galaxiids and another six possible species. I have undertaken freshwater fish surveys in Canterbury, Otago, Southland, Stewart Island, Chatham Islands, West Coast, Nelson/Marlborough, Taranaki, Wellington, Waikato/Coromandel and Hawkes Bay.

6. My research on the Taieri River galaxiids includes my PhD research and additional work as a contractor to NIWA investigating galaxiids in the Waipori catchment. I led the NIWA FRST freshwater fish biodiversity and whitebait research programmes from 1998 to 2001.

7. I was a co-author for the Department of Conservation of the three freshwater fish recovery plans (large galaxiids, non-migratory galaxiids, and mudfish recovery plans) and was the recovery group leader for the non-migratory galaxiid recovery group and a member of the other two freshwater fish recovery groups from 2001-2003. I developed a freshwater fisheries training programme for the Department of Conservation in 2001. For two years I conducted training programmes for Department staff throughout New Zealand, that included fish survey methods, monitoring methods, and habitat assessment.

8. I have been a panel member of the Department of Conservation freshwater fish threat ranking groups since 2002. In June 2009 I chaired the threat panel that has conducted the most recent freshwater fish threat rankings. I am the lead author of

the scientific paper that presents these threat rankings and this paper is currently in review at the New Zealand Journal of Marine and Freshwater Research.

9. Previously I have assessed the effects of hydro-electric schemes on native fish for the Department of Conservation for the Clutha River hydro-electric power stations consent process in 2001 and a hydro-electric station on the upper Waipa River (Waikato); for Environment Canterbury for the North Bank Tunnel Concept; and I was part of the Department of Conservation's technical team assessing the effects of Project Aqua. I was part to the Golder's ecology team that assessed the ecological effects of the Central Plains Water Enhancement Scheme and have reviewed the Assessments of effects for the Hunter Downs Irrigation Scheme and South Bank Rangitata Irrigation Scheme for Environment Canterbury. I have also assessed the effects on aquatic values for the applicants for three wind farms, Mahinerangi Wind Farm (TrustPower), Project Hayes (Meridian) and Puketiro (RES (NZ) Ltd).

10. I have been a contributing author to two books and 24 peer reviewed papers and reports.

11. I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

12. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

13. In this statement of evidence, I will focus on the aquatic ecosystems of the Upper Waitaki River and the history of the river system and the development of its distinctive freshwater fish fauna. I will present the draft threat rankings from the 2009 freshwater fish threat ranking meeting and discuss the national and local implications of the implications of the threat rankings (including the underlying threats and data that lead to these rankings by the expert panel.)

14. I have read the evidence presented for the applicants by: Dr Greg Ryder, Dr Ruth Goldsmith, Dr Dean Olsen and Dr Brian Coffey; for Environment Canterbury by Dr Adrian Meredith and for the Director General by Mr Peter Ravenscroft, Mr David Murray, and Mr Jonathon Bray.

15. My evidence will deal with the following:;

- Native fish of the Upper Waitaki River;
- The biogeographic history of the Upper Waitaki River basin
- Threatened fish of the Upper Waitaki River;
- Assessment of effects provided by the applicants for native fish;
- Likely effects of the water abstraction and irrigation on aquatic communities;

NATIVE FRESHWATER FISH OF THE UPPER WAITAKI RIVER

16. Mr Ravenscroft in his evidence in chief (dated 16 September 2009) noted that nine native fish are found in the upper Waitaki River catchment,

- longfin eel;
- koaro (Figure 1);
- Canterbury galaxias (Figure 2);
- bignose galaxias (see Mr Ravenscroft's evidence in chief);
- upland longjaw galaxias;
- lowland longjaw galaxias (see Mr Ravenscroft's evidence in chief);
- alpine galaxias;
- upland bully; and
- common bully.

17. He also provided detailed information on two of the species, lowland longjaw galaxias and bignose galaxias. I will not repeat that information but below have provided additional information in sections 18 to 32 of my evidence regarding the ecology of some of the other native fish of relevance to this hearing.

18. Longfin eel is the only diadromous (migrates to and from the sea) species present in the upper Waitaki River. This species occurs in a relatively low abundance due the three lower Waitaki River dams, Waitaki, Aviemore and Benmore Dams, preventing fish passage. The distribution of longfin eel in the upper Waitaki can, in my opinion, be considered a relict and declining distribution at this time due to the fish passage barriers presented by the hydro-electric dams and the very low recruitment reported at the elver trap at the Waitaki Dam (Martin et al 2007).

19. Koaro is another species that is often diadromous but it does form landlocked populations in the upper Waitaki River system. Koaro are widespread in the upper Waitaki and utilise many of the streams, rivers, natural lakes and hydro electric impoundments as habitat (Map 1).

20. Koaro is the largest galaxiid in the upper Waitaki River catchment and reaches nearly 30 cm in length. Populations of koaro in the upper catchment have two potential life cycles. Stream populations migrate to lakes as larval fish and rear for approximately six months in the lakes before migrating upstream into lake tributaries to adult habitat in typically in fast flowing riffles and cascades where it will live and spawn for at least 10 years. This migratory life cycle means that fish passage and entrainment into intakes are key issues to consider at water abstraction sites.

21. Diet of stream koaro consists of soft bodied invertebrates (Glova & Sagar 1989a) although large adults will take small fish (Allibone pers. obs. Kusabs & Swales

1991) and have been implicated in the decline of smaller galaxiid species upstream of hydro-electric lakes (Allibone 1999).

22. Koaro can also form lake resident populations and an unusual and possibly unique pink/colourless koaro population is known to exist in Lake Pukaki (Figure 3). The life cycle and biology of lake koaro is essentially unstudied.

23. Koaro in streams spawn on the stream edge and riparian margin in shaded zones that prevent the eggs from being desiccated (Allibone & Caskey 2000, Figure 4). Individual large koaro may lay up to 10,000 eggs. The timing of spawning for landlocked and lake populations is unknown, although diadromous populations typically spawn in late summer and through autumn (McDowall & Suren 1995, Allibone & Caskey 2000); and this is believed to be linked to falling water temperatures and flood flows that allow fish to access areas above normal stream levels for spawning. Changes to flow regimes via water abstraction have the potential to disrupt this spawning behaviour and in my opinion, should be considered as part of any impact assessment.

24. Four species of non-migratory "pencil galaxiids"; bignose galaxias, alpine galaxias, lowland longjaw galaxias and upland longjaw galaxias, are found in the upper Waitaki catchment (Maps 2). This assemblage of "pencil galaxiids" is unique both in terms of the assemblage of species that occur together and the number of species present in a catchment. Historically, the upper Mauria River at Spring Junction and Mauria Springs was the only other river system with a diversity of pencil galaxiids approaching that of the upper Waitaki catchment,

with three species reported to be present in the 1960s and 1970s (New Zealand Freshwater Fish Database).

25. However, since the mid-1990s only one pencil galaxiid, the dwarf galaxias, has been recorded in the upper Maruia River and the other two species (alpine galaxias and upland longjaw galaxias) are now considered extinct at this location (Allibone pers. obs., Waters pers. obs., DOC unpublished data). At all other sites and river systems in New Zealand no more than two pencil galaxiids are known to occur together (NZFFD, Allibone pers. obs.).

26. The alpine galaxias is the most widely distributed of the pencil galaxiids in the upper Waitaki (Map 3) and also occurs to the north and south in other inland Canterbury Rivers as well as in Otago and Southland.

27. The bignose galaxias occurs throughout the upper Waitaki River catchment, but less commonly than alpine galaxias. The range of the bignose galaxias is restricted only to the upper Waitaki River basin and it is therefore endemic to the upper Waitaki River catchment.

28. Upland longjaw galaxias occurs in rivers and streams upstream of the glacial lakes and in two tributaries of the Tekapo River and the upper Ahuriri River (Waters and Craw 2008, DOC unpublished data or NZFFD).

29. The lowland longjaw galaxias is the most restricted pencil galaxiid in range and is generally associated with springs and wetlands scattered across the MacKenzie Basin and up the Ahuriri River. The locations and populations are described in Mr

Ravenscroft's evidence. Populations are also present in two tributaries of Otamatopio River and in a small area of the Hakataramea River. Lowland longjaw galaxias also occur in the Kauru River in North Otago.

30. The four Waitaki River pencil galaxiids are small fish species with individuals generally less than 90 mm long. They can utilise a range of habitat types but in flowing waters are most common in cobble bed stream habitats. Cover and spawning habitat for the fish is provided by the cobble substrate which they can move within using spaces between the cobble particles. Spawning for all species is thought to occur in winter and early spring, although studies of both longjaw species (Bonnett 1979a, Ravenscroft unpublished data) indicate they may have extended or alternate spawning periods in relation to the late winter early spring usually utilised by non-migratory galaxiids. Female pencil galaxiids produce relatively few large (2 mm diameter) eggs, ranging from 60 -150 eggs in the longjaw species and up to 300 in the alpine galaxiid (Bonnet 1992, Ravenscroft unpublished data). Diet studies of the four species are limited but mayfly nymphs and chironomid (midge) larvae are considered the main prey items (Bonnett et al 1989). These items are small and have soft bodies. Cased caddisflies, snails and large invertebrates are not eaten as these are either too large and/or too hard to swallow.

31. Canterbury galaxias, a non-migratory galaxiid restricted to Otago and Canterbury is the sixth galaxiid present in the upper Waitaki River catchment. This species is widespread in the basin and generally resides in clean gravel and cobble bed streams. This species like the other galaxiid feeds on small soft bodied

invertebrates and avoids snails and other cased invertebrates (Glova and Sagar 1989b). It spawns in spring laying eggs in shallow saucer shaped depressions in the gravel bed (Allibone pers. obs., Cadwallader 1975).

32. Two bully species, upland and common bully are present in the upper Waitaki River system. Common bully is found in the lakes and canal systems. It prefers lake or slow flowing habitats. Upland bully is common in the braided and cobble and gravel bed river and stream systems where is occupies a range of habitats.

BIOGEOGRAPHIC HISTORY OF THE UPPER WAITAKI RIVER

33. For the purpose of this hearing, I have defined the upper Waitaki River as areas upstream of the Waitaki dam. This division of the river into the upper and lower catchments does have some relevance to the current aquatic fauna and especially the freshwater fish fauna of the catchment as well as the restriction on fish passage that the dam presents. However, the past history of the catchment and the distribution of the freshwater fish fauna reflect the geological events that have created the river systems in the upper parts of the catchment. I will briefly describe these geological events and how they have affected fish distribution in the following sections of my evidence.

34. The MacKenzie Basin and the current Waitaki River system are the result of mountain building periods and glacial action. Waters and Craw (2008) provide a description of the chain of geological events that lead to the current MacKenzie basin and its river systems. Approximately 3 million years ago the Tekapo and Havelock Rivers were tributaries of the Ophua River and the Ahuriri, Twizel and

Ohau Rivers formed the head of the Waitaki River. Mountain building events that formed the Southern Alps diverted the Havelock River into the Rangitata River catchment by 1 million years ago. In the last 1 million years the Tekapo River was diverted into the Waitaki catchment by the rise of the Two Thumb Range (Figure 5). Subsequent to the mountain building events glacial action in the last 1 million years created the upper Waitaki lakes and moraine deposits.

35. During this sequence of mountain building and glaciation the fish fauna of the upper Waitaki River has been progressively isolated from the freshwater fish to the north in Canterbury and the other high country rivers.

36. Waters and Craw (2008) studied the relationships amongst upland and lowland longjaw galaxias populations in the Waitaki River and elsewhere in Canterbury and Otago. This study found that both species of longjaws in the Waitaki catchment are distinct from the populations of each species in other river catchments (Figure 6). Together with the endemic bignose galaxiid this study showed that components of the upper Waitaki River fish fauna have been isolated in the upper catchment for a period of 300-500,000 years.

37. A key finding of this genetic study of Waters and Craw (2008) was that each lowland longjaw population in the upper Waitaki River catchment is distinct and there is no evidence of intermixing among the populations. This indicates that the lowland longjaw populations in the upper Waitaki exist as a series of isolated stand-alone populations and there is no evidence of movement between populations (including those in the lower Waitaki River). Therefore when

populations become extinct from a specific location, there is no recolonisation of the site by the same species of fish moving migrating from other populations.

38. In conclusion the geological history of the upper Waitaki and subsequent historic isolation of fish in the upper catchment has lead to the development of the locally diverse galaxiid fauna that is a unique to the Waitaki and to New Zealand.

THREATENED FISH OF THE UPPER WAITAKI RIVER CATCHMENT

39. The Department of Conservation undertook a review of the freshwater fish threat rankings in June 2009. I chaired the expert panel that under took the threat ranking process using the methodology of Townsend et al (2008). This threat ranking system is a revision of the system developed by Molloy et al (2002) and utilises some revised terminology for the threat categories. Currently the threat rankings are undergoing peer review before being published in the New Zealand Journal of Marine and Freshwater Research. The draft rankings differ from those published in Hitchmough et al. (2007) that were determined at the 2005 threat ranking meeting that I also attended. I consider it appropriate to utilise the draft rankings from the 2009 threat ranking as opposed to the 2005 rankings in Hitchmough et al (2007) as these revised rankings take into account information not available in 2005.

40. To facilitate a comparison between the various parties evidence currently before the hearing committee, I have prepared a table (Table 1) with the threat rankings from 2005 and the more recent draft rankings from 2009 for species relevant to this hearing.

41. The galaxiid fishes in the Upper Waitaki River catchment comprise the majority of the threatened fish present. This family of fish occur across the southern hemisphere and throughout their range are now in decline (McDowall 2006). A number of threat processes responsible for their decline have been identified in New Zealand and overseas and these include:

- Predation and competition with introduced fish;
- Habitat modification via land development;
- Habitat modification or loss via water abstraction;
- Habitat invasion by predatory fish via water abstractions raceways;
- Habitat modification due to invasive plants and algae;
- Degradation of habitat and food resources due to declining water quality; and
- Impacts of drought and floods.

All these threats are present or potentially present in the upper Waitaki River catchment and it is my opinion that the galaxiids have already been reduced in abundance and range in this region by these threat processes.

42. An important outcome of the current draft threat rankings is that more freshwater fish were placed in the various threat categories than in any previous ranking. This is due, in part, to taxonomic developments that have recognised new, but threatened freshwater fish taxa, but also the recognition that a number of fish

species previously thought to be stable and not threatened do in fact appear to have declined rapidly in the last ten years (Table 2).

43. The four species of particular interest, torrentfish, bluegill bully, redfin bully, and koaro in Table 2 are riffle and run dwelling fish that are more vulnerable to habitat loss due to water abstraction. This is acknowledged by Dr Olsen in his evidence for Lilybank Station Limited and Lone Star Farms Limited (sections 7biii, 30-31 and sections 11.3, 40-41 respectively) where he notes that high water velocity habitat for koaro has the potential to be lost due to water abstraction.

44. The Threatened Fish Expert Panel when considering the upper Waitaki River determined that on the basis of genetic evidence both species of longjaw galaxias in the Waitaki River catchment should be treated separately from longjaw galaxias in other catchments. This was due to the genetic evidence showing the populations in the Waitaki had been isolated for many thousands of years form populations outside the Waitaki catchment. The accumulation of DNA differences at genetic marker sites between longjaw populations in the Waitaki catchment compared with longjaw populations in other rivers is as great as or greater than the DNA difference among established species of galaxiids thereby indicating the Waitaki longjaw populations have accumulated sufficient genetic differences to be considered separately from other longjaws.

45. The outcome of the ranking process is that five of the eight native fish present in the Upper Waitaki River are ranked as nationally threatened fish. For the three

galaxiids previously ranked as threatened, the ranking has either increased (i.e. greater threat ranking) or remained at the highest possible ranking.

ASSESSMENT OF POTENTIAL EFFECTS OF ABSTRACTIONS, USE AND DISCHARGES ON AQUATIC FAUNA

46. The assessment of effects of water takes on streams and rivers can assess a variety of factors including:

- Changes in habitat availability for species;
- The effects of reduced flow on nutrient concentrations;
- Ecosystem process effects where changes in periphyton and invertebrate lead to diet and habitat use changes by fish and birds;
- Fish passage obstructions;
- Loss of fish into the abstraction; and
- Cumulative effects of multiple water abstractions and discharges.

Habitat Assessment

47. There exists a range of methods to assess the effect of water abstraction on habitat availability for fish, birds and other species. Physical habitat models, such RHYHADSIM and 2D modelling can be used to simulate the flow and determine the habitat available for species for which habitat preferences have been

determined. Such methods were noted by Dr Olsen (evidence for LilyBank Station Limited) in his assessment of the water take at Station Creek (paragraphs 26 and 29). Expert opinions into the effects of habitat availability can also be considered (i.e., evidence of Drs Olsen, Goldsmith and Ryder) for various takes. A simpler flow setting method for small streams with common fish species is the designation of a minimum flow regime by an expert panel that is based on the risk of harm of key attributes

48. To conduct habitat modelling preference curves of the fish (or other) species must be available. Habitat preference curves for koaro, Canterbury galaxias, upland longjaw, lowland longjaw and alpine galaxias, longfin eel, common bully and upland bully are available (see Dr Olsen evidence in chief Figure 4). Habitat preference curves do not exist for the bignose galaxias. Therefore, it is possible to assess changes in habitat for nearly all the fish that will be present at potential water take sites.

49. I would note that the assessment of changes in habitat availability with water takes is not required at all abstractions sites this hearing is considering as lake and canal takes present few if any habitat availability issues.

50. I have briefly reviewed each application to determine the location of the water takes and divided the applications into low risk and high risk applications on the basis of the location of the takes and the evidence provided by the applicants.

51. For takes from the Upper Waitaki Lakes and from the hydro electric impoundments (Benmore, Aviemore and Waitaki) I agree for instance with Dr

Ryder (e.g., evidence in chief for Southdown Holdings, Five Rivers Limited and Williamson Holdings Limited Section 6.2) that these abstractions will have a less than minor effect on the fauna of these lakes.

52. The takes from the hydro-electric canals (e.g., Ohau B and C) I would agree with; Dr Ryder (evidence in chief for Rosehip Orchards and High Country Rosehip Orchards Section 6.2, 6.3 and 10.2) will be of low impact on aquatic flora and fauna. These artificial environments contain a limited range of low quality invertebrates and are inhabited by more common native fish species such as common bully and, in my opinion, have a very low risk of direct impacts on threatened fauna.

53. Water takes from the streams and rivers are the takes with which I have the most concern regarding effects on fish and invertebrates. The six species of galaxiid in the upper Waitaki River are all found in streams and rivers and these species all utilise run and riffle habitats, the habitats the suffer the greatest reduction with any water abstraction. The reduction in summer flows is of the greatest concern when irrigation abstraction occurs and natural low flows also occur as this will be when the habitat available is at its lowest and most likely to be limiting the population size.

54. As I previously noted the effect of water abstraction on the riffle dwelling fish has been acknowledged by Dr Olsen in his evidence where he notes that a reduction in water velocity is likely; and that this will favour species such as Canterbury

galaxias that prefer lower velocity conditions and give rise to an unknown decline in the high velocity specialist koaro.

55. I would also note that Dr Ryder implies in his evidence (evidence in Chief for Simon Pass Station Limited and Simon Hill Station Limited Section 16.16) that the surrender of abstractions consents on the Mary Burn has the potential to improve physical habitat. This potential improvement with the return of water supports Dr Olsen analysis that loss of water degrades or reduces habitat for some species.

56. It is important to note that the recent threat ranking now recognise koaro as *declining* and the process described by Dr Olsen of loss of high velocity habitat was considered by the threat panel as one of the effects leading to cumulative decline of koaro that has been observed.

57. In the applications before this hearing two distinct issues are present. For each individual water take there is the assessment of the loss of aquatic habitat associated with the water take. There is then the additional consideration of the cumulative impact of multiple takes on lower river sections within the Upper Waitaki River catchment. No substantive analysis of the stream takes and the cumulative effects on native fish has been undertaken. It is notable that the applicants have commissioned work to attempt to assess the cumulative effects of the irrigation proposals on water quality and periphyton although not on macroinvertebrates and fish and have not addressed cumulative effects of the reduction in water quantity at any level.

58. The effects of the cumulative impacts on water quantity should be considered for all fish species but with significant attention to three key fish species, lowland longjaw galaxias, bignose galaxias and koaro. Drs Olsen and Ryder indicate or imply that abstraction of water leads to habitat loss and while Dr Olsen discounts the loss of koaro habitat as of no concern (due to now previous threat ranking) whereas the actual situation is that this species is likely to suffer from the effects of a cumulative loss of habitat throughout the basin. Any one abstraction, as Dr Olsen notes, may have a limited affect, but the cumulative effect summed across multiple abstractions is of more concern. It is my opinion the combination of cumulative impact on koaro requires consideration as this is a declining species that is widespread in the catchment and noted by experts as affected by the flow modifications.

59. Bignose galaxias also occurs in areas downstream of abstractions and has the potential to be affected by extended periods of low flow and possibly by the decline in habitat availability. For this species the applicants have provided no assessment of the possible effects and for a species now listed as nationally vulnerable it is, in my opinion, important that the effects are considered.

60. It now appears that lowland longjaws, the most threatened fish species in the basin, only occurs downstream of proposed abstractions in the Ahuriri River catchment near Omarama. Given this site also retains bignose galaxias and therefore is of high conservation value an assessment of the changes in flow and the impact on habitat for lowland longjaws and bignose is appropriate to determine cumulative effects.

61. Upland longjaw galaxias is the other threatened galaxiid likely to be exposed to the downstream effects of water quality changes as populations are reported from the McCauley River downstream from Lilybank Station and in the Cass River in the vicinity of the Lone Star Farms and Glenmore Station proposed areas for irrigation.

Nutrient changes

62. In this section where I discuss the cumulative effects on water quality I am referring to water quality changes that come about through two mechanisms. Firstly, a decrease in dilution of existing nutrients as water is abstracted from lakes, rivers and streams. Secondly, the increase in nutrients being applied to farms as fertiliser and from the increased stock numbers present on the irrigated properties that can enter the waterways via surface water runoff or via the ground water.

63. Drs Coffey, Meredith and Ryder, and Mr Snelder and Mr Bray have all discussed water quality effects in their respective evidence. I would like to draw attention to one issue that was briefly discussed by Dr Coffey. He notes in Section 5.2 of his evidence that increases in nutrients can lead to change in periphyton abundance and species that have flow on effects to the macroinvertebrate community. Dr Coffey even discussed this ecosystem effect using the decline of *Deleatidium* (the mayfly nymph) as an example. I agree that this effect exists but it is my opinion that Dr Coffey has not extended this assessment to consider the full potential effects.

64. As I noted in my descriptions of fish diet and Mr Ravensroft describes in his evidence, the galaxiid species prey upon mayflies, generally *Deleatidium* and some chironomids (midge larvae). Changes in water quality that lead to reduction in *Deleatidium*, in particular, will have a secondary effect of reducing the preferred prey of all the galaxiids. The impact of a potential reduction in food availability or changes in the potential prey species has not been undertaken. This issue, in my opinion is a critical consideration for areas where bignose galaxias and lowland longjaws exist downstream of irrigation command areas in the lower Ahuriri River and lower Tekapo / Ohau Rivers areas. For these fish their small body size means they have a limited size range of prey items and for the lowland longjaw the specialist mouth shapes indicates a specialised feeding behaviour that could be disrupted by the loss of key prey items in the preferred feeding habitat.

65. In the absence of any assessment of the effect of ecosystem change effects on diet and survival of key threatened fish, it is my opinion, that consents should be declined or if granted should be accompanied by conditions that include a very precautionary approach to changes in water quality, periphyton abundance and invertebrate and fish community structure.

66. I would also note that the braided river birds described Mr Murray's evidence also feed on the freshwater invertebrates and fish, including native fish. As with the fish, changes in invertebrate species and reductions in fish abundance and their availability as prey items has the potential to affect bird foraging in the braided rivers.

Bywash discharge effects

67. There exists a number of applications for the discharge of bywash from the irrigation systems. I have not researched each of these applications but would note that potential effects of these discharges exist and for which no assessments have been made. The potential effects include bywash discharges into wetlands and springs may impact upon undiscovered lowland longjaw populations or other organisms of conservation value, the intermittent and unpredictable discharges may impact on fish spawning causing displacement of larval fish that are present in stream during the irrigation season. An assessment of downstream fish communities and the risks presented by the bywash discharges would be appropriate. Alternatively, bywash discharges could be directed into soakage areas to avoid direct discharges on surface water bodies.

68. For irrigation systems with continuous discharges to water ways consideration needs to be made for the prevention of fish passage into the race systems. Research I conducted on water race systems in Otago (Allibone 2000) found water races are significant pathway for fish to enter new waterways and for predatory fish to bypass instream barriers and enter predatory free water ways. Of particular concern for any water way in the upper Waitaki River catchment is the provision of fish passage for salmonids or koaro to new areas as these fish are known to impact on small native fish (Allibone 1999, 2000) and their accidental introduction into new water may cause further decline of other threatened fish This is further demonstrated as an issue by Mr Ravenscroft (in Section 9 of his second brief of evidence) where he notes the Department has an active trout

control programme at two sites to protect lowland longjaws. Therefore, it is my opinion that an assessment of the requirement of fish passage barriers should be undertaken and passage should be prevented at the discharge points to prevent upstream migrating koaro and salmonids entering irrigation races.

Cumulative impacts

69. As I have noted in earlier in my evidence the assessment of cumulative impacts of all the applications is important. In my evidence I have indicated that native fish populations are already threatened by a number of threat processes that operate in the upper Waitaki River catchment. Mr Ravenscroft's evidence has also shown that two populations of the critically threatened lowland longjaw may have gone extinct in the last seven years showing that the threat of decline and extinction is continuing.

70. The consideration of the ecological effects of these applications has been conducted by some applicants and I commend this approach as opposed to the lack of ecological assessments provided by other applications. However, as I have noted earlier, no applicant or applicants have considered the cumulative effects of the takes on aquatic ecosystems.

71. A recent analysis of the New Zealand freshwater fish database by Joy (2009) for the Ministry for the Environment highlighted that freshwater fish communities in urban and pastoral areas are less diverse that equivalent populations in indigenous forest. Joy (2009) found that increasing pastoral development was highly correlated with a decline in the diversity of the fish fauna. The recent threat

ranking process also found evidence that broad scale decline is occurring and we believe the cumulative effects of land development and water use are factors in this decline.

72. Therefore, it is my opinion that cumulative effects should be considered with respect to all applications for water takes in the Upper Waitaki River catchment. In addition, it is my opinion that the applications need to be considered for all effects on ecosystems and not and not simply for water quality issues. The granting of these applications has the potential to increase decline rates of threatened native fish that are already under threat from multiple factors.

73. Of particular concern with respect to cumulative effects are the areas with lowland longjaws and bignose galaxias that are downstream of irrigation areas as these species are highly threatened and are key components of the Waitaki River fish fauna.

CONSENT CONDITIONS

74. I have read conditions proposed by Mr Kyle for Ohau Downs as an example of the conditions proposed by some of the applicants and the conditions put forward in the Staff Officer Report Appendix 6.

75. I agree with the requirement for all intakes to be screened according to the fish screen guidelines. However, I do wish to note that as koaro are present in the catchment that very fine mesh screens are required to reduce the entrainment of these larval fish. The Staff Officer recommends (WP09 -10) screens with a 3 x3

mm mesh, or 3x2 mm slot screen and this will be insufficient to screen out the downstream migrating koaro larvae and the loss of some larvae should be expected if 3 mm screens are used. The magnitude of this effect will be less than minor for one take given the size of the koaro population in and upstream of each lake, but for multiple takes at some, as yet unknown stage, the loss of larvae will have effects on koaro survivorship and ecosystems effects in the lake systems where koaro larvae provide a food source for lake dwelling salmonids.

76. The need for these fine mesh screens may be alleviated if the spawning time of koaro was known to occur outside the abstraction season in the Upper Waitaki area. However, I agree with Dr Olsen that at present the timing of spawning is uncertain and therefore screen designs need to limit entrainment of these larval fish. I would recommend that if fine mesh screens are not to be used that a research condition is required to determine koaro spawning timing and demonstrate the risk of entrainment is low.

77. The 3 mm or 3 x2 mm screen will also not exclude non-migratory galaxiid larvae and it can be expected that all five species have the potential to become entrained in the intakes. The effect on the common and abundant non-migratory galaxiids; Canterbury galaxias and alpine galaxias will be local depletion of larval fish around the intake site and possibly lower density adult populations in the vicinity of the takes. This, in my opinion, would be at worst a minor effect on these fish when considering a single take, but cumulatively there exists the potential for more than minor effects across the MacKenzie Basin.

78. The effect of the loss of larval bignose and longjaw larvae has the potential to be less than minor. These fish have relatively low egg numbers so produce few larvae and are more at risk to population decline due to entrainment. For the applications with supporting ecological assessment there does not appear to be any takes that represent a threat to these fish. Therefore I would accept the 3 mm screens where it can be demonstrated that no threatened galaxias exist in the streams within 500 m of the takes.

79. For longfin eel, it is my opinion that the 3 mm screen will provide appropriate protection for the species.

80. An additional consideration with the intakes on streams and rivers is that fish passage is maintained at all sites, unless the abstraction site is a current abstraction site that does not provide fish passage. It has been my experience throughout New Zealand that trout and salmon can be excluded from some areas by water abstraction weirs and these weirs protect upstream native fish populations from the impacts of salmonid competition and predation. In the case I would accept the Staff Officer's recommendation for fish passage at dams (Conditions DW2-03) until any existing barriers have been assessed and retained if the barrier protects native fish communities upstream of the barrier.

81. I note the Staff Officer includes conditions for the operation and maintenance (DW14 -17). I support these conditions as I have found many poorly maintained water races during my investigation of water abstractions in Otago and these have

contributed to increased sediment runoff into streams and catastrophic failure of two raceways to major habitat changes in downslope natural streams.

82. The Staff Officer's provides conditions for sediment control and I support all the conditions with the intent to limit sediment inputs into the lakes, rivers and streams. However, I would note that condition LU15 that seeks to protect spawning is problematic, because as I previously noted, the spawning timing of koaro is uncertain in the upper Waitaki area and a targeted exclusion period for works is difficult to set.

83. The Staff Officer's report also recommends a condition (LU 21) with respect to the transfer of didymo and I would support this condition.

84. Monitoring of fish populations in rivers and streams has not been proposed by the Staff Officer or the applicants. In my opinion fish are likely to be affected if these applications are granted and therefore monitoring to ensure effects on native fish are minor is appropriate.

85. Monitoring should be undertaken using a standardised electric fishing protocol that samples sufficient area (100-200 m^2) of river to obtain fish sample sizes large enough to detect changes in abundance and be conducted annually at the monitoring nodes specified and less frequently at a suite of other representative sites. All threatened fish (longfin eel, koaro, lowland longjaw, upland longjaw and bignose) caught should be recorded, weighed and measured to allow length frequency, fish condition and fish density to be monitored. Fish numbers and a representative sample of common fish species (Canterbury and alpine galaxias,

upland and common bully) should be weighed and measured. The monitoring should be at or adjacent to the water quality monitoring nodes to allow fish population status to be compared to water quality.

86. Additional monitoring in conjunction with the Department of Conservation's monitoring of threatened fish populations would be appropriate for populations downstream of the irrigation areas. In addition diet assessment should be undertaken on 3-5 years basis or if significant declines in fish abundance or fish condition are observed to detect diet switches and this should be coupled with assessments of the macroinvertebrate community.

87. The consent conditions should specify nutrient limits and minimum flows for all streams and downstream areas. I note that there has been a number of monitoring nodes suggested and I agree with this monitoring approach. However, additional sites may be required to ensure data are gathered at all key fish and bird sites to allow direct assessment of nutrient levels and periphyton communities at these key areas.

88. For areas with highly threatened fish species it is, in my opinion, important to recognise that recovery periods are appropriate if consent conditions are breached and impacts on the fish occur. An approached used in the Kakanui catchment, the other catchment with lowland longjaws, is that if the minimum flow is breached all abstractions are suspended until a flow nearly twice the minimum flow has occurred in the Kakanui River. Similar conditions could be applied here for minimum flow conditions and for nutrient levels where irrigation is restricted or

suspended when nutrient levels breach trigger levels and remain restricted until nutrient levels drop and are sustained at or below a specified level below the maximum trigger level.

CONCLUSIONS

89. The Upper Waitaki River and its associated tributaries contain a unique, rare and threatened freshwater fish fauna.

90. This unique fish fauna has been progressively isolated from other rivers during the last 3 million years.

91. The recent freshwater fish threat classification process has ranked more fish as threatened that any previous classification and significant declines in common species have occurred in the last decade.

92. Four of the six galaxiid taxa in the Upper Waitaki catchment are considered threatened and are currently declining due to multiple threats.

93. Key areas requiring protection from irrigation effects are downstream areas occupied by lowland longjaw and bignose galaxias.

94. Water abstraction from rivers and streams, especially during summer low flow conditions, will reduce the habitat available to riffle and run dwelling fish such as koaro, Canterbury galaxias and the pencil galaxiids.

95. Assessment of the effects on aquatic fauna have been made on only a few of the streams and river subject to applications to take water with the remaining applicants providing no information on the ecological effects of the proposed applications.

96. Key ecological information is lacking in the assessment of effects for koaro and due to limited knowledge of its life cycle in the upper Waitaki.

97. The cumulative effect of all the water takes has not been assessed for sub-catchments within the Waitaki catchment that have multiple take use and discharge applications.

98. An increase in nutrient levels and periphyton in streams and rivers has the potential to alter the invertebrate fauna of these streams from communities with organic and nutrient pollution sensitive species such as mayflies to communities with organic and nutrient pollution tolerant species such as snails and chironomids.

99. Fish and bird diets that are closely linked to mayfly and caddisflies have the potential to be affected by changes to the invertebrate community and this has not been assessed by many applicants

100. Consent conditions proposed by the applicants and the Staff Officer include appropriate conditions but also lack sufficient monitoring of effects and targets to limit the effects on aquatic systems.

Richard Allibone

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