BEFORE THE CANTERBURY REGIONAL COUNCIL HEARING COMMITTEE

IN THE MATTER	of the Resource Management Act 1991 (the Act)
AND	
IN THE MATTER	applications by Lilybank Station Holdings Limited to divert water from Station Stream for the purpose of irrigation

STATEMENT OF EVIDENCE OF DEAN ANTONY OLSEN ON BEHALF OF LILYBANK STATION LIMITED

Dated this 23rd day of September 2009

INTRODUCTION – QUALIFICATIONS AND EXPERIENCE

1. My name is Dean Antony Olsen. I reside in Nelson where I work as a freshwater scientist at the Cawthron Institute. I hold the degrees of B.Sc. (Honours I) in Zoology and Ph.D. in Zoology, both from the University of Otago. I am a member of the New Zealand Freshwater Sciences Society and the North American Benthological Society.

2. I have more than 11 years experience in the field of freshwater ecology especially in stream macroinvertebrates, the ecology of the hyporheic zone, environmental flow regime analysis, and freshwater fisheries. After completing my Ph.D. in 2003, I worked for two years as a Post-doctoral Research Associate at the University of Vermont in Burlington, Vermont, United States of America. I

have been employed as a freshwater ecologist at the Cawthron Institute in Nelson since September 2005.

2. I have previously presented evidence at the following hearings:

    i. Resource consent hearing for TrustPower's Wairau River hydroelectric power scheme (joint witness for Fish & Game and Department of Conservation),

    ii. Resource consent hearing for the Central Plains Water Enhancement Scheme (joint witness for Fish & Game and Department of Conservation),

    iii. Ministry for the Environment Special Tribunal hearing for a variation to the Kawarau Water Conservation Order with respect to the Nevis River (witness for Fish & Game).

3. I have been the first author of several scientific articles in the peer-reviewed international journals *Archiv für Hydrobiologie* (now *Fundamental & Applied Limnology), Freshwater Biology, Hydrogeology Journal, Marine and Freshwater Research*, and *New Zealand Journal of Marine and Freshwater Research* and one peer-reviewed report in the Department of Conservation *Research & Development Series*.

4. I regularly peer-review manuscripts for international scientific journals including *Aquatic Sciences, Freshwater Biology, Hydrobiologia, Invertebrate Systematics, Journal of Applied Ecology, Journal of the North American Benthological Society, Marine and Freshwater Research, New Zealand Natural Sciences* and *Restoration Ecology*.

5. I confirm I have read and agree to apply with the Code of Conduct of Expert Witnesses (July 2006). This evidence is within my area of expertise, except where I state where 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

1. In June 2008, I authored a report entitled "Station Stream Ecological Survey" (Olsen, 2008: Cawthron Report No. 1438). A copy of the report is attached to this evidence as **Appendix A**. This report presents the results of a survey of the existing values of Station Stream (including the fish, macroinvertebrate and periphyton communities) and discusses the potential effects of the proposed abstraction on the instream values of Station Stream. This report is the basis for much of my evidence.

6. In summary, my evidence addresses:
    a. Existing ecological values of Station Stream including:
        i. water quality
        ii. periphyton
        iii. invertebrates
        iv. fish (salmonids and native)

    b. Potential effects of the proposed development

EXECUTIVE SUMMARY

7. The key conclusions of my evidence are outlined below:

    a. The affected reach of Station Stream supports the following in-stream values:
        i. Trout spawning and rearing habitat in the lower reaches;
        ii. Habitat for koaro and Canterbury galaxias;
        iii. Habitat for macroinvertebrates (food for galaxiids and juvenile trout in lower reaches, biodiversity values);
        iv. Habitat for periphyton (biodiversity values).
    b. Potential effects of proposed flows:
        i. Residual flows (320 l s^{-1} minimum flow with flow management between 320 and 510 l s^{-1}) to affect 1.5 km of Station Stream;
        ii. Spawning and juvenile rearing habitat for trout are not expected to be detrimentally affected;

iii. Reduced velocities in the residual reach may favour Canterbury galaxias over koaro, both of which are widespread in the upper Waitaki and in other parts of New Zealand;

iv. The risk of periphyton proliferation due to low, stable flows is mitigated by the proposed flow management regime.

v. Invertebrate communities are not expected to be detrimentally affected.

vi. Water quality is not anticipated to be affected by the proposed flow regime

vii. The reduction in discharge is not expected to affect the extent of suitable feeding habitat for wading birds or reduce the abundance of invertebrate prey.

PROPOSED FLOW REGIME

8. The current application is for a maximum rate of abstraction of 100 $l\ s^{-1}$, a minimum flow of 320 $l\ s^{-1}$ (mean annual low flow (MALF) = 312 $l\ s^{-1}$) and reduced abstraction between 320 and 510 $l\ s^{-1}$ (as summarised in Table 1). For more detail, refer to the evidence of Ms Haidee McCabe)

Table 1 Proposed flow management of Station Stream irrigation abstraction

Station Stream flows ($l\ s^{-1}$)	**Abstraction** ($l\ s^{-1}$)
>420	100
395 - 420	75
370 - 395	50
345 - 370	25
321-345	Managed minor takes
<320	0

ECOLOGICAL SURVEY METHODOLOGY

9. Three sites in Station Stream were sampled on 20 February 2008: one immediately upstream of the likely location of the water intake and at two locations downstream (Table 1, Figure 1).

Table 2. Location and physical characteristics of sampling sites in the Station Stream.

Site	Location	GPS E	GPS N	Elevation (m a.s.l.)	Reach gradient
Site 1	Upstream of intake	2313220	5721660	840	0.078
Site 2	Immediately downstream of intake	2312745	5721275	795	0.047
Site 3	Immediately upstream of bridge	2312100	5720940	770	0.034

10. At each site, spot-measurements of water temperature, specific conductance and pH were taken, the percentage of the bed covered by periphyton (algae, bacteria and fungi) was estimated, a single semi-quantitative (kick-net) sample was collected for macroinvertebrate analyses, and electric fishing was conducted. Further details of methods employed in the survey are given in Olsen (2008) (**Appendix A**).

PHYSICOCHEMICAL CONDITIONS IN STATION STREAM

11. Spot measurements of physicochemical conditions are summarised in Table 2. All these values are within the normal range expected in a stream such as Station Stream, with cool water temperatures, low specific conductance, pH close to neutral and relatively high clarity at the time of sampling. A probe malfunction precluded measurements of dissolved oxygen, but dissolved oxygen concentrations were expected to be high in Station Stream due the steep gradient and cool water temperatures observed.

Table 3. Physicochemical conditions observed at each of the sites sampled in Station Stream on 20 February 2008.

Site	Location	Time sampled	Water temperature (^{o}C)	Specific conductance ($mS\ cm^{-1}$)	pH	Turbidity (NTU)
Site 1	Upstream of intake	11:20	8.65	41	7.89	1.83
Site 2	Immediately downstream of intake	13:00	12.27	41	7.06	1.78
Site 3	Immediately upstream of ford		15.58	42	7.26	1.7

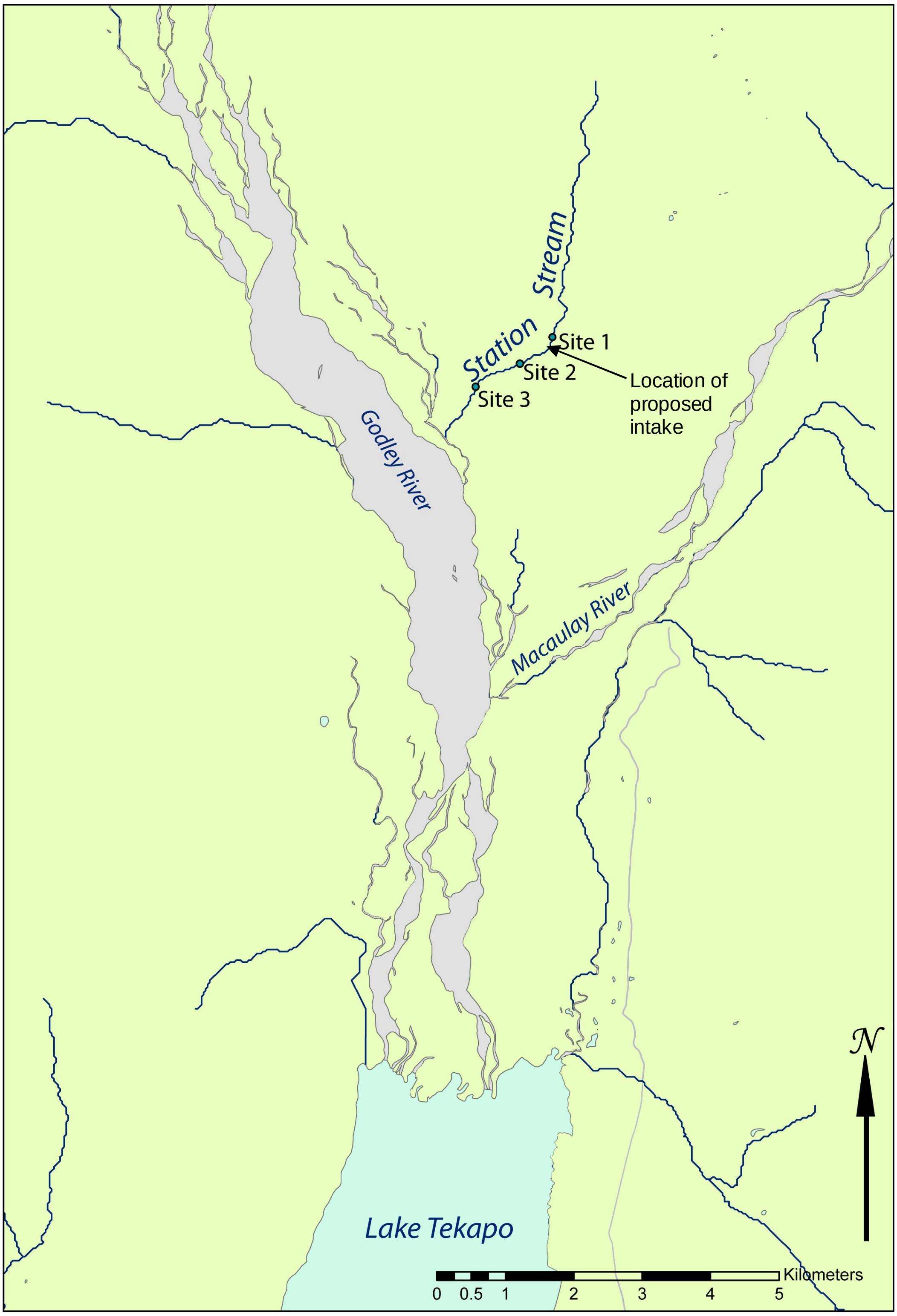

Figure 1. A map showing the location of the sampling sites on Station Stream.

PERIPHYTON COVER IN STATION STREAM

12. Thin green mats of algae were the dominant periphyton at the upper site, while thin and medium brown mats (dominated by diatoms) were the most prevalent periphyton at Sites 2 and 3 (Table 3). Black/dark brown mats (cyanobacteria) were also evident at Sites 2 and 3 (Table 3). At Site 2 these mats were of thin to medium thickness (up to 3 mm thick) while at Site 3 thick mats were evident (Table 3). Sampling of the thick mats at Site 3 revealed that these were dominated by the cyanobacterium (blue-green algae) *Phormidium*. Short and long filamentous green algae were also observed in small quantities at all three sites and the nitrogen-fixing cyanobacterium *Nostoc* was observed at Site 2 (Table 3).

13. I collected a sample of the *Phormidium* mats observed in Station Stream and this was cultured in the laboratory by a colleague. *Phormidium* has the potential to produce neurotoxins which have been linked to dog deaths in New Zealand (Wood *et al.* 2007). Genetic analyses confirmed it as *Phormidium autumnale*, the primary anatoxin-producing species of *Phormidium* in New Zealand, but no toxins were detected in the sample from Station Stream or culture (Heath et al. *In prep*).

14. Periphyton communities observed at all three sites on 20 February 2008 were indicative of good water quality, with overall periphyton scores exceeding seven at all sites sampled (Table 4).

Table 4. Summary of periphyton data including percentage cover of the various periphyton types, and overall periphyton score for the three sites in Station Stream on 20 February 2008. Data was collected following the RAM-2 protocol (Biggs & Kilroy 2000).

Location	Site 1 - upper	Site 2 - middle	Site 3 - lower
Thin green mat	85.25	11.25	-
Thin light brown mat	4.75	22.50	30.50
Medium brown mat	3.00	17.50	55.00
Thin black/dark brown mat	-	0.75	-
Medium black/dark brown mat	-	3.00	-
Thick black/dark brown mat	-	-	2.00
Medium green filamentous	0.25	3.50	0.25
Long green filamentous	-	0.75	-
Nostoc	-	0.50	-
% of rocks with 0% cover	1	3	0
% of rocks with 100% cover	16	2	9
Overall periphyton score	7.17	7.84	7.46

MACROINVERTEBRATE COMMUNITY

15. Twenty-seven macroinvertebrate taxa were collected from the three sites in the Station Stream. The mayfly *Deleatidium*, the stonefly *Megaleptoperla*, the net-spinning caddis fly *Aoteapsyche* were among the most abundant macroinvertebrate taxa at all three sites in Station Stream (Table 5).

16. The macroinvertebrate community index (MCI) scores of all three sites sampled were indicative of good water quality (Stark & Maxted 2007), while the semi-quantitative MCI (SQMCI) score for the upper site (6.21) indicated "excellent" water quality, and the SQMCI score for the two lowest sites (4.87, 4.18) indicate "fair" water quality (Stark & Maxted 2007) (Table 4). The differences in SQMCI scores between the uppermost site (Site 3) and the other two sites are likely to represent significant differences, as Stark (1998) found that for single kick-net samples, a difference of greater than 0.83 SQMCI units was likely to represent a statistically significant difference.

17. MCI scores for the three sites indicate relatively consistent, good water quality across the three sites. Meanwhile, the SQMCI results suggest that water quality at the upstream site is excellent, but that water quality at the two lower sites is lower in comparison, indicating possible organic pollution of these two lower sites.

18. However, it should be noted that the interpretation of biotic indices (such as the MCI and SQMCI) can be complicated by variables that are unrelated to water quality. Macroinvertebrate community structure can be influenced by inter-site differences in factors such as elevation (see Table 1), shading, water velocity (as a result of differences in channel gradient – see Table 1) and water temperature. Consequently, it is premature to attribute differences in community composition between the three sites in Station Stream to differences in water quality. The observed differences in SQMCI scores between the upper site and the two lower sites may reflect the observed difference in periphyton communities between these sites, with the prevalence of medium thickness diatom mats increasing in a downstream direction.

Table 5. Macroinvertebrates collected from the three sites in Station Stream on 20 February 2008. R = 'rare' (1-4 individuals per sample), C = 'common' (5-19 individuals per sample), A = 'abundant' (20-99 individuals per sample).

Taxa	MCI score	Site 1 Upper	Site 2 Middle	Site 3 Lower
Ephemeroptera (Mayflies)				
Deleatidium spp.	8	A	A	A
Plecoptera (Stoneflies)				
Megaleptoperla grandis	9	-	R	-
Megaleptoperla sp.	9	C	A	A
Zelandoperla sp.	10	R	-	R
Coleoptera (Beetles)				
Elmidae	6	R	C	-
Diptera (True flies)				
Empididae	3	-	R	C
Eriopterini	9	R	C	C
Aphrophila neozelandica	5	-	R	-
Austrosimulium sp.	3	R	R	-
Austrosimulium spp.	3	-	-	R
Maoridiamesa spp.	3	-	C	C
Orthocladiinae	2	R	C	A
Neocurupira hudsoni group	7	R	R	-
Paralimnophila skusei	6	-	R	-
Tanytarsus vespertinus	3	R	C	-
Trichoptera (caddis flies)				
Aoteapsyche spp.	4	C	A	A
Costachorema sp.	7	R	R	R
Hydrobiosis charadraea	5	-	R	-
Hydrobiosis parumbripennis	5	R	-	C
Hydrobiosis sp.	5	R	-	-
Hydrobiosis spp.	5	-	C	A
Hydrochorema sp.	9	C	R	-
Olinga feredayi	9	-	R	C
Psilochorema leptoharpax	8	-	-	R
Pycnocentrodes sp.	5	-	-	R
Gastropoda (Snails)				
Potamopyrgus antipodarum	4	-	R	-
Annelida (Segmented worms)	1	R	-	R
Taxon richness		15	20	16
MCI		119	113	115
SQMCI		6.21	4.87	4.18

FISH COMMUNITY

19. Three species of fish were collected in this survey including rainbow trout, koaro (*Galaxias brevipinnis*) and Canterbury galaxias (*Galaxias vulgaris*) (Table 6). Juvenile rainbow trout were collected in swift water at the lowest site in riffle habitat (Table 6). No trout were collected at the other two sites (Sites 1 and 2), which were upstream of a culvert (2312545E 5721175N). It is likely that this culvert prevents trout from accessing upstream reaches of Station Stream. Koaro were the predominant species collected at both upstream sites, with one Canterbury galaxias collected from a minor seepage channel at Site 1 (Table 6). Koaro and Canterbury galaxias can be difficult to differentiate in the field, so it is possible that some of the fish identified as koaro may have been Canterbury galaxias. However, since neither of these species is listed as being threatened or at risk, this uncertainty is of little consequence for these assessments.

Table 6. Summary of fish collected from the three sites in Station Stream, Lake Tekapo on 20 February 2008 and a description of the type and area of each habitat sampled.

Site	Location	Habitat type	Area fished (m^2)	Rainbow trout	Koaro	Canterbury galaxias
Site 1	Upstream of intake	Cascade	30	-	2	-
		Seepage	10	-	11	1
Site 2	Immediately downstream of intake	Cascade	80	-	19	-
		Seepage	5	-	1	-
Site 3	Immediately upstream of bridge	Riffle, cascade	60	6	19	
		Minor channel	10	-	4	-

SUMMARY OF INSTREAM ECOLOGICAL VALUES OF STATION STREAM

20. Based on the information presented above, it is my opinion that Station Stream supports the following instream ecological values:

    a. Trout spawning and rearing habitat in the lower reaches;

    b. Habitat for koaro and Canterbury galaxias;

    c. Habitat for macroinvertebrates (food for galaxiids and juvenile trout in lower reaches, biodiversity values);

    d. Habitat for periphyton (biodiversity values).

EFFECTS OF PROPOSED ABSTRACTION

HABITAT AVAILABILITY FOR FISH - SALMONIDS (TROUT AND SALMON)

21. The survey of Station Stream on 20 February 2008 yielded juvenile rainbow trout at the lowest site (Site 3). It appears that a culvert between this site and the two upstream sites precludes upstream access by trout. The relatively steep and unstable nature of Station Stream downstream of this culvert means that this reach is likely to be of limited suitability for adult trout, primarily due to the lack of deep water but also because of the swift, turbulent nature of much of the stream. Thus, the affected reach of Station Stream is unlikely to have a significant fishery for resident adult trout and it is my opinion that its significance is primarily as spawning and juvenile rearing habitat.

22. It is important to consider the nature of the fisheries values supported by Station Stream when considering the likely consequences of abstraction. Generally, the flow required to provide for trout spawning and juvenile rearing is less than that for adult trout feeding, due to the greater depths and water velocities preferred by feeding adults.

23. Flows within the reach of Station Stream to be affected by this take are generally swift and turbulent, and the substrate is generally quite coarse, conditions that are generally not favourable for trout spawning. However, there may be some areas of suitable habitat within the affected reach.

24. Juvenile salmonids also usually favour areas of relatively low water velocity, but in the case of turbulent flow, such as was evident in Station Stream, they can exploit low-velocity areas in the lee of boulders and other instream obstructions. Adult trout may be unable to exploit these areas due to their size.

25. Brown trout are expected to spawn in late autumn/early winter (May-July) and the eggs and aelvins will incubate until early spring - which equates to April - October. Rainbow trout (which we collected in Station Stream) are late winter-spring spawners (July-October) with fry rearing extending into December. Therefore, I believe that the most appropriate time of the year for in-stream works is between January and March.

26. It is unlikely that the proposed take will negatively affect the availability of suitable areas for spawning, and a reduction in the average water velocity may create more favourable conditions for juvenile rearing. Instream habitat modelling would be required to quantify any effect of flow reductions on habitat availability for spawning and juvenile rearing but in my judgement, the magnitude of the proposed take (and the resultant hydrological effects) However, it is probable that the frequent high flows are a major factor controlling the productivity of Station Stream and its suitability as spawning and juvenile rearing habitat. Thus, it is not anticipated that the proposed take will significantly reduce the availability of suitable spawning or juvenile rearing habitat in Station Stream.

NATIVE FISH

27. Koaro and Canterbury galaxias were collected from Station Stream in this survey. In addition to these two species, previous electric fishing surveys in the Godley Valley (as downloaded from the New Zealand Freshwater Fish Database on 14 February 2008) have yielded upland long-jaw galaxias, alpine galaxias, upland bullies and common bullies. Of these species, the upland long-jaw galaxias is listed as "at risk" in the "declining" category in the New Zealand threat classification listings published by the Department of Conservation (Hitchmough *et al.* 2005 adapted to the revised New Zealand threat classification system of Townsend *et al.* 2008). Both of the species we collected in Station Stream are widely distributed in the upper Waitaki catchment (Figure 2, Figure 3) and are

listed by the Department of Conservation as “not threatened” (Hitchmough *et al*. 2005).

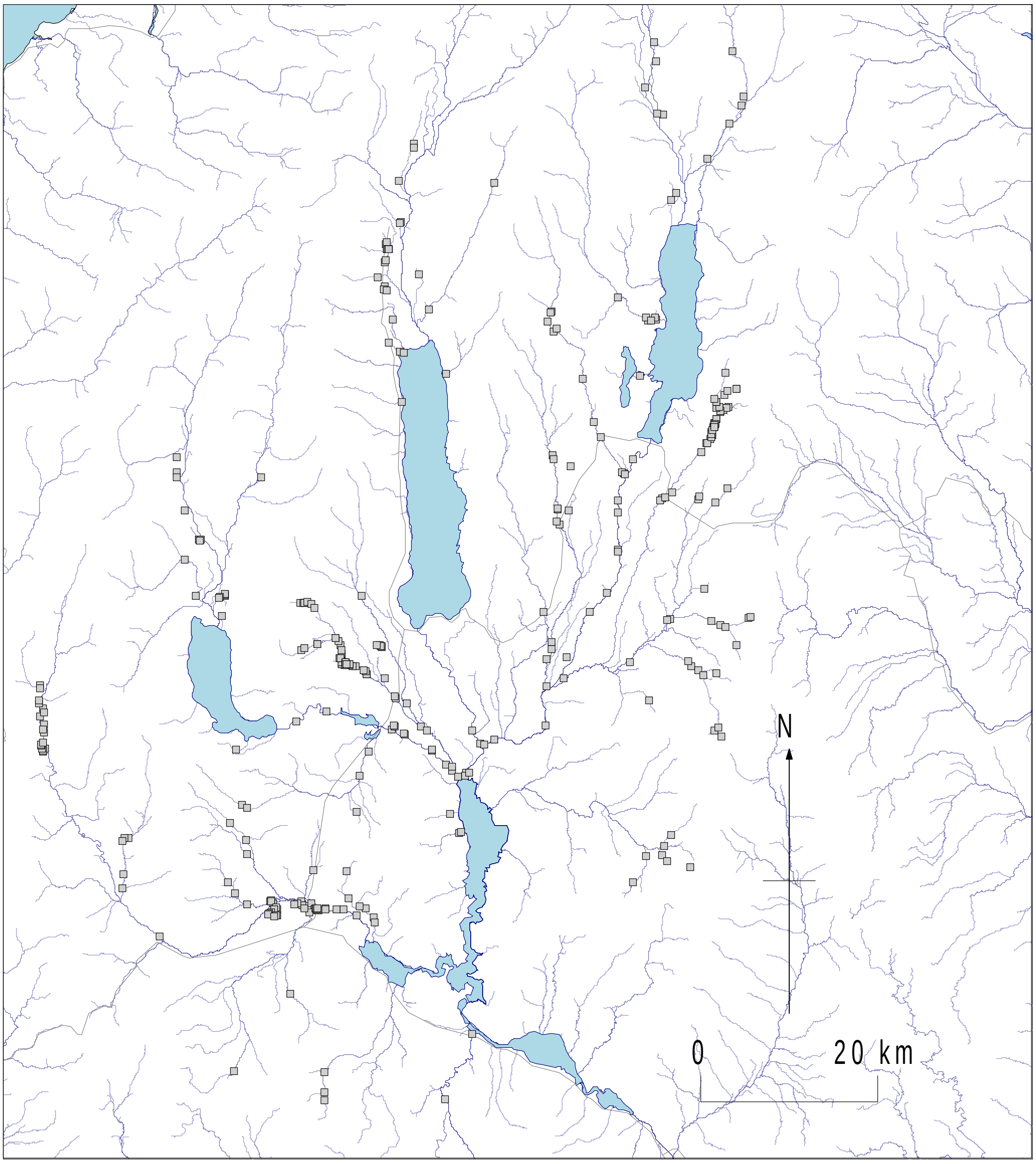

Figure 2 Distribution of Canterbury galaxias (*Galaxias vulgaris*) in the upper Waitaki catchment. Data from the New Zealand Freshwater Fish Database (administered by NIWA).

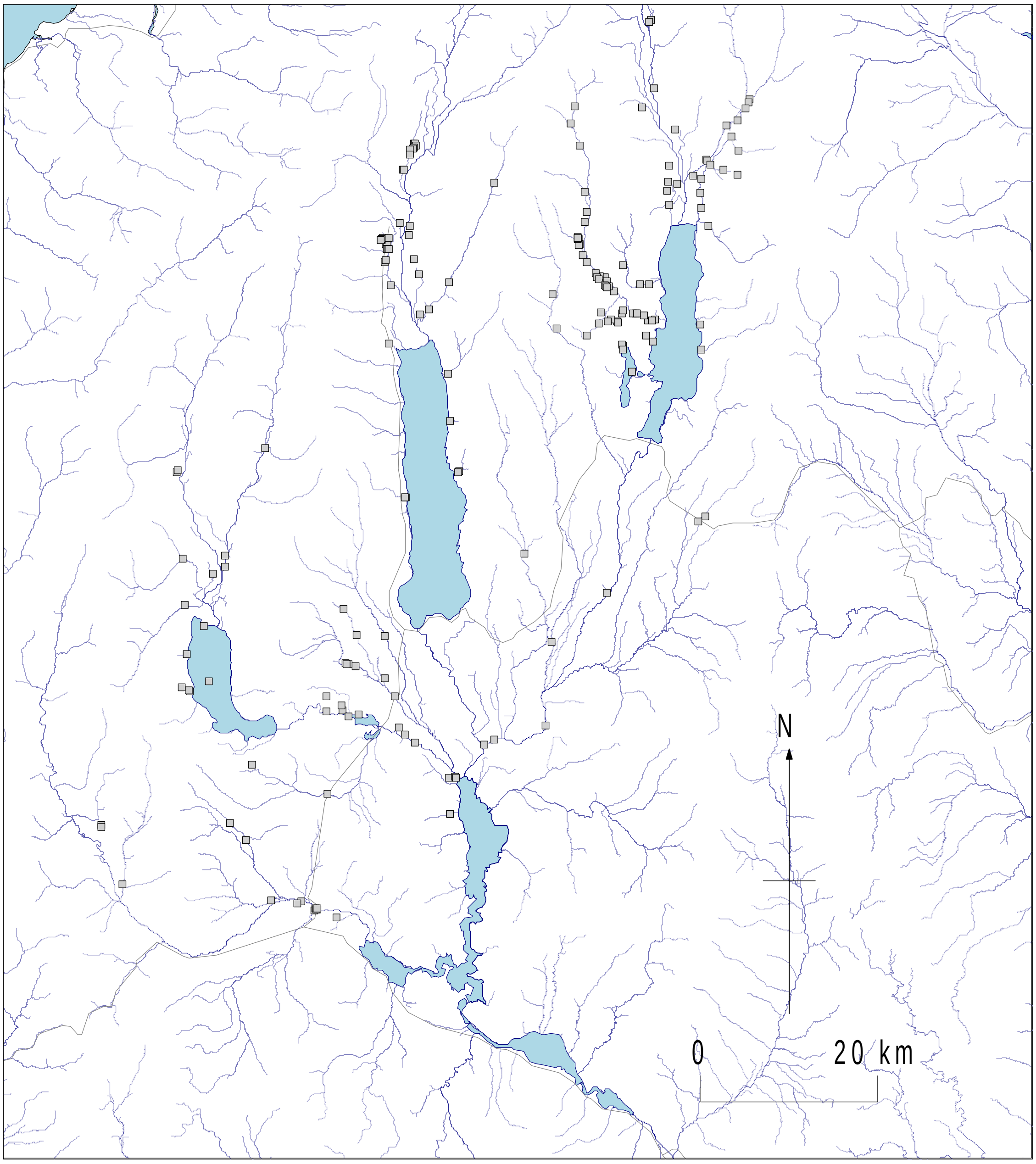

Figure 3 Distribution of Koaro (*Galaxias brevipinnis*) in the upper Waitaki catchment. Data from the New Zealand Freshwater Fish Database (administered by NIWA).

28. There is limited data on the timing of spawning of land-locked koaro in the Tekapo catchment, but the timing of spawning is likely to be wider than that of sea-going stocks of koaro, with spawning expected between autumn and spring. Adults probably spawn in their river habitats with larvae travelling downstream to

lakes soon after hatching where they live and feed before returning to rivers in late autumn (McDowall 1989). Spawning events and any significant fish movement will coincide with natural freshes when the residual reach is unlikely to represent a barrier to migration.

29. Instream habitat modelling would be necessary to quantify the effect of the proposed abstraction on the extent of available habitat for these fish. However, the significance of the species present and the extent of the residual reach do not, in my opinion, justify such an effort.

30. It is possible, however, to comment on the likely effect of flow changes on native fish in Station stream based on the habitat preferences of the species present. Inspection of habitat suitability criteria for Canterbury galaxias, koaro, alpine galaxias, upland longjaw galaxias, upland bullies and common bullies indicate that of these species, koaro have the highest velocity preferences (Figure 4). However, it should be noted that the habitat suitability criteria for alpine galaxias and upland longjaw galaxias are based on small datasets, so these curves should be interpreted with caution. It is also interesting to note that Jowett & Richardson (2008) comment that the velocity and depth preferences of koaro are likely to be affected by the presence of trout, with fish observed in the absence of trout preferring slower water and having a wider depth range.

31. Abstraction of water from a steep, swift-flowing, turbulent mountain stream, such as Station Stream, is expected to reduce water velocities and water depth Reductions in water depth are expected to be of minor consequence for these species given their preference for shallow water (Figure 4). An overall reduction in velocity may favour Canterbury galaxias over koaro, which prefer higher water velocities (Figure 4). I do not anticipate that the proposed abstraction will affect the quality of habitat for either alpine or upland longjaw galaxias (if they are present) based on their habitat suitability curves (recognising the limited data that were used to develop these curves – Jowett & Richardson 2008).

32. The other consideration when assessing the likely effect of the proposed abstraction on instream habitat is the reduction in wetted width caused by

reduced flow. Whilst this represents a reduction in available habitat, this reduction may be offset to some degree by increases in habitat quality resulting from lower water velocity and turbulence.

33. I anticipate that any effect of the proposed abstraction on fish species found in Station Stream will be less than minor. This opinion is based on the widespread distribution of both the species collected in the electric fishing survey, the abundance of similar habitat upstream of the intake and elsewhere in the Tekapo catchment, consideration of the habitat preferences of the fish species that may be present, the relatively short length of river affected by residual flows (~1.5 km) and the fact that the proposed residual flow is set at MALF, which is the lowest flows expected to occur annually (although naturally these low flows are expected to occur in winter).

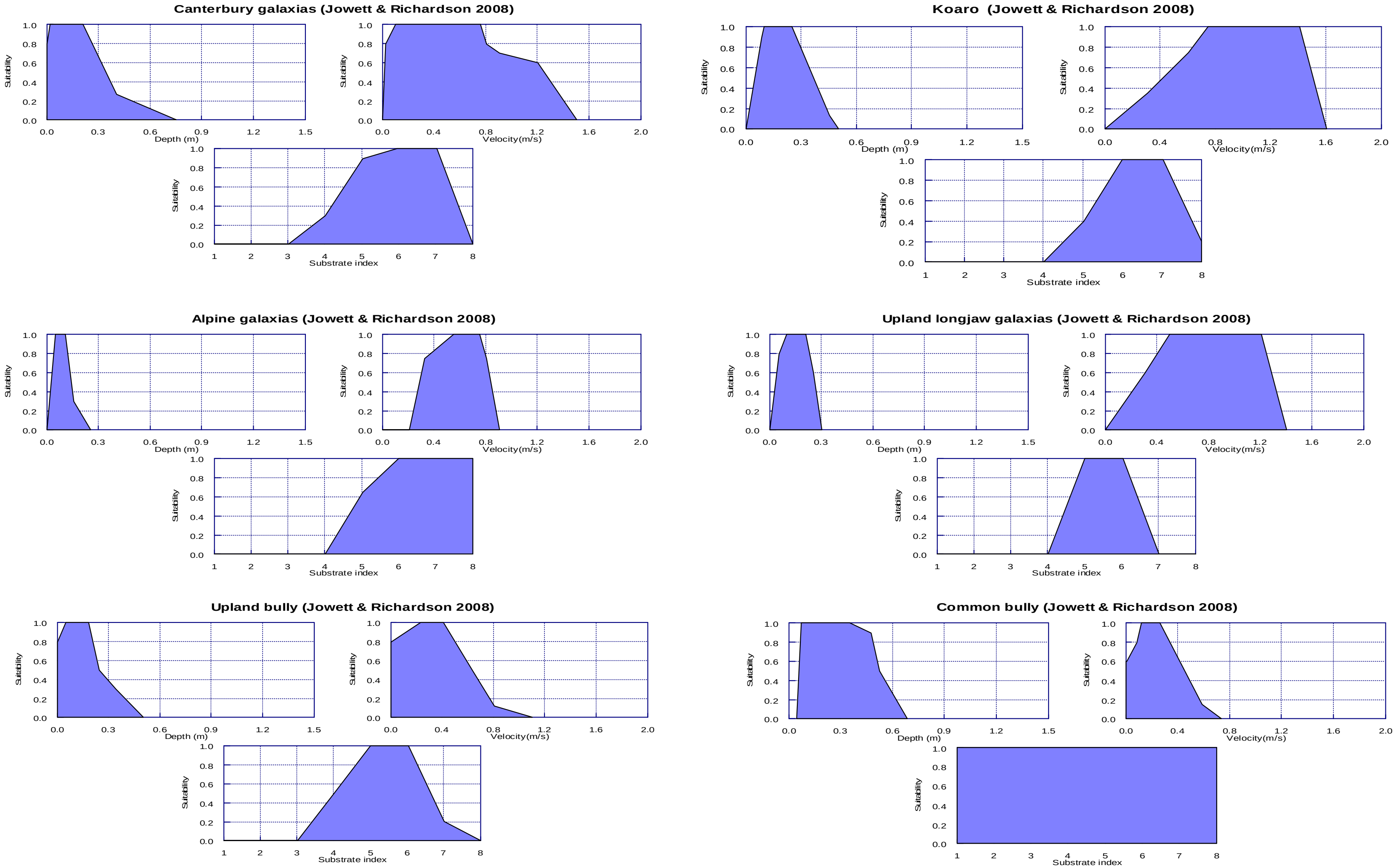

Figure 4 Habitat suitability criteria for Canterbury galaxias, koaro, alpine galaxias, upland longjaw galaxias, upland bullies and common bullies.

INSTREAM HABITAT – PERIPHYTON AND INVERTEBRATES

PERIPHYTON

34. Reduced flows have the potential to result in more favourable conditions for periphyton, resulting in undesirable growths of filamentous green algae and cyanobacteria mats. Periphyton growth in Station Stream is expected to be governed by the relatively frequent high-flow events (Boraman 2007) and associated periods of high turbidity. Thus, periphyton proliferations are expected to be restricted to periods of sustained low flows.

35. Water abstraction has the potential to draw discharge down to the minimum flow, and keep it there for a period of time until sufficient rainfall occurs to result in an increase in flows above this minimum, a phenomenon known as “flat-lining”. The primary ecological concern resulting from flat-lining is that extended periods of low, stable flows favour the development of nuisance periphyton growths which can affect the aesthetic, recreational or ecological values of a stream.

36. In recognition of the risk of the proposed abstraction leading to prolonged periods of low flows and nuisance periphyton growths, the current application proposes 1:1 flow-sharing between flows of 320 and 510 l/s. Flow-duration curves for the irrigation season (October-March) show no indication of flat lining (which would be evident as extended periods of time at the minimum flow) in Station Stream under the proposed flow regime (refer to evidence of Mr Boraman). In addition, under natural conditions the persistence of nuisance growths of periphyton is likely to be determined by the high flow events, and I do not expect the proposed take to alter the frequency of these events. Thus, it is my opinion that the proposed flow management regime (see Table 1) will reduce the risk of an increase in the frequency and/or duration of nuisance periphyton growths.

INVERTEBRATES

37. Invertebrates are an important link in the food chain between energy sources, such as primary producers (periphyton) and detritus (decaying wood and leaf matter), and higher trophic levels, such as fish and birds. As a consequence, it is

important to consider how the proposed abstraction will affect invertebrate populations, as this will be one factor in determining the response of fish and bird populations.

38. In a small mountain stream like Station Stream, high flow events are likely to be the primary factor governing invertebrate populations. During inter-flood periods of lower flows, habitat factors such as water velocity, substrate type and water temperature will affect the rate of growth of invertebrates and their populations. Water abstractions, such as that proposed for Station Stream, have the potential to affect invertebrate populations by changing habitat conditions (water velocity, depth), reducing the wetted area of the stream (thereby reducing the potential area of invertebrate habitat), affecting water quality and water temperature (see paragraphs 40 - 44).

39. Given that invertebrate population dynamics are governed by a range of factors (some of which will have positive effects, others negative), there is some uncertainty when considering the potential effects of the proposed water take. However, because of the high gradient, high velocity and turbulence of flows in Station Stream, it is likely that decreases in velocity and turbulence resulting from reduced flows will favour many invertebrate taxa and, in my opinion, may result in no change or an overall increase in invertebrate productivity. It is unlikely that water quality in Station Stream will be affected appreciably by the proposed take (see paragraphs 40 - 44), and any increase in water temperature is likely to increase invertebrate growth rates, since temperatures in such a fast-flowing, mountain-fed stream are unlikely to reach lethal temperatures for most invertebrate taxa (>23ºC) as a result of an abstraction of this magnitude (see paragraph 42). Therefore, the proposed abstraction is not expected to significantly affect invertebrate populations in Station Stream.

WATER QUALITY

40. I do not anticipate water abstraction to significantly affect water quality in Station Stream. Several submissions received on this consent application relate to

possible water quality effects resulting from the reduced flows downstream of the intake (e.g submission of Fish & Game). These concerns include: reduced water quality (this presumably refers to nutrient concentrations and organic matter inputs), reduced dissolved oxygen concentrations, increased water temperature, and increased sedimentation.

41. The high gradient and turbulent flows of Station Stream mean that the water in this stream is constantly being aerated and make it extremely unlikely that dissolved oxygen concentrations will drop to levels that will impact on any organisms that live in Station Stream.

42. The steepness, the relatively high water velocities and relatively short distance between the location of the intake and the confluence of Station Stream with the Godley River (<1.5 km) make it unlikely that abstractions of the magnitude proposed will affect water temperatures in Station Stream. This is particularly unlikely given the cool water temperatures in Station Stream due to the high-altitude origins of its water. This is supported by the observation during this survey, which was conducted on a warm day in mid-February, that the maximum temperature recorded was less than 16ºC (in mid-afternoon).

43. Concerns were also raised about increased sedimentation resulting from abstraction of water from Station Stream. This is not an issue of major concern in steep, mountain streams such as Station Stream. The majority of sediment movement is likely to occur during periods of elevated flows when the intake will have no effect on sedimentation (since the intake is likely to be shut off during bed-moving flows). The frequency of high-flow events is not likely to be affected by the proposed water take and any accumulations of fine sediments will continue to be flushed during these events.

44. Nutrient concentrations in Station Stream are unlikely to be affected by the proposed abstraction, except that there will be less dilution of any nutrient inputs that occur downstream of the intake. This is relatively unlikely, since the areas immediately adjacent to Station Stream are not heavily stocked and are not irrigated or fertilised. Run-off from irrigated areas is only likely to occur during

heavy rainfall and it is likely that under such conditions, flows in Station Stream will also be high and will dilute any nutrient inputs.

FEEDING HABITAT AND FOOD AVAILABILITY FOR BIRDS

45. In response to concerns expressed by submitters (e.g. Forest & Bird), I have been asked to provide some information on how the proposed activities are likely to affect riverine birds. I am not an expert on the birds themselves, so have relied on published studies when I provide information on bird habitat requirements and feeding. However, I believe it would be helpful to provide evidence in two areas that are within my area of expertise:

    a. Changes in physical habitat relevant to bird feeding,

    b. Food availability for birds.

46. The Forest & Bird submission lists several bird species as being of concern due to their threatened status. These species are banded dotterel, black-fronted tern, black stilt and wrybill. Of these species, banded dotterel and wrybill are considered shallow water waders, and are restricted to feeding in water shallower than 80 mm in depth and most use is of water less than 40 mm deep (O'Donnell, 2004). The habitat preferences of wrybill are evident in Figure 5 – they are limited to very shallow, relatively slow-flowing water. My assessment of these habitat suitability criteria is that the feeding habitat of wrybill in Station Stream will be extremely insensitive to reductions in flow. Stilts are considered deep water waders that can forage in water over 200 mm (O'Donnell, 2004).

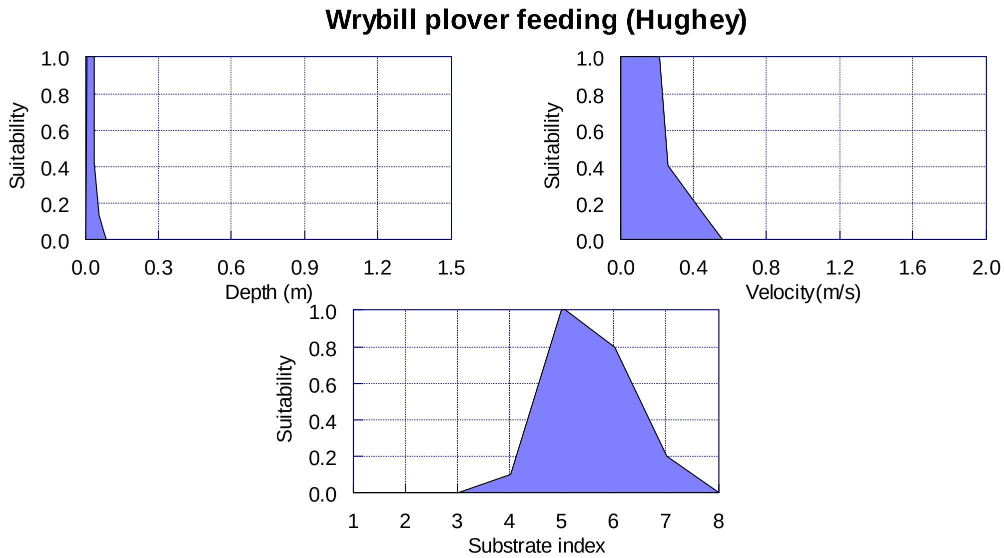

Figure 5 Habitat suitability criteria for Wrybill plover feeding.

47. Based on these published maximum feeding depths and my observation of the physical habitat of Station Stream, I anticipate that the proposed minimum flows (which equates to the MALF) will maintain the availability of suitable feeding habitat for wading birds.

48. Of the bird species listed in the Forest & Bird submission, black-fronted terns are the only aerial feeders. They feed on adult and drifting invertebrates (especially mayflies – Lalas 1977), and small fish (O'Donnell, 2004). Consequently, it is important to consider how the proposed take will affect the availability of prey to birds in Station Stream. Habitat suitability criteria have been developed for black-fronted terns on two large braided rivers, the Waimakariri and Rangitata (Figure 6). Curves developed on the Rangitata indicate that terns prefer feeding over water between 0.3 and 0.6 m in depth of moderate velocity (0.35-1.2 m s^{-1}) whereas curves developed on the Waimakariri indicate that terns prefer feeding over shallow (0-0.4 m) and slow to moderate-flowing water (0-0.7 m s^{-1}) (Figure 6). These differences make it difficult to make conclusions regarding the likely consequences of flow reduction on tern feeding habitat.

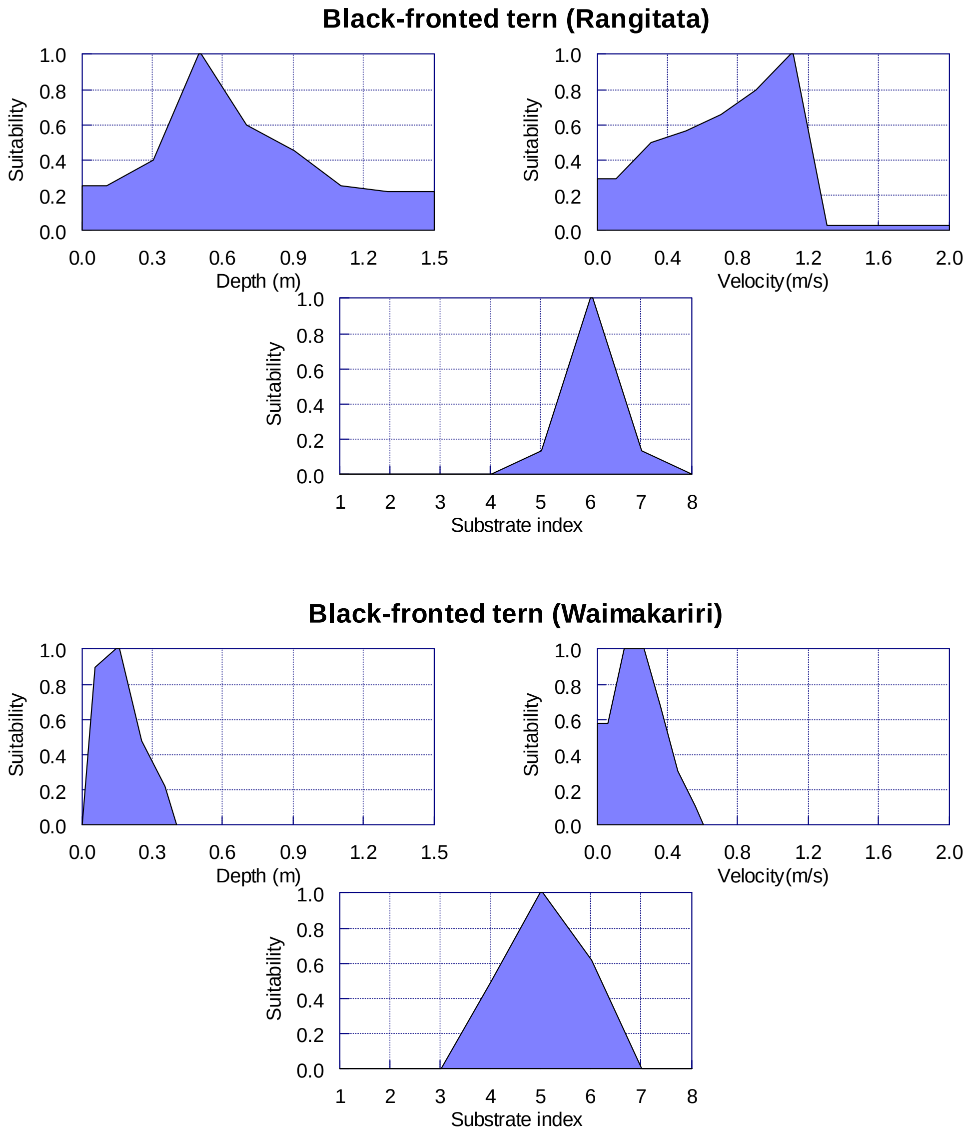

Figure 6 Habitat suitability criteria for black-fronted terns developed on the Rangitata and Waimakariri Rivers.

49. Aquatic macroinvertebrates are an important part of the diet of all of the bird species listed above (Lalas 1977, Pierce 1983, Hughey 1997, O'Donnell 2004). I have concluded above that the proposed water take is likely to have a minor effect on galaxiid fish (paragraphs 31-33) and macroinvertebrates (paragraph 39) in Station Stream. Therefore, I do not expect the proposed abstraction to affect the availability of aquatic macroinvertebrate or fish prey. However, a possible issue of concern is if the operation of the intake causes fluctuations in water levels, this may reduce the suitability of shallow water in the channel margins for invertebrate prey – which may then affect shallow wading birds such as wrybill and dotterel. However, I consider that this issue is of relatively minor concern and could be dealt with by conditions.

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