BEFORE THE CANTERBURY REGIONAL COUNCIL

***IN THE MATTER OF*:**	the Resource Management Act 1991
AND	
***IN THE MATTER OF*:**	a submission on the Proposed Canterbury Land and Water Regional Plan

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EVIDENCE OF DR NICHOLAS REX DUNN
FOR DIRECTOR-GENERAL OF CONSERVATION

Dated 4 February 2013

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STATEMENT OF EVIDENCE OF NICHOLAS REX DUNN

INTRODUCTION

1 My full name is Dr Nicholas Rex Dunn.

2 I am appearing on behalf of the Director-General of Conservation, who has made a submission on the Proposed Canterbury Land and Water Regional Plan (pCLWRP). I am employed by the Department of Conservation (DOC) as a Freshwater Science Advisor in the Freshwater Section of the Science & Technical Group. I have held this role since the start of September 2012. Prior to that I was employed as a Technical Support Officer Freshwater in the Canterbury Conservancy since December 2010.

3 I hold a Bachelor of Science (Earth Sciences) degree from the University of Waikato where I majored in hydrology and soil science, and a Master of Science (Environmental Science) (First Class Honours) degree from the University of Canterbury, majoring in freshwater ecology and hydrology. My MSc thesis investigated aspects of the influences of extremes in flow variations on the ecology of populations of non-migratory galaxias fishes. I also hold a Doctor of Philosophy degree from the University of Otago. My PhD thesis investigated aspects of the influences of flow regimes on the ecology of non-migratory galaxias fishes. Since 2003 I have also been a partner in Ichthyo-niche, a research consultancy specialising in native galaxiid fishes and their habitats.

4 I am familiar with the area of the ecology of native freshwater fish to which these proceedings relate.

5 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.

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

SCOPE OF EVIDENCE

7 My evidence will deal with the following:

- DOC's proposal to augment the inanga spawning site list in Schedule 17, and to include habitats of threatened and at risk freshwater fauna, and the rationale for doing so.
- The impacts upon these species, and freshwater habitats as a consequence of certain activities e.g.:
    - the effects of certain discharges, in particular land drainage water;
    - the abstraction of water;
    - activities within beds of lakes and rivers including damming and gravel extraction;
    - the construction and operation of infrastructure; and
    - activities affecting vegetation and soil.

AUGMENTED SCHEDULE 17: RECREATIONALLY IMPORTANT AND THREATENED AND AT RISK SPECIES

Rationale

8 The freshwater ecosystems of Canterbury have been greatly modified by anthropogenic activities such as removal of native vegetation for pastoral and cropping lands, intensive drainage of wetlands, hydroelectric development, abstraction of water for irrigation, and disposal of waste. The degree of impact is considered greatest in the lowland wetland and swamp systems on the Plains and the short, forested streams of Banks Peninsula (McDowall & McIntosh 2008).

9 A number of threatened freshwater species are endemic to the Canterbury region, meaning they only occur in Canterbury, or have

distributions largely confined to Canterbury (Tables 1 and 2). For example, the Canterbury mudfish (*Neochanna burrowsius*, ranked as Nationally Critical in terms of risk of extinction) has a distribution largely confined to lowland spring fed streams and wetlands, of which only fragments of these formerly extensive wetland areas remain. Whereas, in the Waitaki River catchment, upland spring fed streams containing lowland longjaw galaxias (*Galaxias cobitinis*, Nationally Critical) are threatened by more recent intensification.

10 The recreationally important inanga (*Galaxias maculatus*, At Risk: Declining), constituting the majority of the whitebait catch (McDowall 1965), is considered to be in decline, likely due to habitat degradation (McDowall & McIntosh 2008).

11 Knowledge of, and identification of the distribution of species and communities thus provides a basis for effective conservation (Leathwick et al. 2008). In this regard, the DOC supported in part Schedule 17, in respect to inanga spawning sites, and provided an augmented list, that had in part been collated by Golder Associates (2012) for the Canterbury Regional Council (CRC), completed after the pCLWRP was notified.

12 The above report (Appendix 1) was obtained by DOC u. DOC submitted an augmented Schedule 17 detailing catchments and locations, within the CRC boundaries, occupied by threatened and at risk (Townsend et al. 2008) freshwater fish (Table 1; Allibone et al. 2010) and freshwater invertebrates (Table 2; Hitchmough et al. 2007).

13 These locations are species focussed, differing from the identification of important ecosystems by my colleague Dr West. Nevertheless, identification of locations containing threatened species is important, for as exemplified by the Canterbury mudfish, smaller wetland

habitats may not necessarily be identified in region scale remote sensing surveys.

14 These amendments to Schedule 17 were submitted to provide greater clarification of areas of particular aquatic biodiversity value, where activities may adversely affect threatened and at risk aquatic species, both on public and privately owned/managed land. Several documents give purpose to the submitted lists:

- The New Zealand Biodiversity Strategy (DOC and MfE 2000) provides "a strategic framework for action to conserve and sustainably use and manage New Zealand's biodiversity", coming in response to New Zealand signing the United Nations Convention on Biodiversity in 1992.
- As much biodiversity occurs on private land, The Statement of National Priorities for Protecting Rare and Threatened Biodiversity on Private Land was released by MfE (2007). This was designed in part for use by local government, who under the Resource Management Act (1991) has the primary responsibility for protection of native biodiversity on private land.
- Within Canterbury, the Biodiversity Strategy for the Canterbury region (ECan 2008), contributes to achieving the goals of the New Zealand Biodiversity Strategy at a regional level. This is recognised in a statutory sense by the Canterbury Regional Policy Statement (ECan 2013).
- The Canterbury Water Management Strategy (Canterbury Mayoral Forum 2009) is given direction and balance by target areas including "ecosystem health/biodiversity" and "natural character of braided rivers".
- The Canterbury Regional Policy Statement 2013 provides protection for the habitats of threatened and at risk fauna in 9.3 Policies and as defined in Appendix 3.

15 It was the intention of DOC's submission that the locations contained within these submitted lists would be protected by the same rules that protect inanga spawning sites in the plan. Moreover, they are afforded protection under section 9.3 Policies of the Canterbury Regional Policy Statement 2013.

16 In their report to CRC, Golder Associates (2012) also detailed amendments to the notified rules regarding exclusion of stock from waterways, to provide greater protection for inanga spawning. DOC supported these amendments in its submission. As their rationale for these amendments Golder Associates (2012) stated:

- Rules surrounding stock exclusion from waterways are supported as necessary and appropriate. However the rules should provide for a fuller suite of waterways to be protected, and should be more stringent with regard to areas that are likely to be inanga spawning sites.
- As well as the beds of lakes, rivers and wetlands, inanga also spawn in the beds (defined as including the immediate riparian area that is regularly inundated) of estuarine environments and within hapua (coastal lagoons). As these areas may fall outside of the coastal marine area, they are not covered by rules in the Regional Coastal Environment Plan for Canterbury, but are consistent with rules therein. Therefore, these environments should also be protected from the use or disturbance by stock in rules 5.133 to 5.137 of the pCLWRP.
- Although Schedule 17 lists known inanga spawning sites, they are incredibly difficult to identify due to the size of the eggs and the limited timeframe over which spawning occurs. For this reason it is highly likely that inanga spawning sites are evident in many more locations than those identified in Schedule 17, and the rules should be amended to reflect this

and ensure that inanga are in fact protected to a more appropriate level within the rules.

- The addition below seeks to protect the areas that are likely to be used by inanga for spawning. Specifically, the lower reaches of rivers, wetlands, lake margins, estuaries and hapua which are affected by tidal oscillations or associated with a lake (refer to the Golder report in Appendix 1)

17 In their Section 42 A report, the reporting officers indicate that the inclusion of DOC's augmented and additional lists by way of submission are inappropriate. While this is accepted in part, it should be noted that the operative Natural Resources Regional Plan includes then known locations of Canterbury mudfish. These locations are not given in the pCLWRP, thus this signifies a reduction in protection of this species and the ecosystems/habitats it represents.

18 It was the identification of, and development of the spatial distributions (as opposed to point data distributions) for the NRRP for Canterbury mudfish (O'Brien & Dunn 2007a, b; O'Brien & Dunn 2012), that led to the creation of the spatial data submitted by DOC for this species, and the modification of this approach for the creation of spatial distributions other threatened freshwater fish species in Canterbury for the pCLWRP.

19 An approach similar to that taken in the development of the lists of flow sensitive catchments as discussed in the Section 42A report could be taken. It is stated that the NRRP contains a short list of catchments in which research had been undertaken to ascertain that they should be classed as flow sensitive, and a long list of potential flow sensitive catchments. It is also stated that the research and development is now complete, hence inclusion of a greater number of flow sensitive catchments in the pCLWRP.

20 The identification of locations of threatened and at risk freshwater biota is also important, given the number and nature of activities that are given a Permitted Activity status. These activities may occur in any area containing a threatened or at risk species, and potentially adversely affect this fauna, but would not come to the attention of, or the environmental effects be assessed, by the CRC.

Table 1. Freshwater fish species included in the proposed extended schedule 17 detailing their common, species and Maori names, threat ranking, and distribution as classified by catchment, or region, biogeographic unit, and landscape position/habitat occupied.

Species	Threat ranking (Allibone et al. 2010)	Distribution (NZFFD)	Biogeographic unit (Leathwick et al. 2007)	Landscape position in Canterbury (Lavender 2001)
Freshwater Fish				
Lowland longjaw galaxias (Waitaki River) (*Galaxias cobitinis*)	Threatened - Nationally Critical	Predominantly Waitaki River	Waitaki	Not given
Canterbury mudfish (*Neochanna burrowsius*; köwaro)	Threatened - Nationally Critical	Endemic to Canterbury	Canterbury, Waitaki	Other – lowland streams and springs, drains, water races
Upland longjaw galaxias (Waitaki River) (*Galaxias prognathus*)	Threatened - Nationally Vulnerable	Endemic to Canterbury	Waitaki	Alpine
Bignose galaxias (*Galaxias macronasus*)	Threatened - Nationally Vulnerable	Endemic to Waitaki River	Waitaki	Not given
Upland longjaw galaxias (Rangitata & Rakaia rivers) (*Galaxias prognathus*)	Threatened - Nationally Vulnerable	Endemic to Canterbury	Canterbury	Alpine
Northern flathead galaxias (Marlborough) (Not formally described)	Threatened - Naturally Uncommon	Northern Canterbury, Nelson, Marlborough, Maruia River	Marlborough, ,Grey-Buller, Motueka-Nelson	Not given
Stokell's smelt (*Stokellia anisodon*)	Threatened - Naturally Uncommon	Endemic to Canterbury	Canterbury, Waitaki	Estuarine
Longfin eel (*Anguilla dieffenbachii*; Tuna)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other
Torrentfish (*Cheimarrichthys fosteri*; Piripiripöhatu)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Midland
Dwarf galaxias (Nelson, Marlborough and North Island) (*Galaxias divergens*)	At risk - Declining	Northern Canterbury, West Coast, Nelson, Marlborough, Wellington, Hawkes Bay, Bay of Plenty	Westland, Grey-Buller, Marlborough, Motueka-Nelson, Wellington, Manawatu-Wairarapa, Hawkes Bay, Bay of Plenty, Waikato	Not given
Giant kokopu (*Galaxias argenteus*; Taiwharu)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other – swamps, forest streams, lakes
Koaro (*Galaxias brevipinnis*)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other – rocky forested streams, high country lakes
Inanga (*Galaxias maculatus*)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Transitional
Shortjaw kökopu (*Galaxias postvectis*)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other – small native forested streams
Lamprey (*Geotria australis*; kanakana)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other - widespread
Bluegill bully (*Gobiomorphus hubbsi*)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Midland
Redfin bully (*Gobiomorphus huttoni*)	At risk - Declining	Throughout New Zealand	Throughout New Zealand	Other – rapidly flowing, boulder streams

Table 2. Freshwater invertebrate species included in the proposed extended schedule 17 detailing their common and species, threat ranking, and distribution as classified by biogeographic unit.

Species	Threat ranking (Hitchmough et al. 2007)	Biogeographic unit (Leathwick et al. 2007)
Caddisfly (*Tiphobiosis hinewai*)	Nationally critical	Banks Peninsula
Snail (Austropeplea tomentosa (*Lymnaea tomentosa*))	Nationally critical	Waikato - Southland
Caddisfly (*Edpercivalia banksiensis*)	Nationally endangered	Banks Peninsula
Caddisfly (*Hydrobiosis styx*)	Nationally endangered	Banks Peninsula
Koura/ Freshwater crayfish (*Paranephrops zealandicus*)	Gradual decline	Marlborough - Fiordland
Freshwater mussel (*Hyridella menziesii*)	Gradual decline	Throughout New Zealand
Freshwater isopod (*Austridotea annectens*)	Sparse	Canterbury – Stewart Island
Mayfly (*Nesameletus vulcanus*)	Range restricted	Banks Peninsula
Caddisfly (*Tiphobiosis childella*)	Range restricted	Banks Peninsula
Caddisfly (*Costachorema peninsulae*)	Range restricted	Banks Peninsula
Net-winged midge (*Neocurupira chiltoni*)	Range restricted	Banks Peninsula
Snail (*Potamopyrgus pupoides*)	Data deficient	Northland (western) - Taieri
Amphipod (*Neophreatoicus assimilis*)	Data deficient	Canterbury
Amphipod (*Phreatoicus orarii*)	Data deficient	Canterbury
Caddisfly (Zelandobius wardi)	Data deficient	Banks Peninsula

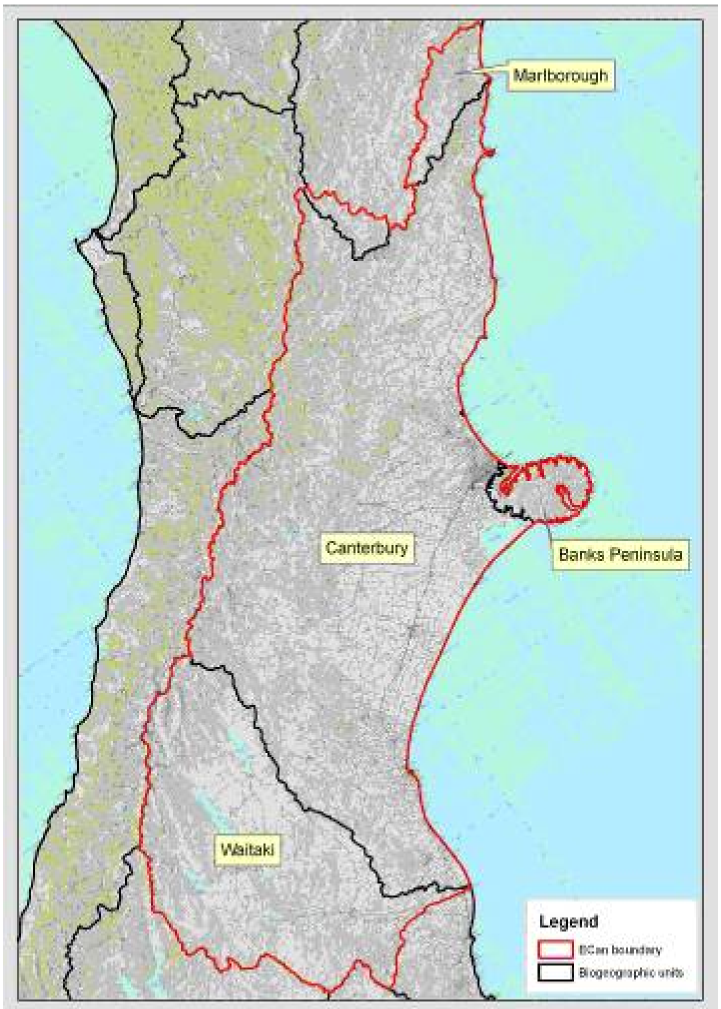


Figure 1. Location of biogeographic units (Leathwick et al. 2007) covered by the CRC jurisdiction.

Creation of species distribution data

21 Data presented in Annexure A of DOC's submission and accompanying maps were developed in several ways.

22 For the submitted Table 1, data were obtained from Golder Associates (2012) who used data from the National Inanga Spawning database (Taylor 2002), and data provided by Dr Mike Hickford of the University of Canterbury who is researching inanga biology. Additional data held by DOC was also included in the submitted list.

23 For threatened and at risk freshwater fish (submitted Table 3), data were obtained from the NIWA administered New Zealand Freshwater Fish Database (NZFFD), the adult fish distribution prediction models of Leathwick et al. (2008), and from local knowledge of habitats. For aquatic invertebrates, distributions were based on data collated for the threat re-ranking of Hitchmough et al. (2007), and previous communications from Associate Professor Jon Harding (University of Canterbury).

24 The NZFFD records the occurrence of freshwater fish in New Zealand, detailing site location, species present, and their abundance, and fishing method used. Data are contributed by NIWA, DOC, Fish & Game councils, universities, and environmental consultants. In this respect the knowledge of the distributions of freshwater fish is more extensive than for many freshwater invertebrates.

25 The prediction models of Leathwick et al. (2008) are based on the river network originally developed as the River Environment Classification (Snelder et al. 2004). The prediction models relate the occurrence of individual fish species to biologically-relevant descriptors of the river and stream environments (but not lakes or wetlands), at sampled sites as given in the NZFFD (Leathwick et al.

2008). These models were then utilised to develop environment-based predictions of the probability of occurrence for each species, for all river and stream segments in the River Environment Classification (Leathwick et al. 2008).

26 For data presented in Annexure A, distributions for each species of threatened or at risk freshwater fish, except Canterbury mudfish, were generated using predicted occurrences of ≥0.2 in those catchments containing NZFFD records for the target species.

27 For migratory species (i.e. those which at some stage of their life cycle move between the freshwater and marine environments), distributions included all reaches from the coastal mouth to the upper most reach with a probability of occurrence ≥0.2. This approach was used as it recognised that even if a reach was not modelled as ideal habitat, it was likely utilised in the upstream or down stream passage of that species.

28 For non-migratory species (i.e. the entire life cycle occurs within a discrete area of a water body without migration to or from the marine environment) reaches with a probability of occurrence ≥0.2 in the vicinity of NZFFD records were considered likely habitat.

29 For Canterbury mudfish, another approach was required. The predicted distribution of this species has not been mapped by Leathwick et al. (2008), principally because it does not occur in habitats included in the REC reaches. To develop distributions of sub-populations of Canterbury mudfish, areas in the vicinity of NZFFD records considered by Dr Leanne O'Brien (Ichthyo-niche) to be likely habitat, were delineated digitally on LINZ (Land Information New Zealand) and CRC georeferenced orthographs.

30 For all species ESRI Arc GIS shp files were created for distributions within catchments. Data extracted from these files were summarised in Table 3 of Appendix 1 of the submission.

IMPACTS UPON THREATENED AND AT RISK SPECIES, AND FRESHWATER HABITATS AS A CONSEQUENCE OF CERTAIN ACTIVITIES

Land drainage water

31 Due to their position within a valley, streams and rivers drain land up slope (Mosley & Duncan 1992). This also applies to surface and subsurface drains, with their ultimate destination being the channel that drains a catchment. Furthermore, in Canterbury these receiving waters may have been modified (Speight et al. 1927; Skrzynski 1968; McDowall & McIntosh 2008). Typically this entails waterways being straightened; this is evident when water courses on cadastral boundary maps and the "Black" maps are overlaid by current water courses given on topographical maps; or moved; and may apply to all or part of a water body. These modifications can lead to the perception that they are artificial waterbodies.

32 In regard to rules 5.55-5.58, threatened and at risk aquatic biodiversity may exist in artificial and historically modified waterbodies, contrary to the statement saying otherwise in the Section 42A report. This observation is based on the augmented list of inanga spawning sites and threatened and at risk species locations given in DOC's submission (Annexure A, Tables 1 and 3).

33 Therefore, giving permitted activity status to the discharge of drainage water with unlimited volumes, and potentially containing contaminates, could lead to acute or chronic degradation of aquatic ecosystems (Quinn 2000; Suren & Elliott 2004), and further threaten already threatened and at risk species, especially if it occurs during the critical spawning and larval rearing period.

Water takes

Take and use of surface water

34 DOC in its submission on Rule 5.96, supported the MfE proposed NES guidelines for determining ecological flows and water levels (MfE 2008). This approach was taken as these are a set of agreed upon and accepted methods. In their analyses of these methods however, Snelder et al. (2011) found that "The application of our method showed that the consequences of proposed default limits (NES minimum flows and allocations) for New Zealand on physical habitat at low flows and reliability of supply vary spatially and between taxa / life-stages.".

35 The minimum flows in the guidelines when applied to small rivers (i.e. $\leq 5\ m^3 \cdot s^{-1}$) in particular, may not adequately protect in stream habitat (Snelder et al. 2011). They found there was typically less habitat available for the species they modelled at the proposed minimum flow compared to that available at 7 day MALF (Snelder et al. 2011).

Lakes

36 In Rule 5.96 the take and use of surface water is a restricted discretionary activity, provided that *inter alia*, "3. The take is not from a natural wetland, häpua, or a high naturalness river that is listed in Sections 6-15."

37 While the above is supported, it should be noted that it does not include high naturalness lakes which are listed in Sections 6-15. These sections contain five river catchments and twenty-two lakes. The lakes listed as of high naturalness in Sections 6-15 are predominantly located inland.

38 According to records in the NZFFD the above lakes are known to contain six native freshwater fish species, of which longfin eel (*Anguilla dieffenbachii*) and koaro (*Galaxias brevipinnis*) are classified as At risk: Declining. Furthermore freshwater crayfish (Koura; *Paranephrops zealandicus*; Gradual Decline) are also recorded in these lakes. These three species are also recorded in the rivers classified as having high naturalness in Sections 6-15. Longfin eel is a migratory species, so utilises the river network to move between the freshwater and marine environments. Koaro is a facultative diadromous species, meaning that there are both migratory populations and populations that have become land locked within inland intermontane lakes.

39 Thus lakes, are an important habitat for these species, and require protective mechanisms (Rowe & Graynoth 2002).

40 Water takes from lakes or drawdowns can influence the physical structure and ecology of the littoral zone (the shallow benthic zone from the lake edge down to the depth at which plants no longer grow; Rowe & Graynoth 2002). This zone is often utilised by fish for feeding, for cover in macrophytes beds if present, or access to tributary streams for spawning (especially for koaro; Rowe & Graynoth 2002).

41 Large fluctuations in lake levels can also affect the distribution and growth of macrophytes, and lead to increases in turbidity through shoreline erosion and suspension on fine sediments. These can affect food resources of fish and their feeding abilities, with consequences for growth and abundance (Rowe & Graynoth 2002).

42 Drawdowns in lakes, as summarised by Lavender (2001), can also influence water quality parameters such as increased turbidity, increase the effects of elevated nutrients through deoxygenation, and increase water temperatures; all of which may further impact on

threatened or at risk freshwater fish species. Thus, high naturalness lakes need to be included in the list of water bodies in Condition 3 of Rule 5.96 from which surface water takes are not allowed.

43 It should also be noted that the list of high naturalness lakes is not extensive, or complete. For example Lake Marion is the only lake in Canterbury that is classified as a faunistic reserve, yet it is not included in the list of high naturalness waterbodies. A similar process as conducted for flow sensitive catchments, as described in the Section 42A report may be appropriate in identifying high naturalness waterbodies.

Effects of water takes on aquatic ecosystems

44 In its submission on Rule 5.96, DOC also sought that Condition 7 of Rule 5.99 is included into the list of conditions for Rule 5.96. This sought to provide greater assessment of the effects of a take on the aquatic ecosystem of the source water body.

45 In riverine environments, takes can influence river mouth closure; influence fish passage through the river network to juvenile, adult, adult and/or spawning habitats; and disrupt flow variability, limiting spawning and rearing habitat during the critical life stages of eggs, larvae, and juveniles as detailed below.

Timing of water takes

46 In terms of timing of takes for migratory fish species, there are two major periods of downstream movement, viz. March – May, and October – November, and a period of upstream movement of August – October inclusive (Lavender 2001; Charteris 2006). These periods represent the 'shoulder months' of the irrigation season. A reduction in flow in late winter – early spring due to takes to storage or low

flows at the end of the irrigation season in April, may hinder passage of fish.

47 For non-migratory species, both mainstems and tributaries are, depending on the requirements of each species, likely important habitats. These species all complete their entire life cycle in the freshwater environment. They also have small home ranges, typically no more than several hundred meters (Cadwallader 1976a, Dunn 2003). Thus, persistence of a subpopulation in a habitat requires suitable habitat for all life stages. In this respect these species can be vulnerable to fluctuations in flow (Glova et al. 1985), particularly low flows and the associated decline in water quality during these periods (Dunn 2003).

48 It is generally considered that prolonged low flows or droughts have a detrimental affect on freshwater fish (Jowett & Duncan 1990; Allibone 2000 a, b). Thus an increase in drought severity and/or frequency, or chronic changes to the hydrological regime of a stream through water abstraction, causing a loss of habitat, will likely decrease long term fish population persistence. In particular, large allocation to out of stream use could have the effect of 'flat lining' rivers for longer, removing mid range flow variability.

49 Mid range flows are important for stimulating fish migrations (Jellyman 2012), are likely important in initiating spawning in many freshwater fish, and provide spawning and rearing habitat (Dunn 2003).

50 Taking large volumes of water to storage or other large takes for out of stream use could alter the thermal regime of a river (Robb & Bright 2004; ORC 2006). Water temperature is an important cue in the latter stages of spawning readiness in many fish species (Bye 1984; Jobling 1995). If alteration of spawning timing means spawning habitat or

food items for adults to regain condition, or juveniles to begin feeding on, become unsynchronised, then this could potentially influence long term population persistence if individuals are unable to respond to changes in environmental conditions.

51 The timing of taking to storage is also important. Migratory galaxias species typically spawn in autumn (McDowall & Charteris 2006), at the end of the irrigation season. Thus flat lining a river in the period before this may affect spawning success. Likewise non-migratory galaxias spawn in late winter – spring (McDowall 2006), a period when water is likely to be taken to storage, and from run of the river takes at the start of the irrigation season.

52 In respect to the effects on water quality and native freshwater fish habitat by surface water takes, gravel bed tributary streams with small flows may dewater rapidly, and due to this smaller volume of water are likely to be more prone to deterioration in water quality adversely affecting native freshwater fish compared to the larger main stems.

Flow sensitive catchments

53 In its submission DOC was supportive of identification of and rules governing flow sensitive catchments. In terms of freshwater fish, any reduction in flow due to changes in vegetative cover to more forested land could be detrimental for the reasons described above. Moreover, low flow conditions may be exacerbated during regeneration of dense stands of *Pinus radiata*. This was considered by Hartman (1990) to have the potential to limit the survival of non-migratory *Galaxias* in small gravel bed streams.

54 During harvest of plantation forests, without adequate setbacks, there is the possibility of increased sedimentation in streams (Fahey et al. 2004). These increased sediment inputs can also have adverse consequences as described in the sections 73-78 of my evidence.

55 The identification of flow sensitive catchments and rules relating to activities occurring in them are likely to be beneficial to threatened and at risk freshwater fish and invertebrates for the reasons stated above. This is exemplified by a degree of overlap between locations identified in the augmented lists in Schedule 17 and the mapped flow sensitive catchments.

Activities within beds of lakes and rivers including damming and gravel extraction

56 In its submission, DOC was supportive of the CRC's approach to gravel extraction. This stems from DOC's submission on the draft Canterbury Regional River Gravel Management Strategy, May 2012, in which DOC indicated that it would like to be involved in the development of the code of conduct. In this respect the augmented Schedule 17 lists provided in DOC's submission on the pCLWRP are important, in that they identify those areas where gravel extraction activities may adversely affect threatened or at risk freshwater fish and invertebrate species and their habitats.

57 The longer term effects of gravel extraction in gravel bed rivers has been found to be the reduction of overall particle size and an increased embeddedness (Shirvell 2002), affecting both native freshwater fish (Dunn & O'Brien 2006), and freshwater invertebrates (Kelly et al. 2005) through loss of interstitial habitat(the open spaces between substratum particles).

58 Loss of interstitial habitat can adversely affect non-migratory *Galaxias* fishes which find low flow refugia by burrowing into the unconsolidated, unsorted substratum of gravel bed streams (Hartman 1990; Dunn 2003; Dunn & O'Brien 2006).

59 Dunn & O'Brien (2006) experimentally demonstrated that the reduced size of particles resulting from gravel extraction activities, impeded movement of lowland longjaw galaxias into the gravel when compared with non-gravel extraction affected substratum. Thus indicating the need for adequate identification of important habitats of threatened and at risk species as in the augmented lists of Schedule 17.

60 The act of gravel extraction itself can result in the destruction of spawning areas for those species of native freshwater fish that spawn within gravel-bed streams, such as Canterbury galaxias (Cadwallader 1976b), alpine galaxias (Dunn & O'Brien 2007). The larvae and juveniles of these species occurring in pool or slow flowing areas (Dunn 2003; Jellyman & McIntosh 2008) are also at risk of extraction activities. This is an important consideration as placement of temporary culverts that create an upstream pool area could potentially be utilised by the young of these species, the rapid removal of these culverts could remove this habitat. Larvae and juveniles are a critical life stage for non-migratory *Galaxias*, therefore loss of these individuals can affect the viability of local sub-populations (Dunn 2003).

61 Gravel extraction activities during the spring spawning and larval and juvenile rearing period should thus be avoided. The spawning and migration timing of freshwater fish species in Canterbury's rivers is provided in Charteris (2006) and Lavender (2001).

62 In its further submission DOC supported the submission of Fish & Game regarding the enhancement of waterbodies and their values through gravel extraction. I disagree with this position, in part due to the adverse affects described above, and if habitat enhancements are designed to favour exotic over indigenous species.

Refuelling in riverbeds

63 In regard to the effect of fuel and oil spills from refuelling of machinery in riverbeds on native freshwater fish and invertebrates, little New Zealand relevant literature is available (Suren & Elliott 2004). However, in their review, Fleeger et al. (2003) reported that contaminants such as hydrocarbons can cause both direct (such as acute toxicity) and indirect effects (such as changes in nutrient cycling and oxygen dynamics that may alter ecosystem function).

64 Moreover, Lytle & Peckarsky (2001) found that freshwater invertebrate density and taxonomic richness both significantly decreased following a diesel spill. Some components of petrol and diesel fuels have ANZECC (Australian and New Zealand Environment Conservation Council 2000) guidelines, and these should be adhered to in this plan, in the absence of other information.

The construction and operation of infrastructure

65 It needs to be made clear that dams do alter fish community composition, as reported on by Jellyman & Harding (2012). Moreover, dams represent a loss of habitat for those species, such as Canterbury galaxias that cannot persist in a lacustrine environment (Stokell 1949), or are outcompeted by land locked populations of koaro (*Galaxias brevipinnis*) or salmonids (Allibone 1999; McDowall & Allibone 1994; Rowe & Graynoth 2002).

66 From a native freshwater fish species richness perspective, creating storage on tributaries without lakes (such as the Waitohi: 3 species) affects fewer fish species than damming or modifying tributaries and mainstem catchments with lakes (such as the North and South Branch of the Hurunui; seven species, based on NZFFD records). The high species richness of intermontane lake catchments is important as typically species richness declines with increasing distance inland (McDowall 2010), and can be attributed to the presence of inland lacustrine populations of eel and koaro, as well as a high diversity non-migratory species.

67 Thus, by requiring consent for any dam allows an assessment of affects on aquatic ecosystem and freshwater fish communities. See the Lake section above for the effects of their manipulation on aquatic ecosystems. Moreover, should a dam be constructed in a location containing the habitat of a threatened or at risk species (as identified in DOC's augmented Schedule 17), this could further threatened these species for the reasons outlined above, as they often are located outside of high naturalness waterbodies (as identified in Chapters 6-15 of the plan).

68 In respect to fish screens in relation to takes, DOC supported Schedule 2 with a minor amendment to bring the stated criteria in line with those on which they are based (Jamieson et al. 2007). I support the stance of the Section 42A reporting officers requiring screens on all takes. Fish, regardless of their threat status, can become entrained in intake structures and essentially 'lost' to riverine communities. This also applies to bypass channels discharging back into river system, where species such as lamprey (*Geotria australis*) migrating upstream can become entrained.

Activities affecting vegetation and soil

Wetlands: their importance in terms of native freshwater fish and invertebrates

69 Wetlands are an important habitat for many native freshwater fish species in New Zealand (McDowall 1990).

70 Wetlands, including those associated with low elevation lakes, act as important spawning, rearing, and adult habitat for fishes; including recreational and commercially harvested species such as inanga, and shortfin eel (*Anguilla australis*; McDowall 1982).

71 Species which typically inhabit Canterbury's wetlands (including those associated with low elevation lakes) include Canterbury mudfish, giant kokopu (*Galaxias argenteus*), inanga, black flounder (*Rhombosolea retiaria*), longfin eel, and shortfin eel. Four of which are classified as threatened or at risk (Table 1).

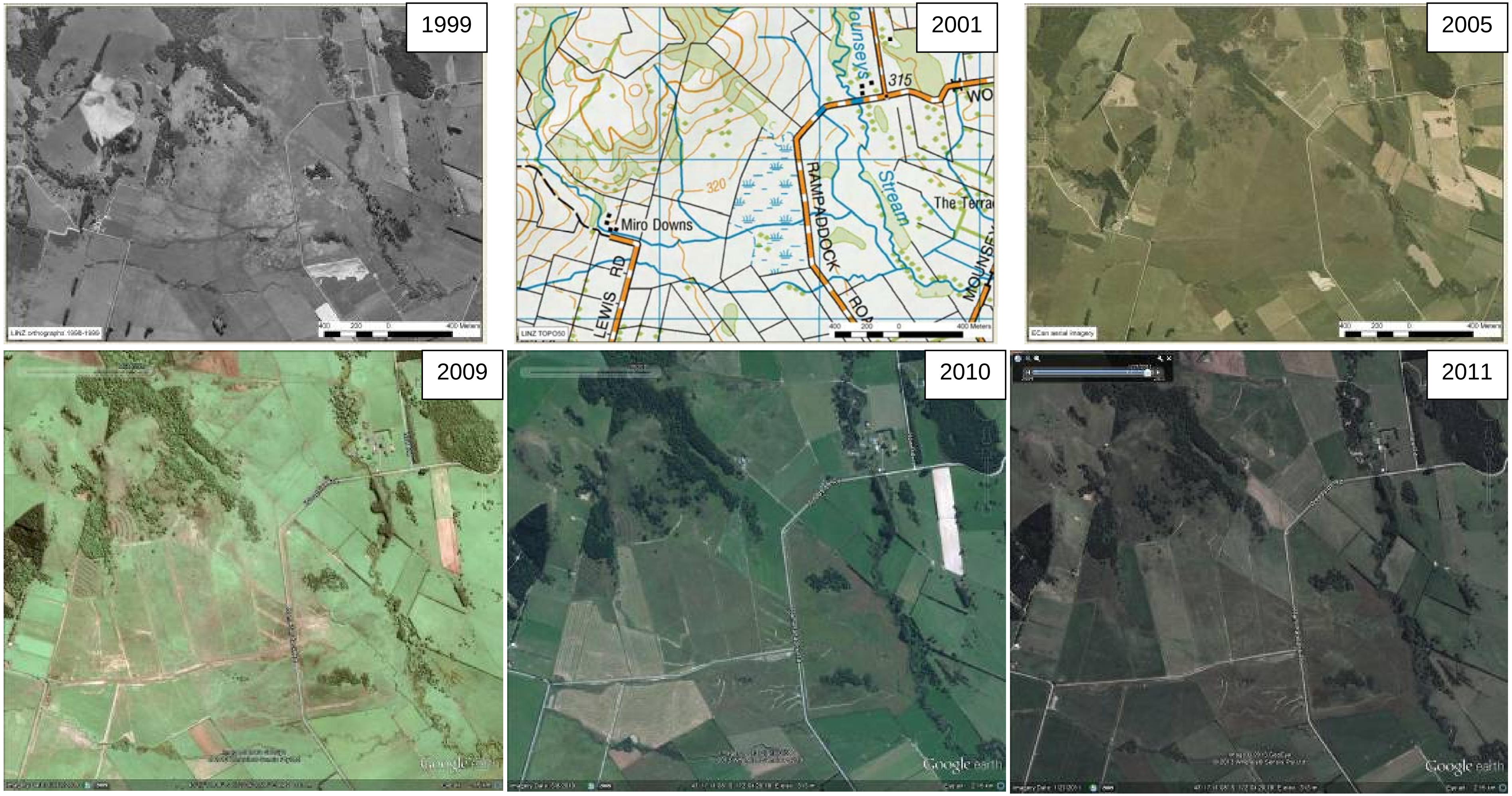
72 There are many factors which influence the quality and abundance of native freshwater fish occurring in wetlands. However, the size of the wetland is not necessarily the determining factor. As both large and small wetlands can be of significance to these species. For example, Eldon (1993) considered both the 175 ha Mounseys wetland/Te Roto Repo o Tawera, and a 0.6 ha near St Andrews as being two of the four most important sites for Canterbury mudfish.

73 Furthermore, a number of smaller wetlands in particular, are not currently defined as being significant when geospatial analysis tools such as FENZ (Freshwater Ecosystems of New Zealand; described in the evidence of Dr West) and WERI (Wetlands of Regional Importance) are applied. However, they are significant from the perspective of threatened and at risk native freshwater fish.

74 Under the NRRP, the only form of protection afforded to these smaller wetlands was through non-regulatory means. That approach leaves these habitats and the species within them vulnerable. This is exemplified in Figure 2 which documents the development of the 175 ha Mounseys wetland/Te Roto Repo o Tawera block in recent years. For this reason, I consider it important that the pCLWRP expand protection to all wetlands, and not just those that have previously been deemed to be significant.

75 I am aware that the pCLWRP does endeavour to protect wetlands through its rules, policies, and objectives. However, it is important to note that the freshwater fish that depend on wetlands often do not distinguish between those wetlands which are outside the margins of lakes or rivers (palustrine wetlands) and those that lie within them (riverine or lacustrine wetlands). Thus, drawing a distinction between these classes of wetland does not make sense in terms of native freshwater fish and invertebrate habitats for that matter.

Figure 2 (below). Time series images showing the development of Mounseys wetland/Te Roto Repo o Tawera, near View Hill. Major drainage works were initiated in 2008 converting the once extensive wetland into a series of paddocks. Imagery sourced from Land Information New Zealand, Canterbury Regional Council, and Google Earth.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Activities that affect vegetation in lake beds and riverbeds: implications for native freshwater fish species

76 Aquatic and riparian vegetation are important components of aquatic ecosystems (Reeves et al. 2004). They regulate water movement, sediment transport, nutrient dynamics, physico-chemical parameters and biotic interactions (Howard-Williams 1991).

77 In this regard, aquatic and riparian vegetation can also be important for some species of freshwater fish (Collier 1995). For instance, the whitebait species inanga, koaro, banded kokopu, shortjaw kokopu, are known to specifically spawn in riparian vegetation (McDowall & Charteris 2006), while Canterbury mudfish spawns on submerged aquatic macrophytes (Eldon 1979; O'Brien 2005). The composition of riparian vegetation depends on landscape position and biogeograhic unit (Leathwick et al. 2003), likewise aquatic vegetation (Coffey & Clayton 1988). However, in riverine systems, aquatic macrophytes are largely restricted to slower flowing lowland streams that have some soft sediment (Riis & Biggs 2001).

78 DOC's amended version of schedule 17 highlights the interaction between aquatic and riparian vegetation and the native threatened and at risk freshwater fish that rely on it. Thus, it is important that the management of riparian vegetation aquatic and aquatic macrophytes takes into account the species present when evaluating the impact an activity (including vegetation clearance) will have on those species. Similarly introducing or establishing such vegetation also needs to take account of species present and their requirements. In this respect it is appropriate for rules or other planning methods to take account of the impact that aquatic or riparian planting (and their disturbance) has on native freshwater fish and invertebrate species.

Earthworks and vegetation clearance in riparian margins: implications for native freshwater fish species

79 Earthworks and cultivation in riparian zones may lead to increased rates and/or volumes of sediment entering the aquatic environment, with both suspended and deposited sediment potentially affecting aquatic ecosystems and fisheries (Ryan 1991). Suspended sediment can influence aquatic physico-chemical parameters such as chemistry, temperature and turbidity, whereas deposited sediment can alter substratum characteristics (Ryan 1991; Quinn & Stroud 2002). This may: (a) alter primary productivity and species composition; (b) reduce invertebrate, adult and spawning habitat for fish; (c) alter drift patterns in aquatic invertebrates, and hence fish feeding; (d) while fish feeding can be affected directly by increased turbidity (Hanchet 1990; Ryan 1991; Rowe & Dean 1994, 1998; Harding et al. 2000; Jowett & Boustead 2001).

80 These adverse effects should be avoided in important sites for freshwater fish and invertebrates as identified in the amended Schedule 17. This could be achieved by specifying set back distances, particularly in the vicinity of known spawning sites. I note that in one of the rules regarding riparian works, a set back of 1 m is referred to. This may not be adequate in terms of protecting important habitats as identified by DOC's amended Schedule 17.

81 Migratory fish species require access through the river network between spawning sites and the marine environment. Rowe et al. (2000) showed that banded kokopu are more intolerant to elevated turbidity than any other species tested. The tested juveniles showed

significant avoidance of, and reduced feeding rates in highly turbid water.

82 Rowe et al. (2000) considered that long term declines in abundance within catchments could occur if banded kokopu juveniles were avoiding turbid river mouths. Rowe et al. (2000) defined turbid water as having suspended solids exceeding 120 mg/L for over 20 % of the time.

83 In this respect the levels of 50 and 100 mg/L in the pCLWRP in relation to sediment discharges from vegetation clearance and earthworks in erosion prone areas is supported, particularly the lower limit in Banks Peninsula streams where Canterbury populations of banded kokopu predominantly occur. It is however important that these levels are adhered to.

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