IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of applications for resource consent by the Central Plains Water Trust and a notice of requirement for the designation of land by Central Plains Water Limited associated with the construction and operation of the Central Plains Water Scheme

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STATEMENT OF EVIDENCE OF ANGUS RONALD MCINTOSH ON BEHALF OF THE DIRECTOR GENERAL OF CONSERVATION

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1. INTRODUCTION

Qualifications and experience

1.1 My name is Angus Ronald McIntosh. I am an Associate Professor of Freshwater Ecology in the School of Biological Sciences at the University of Canterbury where I have been employed since 1997. Prior to that I obtained a Doctor of Philosophy degree in Freshwater Ecology from the University of Otago (1994) and was a Post-Doctoral Fellow at Cornell University and the Rocky Mountain Biological Laboratory in Colorado (1995-6).

1.2 I have twelve years experience in professional freshwater ecology research, teaching and management. The research has focused on the population and community dynamics of stream fish and invertebrates in New Zealand and overseas. I also have also published research on lake and wetland ecosystems and am currently involved in riverine bird research. The research has led to 51 peer-reviewed publications in international scientific journals and books, around 70 conference presentations and the supervision of 20 post-graduate research students.

1.3 I have been a Shirtcliffe Fellow and a Fulbright Scholar, and have received six awards from universities and other organisations for research achievements and a national Tertiary Teaching Excellence Award from the NZ Qualifications Authority. I have recently been a member of the executive committee of the North American Benthological Society, the largest international organisation for stream ecology research, and am a member of the Ecological Society of America, the New Zealand Freshwater Sciences Society, the New Zealand Ecological Society and the Royal Society of New Zealand. I have refereed scientific papers for eighteen scientific journals and three books and I am a member of the editorial boards of the journals *Freshwater Biology* and *Austral Ecology*. I have been engaged by various governmental and commercial organisations to provide scientific advice on matters related to the management of freshwater ecosystems including being a referee for the Department of Conservation's threat classification system and technical advisor and referee to various species recovery groups and plans, including those of New Zealand freshwater fishes.

1.4 I have particular expertise in the area of New Zealand native fish ecology and have together with R. M. McDowall, contributed to recent book chapters describing the ecology of New Zealand and Canterbury fish communities (McIntosh and McDowall 2004, McDowall and McIntosh In press). For the last ten years my New Zealand-based research programme has focused on the Waimakariri River system, particularly the headwater river systems around the Cass/Craigieburn Basin. I was recently the main supervisor for the PhD thesis of Dr Leanne O'Brien entitled, "The conservation ecology of Canterbury mudfish (*Neochanna burrowsius*)". I have also undertaken research for the Selwyn Plantation Board on the Waianiwaniwa valley mudfish population in collaboration with Dr Jon Harding and Associate Professor David Norton of the University of Canterbury, leading to a peer reviewed journal publication on the population (Harding et al. 2007).

1.5 I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses (31 July 2006). This evidence is within my area of expertise, except where I state that I am relying on facts or information provided 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

1.6 My evidence relates to the influences on populations of the rare Canterbury mudfish, *Neochanna burrowsius* of the dam proposed for the Waianiwaniwa River valley, alterations to stream flows and additional irrigation races, all associated with the Central Plains Water Enhancement Scheme (CPW). I have been asked to prepare this evidence by the Department of Conservation.

1.7 My evidence specifically addresses the following issues:

a. Status and characteristics of the Waianiwaniwa River valley population of Canterbury mudfish.

b. Impacts of the Waianiwaniwa dam construction on Canterbury mudfish

c. Adequacy of proposed mitigation measures for loss of the Waianiwaniwa mudfish population.

d. Impacts of changes in flow and waterway creation on Canterbury mudfish and other native fish in the Hororata and Selwyn River systems.

Summary of findings

1.8 The Waianiwaniwa Valley population of Canterbury mudfish (*Neochanna burrowsius*) is very likely the largest and most important population of this nationally endangered fish in existence. It is significant for five main reasons: (a) it is present in a natural stream network, (b) predatory fish (especially eels and trout) are effectively absent from the valley, (c) there are areas of very high mudfish densities characterised by abundant large adult fish and ongoing recruitment in association with high quality stream habitats adjacent to wetland remnants and containing aquatic macrophytes, (d) the subpopulations are interconnected and cover a wide spatial extent (more than 23 km or stream length), and (e) the population is part of the rarer 'northern' genetic subgroup.

1.9 The Waianiwaniwa Valley dam construction will eliminate the natural stream-resident Canterbury mudfish population and mudfish will not be able to live in the reservoir or connected streams.

1.10 The measures proposed to mitigate the loss of the Waianiwaniwa population of Canterbury mudfish (Allibone 2008a) are not well documented and inadequately address the significance and characteristics of the mudfish population that would be lost. Replacing the characteristics of the Waianiwaniwa mudfish population would require at least 23 km of low-gradient contiguous stream network, free of large predatory fish like trout and eels, and with mostly perennial flow.

1.11 The changes to the flow regimes of the lowland and foothill streams affected by the scheme may prose a threat to Canterbury mudfish and other native fish due to expansion in the range of sports fish and other predators (e.g., eels). The extent or likelihood of that effect is difficult to determine because of inadequate information on the flow regime changes and their influence on fish populations. No assessment of this issue has been presented.

2. STATUS AND CHARACTERISTICS OF THE WAIANIWANIWA RIVER VALLEY POPULATION OF CANTERBURY MUDFISH

2.1 The Canterbury mudfish (*Neochanna burrowsius*) is a rare native fish species found only in Canterbury (O'Brien and Dunn 2007a). They have been recorded from fifteen catchments extending from the Ashley River catchment in the north to the Waitaki River catchment in the south. Their populations are fragmented and occur in highly modified habitats due to the extensive agricultural development of the Canterbury Plains. As a result many populations have gone extinct and many of the remainder are threatened. Of the 81 subpopulations identified within the fifteen catchments, 23 are of unknown status, 12 are extinct or likely extinct, 13 are threatened, 22 are vulnerable, and 11 are undergoing management (5 on crown land, 1 covenant and 5 being restored) (O'Brien and Dunn 2007b). These characteristics form the basis of their classification by the Department of Conservation as “Nationally endangered”. Canterbury mudfish are also recognised as a taonga species in the Ngai Tahu Deed of Settlement.

2.2 A 2002 NIWA report (Glova et al. 2002) stated, “The presence of a major population of the Canterbury mudfish in the Waianiwaniwa catchment has significant ramifications for the Central Plains irrigation scheme” (p14). Subsequent reports (summarised by Allibone 2008a) have noted that Canterbury mudfish (*Neochanna burrowsius*) are present in the Waianiwaniwa River valley, are regarded as nationally endangered (Hitchmough et al. 2007) and regionally rare (Lavender 2001), but have failed to rigorously address the characteristics and status of the valley’s Canterbury mudfish population that was identified at this early stage. This is an important shortcoming because the impacts of the dam works proposed for the Waianiwaniwa valley on Canterbury mudfish and any mitigation of impacts depend on the status and characteristics of the population that determine its significance and value.

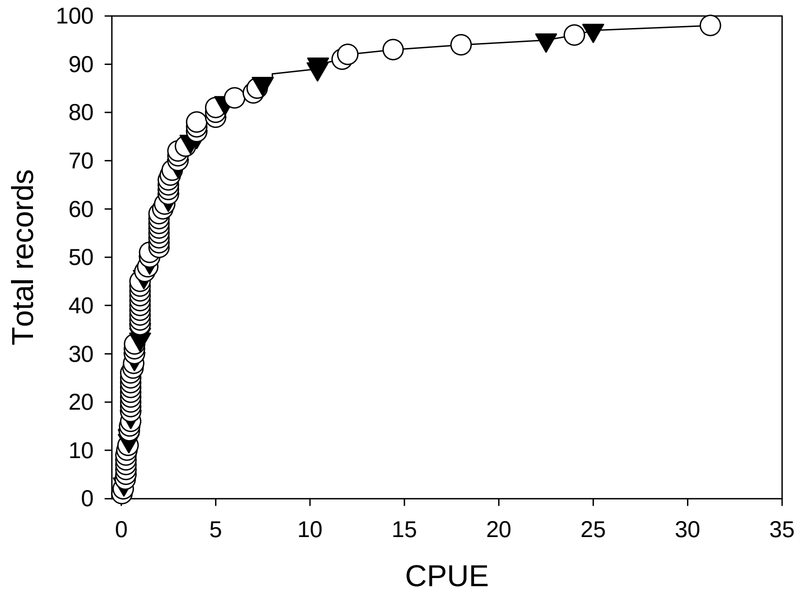
2.3 The Waianiwaniwa mudfish population is very likely the largest and most significant population of Canterbury mudfish in existence. In summary, research by the Freshwater

Ecology Research Group at the University of Canterbury (Harding and McIntosh 2006, Harding et al. 2007a), including a paper published in the *New Zealand Journal of Marine and Freshwater Research* on the status of the Waianiwaniwa mudfish population (Harding et al. 2007b), and research by others (O'Brien and Dunn 2007b) indicates:

2.4 ***The Canterbury mudfish are present in a natural stream network in the valley.*** This is significant because many other Canterbury mudfish records are from wetlands, ponds, channelised ditches or water races (O'Brien 2005, O'Brien and Dunn 2007b). The NIWA 2002 (Glova et al. 2002) report also mentions this characteristic of the Waianiwaniwa population as a significant feature. Their occurrence in streams is important because streams are likely to be an historically important natural habitat from which Canterbury mudfish have been largely displaced in post-European Canterbury. This assertion is supported by observations of their ecology and morphology (O'Brien 2005, O'Brien and Dunn 2007a). The morphology of all six *Neochanna* species ranges from a "stream galaxiid"-type morphology found in the Tasmanian species, *N. cleaveri*, to the extreme eel-like "angulliform" morphology found in *N. heleios* and *N. apoda* which occupy swampy habitats with dense aquatic vegetation (Waters and McDowall 2005). Being the only New Zealand *Neochanna* species (of the five) having pelvic fins, and having a shape more similar to the stream galaxiid-type morphology, Canterbury mudfish occupy a niche closer to the stream end of the morphological gradient (O'Brien and Dunn 2007a). Thus, their occupation of flowing stream habitat makes the Waianiwaniwa population distinctive.

2.5 ***The valley lacks large predatory fish or they are present in very low numbers.*** No eels or trout were observed in either the NIWA electrofishing survey (Glova et al. 2002) or Gee minnow trapping surveys in 2006 and 2007 (Harding and McIntosh 2006, Harding et al. 2007a). Eels were present in 1990 according to the New Zealand Freshwater Fisheries database and have been present historically according to anecdotal reports from locals. However, low flows and dry reaches downstream on the eel migratory pathway have probably precluded their continued presence. Low flows and very low dissolved oxygen levels in the valley during summer probably also preclude trout and eel presence (Harding et al. 2007a).

2.6 ***The Waianiwaniwa valley contains very high abundances of Canterbury mudfish.*** Combining the NZFFD records with the data from the University of Canterbury surveys indicates that samples from the Waianiwaniwa River system with catch per unit effort (CPUE) ≥ 6 fish/trap account for 47% of all records of catches with greater or equal to 6 fish per trap (Harding et al. 2007a). Thus when compared with a representative sample of available Canterbury mudfish records, the Waianiwaniwa River valley contains almost half of the sites where the highest CPUE values have been recorded (Fig 1).



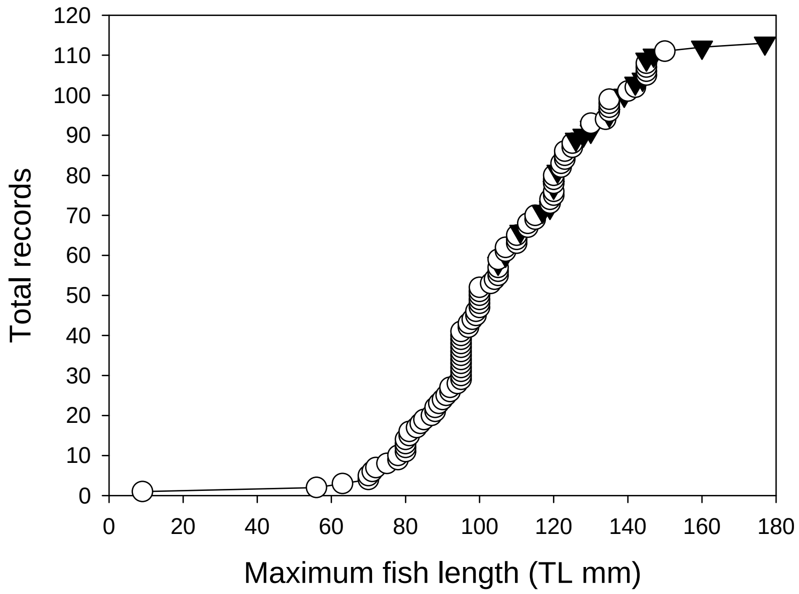


Fig. 1. Cumulative frequency plots of combined NZFFD records and values from each site for the Waianiwaniwa River valley sampled in July 2006, and January and February 2007 showing CPUE (mean mudfish per trap/24hr, n = 117, upper), and maximum fish TL caught for each record in NZFFD and each site in Waianiwaniwa (n = 113, lower). Open circles and solid triangles refer to NZFFD and Waianiwaniwa River sites, respectively. CPUE values from the NZFFD are mean catches per site per record, while the Waianiwaniwa data are the highest mean catch per site across all sampling occasions. From Harding et al.(2007a).

2.7 Another assessment of the significance of known Canterbury mudfish subpopulations produced similar results. In an assessment of all available records of 81 recorded Canterbury mudfish subpopulations, only eleven had CPUE values > 5 (O'Brien and Dunn 2007b). Of those eleven subpopulations, four were from the Waianiwaniwa valley (Cairn Hill Stream, Tara Stream, Bush Gully Stream and the Waianiwaniwa River; Table 57, p134).

2.8 ***The Canterbury mudfish population in the Waianiwaniwa catchment is healthy, undergoing recruitment and many large fish are present, and this is typical of sites with perennial flow and lacking large predators.*** The mudfish population in the Waianiwaniwa consists of a range of size classes throughout the year, the population characteristics were similar on multiple sampling occasions, and successful breeding and recruitment are occurring (Harding et al. 2007a). I have observed fish in spawning condition in multiple parts of the Waianiwaniwa catchment and aquatic vegetation suitable for spawning is present in some places. Although the aquatic habitats in many parts of the Waianiwaniwa valley river system are degraded due to siltation and other impacts, there are wetland remnants associated with the stream network that are linked to high quality mudfish habitat including aquatic macrophytes used by mudfish to suspend their eggs in the water column.

2.9 The maximum sizes of Canterbury mudfish from the Waianiwaniwa River catchment dominate the top fifty percent of all records when combined with the NZFFD information (Fig 1), and the largest Canterbury mudfish recorded to date is a fish recently caught in the Waianiwaniwa. Thus, there are very few other sites where such consistently large mudfish occur. These characteristics are likely linked to the presence of permanent water year round and the absence of large predatory fish like trout and eels, as populations with abundant large fish have usually only been recorded in perennially flowing sites lacking eels (O'Brien 2005).

2.10 Although Canterbury mudfish are known for their tolerance of dewatering (Eldon 1979a), habitat drying still results in high rates of mortality and unstable population dynamics dominated numerically by small individuals (O'Brien 2005). Canterbury mudfish persistence in some locations in the presence of predatory eels is probably linked to their ability to withstand conditions that consistently eliminate eels for periods of time (O'Brien 2005). Although Canterbury mudfish can obviously tolerate some extreme conditions, the impacts of those conditions on their populations make them particularly susceptible to extirpation (i.e., local extinction). Thus, the presence of a stable population associated with perennial flow in the Waianiwaniwa is significant, as most populations (as indicated by the maximum size distribution in Fig. 1) have characteristics typical of the unstable population dynamics associated with predator presence and habitat drying.

2.11 ***There are negative interactions between Canterbury mudfish and almost all species of fish including Canterbury galaxias.*** Predation and competition with other fish species are major factors contributing to the severely restricted and fragmented distribution of Canterbury mudfish (Cadwallader 1975, Eldon 1979b). Canterbury mudfish are non-diadromous and seldom co-occur with other fish species except upland bullies and eels (*Anguilla* spp.) under some circumstances (e.g., periodic habitat drying). The influence of upland bullies on Canterbury mudfish remains unresolved, but there is evidence all other species have substantial negative effects on Canterbury mudfish (O'Brien 2005). Sampling from the Waianiwaniwa valley indicates mudfish were virtually never caught in the same trap as either upland bullies (*Gobiomorphus breviceps*) or Canterbury galaxias (*Galaxias vulgaris*) (Harding et al. 2007a). Moreover, there is spatial separation between mudfish and Canterbury galaxias in the valley, as Canterbury galaxias occur predominantly in the faster-flowing upper reaches of the mainstem and tributaries where mudfish were almost never found (Harding et al. 2007a). Thus, the mudfish population mainly occupies the valley bottom and mid to lower reaches of tributaries under the reservoir footprint. Furthermore, there is very limited scope for the mudfish population to move upstream because of the presence of Canterbury galaxias in steeper and faster flowing water.

2.12 ***Canterbury mudfish are widely distributed throughout the Waianiwaniwa valley and subpopulations are interconnected.*** Spatial analysis of all sampling records from the Waianiwaniwa valley (Fig 2.) indicate the spatial extent of Canterbury mudfish occupies at least 23 km of stream length, with more than 3.9 km of stream supporting relatively dense populations (CPUE > 6) (Harding et al. 2007a). Moreover, the various subpopulations are directly connected in a more or less continuous manner and are not fragmented by habitat occupied by other fish species like trout or eels as is the case elsewhere. This means the Waianiwaniwa catchment very likely contains the largest known contiguous Canterbury mudfish habitat and is substantially larger than any other documented mudfish habitats in Canterbury. All four of the main populations identified by (Eldon 1993) and studied by (O'Brien 2005) are substantially smaller. The spatial extent of mudfish in Te Roto Repo o Tawera (Mounseys Stream (Eldon 1993)) near Oxford, the most extensive of those four populations, measured using the same methods is less than 2 km of stream length with mudfish. The connection of subpopulations in the valley is important because dispersal between sites can act to prevent local extinction in fish populations (Fagan 2002).

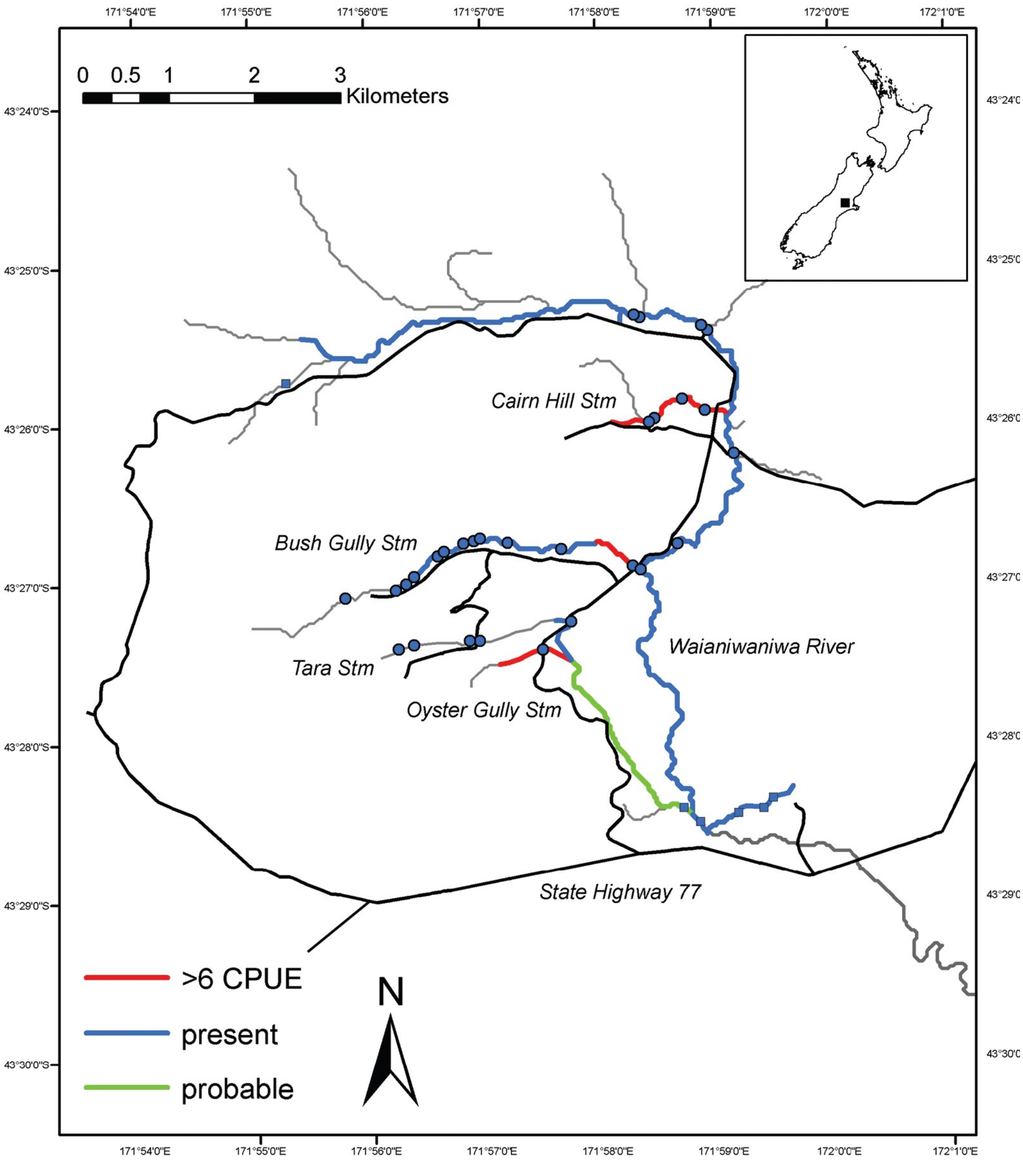


Fig 2. Study area indicating known and predicted distribution of Canterbury mudfish *Neochanna burrowsius* in the Waianiwaniwa River, based on combined data from gee-minnow trapping in July 2006, January and February 2007, and New Zealand Freshwater Fish Database records (from Harding et al. 2007).

2.13 ***Being part of the less widespread 'Northern' genetic subgroup of Canterbury mudfish makes the Waianiwaniwa important for conservation.*** Canterbury mudfish populations show some genetic subdivision between northern and southern populations and the Waianiwaniwa River fish are part of the much less widespread 'northern' grouping (Davey et al. 2003). Thus the population described here is particularly important for the conservation of this species.

2.14 Although Canterbury mudfish have been recorded from a variety of locations on the Canterbury Plains in the last forty years, most populations are sparse and of limited spatial extent, and many have gone extinct. Cadwallader (1975) identified twenty locations with mudfish present in the 1970s. New populations have been discovered in subsequent surveys, but local extinctions of previously recorded populations have also been noted (Eldon 1979b, O'Brien 2005, O'Brien and Dunn 2007b). For example, of the 81 subpopulations identified by O'Brien and Dunn (2007b) 12 are extinct or likely extinct, and 23 were of unknown status. Eldon (Eldon 1993) identified four important remaining Canterbury mudfish habitats known about in 1993 which are included among those listed in the New Zealand Mudfish Recovery Plan (Department of Conservation 2003). However, extensive work by O'Brien (2005) over seven years indicated that at least one of those four populations (Hororata Stream) is threatened by declining habitat quality due to agricultural intensification. Furthermore, mudfish persistence at two of the four populations is linked to disturbance mediated co-existence with eels, and the severe hydrological regimes that periodically eliminate eels also negatively impact mudfish populations. Thus, although Canterbury mudfish may reach high densities in some locations, the status of Canterbury mudfish is precarious due to the limited number of sizeable populations not accessible to predatory fish. Such highly fragmented fish populations are some of the most at risk of extinction (Fagan 2002). These characteristics justify the high threat status given Canterbury mudfish by the Department of Conservation (Hitchmough et al. 2007).

2.15 As part of the mudfish recovery plan (Department of Conservation 2003), considerable effort has been made to sample and record all mudfish populations in Canterbury on the NZFFD. Thus, although I know of sampling carried out on known populations that is not contained in the database, it is very unlikely that another population comparable to that in the Waianiwaniwa exists. This contention is supported by the other recent assessment of known Canterbury mudfish populations (O'Brien and Dunn 2007b). The presence of a population of Canterbury mudfish in the Waianiwaniwa system is probably the result of a combination of unusual conditions which have created a system where natural fish predators are excluded, suitable mudfish habitat is common, competition from other fish species is reduced by poor water quality, but conditions are not so severe that mudfish are subjected to emersion (i.e., they are subjected to being out of the water). This rare combination of conditions makes the Waianiwaniwa River valley a unique ecosystem and creates an important “whole catchment” refuge containing the most significant remaining population of Canterbury mudfish in existence.

2.16 Although previous evidence (Allibone 2008b) correctly states that the Waianiwaniwa valley population of Canterbury mudfish was identified as a key population by the Department of Conservation in 2003, it fails to adequately address the significance of the population as it is now known, and as summarised above. The implication in Section 1.2 of the proposed mitigation plan (Allibone 2007) that Canterbury mudfish are primarily fish of ephemeral and marginal wetland habitats is incorrect. Canterbury mudfish do occupy these habitats, but as explained above, contemporary knowledge of their ecology indicates these are likely to be marginal habitats and their primary habitats are slow flowing streams and springs (O'Brien 2005). Overall, the proposed mitigation plan fails to recognise the significance of the Waianiwaniwa population occupying running water (as opposed to wetland) habitat. Moreover, the description of the Waianiwaniwa valley mudfish population (section 2.1 of the mitigation plan) considerably underplays its significance. The analyses presented above indicate it is the most significant mudfish habitat remaining because of the abundance of fish, the size of fish and spatial extent of the population by comparison to other known populations.

3. IMPACTS OF THE WAIANIWANIWA DAM CONSTRUCTION ON CANTERBURY MUDFISH AND OTHER NATIVE FISH

3.1 Almost all of the Canterbury mudfish population in the Waianiwaniwa Valley occurs in habitat that will be inundated by the proposed dam. Regardless of the exact location of the dam, its size means the proportion of the mudfish population not directly affected by the construction and referred by Allibone (2008b, point 88) would be a tiny fraction and result in further fragmentation of the population.

3.2 The dam construction will very likely eliminate the Canterbury mudfish population in the Waianiwaniwa valley (Kingett Mitchell Limited 2006), if not through inundation of the stream habitat, then through invasion of predatory fish. The mudfish cannot move upstream or into tributaries because of the presence of Canterbury galaxias and the unsuitability of the upstream habitat. Furthermore, any remnant population remaining in stream habitat upstream of the dam would in my view almost certainly be eliminated once other fish like trout and eels colonised the reservoir (and therefore the stream).

3.3 Supplementary evidence hints at some possible opportunity for Canterbury mudfish to inhabit the reservoir if other predatory fish are not present (Allibone 2008b, paragraph 93). I consider this very unlikely. First, it will be impossible to create a system that prevents trout or eels or some other fish not already occurring in the valley from gaining access via the intakes or outlets to the reservoir, as conceded in a subsequent point (Allibone 2008b, paragraph 94). Screening, as described in the evidence of Joe Hay, will be very important to minimise the number of fish entering the reservoir. However, no fish screening will ever be one hundred percent effective. Even if such a system did exist it is possible predatory fish would end up in the reservoir through human-assisted invasion. Secondly, because Canterbury mudfish are the most 'stream-adapted' of the New Zealand mudfishes, as described above, Canterbury mudfish are unlikely to inhabit the reservoir even though other species of New Zealand mudfish do inhabit lake-like conditions (Allibone 2008b, point 92).

3.4 I disagree that koaro (*Galaxias brevipinnis*) are very unlikely to colonise the reservoir (Allibone 2008b, paragraph 95). Firstly, sampling undertaken in the Waianiwaniwa catchment to date has been concentrated in the lower catchment and has been of relatively low intensity (less than ten days of field work have been undertaken by University of Canterbury personnel, for example). Adult koaro could still exist in the upper catchment (as very small numbers of individuals do in other Canterbury catchments (*A. R. McIntosh, unpublished data*). Moreover, it is not inconceivable that larvae from adults in the upper Waimakariri River catchment could be entrained in the intakes and enter the reservoir. They are then very likely to rear in the favourable lentic conditions of the reservoir and migrate upstream as adults and juveniles into the tributaries. Furthermore, the Otago research referred to would be most applicable to the movements of juvenile koaro out of the reservoir. Stream-spawned koaro larvae are very likely to be washed downstream (unless they encounter a lentic environment).

3.5 If koaro were to invade the new reservoir it is very likely that other non-migratory native fish like Canterbury mudfish and Canterbury galaxias would be eliminated. This is because in Otago and in the headwaters of the Waimakariri River in Canterbury, koaro have been associated with displacing other native fish from stream habitats connected to lakes (McDowall and Allibone 1994, Allibone 1999).

4. ADEQUACY OF PROPOSED MITIGATION MEASURES FOR LOSS OF THE WAIANIWANIWA MUDFISH POPULATION

4.1 The measures proposed to mitigate the loss of the Waianiwaniwa population of Canterbury mudfish (Allibone 2008a) are vague and inadequately address the magnitude and characteristics of the mudfish population that would be lost. One would expect a management plan to clearly outline a series of steps with specific and quantifiable goals for mitigation of the loss of the Waianiwaniwa Valley and other populations. The details of the proposed wetland construction for the Waianiwaniwa valley, especially evidence of the suitability of the created habitat for Canterbury mudfish and the size and characteristics of the mudfish populations that would be created are lacking.

4.2 The characteristics of the Waianiwaniwa River Valley Canterbury mudfish population also make replacing the population with an equivalent population elsewhere very difficult. The mudfish population's characteristics are determined by the nature of the habitat. To replicate the Waianiwaniwa mudfish population would therefore require a low-gradient, connected, stream network of at least 23 km, largely free of large predatory fish like trout and eels and with mostly perennial flow. I know of no such potential habitat in Canterbury.

4.3 Although the mudfish mitigation plan states that passage into, and presumably out of, the reservoir will not be provided for fishes (e.g., trout, eels and koaro), no details are provided of how this will be accomplished. Moreover, given the large body of water being created there is a high risk that fish like trout would be introduced illegally (as acknowledged by the applicant). Habitat conditions in the valley at present likely limit the survival of fish like trout and eels. However, a large reservoir, depending on the conditions, would likely create more suitable habitats for these fish. Previous reports commissioned by the applicant also argue that invasion of fish like trout and eels into the reservoir is likely (Glova et al. 2002). This issue is not considered in the mitigation plan, yet the presence of trout, eels or koaro in the valley would compromise any mudfish habitat created in the valley further upstream or in tributaries.

4.4 It was suggested in oral evidence by Dr Allibone that barriers could be created to protect mudfish populations in wetlands constructed upstream from invasion by other fish. Barriers would be important to protect mudfish populations, but designing barriers to completely eliminate fish like eels and koaro will in my opinion be difficult. Barriers certainly limit the distribution of many fish populations in New Zealand. However, eels and koaro are the most adept at overcoming obstacles (McDowall 1990) and I think it will be very difficult to design barriers to completely exclude them. Certainly more details are needed on how this will be achieved and whether it could work.

4.5 Detection and removal of predators as suggested in oral evidence is also problematic. Predatory fish will be hard to detect until a large population is established. Removal will also be difficult. I know of no proven examples of the successful removal of predators like trout and eels from water bodies in New Zealand without the use of fish poison. Suggestions that eel fishermen could do the job are problematic because they are unlikely to reduce eel populations sufficiently using commercial catch methods.

4.6 Dewatering mudfish habitat to remove predatory fish (as suggested in oral evidence) would also impact the mudfish population. Dewatering is linked to extensive mudfish mortality (25-30%) and stunting of populations (O'Brien 2007), and very likely leads to the unstable population dynamics associated with intermittent habitats (O'Brien 2005). The survival of mudfish during dewatering is also linked to suitable damp hollow or burrow habitats that allow survival during emersion. Contrary to popular belief mudfish do not actually ‘aestivate’ because they remain physiologically active during emersion (Meredith 1985), so the conditions are critical for survival. It is unknown how mudfish find or create refugia during dewatering despite many investigations (O'Brien 2005). Moreover, experimental attempts to create refugia that mudfish might use during dewatering have failed so far. Thus, even expecting some mudfish to survive dewatering in constructed wetlands without further research is an unjustified assumption.

4.7 Creation of wetland-type mudfish habitat in the vicinity of the dam would not mitigate the loss of the Waianiwaniwa mudfish habitat because it is stream habitat being lost. As explained above, Canterbury mudfish are primarily flowing water fish, but most flowing water habitat in Canterbury has been lost. Therefore, one of the special features of the Waianiwaniwa mudfish population is its presence in stream habitat.

4.8 The spatial extent of the wetlands proposed for the Waianiwaniwa valley and the expected number of mudfish they would contain have also not been specified. However, given the size and steepness of side valleys associated with the dam, it appears constructed or engineered wetland could not possibly replace the spatial extent or the size of the lost population. Moreover, small and discrete populations, because of their size, would also be more susceptible to stochastic events.

4.9 Enhancement of stream or wetland habitat lower in the Hororata or Selwyn catchment would not mitigate the loss of the Waianiwaniwa because of the prevalence of eels, even in isolated water bodies, lower in the catchment (O'Brien 2005). The increased proximity to the coast, the lack of significant downstream migratory barriers and the well known capacity of eels to travel some distance out of the water, means eels are likely to reach any habitat lower in the catchment, especially if flows increase. As explained previously, one of the characteristics that make the Waianiwaniwa mudfish population so special is the lack of large predatory fish. The only mudfish populations known to co-occur with eels are those which experience consistent de-watering, which has been associated with mudfish populations with unstable dynamics dominated by small fish (O'Brien 2005). Thus, any enhancement of mudfish populations occurring lower in the Hororata of Selwyn River catchments could not possibly be equivalent to those lost in the Waianiwaniwa valley.

4.10 The technology required to replace to any extent the loss of the mudfish population is not well developed or proven to provide any certainty of success. No proven examples of a capacity to reliably enhance or create new mudfish populations have been given in the CPW documentation. In fact historical attempts to establish mudfish populations have met with very mixed success (O'Brien and Dunn 2007c). Ten out of sixteen mudfish translocations that were able to be assessed by O’Brien and Dunn (2007c) were not successful. Thus, while I am excited by the prospect of further research to develop conservation techniques for Canterbury mudfish any assertion that mudfish populations can currently be reliably enhanced or created is misleading. More detail is also needed to indicate how measures will be timed to avoid disruption to mudfish at key times like spawning, egg development and fry development.

4.11 The captive rearing facility proposed would not be as beneficial as indicated. Knowledge gained since the production of the mudfish recovery plan (O'Brien and Dunn 2005) indicates that captive rearing is not needed for this species because they are not limited by poor reproduction. Achieving Objective 4 of the mudfish recovery plan for Canterbury mudfish is currently limited by on-going population losses and a lack of suitable habitat for translocations. Sjaan Charteris addresses translocation in her evidence.

4.12 No detailed plan is presented for the salvage of the Canterbury mudfish from the Waianiwaniwa valley prior to dam construction. How will the tens of thousands (potentially in the hundreds of thousands) of mudfish that would die be dealt with? Large (750 litre) tanks are required to hold twenty fish at densities that do not result in fish being stunted (O'Brien and Dunn 2005). No details are given for how this problem will be avoided in any holding or rearing facility.

4.13 The mitigation plan (section 2.2) asserts there are 20 km of mudfish habitat in the Hororata area. While this site is a key site, the subpopulations are more patchy. Thus, the populations are much less continuous than in the Waianiwaniwa, so using the same method to evaluate spatial extent is inappropriate. Moreover, many of the populations referred to in Section 2.2 of the management plan are associated with the Selwyn Stockwater race system (in sink holes or other discharges). There are plans to close this system, so this habitat may not be present in the future and the long term persistence of the populations cannot be guaranteed.

4.14 Suggestions in the oral evidence of Dr Allibone that Canterbury mudfish inhabit stock and water race systems in Canterbury are correct. However, it is misleading to imply these might provide a replacement for the populations lost. The presence of Canterbury mudfish in stock water race systems is sporadic. Larger self-sustaining populations in races are rare. Moreover, I gather that the water races constructed as part of the CPW scheme will be subject to considerable daily fluctuations in flow as clients alter their requests for flow. Such hydrologically variable systems are unlikely to produce self-sustaining mudfish populations and can not replace natural stream habitats.

4.15 Plans to enhance the legal protection of Canterbury mudfish populations are positive (Section 4, mudfish mitigation plan). However, the management plan provides no guarantees of protection. Promotion of legal protection to landowners is not enough in my opinion. Specific details of the location, status and extent of legal protection that will be provided are needed.

5. IMPACTS OF CHANGES IN FLOW AND WATERWAY CREATION ON CANTERBURY MUDFISH AND OTHER NATIVE FISH IN THE HORORATA AND SELWYN RIVER SYSTEMS

5.1 There are also significant Canterbury mudfish populations in the Hororata and Selwyn Rivers. These mudfish are generally associated with ponds, ox-bows and other semi-isolated water bodies like wetland remnants and drains. Eels are sometimes present in those water bodies, but Canterbury mudfish co-exist with eels in these habitats because predictable drying and low-flow disturbance of these habitats periodically eliminates eels (O'Brien 2005). Increases in flow and increased access to these waterbodies for trout and eels is likely to negatively impact Canterbury mudfish. Mudfish populations would be more impacted by eels and could be eliminated if the flow regime is made more stable, particularly if summer habitat drying is reduced. Furthermore, if trout have increased access to the habitats through either canal construction or increased flows, Canterbury mudfish population would also be impacted.

5.2 Analyses of possible flow patterns in lowland and foothill stream indicate that the flow in many streams may increase following the implementation of the CPW (Kingett Mitchell Limited 2006). Moreover assessments of how available fish habitat may be altered following those changes indicate that habitat for salmonid fishes (trout) may increase disproportionately to that of native fish (Kingett Mitchell Limited 2006). Although these preliminary assessments indicate that flow patterns may alter, the information provided is insufficient to judge which waterways will be affected and how they will be impacted.

5.3 The construction of the proposed networks of water races and other waterways, as well as emergency discharges, could also increase the range of salmonid fishes and eels. Small trout (100-200 mm total length) are known to be one of the primary inhabitants of irrigation canals and water races. Thus there is potential for the CPW to expand the range and distribution of trout and eels.

5.4 There is compelling evidence that salmonid fishes can have strong negative effects on native fishes, particularly non-migratory galaxiids (McDowall 2006). Thus, there is potential for native fish populations to be negatively impacted by CPW Scheme through increased invasion of foothill and lowland streams by introduced predatory fishes associated with increases in flow and increased accessibility of trout to currently isolated waterways through the water race network. This possibility is not addressed or mitigated in the proposal.

6. CONCLUSIONS

6.1 The dam and associated reservoir proposed for Waianiwaniwa Valley will very likely destroy the most significant remaining population and habitat of the Canterbury mudfish, a nationally endangered native fish.

6.2 The potential to mitigate the loss of the Waianiwaniwa mudfish populations is limited because of the characteristics of the population and habitat that make it unique, and the lack of proven technology to translocate, rehabilitate and establish new Canterbury mudfish populations.

6.3 The proposed mitigation measures inadequately address the loss of the Waianiwaniwa population because they do not demonstrate that a population of equivalent spatial extent and population characteristics can be created.

6.4 The CPW proposal also poses a risk to Canterbury mudfish and other native fish through alterations to flow regimes in the area irrigated by affecting the distribution of trout.

These effects have not been addressed by the applicant and could have significant deleterious effects on native fish, especially Canterbury mudfish.

A McIntosh
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