Application by Central Plains water trust for irrigation water on central plains.

Terrestrial environment report and submission follow up
August 2008

INTRODUCTION –submitters experience

Dr Roderick Macfarlane is an independent environmental consultant (entomology) and between 2004 and 2007 I was a member of Kaiapoi community board. I worked as an applied entomologist for the Department of Scientific and Industrial research for 23 years until its closure in 1992. During that time and in the last 15 years I have built up a broad experience on insect communities in coastal Canterbury especially and focused on New Zealand flies at a national level including two comprehensive overviews (Attachment 1 – Macfarlane selected publications).

The main relevant information of these Canterbury invertebrate community surveys has largely been presented only as written reports, which were NOT copied as written reports for the Christchurch library and so remain relatively unavailable. The text of my three most relevant reports is added as attachments to this submission – see yellow highlighted references. Further completed reports for the Department of Conservation had a confidential element as tenure surveys (Irishmans creek, headwaters of Omarama stream and Dunstan river). The last braided river survey (Tasman river) begun in 2005 has now begun a phase where specialists are identifying the more difficult genera, subfamilies and families. Virtually all the specimens have been identified to family and many to genus or species including many of the main and most identifiable species mainly by me (beetles, moths excepted) from about 110,000 specimens.

The insect and spider community studies have included wetlands and spring areas (Travis and Styx Mill conservation reserve), dry colonised ex flood channel riverbed vegetation (McLeans island) and the upper waterways including the margins of the Heathcote and Halswell rivers. All these invertebrate community surveys for the Christchurch city council and Department of Conservation remain much less available than I would have liked. Even more disappointing has been other community studies, for which I did the basic identification work, that were not even written as report headed by Landcare/University staff of central Canterbury native forests. I began investigating insect communities with a Masterate (Lincoln University) in 1970 of the lucerne insect fauna

I also taught insect biology classes part time at Canterbury University for 4 years in the in the 1990's and so leant the basics of freshwater insect ecology. This summer, I also completed an initial survey of insect estuarine, lagoon, sea rush, salt-marsh and salt-marsh shrub-land, and presented an initial report (March 2008). Overall, I have published over 80 scientific papers, and contributions to book chapters during my 41 years as an entomologist and probably about 15-20 reports.

From a submission basis I have had recent responsibility for the community on environmental and planning issues as both a Kaiapoi community board member and currently one of the environment members on the Northern Pegasus Bay steering committee under guidance by Environment Canterbury.

The purpose of this report and follow on submission is to:

1. Emphasize some waterway issues especially from a Waimakariri district and greater Christchurch perspective.
2. Expand as much as current limited knowledge allows on some of the gaps in the knowledge of terrestrial ecology acknowledged in the reports by both Davis 2008 and Grove 2008.
3. Make my self available for questioning by the panel.
4. Provide selected invertebrate information at best only provided as references in my initial submission of August 2006.

SUMMARY

On behalf of the Waimakariri residents, I appeal to the hearing panel to treat the legitimate business and fundamental living concerns to increase the minimum cumec level and also take into account the likely impact in lower flows of coastal waterways adjacent to the Waimakariri river.

From a natural heritage perspective a lower sustained spring to summer take would reduce the risk of habitat degradation to the two larger wetlands along the margin of the Waimakariri river. As far as I can assess prior to any invertebrate survey these wetlands are probably the most vulnerable areas and habitats.

I predict the affect of some reduced waterway flow in the smaller upper reaches of coastal to semi-coastal waterways combined with urbanisation and especially planting an ungrazed waterway banks will reduce the habitat for a quite diverse and only partly described shore fly and predatory insect fauna along a considerable amount of the central Canterbury plains. Unfortunately, the state of our knowledge of braided insect fauna diversity and especially the waterway margins is only now beginning to become partially known. Lack of funding for basic fly identification means that the prospect of adding substantially to this knowledge from quite extensive and reasonably well advanced revisions of some families remains FRUSTRATINGLY uncertain. Consequently at this time, I can not present the clarity about the larger waterway margin invertebrates, which may hopefully be apparent 5- 10 years from now.

RECREATION AND COMMUNITY CANTERBURY COMMUNITY DEVELOPMENT

Overall, I still hope the irrigation scheme can proceed in principle. I favour the ability to irrigate an appreciable portion more of the Canterbury plains. I have basic sympathy for agricultural development as a long standing family that has farmed for 4 generations in northern North Canterbury.

However, I remain concerned about several aspects especially the extended draw off of irrigation water at medium to lower flows and the considerably greater percentage take of water from the Waimakariri river flow compared to the Rakaia river. Apart from fairness the Waimakariri has a much greater population and some businesses (e.g. Salmon fishery, Kaiapoi boating) which depend on freshwater compared to a much smaller population that has lowland waterways which may obtain some flow from surface springs fed from the Rakaia river. The level of irrigation intake from the Waimakariri river and the considerably larger reduction of its flow compared to the Rakaia river. Why apart from making a larger and more economic scheme MUST the proposers of the scheme advocate far greater relative use of the Waimakariri ?. The much larger greater Christchurch and Waimakariri district under the current proposal is being posed with more environmental risk and some economic disadvantage for small surface feed waterways compared to similar waterways and wetlands in the vicinity of the lower Rakaia river. This inequity needs to be addressed when the final plan is approved.

Overall the level of extraction sought from the Waimakariri river seems to be fool hardy. The considerable part of the season for which irrigation water is abstracted and the relative quantity compared to normal summer and autumn flows is I think only appreciated by a small minority of Waimakariri district residents. Thus the submissions received do not necessarily reflect the long term impact the proposed scheme will have on people living in the Waimakariri district. Nearly all will only have a cursory idea on its implications for our district and the scale of the water being extracted in the medium to medium low river flows for the Waimakariri river. A major omission from the initial planning proposal was any consideration of the impacts on the Waimakariri district and the Kaiapoi community board had no chance to assess this before the submissions closed.

The work done to determine the best site for water storage and various other engineering issues seems good to me, but the lack of consideration of prospects for the plains section in the Waimakariri district seems to be unfair. I appreciate the sources of expertise you did obtain on terrestrial ecology and the format of the evidence reports, which helps clarify the basis for the comments made.

The benefits in terms of the net gain in employment and especially which categouries of business where employment loss can be expected to occur is far from being explicit. It might be termed rather "woolly/milky" and unclear. Consequently, I am still left with a gut feeling that this whole scheme will most benefit a relatively few people directly and that any trickle through effect on township employment may be quite modest even although some milk processing and exporting businesses in the region will benefit considerably.

I am uncomfortable with the lower level of flow use at 41 cumecs – my gut feeling is it should be set at 45 to 50 cumecs and then if this proves to be a safe level then an expansion of 3 more cumecs for the central plains trust and 2 cumecs for the Waimakariri district could be approved in about 15-30 years. It is a pity some of the higher flows by about another 5-15 cumecs could not be used if some way to overcome any extra silting and spill over releases into the Rakaia river could be developed.

I recommend against the proposal to feed overflow periodically back into the Waimakariri river. This is based on the assured speed up this will achieve in the spread of didymo from the Rakaia river via the canal system to the Waimakariri river. is considered to has been attributed to A similar overflow discharge into Rakaia river from the shared irrigation scheme with the Rangitata river has allowed for the Raikaia to be infected sooner than was necessary. The impact of didymo on especially insects that form the main part of freshwater fish diets (Mayfly nymphs, Caddisfly larvae and some midge larvae) is under investigation by NIWA scientists (Kilroy *et al.* 2005b, Larnard *et al.* 2007- see *Biosecurity.govt.nz/files/pests/didymo/didymo-ecology-jan-ob.pft* especially p 37 and p 24. Assessment of the impact with comparison of insect diversity and abundance from before and after studies or from controls are not easily made especially on any fly diversity, where larval identification lags well behind unsatisfactory identification for midge adults especially the family Orthocladinae. Dense didymo growth will smother the normal food source on stone and rock surfaces for various freshwater insects. Initial results indicate that the impact varies depending on the density of the didymo. Allowing such an overflow to the Waimakariri will enhance the risk of spreading didymo sooner to much sooner than if no overflow into the Waimakariri is allowed. Some less common and widespread species of caddisfly and mayfly will probably be affected more seriously than some of the more adaptable common species.

The impact of reduced low water flows on the upper Kaiapoi river and the impact this has on both the fish hatchery and the ability of this premier quality stream to retain high quality MUST be taken into consideration in setting SAFE limits to the amount of water allowed to be abstracted by the irrigators in the Central Plains trust scheme. There is already enough of a problem with the quality of the water in the lower Kaiapoi river and the need to allow for sensible revitalisation of shipping activity without aggravating the situation and degrading the long term potential of the 4 km long Silverstream park along this stream for which I helped develop initial plans.

1.1 Reliability of modelling for upper waterway flow predictions

I am VERY UNCOMFORTABLE at the reliance shown in local government planning on computer modelling especially when this is not backed by monitoring of what is actually happening on the ground (e.g. airport noise contours versus motorway noise) or extrapolations of 100 plus years floods. To me is seems the hydrological ground water flow models is another potential example of UNDUE reliance on this approach. Certainly both extrapolation is providing an idea on what might happen and modelling in providing something to verify in the field are useful especially in developing a CONCEPT of what may be involved with environmental changes or environmental hazards. However, unless this is related to longer term filed observations or careful shorter term monitoring of water way flows in this case then the actual validity of this approach is difficult to assess adequately.

Perhaps the hydrologist can explain to the panel why a resident on one of the upper Avon river tributaries, who purchased a property with a desirable waterway that flowed in it found in the last decade that the waterway had lost the reliability of its flow so it was dry more frequently in the decade that my friend had the property.

What, I find VERY HARD TO BELIEVE is that the **surface** flow of water from the Waimakariri is very slow and that water from it takes years to get to the upper reaches of the Avon and Heathcote. In checking last spring for activity on the upper Heathcote for temporary (ephemeral) waterway flow on the east end of Wigram aerodrome I could see the creek actually flowing unlike some winters and springs. This followed both a sustained period of winter rainfall and increased river flows on the Waimakariri river. Hence, my provisional observation suggested that water flow in the upper ephemeral and hence impoverished sections of the waterways that a combination of moistening on the adjacent soil and sustained higher river flows of a month or so allow for the irregular seasonal flows these waterways exhibit and that a contribution from the Waimakariri may take weeks to a few months not years to reach these waterways.

By inference the shortest distance to the main springs of the south branch of the Kaiapoi river (Silverstream) should follow the same principle of flow response from increases in the Waimakariri after low flows there and in the Silverstream. In fact, the flows and linkage of this stream and the Waimakariri have been monitored relatively intensively at least in the last few years, by Boustead of NIWA. The imperfect linkage in increased flows of these two waterways shown is not surprising given that the original river bed under the stop bank remains part of the braided riverbed that existed less than a 100 years ago. Silverstream flows have the advantage of frequent measurements over a considerable period of time. Similarly some of the headwater springs of the lower Waimakariri river may show a closer and faster response after low flows to increased flows in the Waimakariri river.

Any impact of a significant reduction in ground water for the Kaiapoi aquifer is vital especially with the proposed additional supply of this quality ground water for Rangiora in the future. This extra demand from Rangiora was of considerable concern to Kaiapoi community board members during my term. Other submissions I understood that were made on any further reduction to the water level at the river mouth for the larger boats that "harbour" at Kaiapoi are also legitimate concerns, but of less importance in my opinion. An appreciably lower flow during the drier season and years will also not help improve the water quality of the Kaiapoi river within Kaiapoi, which at least some residents would like to see achieved.

WATERWAY AND WETLAND INVERTEBRATE ECOLOGY

It seems certain there will be some lessening of surface water flow from springs boosted by the adjacent Waimakariri river, which can be quite well away from the waterways affected more directly by dairy cattle effluent and fertilizer enrichment. These latter impacts will occur over a significant part of the lowland waterways of the Canterbury plains and their direct effect has been at least mentioned in other submissions and assessments. However, Environment Canterbury in the recommendations to plant the sides of streams with vegetation such as sedges and fence off the waterways will eventually reduce the amount of open muddy to silty waterway margins virtually to fully free of vegetation. This habitat was shown to be important for a significant waterway margin –wetland fauna chiefly of native flies some of which at least remain undescribed in the South west Christchurch and Styx mill conservation park survey (Macfarlane 2004, 2007).

Unfortunately the impact is hard to quantify in both quantity and duration of critically low seasonal flows and water quality. However, the report submitted by Williams (2008) does note there will be a general increase in low flows in spring feed streams. This reduced flow combined with the continued urbanisation of the upper Heathcote watershed and parts of the upper Styx River with further silting that normally occurs during the standard considerable period of exposed raw dirt and silt during development of new subdivisions will mean the headwaters of the Kaiapoi river (Silverstream) and the south Waimakariri river above the Clearwater development will become even more significant as the least disturbed lowland semi-coastal waterways in Canterbury.

Even the previous two terrestrial ecology including wetlands had no information on the impact on insects or spiders. The value of waterway margins for flies especially and open to sparsely vegetated gravel to sandy sites in braided riverbeds is not even mentioned in the relatively comprehensive overview of our natural heritage for Canterbury (Knox 1969), so how could Davis 2008 and Grove 2008 in preparing impact reports on the environment do more than point to the principle that unrecorded/unkown effects does not mean there are none.

I have volunteered an appreciable part of my time to provide some insight about the scale of insect biodiversity and what limited statements that can be made from reports and collecting I have done from waterways and riverbeds in the last 10 years in Canterbury especially, but also inland Otago.

In my original submission, I explained the significance of reduced flow and warmer water on oxygen carrying capacity within waterways, so this does not need repeating. However, the current length of waterway favourable for insects within the upper parts has declined considerably since the 1980's and anecdotal evidence suggests, which includes about 10 years where I lived in Halswell have resulted in a decline in flow and so extension of the length of temporary waterways in both the upper Halswell and Heathcote river catchments. This trend for an increase in completely dry parts and still pools with no inflow combined with continued silting means that any further reduction in their flow due to inflow received from the Waimakariri will there fore reduce even further the length of the more favourable waterways in urban Christchurch and its parks.

For terrestrial ecology, the main issue I want to clarify is the range of habitats that insects inhabit, which the other terrestrial ecology reports do not deal with. The main literature sources including my reports were presented in my 2006 submission. My relatively unavailable SW Christchurch river report can now be made available for the web as I include it as an "appendix attachment. The Styx Mill conservation reserve report (Macfarlane 2007) is available as a hard copy from CCC and Environment Canterbury and could be on the CCC web too.

Until I made a range of insect community surveys (Table 1) I did not appreciate the full diversity of native insects in semi-naturalised habitat through even to the sand dunes with only a few introduced plants virtually completely providing the plant cover. These coastal Canterbury surveys with from about 1 week to a month of collecting always revealed a few undescribed species and some very little known species.

From a natural heritage perspective the panel should realise that only about half the insect species that probably occur in New Zealand have been described (Macfarlane et al in preparation) and the undescribed species will include a considerable number more localised and uncommon species.

Table 1: Recorded invertebrate diversity in Greater Christchurch

	Number of species					
Taxonomic group	Native bush	Wetland- swamp		Savannah like danthonia grassland	Sand dunes	Waterways (Fresh-saline)
		Travis	Styx			
Beetles, Coleoptera	95	70	25-7	42	16	14
Flies, Diptera	83	135	146-54	41	55-61	47-50
Moths, butterflies	243	59	12	61	10	1
Parasitic wasps, ants, bees	44	134	72-74	41	28	0
Bugs, scales, aphids, etc.	59	46	21	13	17	6
Caddisflies	-	1*	19	11 (water-race)	0	17
Other insects	30	32	14	21	14	13+
INSECTS	**495**	**459**	**309-21**	**229**	**140+**	**98-101**
Spiders	-	27	12+	22	10-15	1
Snails, slugs	2+	12		-	3	
Insect species to native plant ratio		7.5		10.0	Does not apply	

1.2 Reduced water flow and waterway invertebrates

Thus my major concern for this scheme is that the impact on flows of the premier upper waterways of greater Christchurch and the Kaiapoi river will to some ill understood extent be lowered by the extended seasonal take from the Waimakariri river. This impact has been glossed over by the proposers of the scheme and inadequately assessed in the evidence supplied to date as evidence by Davis 2008 and Grove 2008 as they acknowledge.

This impact effects three sections and habitats of lower consistently flowing waterways of Greater Christchurch and the south Kaiapoi river. In greater Christchurch, the likely impact will be more extended periods of low flow and longer sections of ephemeral waterway in the few non built up sections of this area and an extension of seasonal pools with no water flow as already occurs on too much of the upper Heathcote river, which I observed when I surveyed the insect fauna in 2004. Low flows allow for less oxygen in the water, which means aquatic freshwater species that are more demanding in their habitat simply cease to exist in considerable portions of these waterways. This change has already been documented in the surveys of the 1980's and the 2004 surveys by McMurtrie and Taylor 2004 and myself. There are 44 insect species within these waterways and the marginal and small adjoining waterways here and in the Styx river conservation reserve even included some undescribed species of flies (Macfarlane 2004, 2007).

1.3 Shore side or water way margin (riparian zone) species

However, what was not appreciated for lowland Canterbury at least until my survey (Macfarlane 2004, 2007) was that about another 15 to 20 fly species inhabit the fringes and edges of these small waterways and streams. Nationally, insects along waterway margins, was not covered in the excellent review on (Collier & Winterbourn 2000 –see my 2006 submission) These mainly dark predatory flies require open spaces as well, because the sun allows them to passively soak up heat and be more ready to seek their prey. Once again insect diversity for this habitat is lacking nationally.

Two of the major shore side inhabiting families of flies have been partly revised by Mathis (shore flies, Ephydridae) and Muscidae (Harrison deceased) and I have been priveledged to have the draft manuscripts. Wayne Mathis (Smithsonian institute, Washington DC, United States) in his pending revision of this significant fly family has recognised 63 species (Macfarlane *et al* in press). This more than doubles the number of shore flies known from New Zealand The basic shore fly larvae in this habitat have been described and their larvae feed on the near microscopic green alga that are on and within the mud and silt. This source of larvae and smaller adults of aquatic insects in the adjacent stream (midges, mayflies, caddisflies especially) provide the basic food source for a considerable array of predatory fly species,

The other species diverse groups along the waterway margin include *Spilogona* and *Limnohelina*, which account for many of the 143 species of Muscidae. The greater Christchurch survey recovered about 10 species from mainly non gravel waterway margins.

As far as is known these are predatory flies as are the long legged flies (Dolichopodidae 141 species especially *Chrysotus, Hercostomus* and maybe some *Parentia*) as both larvae and adults. This will probably mean some of these species being higher in the food chain will be more susceptible to environmental degradation. Canterbury and at least inland Otago gravely waterways usually have will a few *Hilara* (dance flies Empididae) species and *Dasyhelea* (biting midges Ceratopogonidae) too, but both these genera have or could have quite a lot of undescribed species.

1.4 Aquatic diversity

If this project is approved then there should have been some monitoring of waterway flows in the BEST QUALITY stretches of waterway in the greater Christchurch creek and small streams (e.g. Cashmere, Styx and a few other stretches). At the least some gathering of anecdotal evidence should be gathered to check computer flow predictions especially when it is agreed that this does affect surface flows. The recent resurveying of within waterways in FLOWING water in Christchurch (McMurtrie & Taylor 2004) and my pioneering waterway margins surveys (Macfarlane 2004, 2007) under supervision of Kelvin MacMillan & Christine Hieremia (Christchurch city council staff) demonstrate that it is only the lower flowing waterways free of appreciable silt that have the stony habitat to provide shelter, less fluctuation in temperature and water speed to have the best levels of oxygen and the seasonal consistency of water flow to allow for a reasonable representation of the more sensitive aquatic invertebrates.

Within the water there are a considerable number of aquatic midges (Chironomidae, biting midges Ceratopogonidae, which have quite inadequate bases for species recognition and diversity. This combined with the uncertainty on the proportion especially of Empididae as aquatic species means that the size of the aquatic fly fauna for New Zealand could only be very roughly estimated (Macfarlane *et al* in press). What is certain is that a considerable portion of the 842 undescribed Diptera species in New Zealand originate from within water or from the wet waterway margins or wetlands (Macfarlane *et al* in press). Similarly the revision of New Zealand Muscidae hampered by the death of Harrison revision had recognised and partially described a similar number of undescribed and larger predatory Muscidae flies especially of the genus *Spilogona*.

1.5 Braided river bed insect and spider fauna

My secondary concern is that the acknowledged lessening of the size and number of small channels in the Waimakariri riverbed has taken no account of the impact especially of shore line insect species. This has been understandable, because what limited information is available was largely relatively unavailable and virtually unknown except to a few including Christchurch City council managers. Both these consultants correctly pointed out that the information on terrestrial ecology was deficient and that the schemes proposers had underestimated its importance. It will as the reports of Davis and state reduce the quantity of water and availability of shore side (riparian) habitat. This affects almost 70km or the lower half of the Waimakariri river, which insects and spiders rely on as a “place to live” (habitat). I expect the proposed considerable and

seasonally prolonged extraction of irrigation water will reduce the amount of suitable shore silt, sand and moist mud along the smaller side channels considerably. This will restrict the amount of habitat for shore flies and the predatory flies that rely on them including an appreciable number of undescribed *Spilogona* auct species (Harrison & Macfarlane unpublished). Harrison, who died in 2007, identified just 4,400 specimens of native Muscidae. These identifications revealed that there were an appreciable number of the undescribed species, which were represented by less than 12 specimens and known from only a few locations, but the Lincoln University collection still has an appreciable number of unidentified specimens and further inland Canterbury specimens were collected in a survey in the Boyle river catchment supervised by Raphael Didham (Canterbury University). Thus it could be assumed there might be one to a few localised species from lowland waterway margins from Canterbury or at least the eastern South Island. An example is a grey undescribed species of *Hecamedoides* (Ephydridae), known from the lower Hurunui river to the Lake Wanaka margin. I collected specimens from Okuku river, which is only the 5th known site from a silty side pool margin. The allied more advanced study of shore flies by the Mathis revision and the Tasman braided riverbed survey has revealed a considerable difference between the upper Tasman river and the coastal Canterbury waterways in at least the shore fly and midge Chironomidae fauna.

The as yet incomplete Tasman braided riverbed survey will be the first comprehensive survey of insects spiders and millipedes for New Zealand. An appreciable increase in identification of species and especially the true level of undescribed species should become available in the next 12-24 months specialists have identified species rich taxa waterway margin genera e.g. *Hilara* and *Spilogona* and some groups other groups including the aquatic Chironomidae. At present possibly similar numbers of *Spilogona* species were collected in the Tasman braided river bed survey, Apparently these species are partly to mainly different species as is a distinctive species in the Avon-Heathcote estuary and Ashley lagoon and so presumably in selected parts of the Brooklyn lagoon and tidal parts of the Waimakariri river banks. However, the *Limnohelina* species seems to be the same widespread species found in lowland Canterbury in my surveys.

Another issue is that with only short periodic floods and longer spring to autumn periods of substantially lower river flows, this will allow for extra weed a vegetation growth to establish. This will reduce habitat for typical river bed inhabitants (Appendix 1) of which only the quite species rich *Anabarhynchus*, may have localised species. *Anabarhynchus* larvae are predatory especially in the drier and lighter soils-sands and the prey of the larvae of at least some species are likely to be root feeding Scarabaeidae (grass grubs) beetle larvae and pupae.

1.6 Wetlands

Studies of insects and spiders of the Travis wetland (Macfarlane *et al* 1998) and the Styx Mill conservation reserve (Macfarlane 2007) are the only comprehensive surveys of wetlands in New Zealand. The insect community Travis wetland had for land management a surprising estimated 650-800 resident species of insects. In only about a month of collection I found and recognised 410 insect species and 27 spider species there (Macfarlane *et al* 1998). For greater Christchurch I have estimated there are at least 2,000 native insect species or about 10% of the national total. Part of this diversity survives in very limited areas of wetland, salt marsh, salt-marsh shrubland and even sand dune habitats. In habitats, that will be affected to some extent by lower waterway flows some species of known very local Christchurch distribution e.g. the flightless daddy-long legged fly *Gynoplistia pedestris* (habitat wetland/waterway margins) and perhaps two undescribed species so far only known from the Styx mill conservation reserve namely *Hercostomus* new species (waterway margin) and *Isodrapetes* species, There are other little known species such as *Hydrellia acutipennis* (plant host unknown, waterway margin), which has only been found at Otago Peninsula previously despite a quite extensive modern collecting by Wayne Mathis and a check of much of the collections since the last revision of shore flies (Harrison 1959). Since, the Styx survey has been completed the two *Chelipoda* species collected can now probably be identified, because of the 2007 revision of this genus by Plant (Macfarlane et al in press). Identification with 38 species is quite tricky despite the good quality revision.

Some additional species including some rarely known fly species were recovered from the Styx Mill conservation reserve and the habitat for some of these virtually unknown described e.g. the herbivorous *Hydrellia acutipennis* or undescribed species *Hercostomus* and *Isodrapetes* species was partially identified by mapping the species distribution (Macfarlane 2007). Consequently, with so much of the larger wetlands gone

or degraded it is not safe to assume the few larger wetlands along the edges of the Waimakariri river may not still retain such useful remnants of our precious natural heritage.

I had expected that the wet and cold soil substrate and presumably oxygen deprived wetland might have an impoverished insect fauna. This did not prove to be the case and it seems consistency in moisture and the availability of rotting and decaying plant material provide help provide for some of the diversity observed at Travis wetland, while the Styx conservation survey provided an insight on what better quality (mainly muddy fringed waterways) and wetlands harboured in the way of little known and undescribed insect species. At least 3-5% of the species were still undescribed when allowance is made for the only partly determined parasitic insect species.

This data on insect diversity and the level of undescribed species may come as a surprise to the panel and others reviewing the information generated about this scheme. However, the estimates for fly species diversity in New Zealand, which is 30% higher than the number of species which we know of is broadly twice or somewhat more than the species of flowering plants to ferns in new Zealand. When all other insects are taken into account there are an expected 10 insect species for every native plant species and about one spider species per native plant. For every naturalised introduced plant species there is about one insect species. This generalisation provides some insight into the sort of diversity, which can be expected if the native and introduced plant diversity has been recorded for specific sites and habitats assuming the overall national average.

1.7 Habitat restoration

Developers and even current district land managers place undue FAITH in our ability to restore plant (not so difficult) and the too often poorly known related insect, spider and other larger invertebrate fauna at sites, where the restoration is well ISOLATED from remnant sites of the original habitat with suitable diversity of vegetation and any associated decaying wood, fungi and litter or shade. This led me to comment on our ability to eventually restore the dominant and inspiring or interesting vegetation in restoration (Macfarlane 2007). Thus an impressive podocarp-hardwood forest may be created eventually that vegetatively is like a cathedral. However, if this areas is some to several kilometres from the nearest "reasonable" size remnant area of native vegetation (may well be quite a lot smaller than that needed for birds) then this "cathedral" of vegetation can be expected to lack many of the original "congregation" of small animals simply, because the area is too far from the remnant source of such animals. Thus in principle it is better to retain areas of wetland for instance such as still occur along the north banks of the Waimakariri river without undue seasonal drying out of suitable moist margins including open (partly sunny sites) for the wetland species.

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Harrison R.A. 1959: Acalypterate Diptera of New Zealand. *New Zealand Department of Scientific and Industrial Research Bulletin* 128: 382 pp (233 species)

Harrison R.A., Macfarlane R.P. manuscript Muscidae (Insecta Diptera). ? for *Fauna of New Zealand* 160 pp (143 of which are undescribed species) **Status:-** Incomplete keys and some descriptions for main genus and descriptions for the introduced species, includes no figures (illustrations – those done are being kept by Landcare and have yet to be made available to me) including distribution maps of the species, but I have compiled a spreadsheet of the species described and identified by Harrison

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Macfarlane R.P. 2004: South west Christchurch waterways: habitat assessment for insects. *Christchurch city council report - Greenspace unit* 26 pp (Attachment 2)
Macfarlane R.P. 2007: Styx Mill conservation reserve: invertebrate assessment and implications for management *Christchurch city council report - Greenspace unit* 126 pp (expected to be available on the web later this year – Hieremia personal communication (Attachment 3)
Macfarlane R.P., Andrew I.G. and 44 other authors (submitted 2001 – 5th revision 2008): Phylum Arthropoda –section Subphylum Hexapoda in The New Zealand inventory of biodiversity. Volumn 2. Kingdon Animalia Chaetogantha and Ecdysozoa. Canterbury University Press (about 470 pp).
Macfarlane R.P., Clark J.T. 2008: Avon-Heathcote estuary central Canterbury lagoon margin insects: baseline survey with questions and issues raised. *Christchurch City Council report for Avon-Heathcote Estuary Ihutai trust* 51 pp (habitats within estuary tidal flats, sea rush, salt marsh, salt marsh shrubland, Ashworth Flats to Avon-Heathcote Estuary – the main area sampled)
Macfarlane R.P., Patrick B.H., Johns P.M., Vink C., Dalton S. 1998. Travis marsh: invertebrate inventory and analysis. *Christchurch city council, Parks and Recreation division* 66 pp (mainly wetland) (Attachment 4)
Macfarlane R.P., Patrick B.H., Vink C., 1999. McLean's Island: terrestrial invertebrate inventory and analysis. *Christchurch city council, Parks and Recreation division* 42 pp (dry short grassland with significant moss and some kowhai and very limited shrub species –dry savannah style grassland)
Mathis W.N., Macfarlane R.P. unpublished: Shore flies (Diptera : Ephydridae) of New Zealand. 176 pp draft manuscript **Status**:- largely written draft, which lacks descriptions of species in four genera and collection results from 2004 collection by Mathis
McMurtrie S, Taylor M. 2004: Aquatic values in the south west Christchurch area. Aquatic Ecology Limited report: 66 pp
Savill R. A. 1999: A key to the New Zealand tiger beetles, including their distribution, habitat and new synonyms (Coleoptera: Carabidae: Cicindelinae). *Records of the Canterbury Museum* 13: 129-146
Vink C.J. 2002: Lycosidae (Arachnida: Areneae). *Fauna of New Zealand* 44: 94 pp

Appendix 1 Known braided riverbed insect inhabitants

Over the last decade I have collected various larger insects from open sand or silt, where they were nesting. I know these insects are active in the drier exposed gravel with no or scant or patchy plant cover in riverbeds from collections in North Canterbury e.g. Conway, Okuku, Cust, mid Ashley) riverbeds apart from them being a significant component of the Tasman braided river bed survey. Their distribution and other details about their flower requirements or the insect prey have now been published to nest in namely native *Leioproctus* bees (Colletidae), spider hunting wasps *Priocnemis* species (Pompilidae), fly and cockroach hunting solitary wasps (Sphecidae) all of which have been revised in the *Fauna of New Zealand* (Harris 1987, 1994, Donovan 2007) as well as the larvae of stilleto flies *Anabarhynchus* (Therevidae) (Lyneborg 1992).

Apart from these bees and predatory wasps there will be small ground beetles especially *Bembedion* species along the waterway margins, some other ground beetles especially tiger beetles *Neocicindela feredayi* and the less widespread *N. austromontana* (Savill 1999) and various rove beetles that prefer this open habitat with some places to shelter. I am not aware that any of these species has a particularly restricted distribution in New Zealand, but Larochelle & Lariviere (2001) summarize the known distribution of ground Carabidae beetles including *Bembidion* in New Zealand. The spider fauna on braided river beds will include wolf spiders and some of these species make retreats in relatively bare silty-gravely dry riverbeds (Macfarlane *et al.* 1999, Vink 2002).