

SOUTH WEST CHRISTCHURCH WATERWAYS: HABITAT ASSESSMENT FOR INSECTS December 2004

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SUMMARY

Waterway invertebrates

- Heathcote river catchment:- the amount of flow in creeks is critical for diversity of the freshwater insects especially for the upper Heathcote river. Substantial housing development in the Wigram watershed and diversion of storm water from Aidenfield into the Cashmere waterways will add to the length of ephemeral and still waterways here. The relatively biological dead Hayton drain will also have a more serious impact of the downstream waterway until it is suitably diluted. It is difficult to assess the amount of risk in terms of loss in midge abundance and species, which will also affect fish food supplies, because this area could not be covered in this survey.
- Halswell catchment:- in the upper part of Knight stream there has been major silting and possibly chemical pollution too. This has destroyed mayfly, stonefly and dragonfly populations, which were in there in the 1980's to the 1990's. Cashmere stream is also under pressure from sustained low level silting. It could also experience major silting with hillside urban development at Kennedys bush or within Hoon Hay valley if inadequate planning and monitoring during development is not achieved. Silting of the premier faster flowing upper streams has the greatest impact on the insects, which are of major importance in the diet of freshwater fish. In addition, planned urbanization of the headwaters threatens to cause further surges in water flow for this catchment unless an adequate pooling system is developed. In the Halswell catchment, the short length of unstudied spring, downstream waterway needs to be kept as free from urban pollution to assist with retaining the now considerable less diverse freshwater in as good a condition for freshwater invertebrates as possible. It would also be helpful to know, how useful the stony stock races are for retaining midge diversity and how the Quaifes pond insect fauna compares with the Curtletts reserve lake and Halswell quarry. This would put the ecological value of these three man made water reserves in context for conservation of waterway invertebrates. It should also be useful in understanding the usefulness of constructing further ponds and whether some should have silt rather than mud shores.
- Both 2004 surveys of freshwater insects generally agreed on the commonness and consistency of the main taxa. The identification of *Corynoneura scutellata* by my streamside sampling was a notable exception. The combined pan trapping and light trapping revealed 11 species (reasonable diversity) of Orthocladinae midges, which were concentrated in the highest quality streams. Light trapping allowed for more precise identification for four caddisfly species.
- Cashmere stream upstream from Westmorland to Sutherlands road has retained the best diversity of caddisflies. The most unusual species recorded from this area were the flightless crane fly *Gynoplistia pedestris*, the dance fly *Ceratomerus crassinervis* and the caddisfly *Aoteapsyche catherinae*. The upper Cashmere stream is the best moderate flow stream and is vulnerable especially to urban development and sedimentation. Degradation of ditches such as Milnes drain has already occurred. Inappropriate cultivation close to the waterway fringe and to a lesser extent continued use of the upper waterways by cattle still add silt to the Cashmere stream headwaters.
- Muddy fringes of these waterways have a considerable suite of 26-29 species, which are mainly fly species. In addition, most of these fly species strongly prefer open sunny sites. Residential development in the vicinity of Westmorland has reduced the corridor of muddy fringe for this fauna. Extensive modification of banks and clay banks within Christchurch will have severely limited the network of corridors previously available to this suite of mud fringe to wetland insects. This wet soft fringe has about 40-45% of the species diversity of the combined freshwater and mud fringe insects.
- The most valued collections were of either wetland species:- the flightless crane fly *Gynoplistia pedestris* (Tipulidae) or shore species *Ceratomerus crassinervis* (Empididae), *Helichochaetus discifer* (Dolichopodidae) and *Neolimnia sigma* (Sciomyzidae).
- Trees, which shed leaves into the streams and shade the stream, favour certain insects. These include some of the moth fly (Psychodidae) species and apparently some of the long legged flies such as *Alchalcus seperatus*. Conversely, open sites favour the major mayflies, caddisflies, 'earthworms' and many of the mud inhabiting flies. Maintenance of the full natural heritage values of the best streams in the area requires variation in the vegetation beside streams.

Terrestrial habitat

- The waterways of south west Christchurch provide corridors of land, which are supplemented with reserves and parks. These reserves and parks allow for the development of more extensive areas of native bush especially to encourage native birds to become residents in the city again. Generally, wetlands with their characteristic rush and sedge vegetation, but also sparsely vegetated silty shores with *Cotula* were previously much less extensively present. Along the banks of the lower reaches of the urbanized waterways of Christchurch there is an almost uniform planting of linking sedges partly for ducks to nest in. This relatively uniform planting is probably of little concern for the preservation of waterway insects, because these zones in the city have relatively few insect species within the freshwater and perhaps a less diverse mud/wetland fringe fauna of flies than was found in this survey.
- For the low to medium flow headwaters of the SW and NW of Christchurch extension of tall sedge planting along the banks or the planting of trees to provide shaded waterways is undesirable for shoreline flies. Trees and shade are deemed most suitable for fish, but tree lined banks will reduce the habitat for the suite of mainly dark coloured flies that are concentrated along the narrow fringe of these waterways. Key top of the food chain *Millerina* and the more ecologically demanding *Limnohelina* species have been shown to need open sites and banks with slushy mud or silt. Consequently, in the remaining headwaters of waterways surrounding Christchurch it is imperative that habitat diversity is maintained at least in pockets. The colonization of the Halswell quarry pond shore by *Limnohelina spinipes* shows that these shore loving flies can disperse and find such suitable new habitat away from consistently running waterways.
- The construction of small pools such as at Quaifes road and to the SE of Halswell and planting of sedges and other wetland plants can do something to redress the loss of wetlands, which has been relatively severe compared to areas of native bush in this district.

INTRODUCTION

Urban development in south west Christchurch and the requirement on regional government to look to the future has meant more information was needed on the invertebrate fauna and especially insects that inhabit these waterways and the associated mud fringe and wetlands. Understanding how to provide a full range of wetland, grassland, shrubland and forest along the waterway banks and adjacent reserves is required, because the waterways of Christchurch provide important corridors and reservoirs of the less extensively preserved habitats. Just beyond the study area, the council and private organizations have retained a considerable number of native forest reserves of the Port hills from Ahuriri to the bush behind Sugar loaf. There are further more isolated and smaller remnant patches even on the northern slopes such as Dry bush through to Sumner. These areas of bush and the much less extensive original but modified shrubland are supplemented by relatively recent plantings (under 30 years old) of native forest patches in Curtletts reserve and Halswell quarry. The value of these renewed areas in providing habitat for native insects compared to larger tracks of original native bush such as Kennedys Bush remain undetermined, because of the considerable insect fauna associated with broadleaf forest in the east coast of Canterbury/Marlborough (Didham 1992, Ward *et al* 1999). Even for a masterate study, only some of the dominant species of Diptera in the forest not far north of Kaikoura were reported on (Didham 1997).

Consequently, I have chosen to focus on the least understood of the habitats the mud periphery of the waterways and to extend what is known about the genera and species of Diptera that exist in a range of habitats. For wetlands, which have been relatively decimated in lowland Canterbury the investigation of Travis wetland provides a reasonable insight into the potential diversity of this habitat and the upcoming report of the wetland and small slow waterways of Styx Mill reserve can be even more directly compared with the study of south west Christchurch, because yellow pan traps were used extensively in both surveys.

Freshwater insects

The freshwater invertebrates of the four Christchurch rivers was surveyed in the early 1980's with little interpretative commentary (Robb 1980, 1980, 1989). At least 77 insect species (5.5% of the national fauna) were found mainly by in stream studies to inhabit the Styx, Avon, Heathcote and upper Halswell rivers and their lowland tributaries and about half the species favour running water. Most of this diversity is in caddisflies (Trichoptera) 30 species in 8 families, flies (Diptera) with 20-26 species in 11 families and beetles (Coleoptera) at least 14 species in 3 families. The remaining species are water bugs (Hemiptera- Heteroptera) with at least 6 species in 4 families, mayflies (Ephemeroptera) with 3 species in 2 families and damselflies (Odonata) with 2 species in two families. From scanning the tables it was apparent that diversity varied within the river systems and the overall trend for diversity of freshwater insects to be about halved was confirmed in both a summary of the south west Christchurch waterways (Macfarlane 2004a) and also of the Styx river (Taylor *et al.* 2000, Macfarlane 2004b). Suren (1993) compared urban and rural waterways from seven lowland Canterbury waterways. This survey in February 1993 included 5 sites on the Heathcote river catchment, two sites on the Halswell river and 16 other sites as far north as Rangiora. His survey pointed to the build up of filamentous algae in the urban waterways since the 1980's, but even in 1993 there were still mayflies of *Deleatidium* in the Heathcote catchment. Empididae larvae and pupae were present in both the Avon and Heathcote waterways only and Psychodidae were collected in the Avon. He listed 12 insect taxa found only in the rural waterways including the mayfly *Coloburiscus humeralis*, the crane fly *Paralimnophora skusei* and 14 caddisfly species compared to 6 in the urban waterways. Both the algal piercing *Oxyethira albiceps* and Hydrobiosidae were present in Nottingham creek. He noted the caddisflies *Pyncocentria evecta* and *Aoteapsyche colonica* were characteristically rural, but he did not provide details on species distribution in the rural waterways of the Halswell, Waimakariri, Styx, Kaiapoi, Ohoka or Cam rivers.

The aquatic insect fauna of New Zealand has at least 1,400 species, which accounts for 7-10 % of the insect diversity in New Zealand. Species diversity is dominated by many of the more primitive Diptera families (i.e. Chironomidae, many Empididae, Culicidae, Simuliidae, many Ephydriidae, Sciomyzidae, Blepharoceridae, Muscidae (Macfarlane & Andrew 2001), caddisflies and beetles. However, stoneflies in more pristine faster running water and mayflies in most stony running waterways are important ecologically (Wise 1973, Winterbourn *et al.* 2000).

A check of the river sites sampled by Robb (1980, 1981, 1989) showed that zones existed (Macfarlane 2004a). Water flow in the upper catchment was vital to insects with 3-5 times more species per site. Here oxygen, stone bases and other conditions including a relatively fast current are at their best. Such sections allow water to absorb and retain oxygen, which is important for running water insects that suffocate with lower oxygen levels. Shady and colder water slows down growth of the immatures. These then are likely to be the premier areas for freshwater insect and crayfish diversity. Consequently, much of the survey focused on understanding habitat variation within this area of the waterways and in assessing threats of habitat loss and degradation.

A survey in 1997/1998 of Travis wetland invertebrates incidentally considered freshwater insects. There was a notable for the lack of caddisflies and limited numbers of mosquitoes there. At least 4 midge species and one biting midge species were collected, but only identified to subfamily. Since then, the water level has been raised to make a large pond suitable for water birdlife, which may not have affected the freshwater insects. However, this flooding obliterated the studied area of partly bare *Cotula* vegetation and may have adversely affected the flow of the ditches.

An investigation of the insects other than moths has been made of the Styx Mill reserve focusing on the waterways and wetlands. This survey demonstrated that small muddy based waterways can harbour impressive diversity of shore fly species and regionally uncommon caddisfly species. A somewhat better diversity and frequency of dance flies was found in the three types of low flow waterways at Styx Mill reserve compared to the south west Christchurch waterways survey. Three *Hilarempsis* and a *Hilara* species were collected from wild parsnip flowers in the vicinity of a stony creek (Macfarlane 2004b). In addition, associated vegetation (plant species unknown) at Styx Mill reserve supported a very poorly documented herbivorous shore fly *Hydrellia acutipennis*.

In terms of habitat open unshaded water favours *Deleatidium* and *Coloburiscus* mayflies, *Aoteapsyche*, *Olinga*, *Hydrobiosis*, Leptoceridae caddisflies (Lester *et al.* 1994). Most of these aquatic insects prefer open (unshaded) water. Conversely, sand flies *Austrosimulium*, *Pyncocentria* caddisflies and freshwater crayfish *Paranophrops* favour shaded sites. However, the influence of shade on mud and wetland fringe insects was unknown

(Macfarlane 2004a), but the black colouring of most *Millerina* species (Muscidae) suggests they may need to be dark to absorb radiant energy so they are ready to seize prey for as much of their lives as possible. Conversely, the *Limnohelina* species and the introduced *Hydrophorus praecox* (Dolichopodidae) are mainly grey, so for them cryptic colouring to reduce the chance of predation could be more important. Consequently, in my 2004 survey, I attempted to clarify this habitat influence as much as possible.

Mud fringe, wetland and ditch invertebrates

Generally, little has been published in New Zealand about what could be a quite extensive fly fauna associated with the mud/silt shores along waterways and any mini-wetlands there. Also before the survey of Travis wetland (Macfarlane *et al.* 1998), there was a lack of a reasonably comprehensive insect community study of boggy wetland insects apart from moths of Otago and Southland wetlands and a survey of flies in a flax wetland in Northland (Cumber & Harrison 1959).

A collection was made of representative ditch, mud flat and bog inhabiting species from Travis wetland (Macfarlane *et al.* 1998). The dance fly *Hilara fossalis* species group was quite common in open, slow flowing and low flow drains, but was not found in the survey of Styx mill wetlands, creeklets and streams. On partially vegetated silt flats with *Cotula* in Travis wetland, there was *Limnohelina spinipes** (Muscidae) as well as the predatory shore bugs *Saldula* (Saldidae) as characteristic insects not found elsewhere in the park apart from about three species of abundant *Scatella* (Ephydriidae) and quite common *Millerina aucklandica* (Muscidae). * This *Limnohelina* species was identified as *L. smithii* (Macfarlane *et al.* 1998), but Harrison after further study has now placed several described species as synonyms. These invertebrates were collected in water traps, light and malaise traps and by sweeping at Travis wetland, but not pan traps. Consequently it is not possible to assume some of the less usual mud/silt or bog fringe insects have retained as much favourable habitat there as was the case during the survey. The boggy rush land stronghold for the wingless crane fly *Gynoplistia pedestris* (Tipulidae) has been retained, but whether the raised water level affects its well being remains to be determined.

METHODS

Waterway habitats

For the 2004 survey, sites were chosen for three zones of freshwater habitat: - slow flowing but highest flow water (Zone 3), fastest flowing water but moderate flow (Zone 2) (Fig 1). In addition, a comparison was made between still waters with of two ecological types. Curtlett's lake (site 16) has year round flowing water, while Halswell Quarry is a pond ecologically. This pond was full in mid October 2004, but had dried up and had an upper shore with sparse vegetation dominated by *Cotula*. By March there was about a 1m wide silt/mud fringe, where the pan traps were placed. For each stream with running water, 5 sites per stream were surveyed where possible. As many sites of Cashmere stream and the Halswell catchment were chosen in common with the within stream invertebrate survey of McMurtrie & Taylor (2004). Three sites in common were sampled in the Halswell river catchment (M 11, 12, 18) and four sites on Cashmere stream (M2, 4, 22, 27; Table 1). The number for these site is given as M on the Halswell river sites 7, 11, 18 24, 35 and NC 18 of Robb (1981) were sampled again. Likewise streamside sites sampled in my 2004 survey corresponded to sites 34 39 42 (Cashmere) and 53 83 84 86 (Heathcote) of Robb (1980).

Figure 1 Upper Heathcote river and Cashmere stream sites and freshwater zones

The lower two Halswell river sites represent slow flowing water (Zone 3). Cashmere stream up to 428 Cashmere road and Halswell stream up to Whincops road represent the fastest flowing water (Zone 2, Fig 2). Nottingham creek and the upper Halswell creek represent low flow running water. The Heathcote river survey included only still pools, which were all upstream from the within stream 2004 survey of McMurtrie & Taylor (2004). In summer, the Heathcote and Hoon hay valley sites were all linked to still water with a stony bed and little muddy fringe (site 12, Heathcote river at Curletts reserve) and (site 13, Templeton road downstream site) or with a silty/gravelly bed (Site 11 below Hoon Hay Valley bridge). Two sites were on ephemeral waterways notably the upstream site 14 at Templeton road, which was a mere 15m from site 13 below the bridge. Site 14 had a relatively extensive muddy fringe and the gravel bed was dry, but still moist enough for an eel to wriggle up from the last large still pool in the Heathcote river catchment. The last large pool extended around the major bend in the river by Aidenfield. I did not check for further upstream pools, but there were no pools for at least 40m downstream from the Wigram road site 15. This site had a narrow, shallow mud ditch surrounded by semi-sparse grass. This Wigram road site was lightly shaded by willow trees and horses grazed the paddock periodically. I collected characteristic introduced dung (*Hybopygia varia*) and blood feeding flies *Stomyxs calcitrans*- stable fly even the horses were elsewhere during the sampling. This site had the highest numbers of the South America *H. varia* (Sarcophagidae) and the only stable flies detected in the survey. This provided confidence of the effectiveness of the pan traps in discriminating the ecology of the land surrounding the waterways.

Figure 2 Upper Halswell river and Knight stream sites and freshwater zones

There were extremes in the degree of shading and availability of nearby woodland with its associated leaf litter from deciduous trees (in bold, Table 1). Two sites were in thick willow (Site 12, Heathcote river, Curtletts reserve) woodland or introduced garden woodland (site 4 Whincops road) (see bold in Table 1). Conversely, the nearby Curtletts lake site was fully open to the sun except for a little shade to one pan from a rush. The Halswell quarry was similarly open except for early morning and afternoon shading by the long vegetation at site. Three open sites were subject to shading for part of the day, because the site Sutherlands road was in a quite deep ditch and bridges and high banks would shade both the Saby road and Hoon Hay sites for part of the day. Trees to the southwest would shade from the bridges just the Esplanade site in the late afternoon as would trees at Templeton road and for some of the traps at Henderson road.

Table 1 Location and ecological differences of the sample sites

* = concurrent freshwater survey

Halswell river catchment									
Site no	River/stream *	Road	Longitude S	Latitude E	Height in m	Flow	Bed	openness-closed canopy	
1- M18	Halswell River*	Leadleys	43 36.5	172 33.5	11	Largest, slow	Mud	slight shade	
2	Knights stream	Saby	43 36.1	172 33	12	Large, slow	Muddy	shade from bridge	
3	Knights stream	Trices	43 35.3	172 33	14	Moderate, moderate	Silt	part shade	
4	Knights stream	Whincops	43 35.2	172 32.5	16	Smallish, moderate	Silt	full shade	
5 -M12	Knights stream*	Upper site	43 35	172 3	17	Small, moderate	stony, silt sides	part shade	
6- M11	Nottingham*	Glovers	43 35.5	172.34	12	Small, slow	Silt	part shade	
Heathcote river catchment									
Site no	River/stream *	Road	Longitude S	Latitude E	Height in m	Flow	Bed	Degree of shading	
7-M22	Cashmere stream*	Esplanade reserve	43 35.6	172 36.5	5.5	large, mod.-fast	Gravel/silt	some shade	
8-M4	Cashmere stream*	Cashmere road bridge	43 35.7	172 36.1	6	large, fastest	Stony	part shade	
9 -M27	Cashmere stream*	408 & 428 Cashmere	43 35.8	172 36	7	large, mod.-fast	Stony	mainly open	
10- M2	Cashmere stream*	Sutherlands road	44 33.5	172 34.6	12	moderate, mod	Stony	open, deep ditch	
11	Hoon Hay valley creek	below Hoon Hay bridge	43 36	172 35.9	8	None	Gravel/silt	part shade	
Heathcote river									
Site no	River/stream	Road	Longitude S	Latitude E	Height in m	Flow	Bed	Degree of shading	
12	Curtletts reserve	Pool by track	43 33.4	172 35	16.5	None	Gravel	Full shade	

13	Templeton road	below bridge	43 33.5	172 34	17	None	Gravel	mainly shaded
14	Templeton road	above bridge	43 33.5	172 34.7	17	None	Gravel,	open,part shade
15	Wigram road	above the road	43 35.5	172 33.3	19	Dry mud/grass	firm mud	Light shade

Lake and pond sites and wetlands

Site no	River/stream	Road	Longi-tude S	Lati-tude E	Height in m	Flow	Bed	
16	Curtletts reserve	Lake	43 33.3	172 34.9	17	None	Stony	Fully open
17	Halswell quarry	Pond	43 36.1	172 34.6	18	None	Silty	Fully open
18	Halswell quarry	edge vegetation	43 36.1	172 34.6	18	Dry - <i>Cotula</i> /silt	Sparse plants	Fully open
19	Halswell quarry	dry gully	43 36.1	172 34.6	18.5	Dry- long grass/rushes	Full Vegetation	Slightly shaded from rushes,long grass

The greatest extent of muddy fringes were at the Halswell Quarry and Curtletts lake, but during the seasonally low flows there were quite extensive areas of watery mud along the Saby road site and the upper Templeton road site. Conversely the next sites below them at Templeton road were fully gravelly and the Leadleys road site was virtually fully covered with matted vegetation including waterweed.

This allowed for comparisons where there was the least difference in the speed of the current - if any and the amount of watery mud available and also in the amount of shading from Curtletts reserve to the only partly shaded upstream site at the end of Templeton road. Both sites above and below the Whincops road site were partly shaded. This proved to be important in understanding the relative abundance of much of the suite of mud fringe preferring Diptera species.

The Cashmere stream banks had little or no mud by the banks, which had gravel or vertical dried clay along them. All species of the endemic Muscidae along waterways, the long legged flies Dolichopodidae (except for *Parentia*), the dance flies (Empididae), the shore flies (Ephydriidae), the lesser dung flies (Sphaeroceridae), moth flies (Psychodidae) were described in the 1920's through to 1959 (Harrison 1959, Macfarlane & Andrew 2001). Often they were described from just a few locations with no information on the habitat they were collected from, but these families are known from European and American studies to have species that favour wetland or have some species, which are recorded as aquatic species. Indeed, the larvae of Muscidae and Ephydriidae are very similar in overall appearance and shape. Neither group has been recorded very often from within stream freshwater surveys (Winterbourn *et al.* 2000), possibly because the fringes of these waterways carry little current for the larvae to be collected in the net. Consequently, it was rather unusual that McMurtrie & Taylor (2004) recorded Muscidae larvae so frequently in their survey and Suren (1993) recorded them from the Avon, Heathcote and rural catchments.

Ecologically the Halswell quarry "lake" is a pond, because it only has running water for less than 6 months each year. The variable Haytons drain runs into the Curtletts reserve lake. I used a light trap just downstream from Wigram road, where this drain is heavily contaminated with silt. A light trap gathered no insects.

The sample sites also included considerable differences in the amount of muddy to silty fringes. The wet fringes at most sites ranged from 0.2 -0.4m, but on a few sites they were more extensive at about 0.5 to almost 1m wide (Templeton upstream site, Halswell Quarry pond). Conversely, modified banks along the suburban stretch of the lower Cashmere stream, the Heathcote river- Curtletts reserve with near vertical clay banks, clay infused stony edges and concrete paths eliminated or very greatly restricted this fringe mud habitat. Also introduced vegetation to the waters at Leadleys road eliminated this habitat there too as did the shingle almost did at the lower Templeton road site.

Sampling methods

Yellow pan traps were used for the first known survey of waterway insects in New Zealand. They trap insects active close to water, while Malaise traps gather more actively flying insects. In addition, pan traps are proven to reveal certain waterway fringe species (e.g. long legged flies, Dolichopodidae) relatively well (Bickel 1999).

The pan traps were run at five to six sites concurrently to minimize the effects of weather and to keep costs of sampling to a reasonable level. The traps were left in operation for 20-30 hours. Generally the weather was fine and suited activity, but when the upper site at Knights creek was sampled there was light rain overnight. Pan tapping commenced on February 12th and was largely completed by February 26th, at a time in the season when many

insects are still pretty active. I resurveyed with pan traps at Whincops road due to heavy leaf fall contamination in the first sample. I resurveyed the two Templeton road sites on March 24th to clarify the comparison between the two different habitats. Similarly at Halswell quarry pond I placed pan traps next to the waterline and then another set among long grass in some cases by rushes in the shallow gully by the car park. These pan traps were about 40 m apart. Finally, the fifth set of pan traps was placed by the still clear pond of Heathcote river in Curtletts reserve, (site 12), because the previous combined light and pan traps had gathered a fairly modest amount of specimens. The catch at from the February and March sampling at site 12 have been combined. An upper shoreline sampling of the Halswell quarry pond and vegetation was also combined. A set of 6 traps was placed just 1-2 m within low growing vegetation and 6 more traps about 0.5-1m from the edge of this vegetation in the sparse *Cotula* dominated foreshore of the Halswell quarry, because superficially there was not a great difference in the trap results and I had a lot of tubes to sort and label. I regret I did not keep them separate, because for some of the species there was probably a difference even although the set of pan traps were only about 5 to 15 m apart.

Pan traps were placed by the stream side whenever possible, or at least within .05m of running freshwater and the stagnant pools at one site on Cashmere stream and at the Halswell quarry. The pan traps were left to trap insects for 20-30 hours. Six pan traps were set up per site, except for the downstream Templeton road site, where the two pools were under closed canopy, which were allocated 3 extra traps and the six in the open. Strong winds spilt one trap in the uppermost site with running water on the Halswell creek, at Trices road and the lowest site on the Halswell river.

The pan traps gathered so much material and distinguished habitat considerably better than expected. Consequently, plans to sweep wetland vegetation and springs were abandoned. Also the survey would have needed to begun in mid spring (October/November) to monitor cabbage tree, kanuka and other native flowers for wetland flies such as Tabanidae and Stratiomyidae. These trees are present in Curtletts reserve.

Ultra violet light trapping was conducted at 14 sites on two nights. Each trap was run for 1-1.5 hours at the beginning of the evening except for the uppermost site on the Halswell creek, which was run all night because the catch was low. The first night (23 February) was a warm northwester, which favoured catches and Cashmere stream and the upper Heathcote in Curtletts reserve and Templeton road were sampled. The second night was favourably dark and was initially a mild night, which got cool by midnight. The upper Cashmere stream site in Westmorland and all but the lowest Halswell river sites were sampled as well as Haytons drain by Wigram road. The Cashmere stream catch was reasonable. Conversely, both the Wigram road and Nottingham creek samples gathered no insects.

RESULTS AND COMMENTS

WATERWAY INSECTS

The survey revealed an estimated 212-251 insect species, from 788 discrete sorted samples and 7357 specimens. This did not include about 10 -15 species on moths collected primarily in the light trapping, which were discarded. The considerable number of species, which were not readily identified, meant that initially for each location many of the species or species groups had to be sorted, labeled and put into tubes and then placed in discrete locations. Then these records were compiled and entered on the spreadsheet, key families were then sorted even further to species. In several families (notably Muscidae, Chironomidae, Sphaeroceridae) keys needed to be made to distinguish the species. Unless references specimens are kept and sorted into their families and then curated it is impossible to accurately compare results between surveys such as from the Styx Mill reserve and Travis wetland.

At least 36 insect species were identified from running waterways (Table 2) and 8 species from still to slowly running waterways. In all, 95% of these species were endemic to New Zealand.

There were 12 species of midge (Chironomidae) in sites with running water throughout the season. Light traps. Male midges came more readily to light trapping than to pan traps. This diversity exceeds somewhat that found in Waikato farmland and the upper part of the Tongariro river, but well below the diversity on the west Coast (Collier 1993). There were 11 species of Orthocladinae and McMurtrie & Taylor (2004) recorded four genera of Orthocladinae, *C. zelandicus*, *Polypedilium* and the tribe Tanytarsini (Chironominae) and the tribe Macropelopiini. These identifications have not been verified by Ian Boothroyd, who is developing a key to immature Chironomidae

in association with NIWA on a contract. Previously within stream surveys could only identify specimens to the subfamily Orthocladinae.

Table 2 Southwest Christchurch waterways survey: freshwater to wetland species (SPREADSHEET)

For Orthocladinae, there is one significant difference in the identifications with the smallest species in my survey being identified as the adventive *Corynoneura scutellata*. This species was not represented among the species identified in the Canterbury Museum by Freeman in the 1950's, but the wing venation is very distinct with the distinct pale brown frontal vein and lack of obvious veins behind the leading edge of the wing. Only females were collected and it clearly favoured waterways with slow but assured moderate to larger flows. The four sites on the faster flowing Cashmere stream averaged 5.25 (range 0-9) specimens compared to 66 (range 10 & 122) for the slow flowing Saby road bend and Leadleys road sites. The two lowest flow Nottingham stream and upper Knights stream sites averaged 1 specimen (range 0 & 2). The failure to record this species previously from around Christchurch suggests that perhaps the larvae are concentrated towards the upper banks of the waterways, where within stream surveying has less current to carry specimens into the collecting net. The pinned collection in the Canterbury Museum is small so it is difficult to know if it was not present then or just not collected from Christchurch. This may be resolved, when the much larger collection in the Canterbury Museum of Chironomidae in alcohol is checked and at least partly identified.

Pan traps at low flow sites at the upper Knights stream and Nottingham creek detected 2 and 1 Orthocladinae species respectively compared to 0 and 1 with in stream sampling (McMurtrie & Taylor 2004). For the more species rich Cashmere stream sites the side of stream sampling revealed 5 Orthocladinae species, 1 or 2 specimens of *Polypedium parvum* (Chironomini) at 50% of the sites and *Gressittus antarticus* (Macropelopini) in 75% of the sites. This was similar to the 33% and 67% for within freshwater sampling between Sutherlands road and the Esplanade reserve. Thus both surveys agreed on the relative frequency of these less common species. Two further species of quite distinct Chironomini were also present in the waterways with consistent running water.

Orthocladini species 1 and species 2 were both most consistently recorded (90 & 80 % respectively) and numerous species after *C. scutellata* in waterways, which retained running water in the summer. They are larger so in terms of biomass they will be more important than *C. scutellata*. Orthocladini species 1 (may be *Cricotopus* sp) clearly has the ability to survive in pools as it was present in both still fully shaded to partly shaded sites on the Heathcote river and also to my surprise at the dry site (moist mud only) just above Wigram road. The presence of 31 specimens at the Wigram road site suggests it might survive in mud and adults emerge in the autumn in time to seek suitable pools. Already by October 2004, this stream bed had dried up again and it was apparently only flowing for 2-4 months this season (Kelvin McMillan pers. com.). Some pollutant clearly affects Orthocladini species 1, because it was not detected in either the Haytons drain site or in Nottingham stream. I suspect it could be a *Cricotopus* sp, because McMurtrie & Taylor (2004) found this in the headwaters of the Cashmere stream more than the other genera. Orthocladini species 2, was also present in still but shaded to partly shaded sites in the Heathcote river, but was not detected in the open Curtletts lake or Halswell quarry pond or the upper pool site at Templeton road, which was also more open and did not have water flowing from it during the lowest flow period in the late summer. It might be a bit more tolerant to pollution, because it was present at Nottingham stream. Nottingham stream where McMurtrie & Taylor (2004) found Nottingham stream was devoid of Chironomidae, so both surveys indicate that even the more tolerant Orthocladinae could show symptoms of pollution. Orthocladini species 5 and 6 and the apparent Orthocladini species 7-9 were only found in 10-20% of the sites with running water and presumably include *Eukiefferiella*, *Naonella* and *Paratrichocladius* species recorded by the within stream survey.

Four species of midges (Chironomidae) apparently prefer sites with still water. *Chironomus zelandicus* is well known as a major midge in still ponds and slow flowing water (Winterbourn *et al.* 2000). It was the dominant species in these sites, but it can tolerate the moderate flow of Cashmere stream. It is also tolerant to shaded sites being found at both the still clear pools in Heathcote river at Curtletts reserve and at Knights stream by Winchops road, but it does not seem to tolerate low flow and ephemeral waterways a well being absent at Templeton road, the

upper site at Knights stream and Nottingham creek. However, it was detected in Nottingham creek by the within stream survey. Orthocladini species 3, 4 and *Paratrichocladus pluriserialis* (sp.10) have an interesting distribution in these waterways. They are scarce or absent in the faster and fuller flowing waterways of Cashmere stream and the lower Halswell and Knights stream, and are most abundant in the still pools of the Heathcote river and Halswell quarry. McMurtrie & Taylor (2004) did not sample these types of sites, so they could well represent additional species to those found by this within stream survey. Some caution on species diversity is needed for these taxa, because of the difficulty of associating male and female sexes. Boothroyd has identified some species, but the species represented by females are difficult for him to identify too.

Caddisflies are probably the next most important freshwater insect group both in terms of abundance, but also in terms of species diversity. They were confined to the sites with consistent connection to running water except for the small blackish *Oxythera albiceps* (Hydroptilidae). None were found in the open pools of Halswell quarry or Curtletts reserve lake. Ten species were found in the waterways with larger to moderate flows. Only *Paraoxythera hendersoni* and *Polytrectodes pueralis* extended to the still pools of the Heathcote river and the Hoon hay valley creek. A further four species of Leptoceridae were found in these same still pools, but not in the ephemeral waterways of the upper Heathcote at Templeton road or the low flow, silty bedded Nottingham creek and creeklet site at upper Knights stream. Species not identifiable by the within stream survey were: - *Hydrobiosis frater*, *Triplectides cephalatus* and both *Psilochorema* and *Pycnocentrodes* were represented by two species. In addition, *Aoteapsyche cathrinae* was recorded from Cashmere stream, and this is a less common species within *Aoteapsyche*, which has a moderate MCI 4 rating (Winterbourn *et al.* 2000). However, the side of stream survey failed to detect *Hudsonema alienum*. The absence of *Triplectides* spp. (MCI index 5), and especially *Pycnocentria evecta* (MCI index 7) and the two *Psilochorema* (MCI index 5) from all of the Halswell catchment except for the Leadleys road site indicate that these upper waterways are now unfavourable to unsuitable for these species, which were only present in the Cashmere stream with its moderate to fast current and stony bed. Suren (1993) did not collect *P. evecta* from 4 sites which apparently include 2 upper Cashmere stream sites. These species probably extended to the smaller flowing remnant of the stream to Sutherland road, but a light trap was not operated here. However, this part of Cashmere stream had 4-5 caddisfly taxa per site in the within stream survey, so the two survey methods verify the greater suitability of this stretch of water way for caddisflies. Generally, the light traps backed by the skill in identification of the adults by John Ward were able to reveal the true caddisfly species diversity in these waterways. The record of *Aoteapsyche cathrinae* was a new record for the freshwater streams (Appendix 2). A further 7 species of caddisfly have been recorded from the south western Christchurch waterways, but were not recorded in either survey for 2004 (Appendix 2).

Both surveys also show that mayflies are absent from these waterways except for a within stream site from the upper Halswell not included in my survey. The loss of the mayflies and reasonably limited diversity and frequency of midge species in sites with consistent flowing water are consistent with the observation of several residents that there are now far fewer fish than there used to be 25 or more years ago. There has clearly been a major loss of food for freshwater fish since the survey studies by Robb and Suren up to 1993. This may be impossible to rectify as long as chemical pollutants affect these waterways even if they retain the appropriate gravel/stony beds and consistent moderate stream flows.

Crane flies (Tipulidae) were the next most consistent freshwater group found in my survey. Two species are apparently involved. The second small less marked species, which I have provisionally attributed to *Erioptera* may prefer boggy wetland based on the survey of Styx mill reserve. So far many of the Tipulidae (Table 5) have not been identified by a competent authority (Peter Johns). However, it is clear from his identifications that *Paralimnophora skusei*, which incidentally has a MCI index of 6 is commoner in these waterways than both within stream surveys (Suren 1993, McMurtrie & Taylor 2004) indicate. Perhaps it is more frequently found towards the side banks of the waterways.

Both surveys confirmed that *Nothodixa* (Dixidae) is infrequently found in low numbers in Cashmere stream and my survey confirmed the more oxygen demanding black or sandflies *Austrosimulium* are still present infrequently in the faster flowing parts of Halswell river. Both the 1993 and 2004 within water surveys proved to be better at detecting the modest fauna of beetles. In a tenure survey which included the stony based Omarama stream I also found *Hydora* (Elmidae) species on nearby *Olearia* flowers. Thus checking of native flowers may be an

alternative way to detecting *Hydora* and it should make identification of the limited species involved more precise. Checking flowers of cabbage trees, kanuka, lacebarks *Hoheria* and *Olearia* by stream sides should also in the future resolve what species of Statiomyidae (*Odontomyia*) and Tabanidae are still retained in waterways around and within Christchurch. Clearly pan traps are also not very suitable for collecting aquatic beetles from still waterways, because four species have been recorded in previous sampling (Appendix 2).

This beside stream survey detected three species of Ceratopogonidae, known elsewhere in the world as biting midges. Two of the three genera identified are known elsewhere in the world have at least some freshwater inhabiting species (Usinger 1968, Williams & Feltmate 1992). Only low numbers were involved, but the incidence for all Ceratopogonidae 41 % of sites in this survey was over 2 times that of the within stream sampling from the most favourable Styx river in the 1980's (Table 3). The two small species of *Dasyhelea* were found in 25% of the sites. Both *Dasyhelea* species and the considerably larger *Palpomyia* species # were found at open sites with still freshwater, but the *Palpomyia* could also apparently extend to sites with running freshwater. The *Dasyhelea* ?*egraria* at Saby road had still muddy shallow water at the side of the waterway available, but *Dasyhelea* new species had little such still water at Nottingham creek. The specimens attributed to *Dasyhelea* ?*egraria* key to this species. However, the whole of the revision of New Zealand Ceratopogonidae between 1928 and 1931 is based on only around 300 specimens, so further undescribed species may well be involved. No Ceratopogonidae were found in the in stream survey, which infers that these species may be largely found in the wetter banks of the waterways, where there is no current to carry immatures into freshwater sampling nets.

The presence of the dance fly *Ceratomerus crassinervis* (Empididae) at the Trices road site was interesting. This species was described from Christchurch and was found somewhat more abundantly at some of the sites with low flow, silty drains in the Styx Mill reserve. The species is only known from five sites from NW Nelson, Buller and Lake Moana and the three sites lowland sites in Canterbury (Styx Mill, Horseshoe lake and this site) and is active from at least 23 November to 23 March. Once the habitat is known better, then finding the actual distribution of this species may be considerably less exceptional. However, I suspect it will prove to be less readily found than the freshwater crayfish. This was probably the second most useful species find other than that of find of *Gynoplistia pedestris*. Both the Styx Mill reserve especially and the Travis wetland had considerably better diversity of Empididae species.

It was not surprising to find *Neolimnia sigma* (Sciomyzidae), because this is one of the commonest species in the family. All species in the family are snail and mollusc parasites.

The evenly greyish native mosquito (Culicidae). I attributed this to be the vigilant mosquito *Culex pervigilans*, which is the only species found in previous surveys. It is certainly not *Aedes notoscriptus*. This species was found much more consistently in average 75 % of the freshwater sites in my survey and only 4 % of the within stream survey. It breeds prolifically in any still water and feeds at night (Scott 1984). Pan traps were low enough to the watery margin to pick up its larvae at site 14 at Templeton road along with small Ephydriidae/Muscidae larvae. Immature flies of two other types were also detected at 2 other sites, but have not been identified, partly because one is a pupae.

Finally, the shiny grey long legged fly *Hydrophorus praecox* (Dolichopodidae) was assigned as an aquatic species. The actual habitat, which this European species uses (Smith 1989), has not been recorded, but another *Hydrophorus* species has been breed from the tidal zone in Europe. Although it was present at Winchops road within closed canopy, the highest numbers were found where watery muddy shorelines were present notably at Halswell quarry, but also at Saby road. No Dolichopodidae has been recorded from freshwater habitats for certain in New Zealand (Winterbourn *et al.* 2000), but considerable numbers of an undetermined Dolichopodidae larvae were found in estuarine shore of Brooklyn lagoon (Knox & Bolton 1978). This species is associated with silty and gravelly shores along rivers with specimens collected from Coes ford (LCNZ) and on weed along the ponds shore in Styx Mill reserve and the fringe of the concrete ford especially. Thus its association with freshwater, which is inferred from its genus name is warranted, even if the larvae are eventually found to breed more in firm silty mud than on the sides of slow flowing fresh waterways.

Predatory freshwater insects

Invertebrate feeding tactics in freshwater can be divided into four categories. Browsers or grazers are most prevalent, a minority of caddisfly genera *Olinga*, *Triplectides* are shredders, and the mayflies *Coloburiscus*, the caddisflies *Aoteapsyche* and sand flies are filter feeders (Lester *et al.* 1994). Damselflies *X. zealandicus*, *Lestes colensis*, most Muscidae, perhaps the biting midges Ceratopogonidae, apparently the midge subfamily Tanypodinae and Hydrobiosidae caddisflies are all predatory at least as larvae. Damselflies and most Muscidae adults are also predatory. Both the 2004 within stream freshwater survey and my survey recorded the common red damselfly more readily than in the surveys of Robb (Table 3).

Table 3 Incidence of less common predators in 1979 -1980 survey

Species	Common name	% of river sites with		
		Avon	Heathcote	Styx
<i>Xanthocnemis zealandica</i>	Red damselfly	2.2	2.5	20.5
<i>Austrolestes colensis</i>	Blue damselfly	0	0	7
Ceratopogonidae	Biting midges	0.6	3	15

Waterway shore and wetland species

The pan traps collected about 26-29 species of the mud shore fringe to wetland fly species.

The basic species in the apparent food chain were the small dark *Scatella* species of the shore fly family (*Ephydriidae*). In addition to the readily recognised *Scatella nebeculosa* there was apparently a minority of *Scatella nitidithorax* with its slightly undulating veined wings. Most of the undetermined *Scatella* are thought to be *Scatella nelsoni* and *S. nitidifrons*, which are not readily distinguished in alcohol especially without a microscope that can measure relative eye and cheek depth (Harrison 1959, Mathis & Macfarlane unpublished). These species were abundant in the soupy/slushy mud at the side of the slow flowing waterways at Travis wetland (Macfarlane *et al.* 1998). In this survey *Scatella* flies were most abundant along the shores of ponds and lakes with silt or muddy fringes. Three waterway sites averaged 108 (range 82-126) specimens of *Scatella* species and in addition the larger *Ephydrella* sp was present at the Sabys road site. Conversely, on average of 1.83 (range 0-6) were found along Cashmere stream and Halswell river with little peripheral mud. The Templeton road sites with their contrasting catches of *Scatella* (Table 2) were within 15m of each other. Four other sites averaged 3 (range 0-6) *Scatella*. These sites had either little mud or for Nottingham stream and the Hoon hay valley site were under closed canopy in the low to still water sites on the Heathcote river.

At least four species of lesser dung flies (*Sphaeroceridae*) were collected from the margins of the waterways. The main *Phthitia lobocercus*, appears to favour wetland or perhaps moist decaying vegetation with the highest numbers at Curtletts reserve lake and the adjacent river pond site, but bare silt the waters edge at Halswell quarry had but one specimen. The habitat for *P. lobocercus* was not apparent from the 1992 study that included its description. Conversely, the species I have provisionally attributed to ?*Spelobia* undetermined average 24 specimens by the shore of the pond and lake studied, and was not present in the three dry vegetated sites of Wigram road and Halswell quarry lake or the sites with closed canopy or the firm bank sides of Cashmere stream. Finally, *Phthitia "thomasi"*, which could also include some *P. nothomasi* was often found in sites where some trees were also present and was absent from the muddy edges of both Halswell quarry pond, Curtletts reserve lake and Saby road. Provisionally, this species group should perhaps be allocated to the forest/grassland litter habitat. This species group is among the commonest species of *Sphaeroceridae* in New Zealand.

The smaller grey *Limnohelina spinipes* (*Muscidae*) with grey and white spotted wings and incomplete stripes along the top of the thorax, were most apparent along the shore of the Halswell Quarry pond. In October, they had been forced to use the semi-open grass vegetation above the shore line, when the pond was full. Here I saw them pouncing at *Scatella* species, presumably in an attempt to prey on them.

All *Millerina* species (*Muscidae*) except for species 2 were absent from the two sites (4, 12) with closed canopy. Seven sites with full or partial vegetation (sites 17 & 18), minimal deep mud (sites 5 & 15) and along Cashmere stream (sites 7-10) averaged 2 (range 0-7) *Millerina* specimens per site. Conversely # *Millerina* species were collected at four sites (2, 14, 16, 17) with still muddy water on their shores. At these four sites *Scatella* averaged 35 flies (range 11-94) per site. There were apparently 10 species of the larger *Millerina* species. *Millerina* species 1 had a distinctive grey spotted pattern on the abdomen and two dark spots on the cross veins of the wings. *Millerina* species 2-9 had clear wings, some were grey with yellowy legs, others were blackish and had red brown tibiae. *Millerina* species 3 had completely black legs and could well be *M. aucklandica*. Numbers varied considerably between sites, but it was collected at 54% of the sites in this survey. At Styx mill reserve it was very common along the fringes of the pool and it was also the main *Millerina* species recorded from Travis wetland. *Millerina* species 4 with red brown tibia with the tip of the femur the same colour and black palps, could well be the widespread *Millerina melas*. This species was found at 46% of the sites and the small grey yellow legged species 2 was found at 30.7% of the sites.

Eight general surveys have been made of pasture and tussock grassland (Macfarlane & Andrew 2001, Bowie *et al.* 2004). *Muscidae* were not prominent in any of these surveys, nor were they prominent in an unpublished MAF survey I helped identify of subtropical orchards. Three further national surveys of stone fruit, grapes and citrus have also been reported on (Macfarlane & Andrew 2001). The insect community complex from crops of beans, fodder crops, lucerne and cereals have all been surveyed and flies were included. Therefore it is possible with some confidence to conclude that the *Muscidae* are concentrated along waterways, wetlands and in alpine habitats. This

provides further more extensive evidence that few of the adults of many of the species regularly stray far from the shores of wetlands. Elsewhere in the world the larvae of this subfamily of Muscidae (Ceonosiinae) are all known to be predatory including on Simuliidae larvae in streams. The association with *Scatella* and one of the Sphaeroceridae species, which along with *Millerina* increase in average density provides circumstantial evidence that the larvae could well prey on larval *Scatella* and *Ephydrella*, while the adults may well include *Scatella* adults, and the smaller midges and biting midges among their prey. The presence of teeth within the central tip of their tongue shows their adults have evolved to prey on other insects. Finally, light trapping was completely ineffective in picking up Muscidae and virtually ineffective in collecting Ephydriidae. The presence of Muscidae more frequently in the concurrent within stream survey (McMurtrie & Taylor 2004) hints at the possible further penetration of Muscidae larvae into the soft sides of waterways below the water line to a greater extent than with *Scatella*. Thus the Muscidae larvae may reach other soft bodied prey such as midge larvae resting on the sides of the waterways.

Table 4 Incidence and overall abundance of key wetland to slow flowing waterways

	Flow of sites			Percentage of sites with key species by the three decreasing types of water flow			
	Largest, slow	Low, faster	Still waters/mud 3mud	Large	low	still	overall *
No of sites	8	6	2				
Key species	Average	per	site				
<i>Chironomus zelandicus</i>	12.9	14.3	4.5	87.5	33	100	68.8
<i>Culex pervigilans</i>	1.75	0.3	0.5	62.5	33	50	50
<i>Scatella</i> spp	32.9	34.8	650	75	67	100	76.5
Sphaeroceridae	4.4	6.2	79	75	67	100	76.5
<i>Millerina</i> species	4.6	9.3	37.7	75	100	100	88.2
<i>Hercostomus argentifacies</i>	6.6	12.2	0	62.5	67	0	52.9
<i>Tetrachaetus bipunctatus</i>	1.25	19.2	9	37.5	67	67	52.9
Habitat	Number of specimens			Total	No of insect species		
Freshwater	527	223	95	851	34	36	
Slow flowing water	311	123	120	559	8	8	
Mud and wetland	441	527	2380	3332	28	30	
TOTAL	1279	873	2595	4742	70	74	

*freshwater species excludes one site

I have often collected the spotted winged long legged fly (Dolichopodidae) *Tetrachaetus bipunctatus* in wet shores and by ditches, when I sample for shore and muscid flies. It was among the commonest and most regularly found species in this family in my survey. It was a pleasant surprise to collect a good series of specimens of both sexes of the distinctive *Hercostomus argentifacies* for which there are probably no published records since its description by Parent from a few locations in 1933. This dark species prefers sites with generally lower flows and 94% of the specimens were found at four sites (range 19-51 flies/site) with these features. The sites were also partly but not fully shaded. None were found at the pool and lake sides and the two sites on the Halswell river and Cashmere stream with the greatest flow of water. There are limited specimens of the distinctive *Helichochoetus discifer* in the Canterbury Museum collection, which infers it is either a less common species or it has some distinct habitat preferences. A few of the yellow and black *Sympycnus* were collected too. They were more abundant and frequently collected in wetlands and small drains in Travis wetland and Styx Mill reserve. At least two other species of smaller dark brown Dolichopodidae, which could be *Diaphorus* species were found quite consistently in the survey. The shiny green to blue green *Parentia*, were much less common than they have been in some terrestrial studies I have done, so they I excluded them from this section.

From a conservation perspective the most useful finds were of the large flightless crane fly (Tipulidae) *Gynoplistia pedestris* at both Sutherlands road and Sabys road. This species is only known from wetland sites from the Christchurch area to Waipara. Since it was first described in 1923 a considerable area of wetland in Christchurch and even towards Waipara has been drained for farmland or has become residential urban land. More rushy wetlands are under threat from the development of the Pegasus township. Therefore we can not be confident that this crane fly species still exists in some of the earlier sites, where it was previously collected. Since, I first collected specimens from a limited waterlogged part of Travis wetland I have also collected more specimens from the Styx mill reserve again from a wetland rather than a waterway. Consequently, it was gratifying that even small areas along waterways and south western sites for this species remain occupied by this distinctive species. These muddy parts of our local waterways clearly have the potential to provide linking corridors for the species, but alteration of many drains to have wooden sides and the firming and modification of banks such as along the Cashmere stream could already have lead to fragmentation of the populations, which must have limited mobility, because the only have short narrow wings, which will not allow for flight.

Herbivores and pollinators

The known plant hosts for the various herbivores are listed in Table 5. In addition to the 35 species listed, a further 1-2 more species of vinegar flies (Drosophilidae) could be one of two adventive leaf-mining *Scaptomya* species. A further 6-10 species of moths were collected as adults with the light traps including Noctuidae (*Agrotis ipsilon* -greasy cutworm), leaf roller moths (Tortricidae), Crambidae (grass snout moths). However, the surrounding vegetation was mainly of introduced plant species or the native species had been planted, so with a dearth of moth specialists in New Zealand this catch was of little interest to the three top specialists living beyond Canterbury or the two more competent entomologist in M.A.F., who could identify some of them.

Grassland: Several characteristic grass or pasture herbivore species were collected including the Australian *Cerodontha australis* (Agromyzidae) and *Hydriellia tritici* (Ephydriidae). The herbivorous gall midge species of the subfamily Cecidomyiinae could well be partly to mainly introduced grassland feeding species. The means to identify this group to even genus in New Zealand is quite inadequate. *Psilopa metallica* (Ephydriidae) was really only common at Saby road (30 specimens), where there was some lush growth associated with the muddy margin. Conversely no specimens were collected from sparse grassland and dry vegetation (sites 6, 11, 13, 15, 19) or at the two sites within closed canopy woodland. This reinforces consistent impressions based on my 1967 lucerne survey, other North Island insect community studies and the Styx Mill reserve survey, that *Psilopa metallica* prefer longer moist vegetation. Therefore it could be involved in litter decomposition as is *Scaptomyza fuscitarsis* rather than being a herbivore. Some if not most of the aphids were probably associated with the grasses and herbs of the grassland. It is well known that the wheat bug *Nysius huttoni* favours dry open grassland, which was a feature of the bank above the traps at Nottingham creek. *Zygina zelandica* is apparently associated with some of the weed herbs in pastures and lucerne.

Rush and sedge wetlands: The native *Hydriellia enderbii* has been bred from rushes (Macfarlane & Andrew 2001) and it was quite common at some sites. Some of the plant hoppers Cicadellidae especially the long snouted species found at Halswell quarry were also swept from the rush/sedge vegetation at Travis wetland.

Perennial herbs: The hosts of some other species such as the *Hydriellia* species are currently unknown, but could well be herbs, but may include sedges or rushes. The introduced weed hosts for most of the Agromyzidae species (*Haplomyza chenopodi*, *Phytomyza atricornis*, *Phytobia umbria*) are known from the 1976 revision of Spencer (Macfarlane & Andrew 2001).

Trees: The Triozidae species probably come from the native lemonwood, while a likely host for the Pysllidae species is the wattle. Two species of willow gall wasps were collected quite regularly in small numbers. *Pontania proximus* is dark grey, while the much more recently established *Nematus oligospilus* is yellow.

Table 5 Southwest Christchurch waterways survey: terrestrial invertebrates (Spreadsheet)

Two specimens of valued pollinating social honey and bumble bees (Apidae) were trapped at all sites. Two species of ground nesting native bees were also collected. The foreshore of the Halswell quarry pond was the exceptional site, where the yellow flowered *Cotula* dominated the low and sparse vegetation. *Cotula* was flowering at the time, so it was not surprising distinctly more native bees of *Lasioglossum sordidum* were collected in the yellow pan traps. Once again this demonstrated the ability of the pan traps to show activity of certain insect species, under suitable conditions. Thus it gave more confidence for the interpretations made for the mud and wetland dwelling insects as being real ecological differences.

Litter and fungi consumers

At least 36 species of apparently largely forest dwelling were collected in this survey and a further nine species more characteristically found in gardens, grassland or compost. Five of the seven species certain garden (includes composts, rotting vegetables) or pasture litter species were adventive flies, which are known to breed in compost and grass litter from studies overseas (Smith 1989) and in New Zealand (Scott 1984). The native *Gaurax mesopluralis* has been collected from rotting swedes (Harrison 1959). Martin pers comm. has found the vinegar fly *Scaptomyza fuscitaris* breeds in decaying litter in grassland. Other species in this genus are herbivores. Both species of Lathrididae beetles could perhaps be added to this list along with some of the Phoridae. A considerable part of the larger crane fly (Tipulidae) specimens remain unidentified, and some of these are likely to include soil inhabiting species which feed on roots. Similarly, some of the root gnats extend into or are mainly found in grassland, but females of the main genera can not be reliably distinguished.

Some of the *Drosophila* species, Phoridae and Sciaridae breed on bracket fungi including mushrooms. Others such as the fungus gnats (Mycetophilidae, Keroplatidae) and wood gnats (Lestromiinae) are so far known to mainly breed on fungi among leaf litter especially in forests or fungi in decaying logs. The few Keroplatidae including *Macrocera* sp were all collected in the vicinity of sites with trees. The sites with trees quite regularly had light brown species of *Mycetophila*. It was interesting that a good series of a dark slender species was collected from the dense grassland/rushes at Halswell quarry. As most of these species do not live off specific plants, then more flexible species like *Anomalomyia* can extend into wetland or long grassland to some extent (Macfarlane *et al.* 1998).

The moth fly family (Psychodidae) were collected quite frequently. For simplicity these small flies have all been allocated to forest litter. The species allocated to *Psychoda ?alternata* may include *P. pseudoalternata* too. These two species and the distinctive *Psychoda penicillata* are introduced species. Some of the other introduced species can definitely occupy wet habitats (Winterbourn *et al.* 2000). Many of the remaining specimens had either a dark brown notum or a pale brown notum, and are more likely to include endemic species. The pattern of abundance showed no link to the sites with muddy shores unlike *Scatella* and *Millerina* species.

Dung and carrion

The four species of dung consuming flies are all adventive species from South America (*Hybopygia varia*, Sarcophagidae) Australia (*Lasiomemmapoda hirsuta*, Sepsidae) or Europe. The number of *H. varia* specimens was quite variable. These flies were associated with the presence of livestock such as horses rather well. This is the first record of *L. hirsuta* from the South island. This small dung consuming species became established in the North island by the 1956, where the spread has apparently been slow. The recent extension into the South island could be expected considering the many dairy cows transported to the South Island in the last decade.

Similarly three of the four certain carrion breeding species were adventive species. The exception was the smaller light blue native blow fly *Xenocalliphora hortona*, which I have found is common in pasture areas from unpublished blow fly trapping in the 1990's in the vicinity of Lincoln. It is quite possible that both *Gaurax neozelandica* and *G. flavoapicalis* (Chloropidae) actually breed in invertebrate carrion. This similarly marked species pair was attracted to insect carrion in my survey of invertebrates at McLeans island (Macfarlane *et al.* 1999). In addition at least some of the *Megaselia* (Phoridae) also breed on insect carrion and the most commonly collected species are adventive species. Other Phoridae breed in fungi such as mushrooms or are found in forest litter.

Parasites and predators

In all there were probably 40-60 species of parasite represented in the 374 specimens collected in this survey. Some such as the lacewing parasite *Anacharis zelandica*, many of the Encyrtidae and at least some of the aphid parasites (Aphidinae), the "Pteromalidae" and other chalcoids have within my experience been typically The survey

collected from pastures. In both my previous surveys of insect communities (Macfarlane *et al.* 1998, 1999), no earthworm parasites were collected. This time they were and more were also found at Styx Mill reserve demonstrating the relatively recent establishment of these cluster flies in the Christchurch area. The *Gonozius* sp, the *Elasmus* sp, and perhaps the largish blue *Pales* are known as parasites of leaf roller caterpillars, which affect shrub, tree and herbaceous foliage.

The ecologically most interesting parasitic find were of the fly parasitic Diapriidae (*Hemilexomyia spinosa*, *Styloclista* and other species). These other Diapriidae species are likely to be mainly *Spilomicrus* species. These smaller diapriids were commonest at sites with longer vegetation, and considerable fewer were collected along the pond and lake margins and more were collected at the relatively mud less Leadleys road rather than at Sabys road. Therefore, I think it is unlikely that many if any at all parasitise the smaller *Scatella* species. However, the pattern of abundance would fit to some extent with some of them being parasites of *Psilopa metallica*. *Hemilexomyia spinosa* was clearly associated with the wetland parts of both Travis wetland and the Styx Mill reserve and was not collected at the dry ephemeral creek bed at Wigram road, the fully vegetated temporary waterway at Halswell quarry (Site 19) and the four bank side sites along Cashmere stream. Numbers collected do not peak in the most muddy sites with maximum numbers of *Millerina*, but larger potential hosts such as the native blow fly or Tachinidae flies show even less of a common pattern with peak numbers. *Hemilexomyia spinosa* is considerably larger than the other diapriid species collected in this survey. At the remaining 13 sites, I collected all the *H. spinosa* specimens and 92.5% of the *Millerina* species. Provisionally, I suspect this species is hosted by some of the *Millerina* species. The peak numbers of *H. spinosa* were present, where *Millerina* species 4 was by much the most common *Millerina* species collected.

Among the predators spiders accounted for just over half the specimens collected. The spiders included some wolf spiders, some Clubionidae and a few jumping (Salticidae). About a further 12 species of predatory insects were collected. The long legged fly, which I have currently attributed to *Alchalus separatus*, was mostly collected in areas with the most trees in the vicinity such as Winchops road. Conversely, only modest numbers of *Parentia* of at least two species were collected. This included an interesting southern extension to the recorded distribution of *Parentia anomalicosta*, which Bickel (1991) described from only 4 sites with southern records from Nelson. Conversely, it was reassuring that high populations of the common wasp were not present in the areas sampled.

DISCUSSION AND CONCLUSIONS

Assessment of habitat preferences for shoreline species

The main discovery of this survey has been the sizable diversity in the insect fauna associated with the muddy fringes of the waterways. The few samples only meters away from this habitat collected a very reduced range of aquatic and of these shore side insects. Malaise trapping especially in the Styx Mill reserve did collect limited numbers of midges especially sheltering or resting in woodland (Macfarlane in preparation). It is reasonable to surmise that in their normal daily activities, that these species a focus their flight activity along a very narrow band of this habitat. If this was not so, then the various surveys of pastures, crop and orchard insects would have found more of these insects.

Unevenness in the width and quality of the muddy shore along the corridor that the waterways provide mean that species such as the medium sized and predatory *Limnohelina spinipes* must at times disperse quite considerable distances from such strongholds as the Halswell quarry pond, because only meager numbers were found elsewhere in this survey. Thus for normally daily flight distances of 50-100m of suitable habitat are likely to be like the human equivalent of separate towns or cities, which are only breached by unstudied periodic dispersal of the species.

With midges, the massed mating flights or swarm where males are prominent is a conspicuous feature in the vicinity of waterways and lakes. Thus it was not surprising that for some of the midges collected that females dominated in my catches along the waterways. *Corynoneura scutellata* was apparently an extreme example, because I could not match any males to the numerous females collected.

The shoreline Diptera dominated insect fauna provides an important challenge for New Zealand entomology to develop further effective sampling methods to reveal the immature stages. This will also require the development of appropriate means to identify the larvae of the several families and genera that are apparently involved. Currently,

we can not expect to find extensive guidance from the overseas literature at a genera level, because around 40% of New Zealand Diptera are endemic to New Zealand. The genus *Hercostomus* illustrates the sketchy nature of supporting evidence from overseas. Some species in Western North America are associated with waterways (Cole 1969), but the genus does not occur in Great Britain and so there is no information on its ecology from the relatively well studied fauna of Great Britain (Smith 1989).

Consequently, it has been extremely gratifying to provide the first real, but admittedly circumstantial evidence, of the habitat preferences for so many of the shoreline Diptera species from such a deficient New Zealand scientific base.

Threats to invertebrate diversity

Severe or chronic threats to each catchment are listed in the summary, so they do not need repeating here.

During the survey, I observed part of a herd of young cattle wading within the shallow gully of Cashmere stream above Sutherlands road, which stirred up a considerable amount of silt. The cattle enter the waterway just to graze in the cool shade apart from drinking. Downstream across the Sutherland road, where I put the pan traps, there is a quite deep trench. It is semi-unavailable to livestock, because of the vertical clay banks apart from being largely fenced off from stock. When, I placed the pan traps at 428 and 404 Cashmere road (site 10) the Cashmere stream was partly cloudy too. The adjacent field across the stream and was bare and finely cultivated except for a very narrow band. Thus it is conceivable that the horticultural enterprise there may be continuing to add silt to the already overloaded Milnes drain. Education about the ecological value of the upper Cashmere stream and if possible some agreed way to limit continued addition of silt into Milnes drain is needed to rectify this chronic problem. It was apparently inappropriate horticultural use towards Prebbleton, which caused much if not all of the degradation to the upper Knights stream. This has certainly occurred since the last survey 24 years ago. Thus there is a need to educate landowners about degrading the most precious headwaters of such lowland streams.

Perhaps a bylaw could be negotiated is to leave a 3-10m grassed band along the side of the waterway to avoid silting. There is simply not enough fall within the catchment to clear our such silt in the long term. If continued degradation from further silting can be control, then perhaps trials and some investigation on whether some common mayfly species can be restored to the remaining faster flowing gravel bedded head waters might be considered. If this could be achieved then freshwater fish numbers might improve to reverse anecdotal observations of the decline noticed by residents.

There is little doubt that the quality of the within creek insect fauna in Nottingham creek has declined since 1993 based on the combined results of my survey and that of McMurtrie & Taylor (2004).

Habitat modification

Urbanization will virtually inevitably at least halve in stream invertebrate diversity. Clearly modification of both the banks and bed of headwater ditches and the faster flowing gravely creeks should be limited in some representative areas to preserve the full range of habitats. It is difficult to place the diversity of Cashmere stream in full context without a modest scaled resurvey of some of the fuller flowing Heathcote river waters. This will be considerably easier to achieve than in the current investigation, when adequate reference specimens including those of the adult midges have been checked by Boothroyd and one or two Sphaeroceridae species have been checked by Steven Marshall at Guelph in Canada.

Adjacent land use

This survey clearly indicates the importance of the waterways as corridors for wetland and freshwater insects and compared to previous studies shows the importance of including areas with open space. This is vital for a suite of mainly dark coloured shore (Ephydriidae), lesser dung (Sphaeroceridae) and muscid (Muscidae) flies. These flies along with most of our native bee are mainly black, because black allows them to absorb the heat of sunlight and so increase their blood temperature. It is particularly important that species with predatory adults can do this and for their potential prey to, so they can minimize the possibility of being preyed on.

It is also gratifying that relatively newly constructed wetlands and ponds such as the Halswell quarry can develop as strongholds for at least a small suite of shoreline species notably *Limnohelina spinipes* and *Hydrophorus preacox*. What is not clear at the present is how much of the wetland insect fauna of the Christchurch area has been able to colonize the rush and sedge plantings in Halswell quarry or the fringe of these plants in the older Curtletts reserve. Once the Sty Mill reserve community study has been completed, then there will be a baseline for comparison because this adds to the wetland study of Travis wetland (Macfarlane *et al* 1998). Therefore it will be possible to gain a reasonable understanding on what species are present or missing. The distinctive *Caligera* ? new species from the small tribe Vorini (Tachinidae) was one species, which I have noticed missing from the south west Christchurch survey compared to the Travis wetland survey.

Conversely, it was a relief to find the large flightless Canterbury lowland crane fly *Gynoplistia pedestris* in small suitable pockets of wetland along the waterways of both Cashmere stream and the upper tributaries of Halswell river. This provides a clue on further sites to check for this species and the possibility it may occur considerably further to the south east in suitable wetland habitat down towards Lake Ellesmere and maybe even further on similar sites in Banks Peninsula. There is also a need to check for this species in the least modified lowland wetlands along the coast to Waipara, to determine if there are still populations in this area. Already parts of these sites have been modified with the need to plant a pine forest along the coastal sand dune and the covering up of wetland ponds behind these dunes with thick grassed vegetation and volunteer willows. In addition, further areas of rush wetland are scheduled for severe modification, when a lake is constructed along with the development of the proposed Pegasus town. Consequently, for the long term survival of this species having some more wetland sites, which it could either colonize or at least be taken to in the south west of Christchurch provides some assurance for its long term survival. It will require either a period of quite a lot of years or a sponsored survey to clarify, whether this crane fly is a vulnerable species or just a rather localized lowland wetland species of central Canterbury.

Gaps in current knowledge of waterway insect fauna

The upper km or so of Cashmere stream has only three site collections (two in Robbs survey and one in mine) upstream of the junction of the ephemeral Hoon hay creek. It has been assumed this whole length is a premier section of waterway, but it would be desirable to have more information on the frequency of invertebrates along this length of the stream. This should be addressed before and significant urban development with the twin threat of more extensive silting or chemical pollution. In the Halswell catchment, the short length of unstudied spring, downstream waterway needs to be kept as free from urban pollution to assist with retaining the now considerable less diverse freshwater in as good a condition for freshwater invertebrates as possible. It would also be helpful to know, how useful the stony stock races are for retaining midge diversity and how the Quaiques pond insect fauna compares with the Curtletts reserve lake and Halswell quarry. This would put the ecological value of these three man made water reserves in context for conservation of waterway invertebrates. It should also be useful in understanding the usefulness of constructing further ponds and whether some should have silt rather than mud shores. For the

Heathcote catchment, it would be useful to know what diversity of shore line fly species especially has been retained in the gravelly based middle sections of the catchment with the swiftest flow and a reasonably assured flow. This would help put the surveys of Robb and Suren in better perspective and update the current situation.

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Appendix 1 SW Christchurch waterways survey: species list, commonness and consistency (Spreadsheet)

Appendix 2 SW Christchurch waterways aquatic species not recorded in 2004 surveys

Species E = endemic genus Surveys # = Robb * = 2004 River symbols 0 = not found - = survey not enough to find it (A or H) = survival uncertain 1919-1980 data base records D for ditches, All = all main tributaries

Others - North or Northwest M = McLeans Is, water race & caravan park, G = Groynes, C = Coutts Is - S.Waimakariri

Styx K = Kaputone stream, Sm = Smack creek, S = Styx Halswell N= Nottingham creek

SECTION 1 RUNNING WATER

	Styx & others	Cash mere	Heath-cote R	Hals-well R	Knights stream	Ecology & comments	
EPHEMEROPTERA Mayflies							
Leptophlebiidae							
<i>Deleatidium</i> * species	E	Sall,C	#	0	#	Graze alga & ? other plants	
<i>D. autumnale</i>		SC		0	#	Kennedys bush stream	
<i>D. lillii</i>	*	C		0	#	Kennedys bush stream	
<i>D. verna</i>		SC	#	0	#	Hoon Hay valley	
PLECOPTERA Stone flies							
Gryopterygidae							
<i>Zelandobius confusus</i>	E*	0	0	0	#	#	Detritus, prefers forest, stony bed
TRICHOPTERA Caddisflies							
Conoecidae							
<i>P. new species near forcipata</i>		0	0	0	#	0	Graze alga, often cling to stones Kennedy's Bush stream
<i>P. aureola</i>	*	Sall,CGM		#	#	0	Abundant
Hydrobiosidae No larval case							
<i>Neurochorema confusum</i>	E*	Sall,CG		(#)		0	Build shelters, predatory Prey <i>Aoteapsyche</i> pupa
Hydropsychidae No larva case							
<i>Aoteapsyche catherinae</i>	E	CGM	*	0		0	Filter feeds on alga with nets light trap in 2004
Leptoceridae							
<i>Hudsonema aliena</i>	*	C	KSt	0	#	#	Often use weeds in cases in still or slow waters Likes weed or roots for shelter, omnivore
Oeconesidae							
<i>Oeconesus maori</i>	*+	CGM	KSt	H		N	Shreds dead leaves, prefers smaller streams
Polycentropodidae							
<i>Olinga feredayi</i> Horny case	*	CGM	All	H		#	Uses rocks for shelter, shreds dead leaves
<i>Polyplectropus puerilis</i>	*	GM	All	All	#	#	Abundant, insect prey mainly mayflies

SECTION 2 STILL WATER

COLEOPTERA						
Dytiscidae						
Diving beetles						
<i>Antiporus strigulosus</i>			KS	All	#	N
<i>Liodessus plicatus</i>	*		KS	DH	#	K
<i>Rhantus pulverosus</i>	*			D		0
HEMIPTERA BUGS						
Corixiidae Waterboatmen						
<i>Diaprepocoris zealandiae</i>			0	0	#	
<i>Sigara arguta</i>	*		KS	CaH	#	N
Notonectidae Backswimmers						
<i>Anisops assimilis</i> or species	*		DS	H	#	N
<i>A. wakefieldi</i>			S	?		?
Veliidae						
<i>Microvelia macgregori</i>	*		All	0	#	KN
LEPIDOPTERA Moth						
Pyralidae						
<i>Hygraula (=Nymphula) nitens</i> *			KS	D	#	
						Feed on <i>Elodea</i> leaves & young stems

Appendix 3 Incidence of aquatic insects previously recorded from the Halswell river catchment

* = sites (5-11) dry up in summer

Unidentified Chironomidae will be mainly smaller Orthocladinae, but with perhaps some Tanyderinae.

INVERTEBRATE TAXA OF RUNNING WATER	RIVER SECTIONS: - % SAMPLE SITES WITH EACH SPECIES			Zone preference if any
	Halswell river No of samples 5 : 28	Creeks Knights 4 : 13	Nottingham 7* : 14	
COLEOPTERA Beetles				
Elmidae				
<i>Hydora</i> species	0 : 7	0 : 0	0 : 0	Reliable lower flow
DIPTERA Flies				
Simuliidae Black flies				
<i>Austrosimulium</i> species	20 : 28	0 : 23	0 : 0	Reliable cool flow
EPHEMEROPTERA Mayflies				
Leptophlebiidae				
<i>Deleatidium</i> species	0 : 75	0 : 15	0 : 0	
<i>Zephlebia nodularis</i>	0 : 0	0 : 0	0 : 0	
PLECOPTERA Stone flies				
Gryopterygidae				
<i>Zelandobius confusus</i>	0 : 0	0 : 33	0 : 0	
TRICHOPTERA Caddisflies				
Conoescidae				
<i>Pycnocentria evecta</i>	+	0 : 46	0 : 0	
<i>Pycnocentrodes aeris</i>	0	0 : 0	0	
<i>P. aureola</i>	+	0	0	
Hydrobiosidae				
<i>H. parumbripennis</i>	+	0 : 62	0	
<i>Neurochorema confusum</i>	0	0 : 0	0	
<i>Psilochorema bidens</i>	+	0 : 0	0	
Hydroptilidae				
<i>Oxyethira albiceps</i>	+	50 : 46	+	
<i>Paroxythera hendersoni</i>	40 :	0 : 0	0 : 0	
Leptoceridae				
<i>Hudsonema amabilis</i>	+	0 : 15	+	
<i>H. aliena</i>	+	0 : 8	0	
<i>Oecetis unicolor</i>	0 : 0	0 : 0	0	
<i>Tripletides cephalates</i>	0 : 0	0 : 0	0	Better mid sections
<i>T. obsoleta</i>	+	0 : 0	+	
Oeconesidae				
<i>Oeconesus maori</i>	0 : 0	0 : 0	+	
Polycentropodidae				
<i>Polyplectropus pueralis</i>	0 : 68	100 : 85	+	
<i>Olinga feredayi</i>	+	0 : 15	0	

Appendix 3 Incidence of aquatic insects previously recorded from the Halswell river catchment

catchment

* = sites (5-11) dry up in summer

Unidentified Chironomidae will be mainly smaller Orthocleinae, but with perhaps some Tanyderinae.

INVERTEBRATE TAXA	RIVER SECTIONS: - % SAMPLE SITES WITH EACH SPECIES			Zone preference if any
	Halswell river	Creeks Knights	Nottingham	
COLEOPTERA Beetles				
Dytiscidae Diving beetles				
<i>Antiporus strigulosus</i>	80 :	0 : 0	0 : 7	
<i>Liodessus plicatus</i>	20 :	25 : 0	0 : 0	
DIPTERA Flies				
Ceratopogonidae Biting midges				
Undetermined species	0 : 0	0 : 0	0 : 0	
Chironomidae				
<i>Chironomus zealandicus</i>	20 :39	0 :31	7 : 36	
<i>Maoridiasmesa harrisi</i>	0 : 0	0 : 0	0 : 0	This species not yet verified in 2004
Orthocladinae species #	100 :89	75 : 92	86 : 79	
Culicidae Mosquitoes				
<i>Culex</i> species	80 : 7	25 : 15	0 : 7	
Dixiidae				
<i>Dexilia (Paradixa)</i> species	0 : 4	0 : 0	0 : 0	
Muscidae				
<i>Limnophora</i> spp.= (?unidentified)	20 : 0	0 : 0	0 : 0	Actually Millerina
STRATIOMYIIDAE				
Unidentified = ? <i>Odontomyia</i>	20 : 0	0 : 0	0 : 0	
Tipulidae Crane flies				
<i>Limonia</i> species	0 : +	0 : 0	0 : 0	
<i>Paralimnophila skusei</i>	0 :14	0 : 0	0 : 0	
<i>Zealandotipula</i> species	0	0 : 0	0 : 0	
HEMIPTERA BUGS				
Corixiidae				
<i>Sigara arguta</i>	60 : 0	0 : 0	0 : 21	
Notonectidae				
<i>Anisops assimilis</i> or species	60 : 4	0 : 0	0 : 36	
Veliidae				
<i>Microvelia macgregori</i>	40 : 0	25 : 8	0 : 21	
LEPIDOPTERA Moth				
Pyalidae				
<i>Hygraula (Nymphula) nitens</i>	+	0 : 0	0	
ODONATA				
Ceonagrionidae				
<i>Xanthocnemis zealandica</i>	0 : 32		75 : 0	