5. Aquatic Ecology of the Little Swanport Catchment

5.1 Fish

Seven native fish species and three introduced species have been either recorded or sighted from various locations in the Little Swanport catchment. Six of the seven native fish species are migratory and require free passage between rivers and the sea in order to complete their life cycles. The distribution patterns for native and introduced fish species caught during the electrofishing surveys are presented in Figures 129 and 130 respectively. The raw data is presented in Table 32.

The distribution maps show the known locations of each species, marked by the circle, and potential range based on these records. Population densities and range within any given range are likely to reflect a combination of the individual species habitat requirements and availability of preferred habitat, stage in migratory travel and a known decrease in native fish species diversity in an upstream direction (Davies, 1989). It is important to remember that this distribution reflects sites sampled by DPIW, and there are many areas (eg. tributaries in the lower catchment) that haven't been sampled but are likely to have fish in them. Distribution maps have not been produced for species with only one record.

5.1.1 Native fish species

Short finned eel *(Anguilla australis)*

The short finned eel *Anguilla australis* is widespread in coastal and lowland rivers in Tasmania (McDowall, 1996). DPIW electrofishing surveys indicate that *A. australis* is widespread throughout the Little Swanport catchment. *A. australis* populations are common throughout the Little Swanport mainstream and a number of major tributaries. This is likely to reflect the occurrence of this species in a wide variety of lowland habitats. Specifically, *A. australis* prefer to inhabit still waters in areas of slow silty habitat and this may account for it's extent in the upper reaches of the Little Swanport mainstream where this habitat type is common.

Long finned eel *(Anguilla reinhardtii)*

The Long finned eel *Anguilla reinhardtii* is commonly distributed in coastal lowland rivers along the northern and eastern coasts of Tasmania. It occurs less frequently in lakes and like *A. australis* generally prefers still water habitats. This species was not sampled during the DPIW surveys although a single record for this species exists at the old weir in the lower catchment (Inland Fisheries Service survey – February 2002). This record in the lower catchment and the lack of records for this particular species upstream in more comprehensive catchment surveys by DPIW is consistent with general observations within the scientific literature of decreasing abundance with increased distance away from the sea for this species (Koehn and O'Connor, 1990). This is thought to relate to a general avoidance of lower riverine temperatures and the availability of more suitable forage fish in estuarine and extreme lower freshwater reaches (Koehn and O'Connor, 1990).

Common Jollytail *(Galaxias maculatus)*

The Common Jollytail *Galaxias maculatus* is widespread and common in Tasmanian catchments and generally occurs in low elevation streams in Tasmania (McDowall, 1996). The species can tolerate a wide range of habitat conditions and commonly occurs in still or gently flowing streams and rivers, lakes and lagoon margins usually in small shoals (schools). The species can also tolerate extremely high salinities. To date, electrofishing surveys in the Little Swanport catchment suggests that *G. maculatus* populations are common within the mainstream with the exception of the uppermost reaches and are also found in a number of major tributaries (Green Tier Creek, Pages Rivulet and Eastern Marshes Rivulet). The widespread distribution of this species throughout most of the catchment reflects wide tolerances of this species and preference for a wide variety of in-stream habitats.

Spotted Galaxias *(Galaxias truttaceus)*

The spotted Galaxias *Galaxias truttaceus* is similar to the common jollytail in that both species have a marine juvenile stage and a diadromous life cycle (McDowall & Fulton, 1996). Spotted galaxiids have more defined and specific habitat preferences than *G. maculatus* and prefer to inhabit quieter stream areas with riverine populations preferring lower elevation, slower flowing streams where they are found in pools with abundant cover from log debris, overhanging banks and boulders. The preliminary fish surveys support this distributional pattern with all *G. truttaceus* found in the lower reaches of the catchment in habitats that contain good in-stream cover and riparian vegetation.

Table 32: Distribution of native and exotic fish at sites in the Little Swanport River (LSR) and some of its major tributaries, determined from surveys conducted by DPIWE and IFS.

site	*date*	*A. australis*	*A. reinhardtii*	*G. maculatus*	*G. truttaceus*	*G. brevipinnis*	*P. maraena*	*P. urvillii*	*P. fluviatilis*	*S. trutta*	*T. tinca*
LSR at Tasman Hwy			**1**						**present**	**present**	**present**
IFS survey	Jan-87		1						present	present	present
LSR 3 km us Tasman Hwy (LSWA01)		**30**		**171**	**2**			**55**			
IFS weir downstream	Feb-02	12		40				39			
IFS weir upstream	Feb-02	6		76	1			2			
DPIWE survey	Sep-03	1		45	1						
DPIWE survey	Feb-04	11		10				14			
LSR at Deep Hole (LSWA02)		**2**					**1**				
Mawbey sighting	1998						1				
DPIWE survey	Sep-03	2									
LSR below Thallans Creek (LSWA03)				**~80**	**2**						
DPIWE snorkelling	Jan-04			~80	2						
LSR below Green Tier Creek (LSWA04)_		**29**		**21**	**6**			**1**		**4**	
DPIWE survey	Feb-04	29		21	6			1		4	
LSR at Swanston (LSWA05)		**12**		**51**	**40**		**4**	**4**	**6**	**1**	**5**
DPIWE survey	Sep-03			48			4	2		1	3
DPIWE survey	Jan-04	12		3	40			2	6		2
LSR above Eastern Marshes Rt (LSWA06)		**21**		**24**	**5**			**5**	**8**	**4**	**3**
DPIWE survey	Sep-03			8							3
DPIWE survey	Jan-04	10		6	4			1	5	3	
DPIWE survey	Feb-04	11		10	1				3	1	
LSR at Stonehenge ford (LSWA08)		**1**		**11**							
DPIWE survey	Sep-03	1		11							
LSR above Pages Creek (LSWA09)		**2**						**2**	**2**		
DPIWE survey	Sep-03	2						2	2		
LSR at Swanston Rd (LSWA10)		**13**		**12**				**1**	**4**		**8**
DPIWE survey	Sep-03	1									
DPIWE survey	Jan-04	9		11				1	2		2
DPIWE survey	Feb-04	3		1					2		6

Freshwater Flathead *(Pseudaphritis urvillii)*

Freshwater flathead are abundant in coastal streams around the state and although they are primarily a marine species, they can be found in both fresh and salt waters and can move considerable distances upstream as was evident from DPIW surveys. Their preferred freshwater habitat is usually slow flowing water around log snags, under overhanging banks or among leaf litter. Juveniles are generally more abundant in the lower reaches of rivers while larger individuals are more common upstream. Electrofishing surveys in the Little Swanport catchment suggest that this species is restricted to the mainstream.

Swan Galaxias *(Galaxias fontanus)*

Swan galaxias are endemic to Tasmania and naturally occur only at a few localities in eastern Tasmania (the headwaters of the Swan River upstream of Hardings Falls and tributaries of the upper Macquarie River). In these localities, Swan galaxias live exclusively in freshwater with no marine migratory stage in their lifecycle (Jackson, 2002). Their preferred habitat is in slow to moderately fast-flowing rocky streams containing abundant shelter from within the stream and from stream side vegetation. The Swan galaxias does not naturally occur within the Little Swanport catchment however populations have been translocated into the upper reaches of Rocka Rivulet and Green Tier Creek as part of a wider Inland Fisheries Service Recovery Program for the species (Jackson, 2002).

Australian Grayling *(Prototroctes maraena)*

Australian grayling are native to Tasmania and southeast mainland Australia where in recent years abundant but localised populations have been found (McDowall, 1996). In Tasmania they are found in the middle and lower reaches of rivers and streams that open to the sea. Much of their basic biology, including distribution and migratory behaviour, is unknown. Spawning takes place in moderately flowing fresh water in late spring to early summer with a large number of eggs laid on gravelly streambeds. The larvae are probably swept to sea and return as whitebait after four to six months. This species has been sighted at one location in the lower Little Swanport catchment (Deep Hole) and recorded at one location in Lisdillon Rivulet (Table 32).

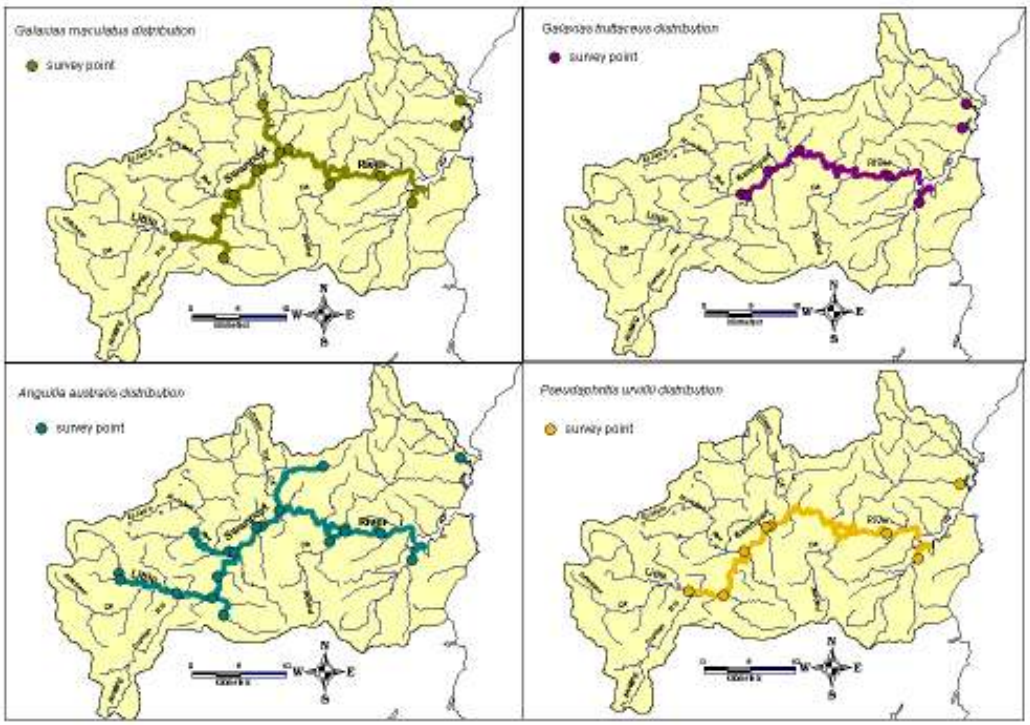


Figure 129: Native fish distributions in the Little Swanport catchment.

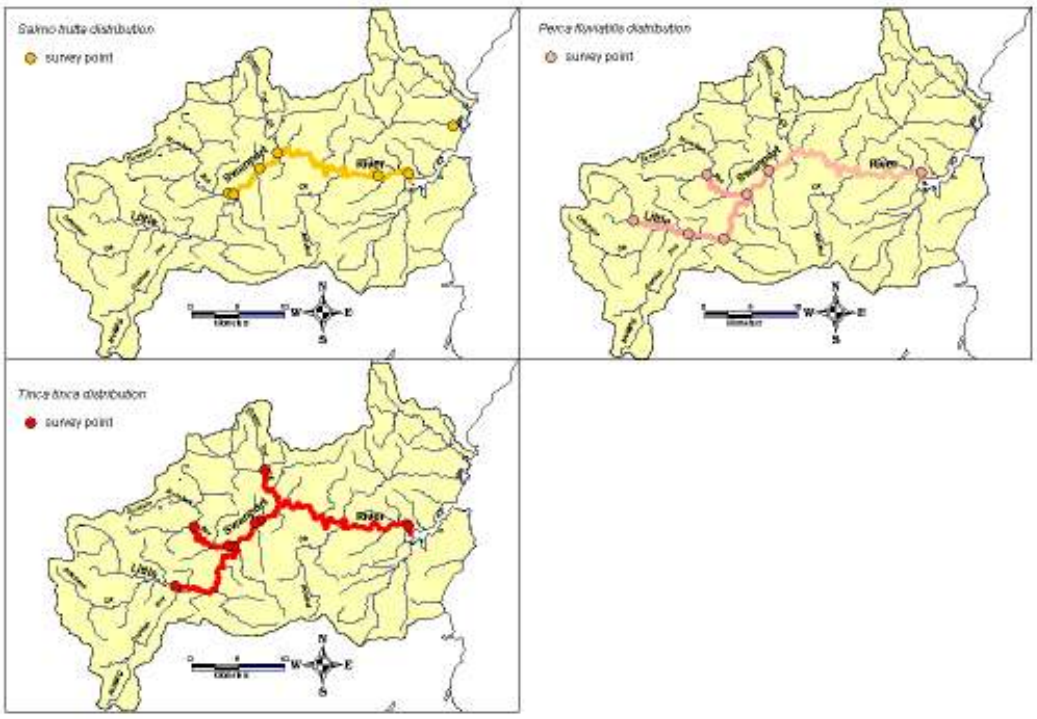


Figure 130: Exotic fish distributions in the Little Swanport catchment.

Pouched Lamprey *(Geotria australis)*

Pouched lamprey are native to Tasmania and south-east Australia. They require waters with sand, gravel or pebble substrates for spawning. The larvae prefer slower flowing water where they can burrow into mud, sand or silt. Adults are found in faster flowing water on the sides of rivers with suitable burrowing habitat and shelter that they tend to burrow into at night. This species has been identified from the old weir in the lower catchment (Inland Fisheries Service survey – February 2002).

5.1.2 Introduced fish species

Tench *(Tinca tinca)*

Tench are tolerant to degraded conditions were they can establish large populations. They are usually found in slow flowing or still freshwater habitats, often in weed and deep sheltered holes. DPIW surveys have found tench from a number of sampling spots in the mid to upper reaches of the Little Swanport mainstream and in Green Tier Creek and Eastern Marshes Rivulet.

Redfin Perch *(Perca fluviatilis)*

Electrofishing surveys found redfin perch in the upper reaches of the Little Swanport River. They occur predominantly in still and slow flowing waters, especially were there is an abundance of aquatic vegetation. Redfin perch have the ability to out-compete native fish, and in some cases seriously reduce or even eradicate populations. As such they are recognised as a major threat to native fish populations.

Brown trout *(Salmo trutta)*

Brown trout commonly occur in cool, well-oxygenated waters, usually in streams with moderate to swift flow. They frequently migrate upstream into small tributaries or feeder streams with gravel beds. The upper tributaries and upper reaches of the mainstream in the Little Swanport catchment generally have silty substrate types and do not provide the preferred habitat type for this species. DPIW surveys reflect these habitat preferences as brown trout populations were recorded in the middle and lower

reaches of the catchment where coarser substrates are more common. No trout were caught in the upper catchment.

5.1.3 Summary

Surveys of fish species distributions in the Little Swanport catchment to date are largely consistent with the current understanding of their general habitat requirements in the scientific literature and known distributions in Tasmanian rivers. Within the Little Swanport catchment, there is a general pattern of decreasing diversity in an upstream direction consistent with Davies (1989) observations for Tasmanian populations, and populations of individual species are largely found in their preferred habitats. Populations of native fish are more common in the lower reaches and this may relate to the availability of good in-stream cover and riparian vegetation, a greater diversity of coarse substrate and meso-habitat (pools, riffles, runs) and the proximity to the coast. In contrast the upper reaches are generally in a more degraded state with little riparian vegetation, low habitat diversity and cover and silty substrates. Exotic species (with the exception of brown trout) and native species with wide habitat preferences and a tolerance for life in degraded habitat (e.g. eels) are more common in these reaches.

5.2 Macroinvertebrates

The complete faunal list is presented in Appendix 3. A total of 63 taxa were identified from the riffle habitat and 78 taxa from the edgewater habitat. These taxa represent all the major taxonomic groups typical of freshwater streams in Tasmania. Insects were the most dominant group, representing around 70% of the total number of taxa collected and the total number of individuals collected. The total taxon diversity for each site for the riffle and edgewater habitats is presented in figures 131a & 131b respectively. The distribution of macroinvertebrates reveals broad ecological patterns that reflect changes in physical and chemical characteristics throughout the Little Swanport catchment.

5.2.1 Riffle habitat

For the riffle habitat, in terms of overall taxon richness, the most diverse sites were those located in the middle reaches of the Little Swanport River. Sites on Nutting Garden Rivulet (LSWA30) and Ravensdale Rivulet also had rich macroinvertebrate faunas with an average of 22.5 and 23 taxa collected at each site respectively although Ravensdale Rivulet was only sampled in spring 2004 due to insufficient riffle habitat in autumn 2004.

A sharp decline in macroinvertebrate diversity was observed at sites upstream of the Pages Creek confluence with the Little Swanport River mainstream and in most of the tributaries. Reduced taxon richness at these sites is consistent with intermittent flow at these sites at the time of sampling and the associated loss of riffle habitat during drier periods. The most depauperate sites were Crichton Creek (LSWA32) and the upper reaches of Pages Creek (LSWA32) with only 11 taxa.

Many taxa are cosmopolitan, having been found at all or most sites. Such taxa include Ceinidae (amphipods), Hydrobiidae (snails), Oligochaeta (worms), Simuliidae (blackfly larvae), Orthocladiinae and Chironominae (midges) and Gripopterygidae (stoneflies). Due to their wide distribution, prevalence and general tolerance to a range of habitat and water quality conditions these taxa are not as useful as indicators of river health as some of the less widespread and more sensitive taxa. Figures 132 to 135 present the percentage contribution of the major taxa to the total number of individuals at each site. EPT (Ephemeroptera-mayflies, Plecoptera- stoneflies and Trichoptera – caddisflies) taxa are generally considered to be intolerant to pollution and habitat degradation and streams with high numbers of EPT taxa tend to have greater biological integrity and health compared to streams with low EPT taxa richness.

Taxon richness is an important measurement of stream biodiversity. Typically, as taxa richness increases so does stream quality. EPT taxa are generally considered to be intolerant to pollution and habitat degradation while bloodworms and aquatic worms are highly tolerant of pollution and habitat degradation. Therefore, streams with high numbers of EPT taxa and low numbers of bloodworms and aquatic worms tend to

have greater biological integrity and by inference, health compared to streams with low EPT taxa richness and a high incidence of pollution tolerant taxa.

In spring 2003, EPT taxa dominated the lower and middle reaches of the Little Swanport main channel as well as sites on Pepper Creek, Green Tier Creek Rocka Rivulet, Eastern Marshes Rivulet, Pages Creek, Nutting Garden Rivulet, Lisdillon Rivulet and the Buxton River accounting for 40-60% of the total number of individuals at each site. However the high proportion of EPT taxa at many sites was due to the high abundance of stoneflies (represented almost exclusively by the stonefly family Gripopterygidae). Caddisflies were represented by only 1-2 families and generally contributed to less than 5% of the total number of individuals (Figure 133). Similarly, mayflies were found in low numbers, accounting for less than 10% of individuals except for sites sampled on Lisdillon Rivulet and Buxton River where they comprised 64% and 47% respectively (Figure 132).

There was a sharp decline in the abundance of EPT taxa in the upper reaches of the Little Swanport mainstream from 25% at the Little Swanport River upstream of the Pages Creek confluence to 0.5-2% at sites between Swanston Road (LSWA10) and the Inglewood Road Bridge (LSWA12). Other sites where low numbers of EPT taxa were sampled included LSWA23, LSWA32 and LSWA33 (Figure 133). These sites tended to be dominated by flies and chironomids which collectively accounted for 68 – 84% of the total number of individuals collected at these sites.

Crustaceans were present throughout Little Swanport River, reaching a peak abundance of 13% at LSWA09. Significant numbers crustaceans were also collected from Eastern Marshes Rivulet (LSWA22 and LSWA23) (Figure 135). Molluscs were most abundant at sites LSWA07 (17%) and LSWA30 (16%) (Figure 135). The principal members of this group were snails of the family Hydrobiidae.

Subsequent sampling of the Little Swanport catchment in autumn 2004 revealed a significant change in macroinvertebrate community composition. Sites which were sampled in both seasons had a significantly richer fauna in autumn 2004 than in spring 2003 (Figure 131a). In many cases this was due to a significant increase in the diversity and abundance of caddisflies collected from each site. The number of

caddisflies was found to be highest at LSWA05 where they represented over 20% of the macroinvertebrates collected compared to 0.7% in the spring 2003 sample. Conversely the abundance of stoneflies display a marked decrease from 40-60% in spring 2003 to typically less than 10% in autumn 2004. Mayflies were found in similar numbers as in spring 2003 except at LSWA34 and LSWA37 where their abundance was reduced to 8% and 0% of total numbers. Collectively numbers of EPT taxa fell to approximately half of those observed in spring 2003. At most sites there was a corresponding in the proportion of crustaceans and molluscs.

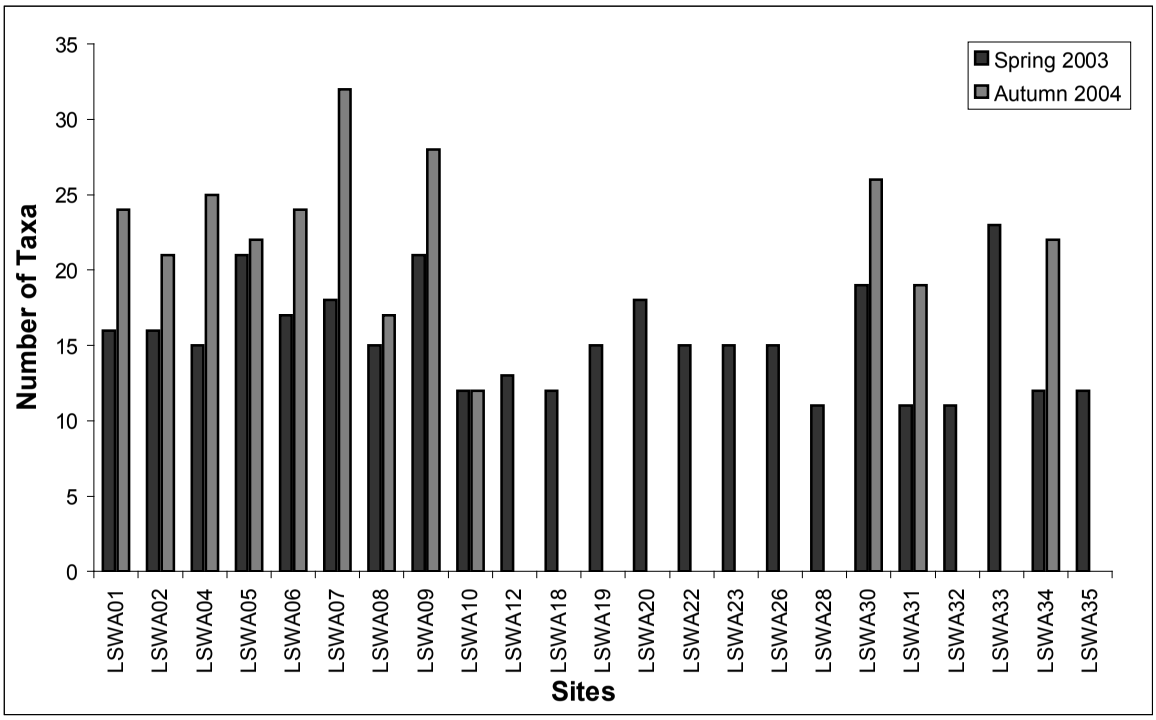
5.2.2 Edgewater habitat

As with the riffle habitat, caddisflies were more abundant in the autumn than the spring with the exception of Buxton River in which caddisflies accounted for more than 70% of all macroinvertebrates collected in spring 2003. However this was almost exclusively due to the high number of caddisflies of the family Leptoceridae. In the Little Swanport River mainstream, caddisflies were most abundant in the lower reaches (LSWA01 to LSWA04) contributing to approximately 50% of individuals collected. Mayflies were found to comprise a much higher proportion of the macroinvertebrate community in the edgewater habitat than in the riffle habitat, particularly in some of the tributaries, where their numbers exceeded 20% of the total sample. However with the exception of a few sites, this study found little difference in the proportion of mayflies between the spring and autumn sampling seasons. Stoneflies were dominant in far fewer sites than in the riffle habitat with only the Little Swanport River at Pine Hill (LSWA07) and Rocka Rivulet (LSWA21) having abundances exceeding 30%. As with the riffle habitat, stoneflies generally contributed to less than 5% of individuals collected.

Collectively, EPT taxa dominated the lower reaches of the Little Swanport River, particularly in autumn, accounting for almost 70% of all taxa. The proportion of EPT taxa displayed a decreasing trend towards the upper part of the catchment, falling to as little as 1% at McGills Marsh (LSWA11) in Spring 2003. Chironomids generally displayed the opposite pattern, increasing from over 10% at LSWA01 to over 40% at LSWA11. At all sites chironomids were more abundant in spring than in autumn.

With the exception of Green Tier Creek (LSWA20) and Rocka Rivulet (LSWA21), crustaceans were collected in significant numbers in both spring and autumn. The majority of crustaceans were of the families Ceinidae and Eusiridae (both amphipods). Molluscs were most abundant at the Little Swanport River at Pine Hill (LSWA07), Pages Creek (LSWA26) and Nutting Garden Rivulet (LSWA30) with abundances raging from 20-30%. At other sites their abundance was generally less than 10%.

(a)



(b)

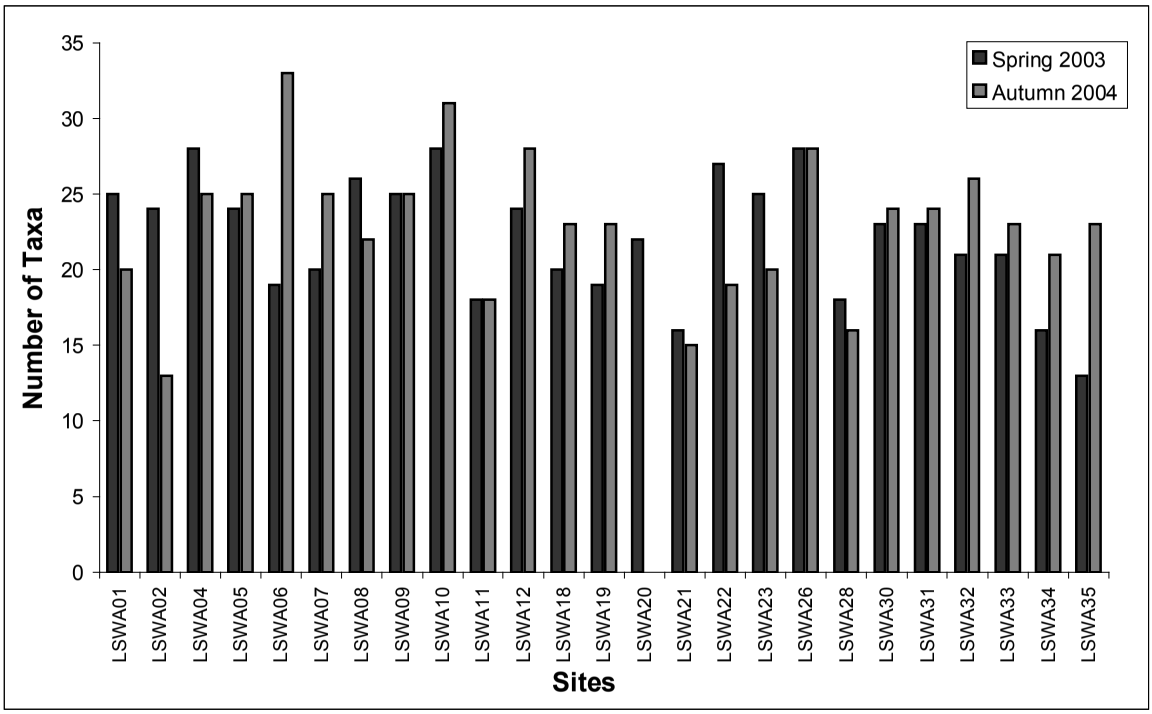


Figure 131: Total number of taxa collected from: a) riffle habitat and b) edgewater habitat at monitoring sites in the Little Swanport catchment.

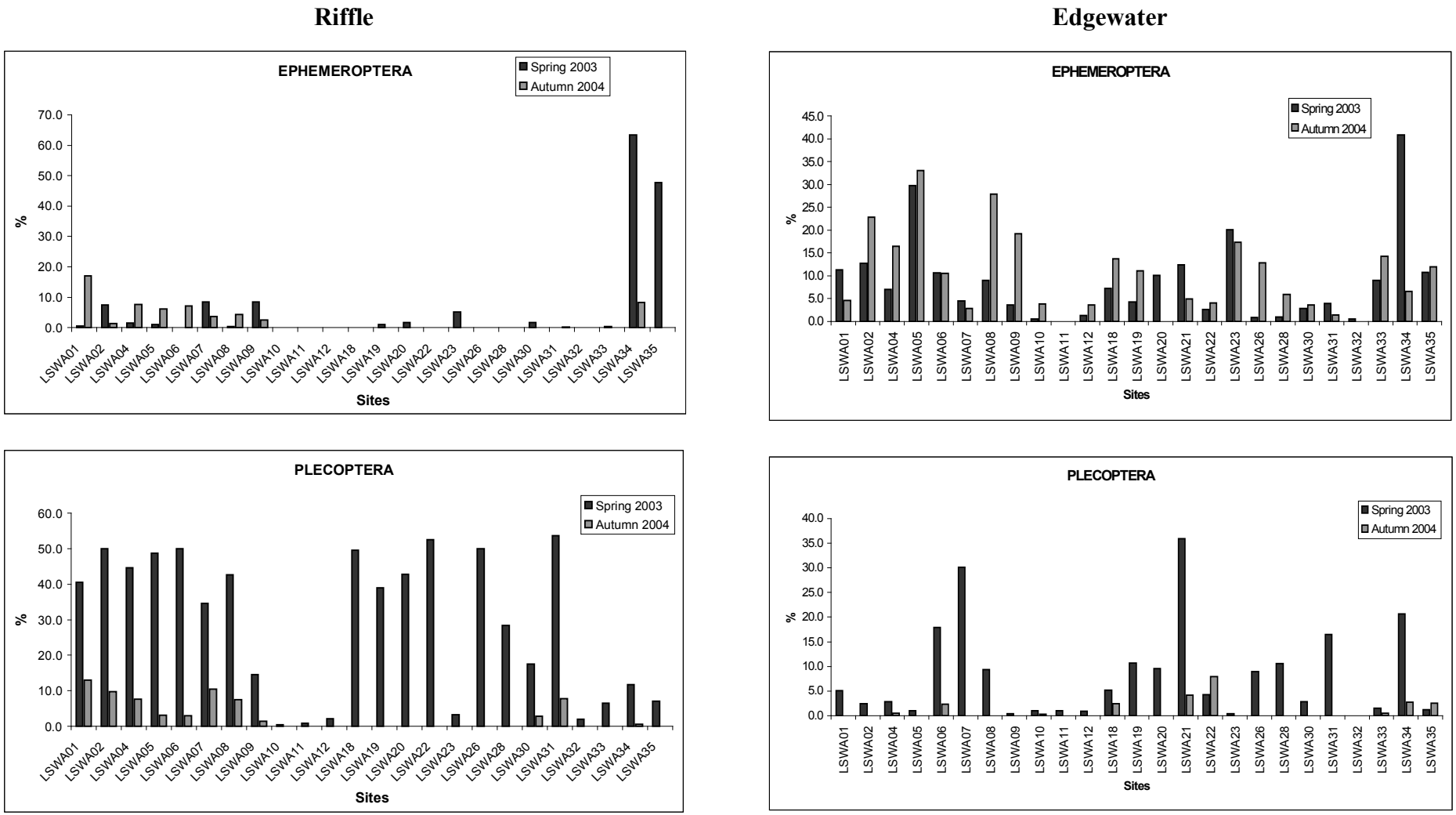
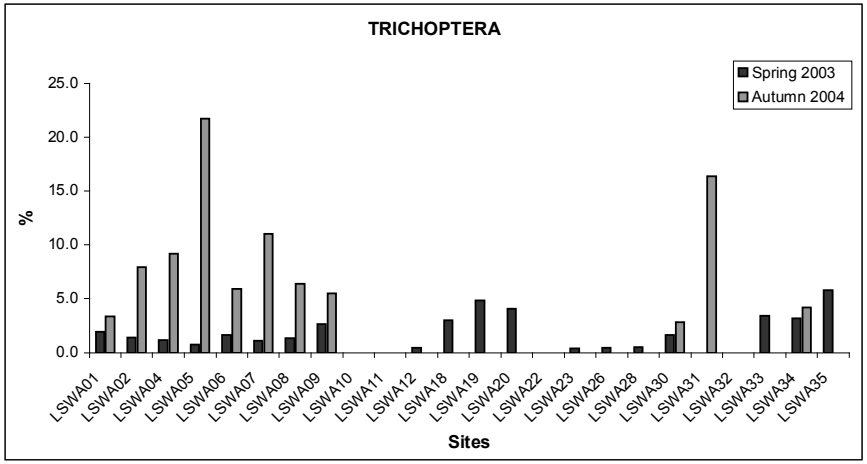
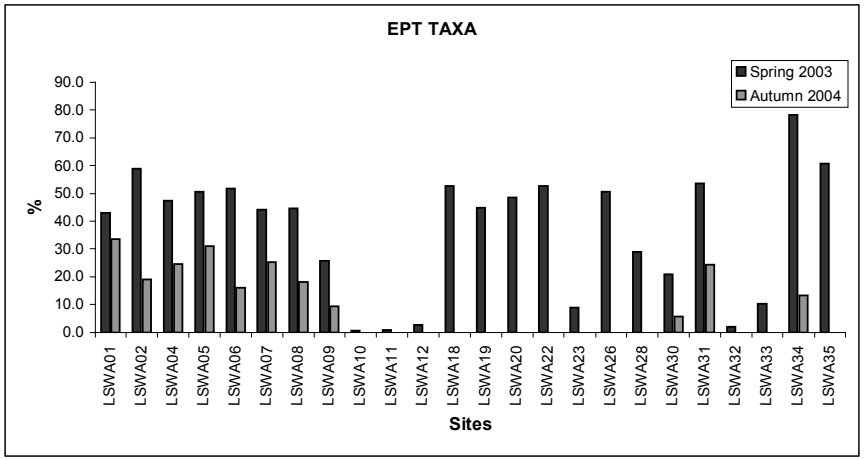


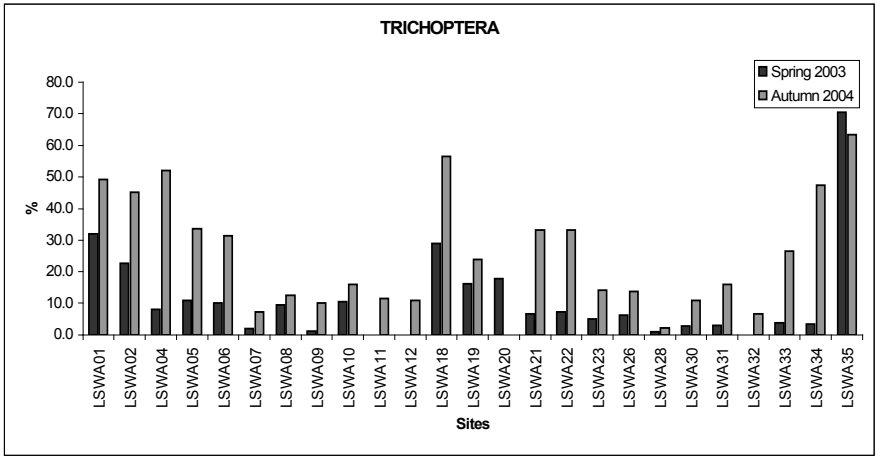
Figure 132: Numbers of mayflies (Ephemeroptera) and stoneflies (Plecoptera) as a proportion of the total number of taxa collected in the riffle and edgewater habitat at each site in the Little Swanport catchment.

Riffle





Edgewater



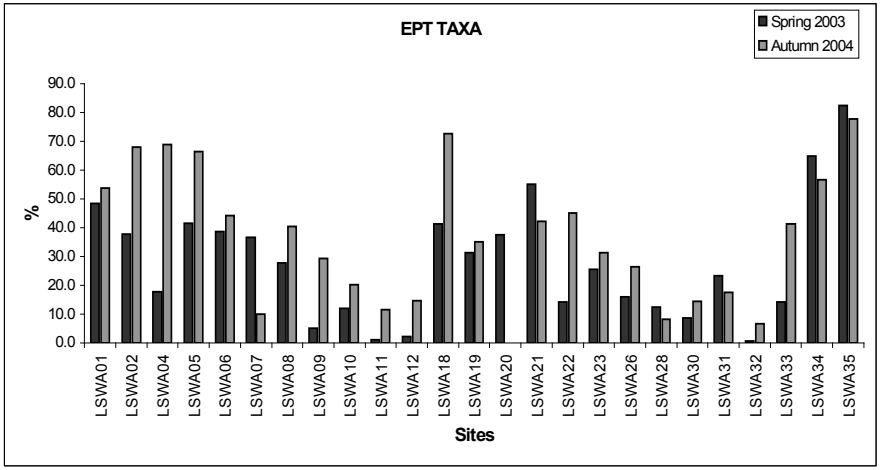
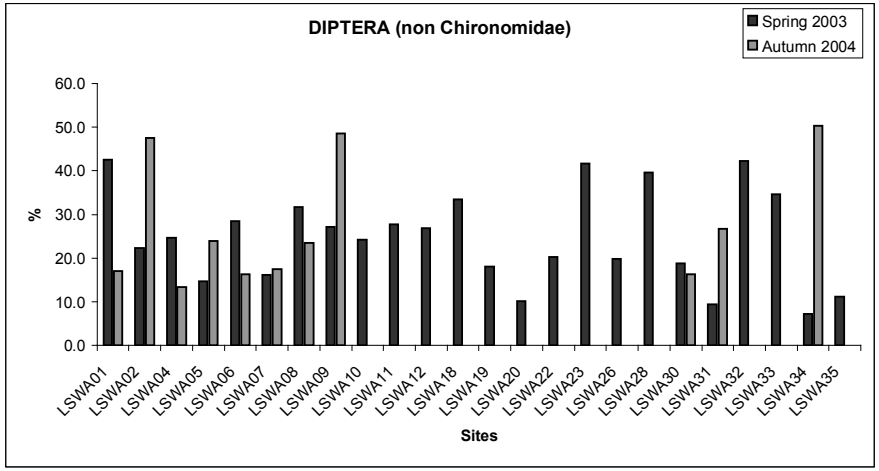
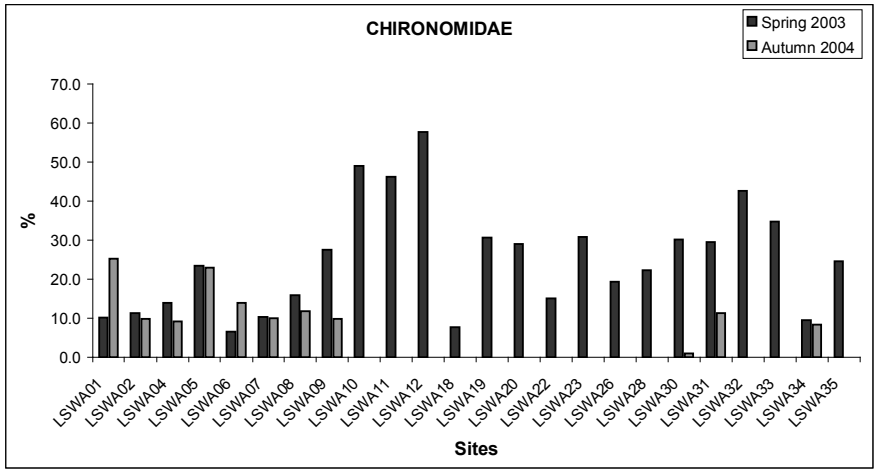


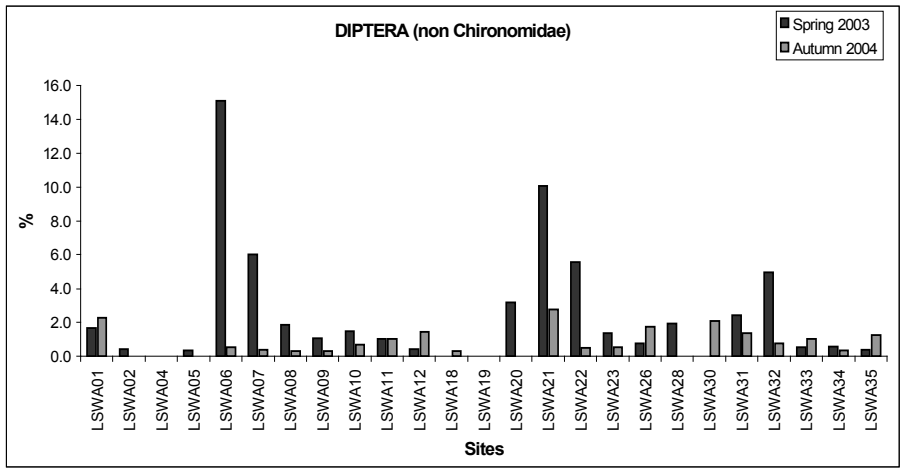
Figure 133: Numbers of caddis flies (Trichoptera) and EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa as a proportion of the total number of taxa collected in the riffle and edgewater habitat at each site in the Little Swanport catchment.

Riffle





Edgewater



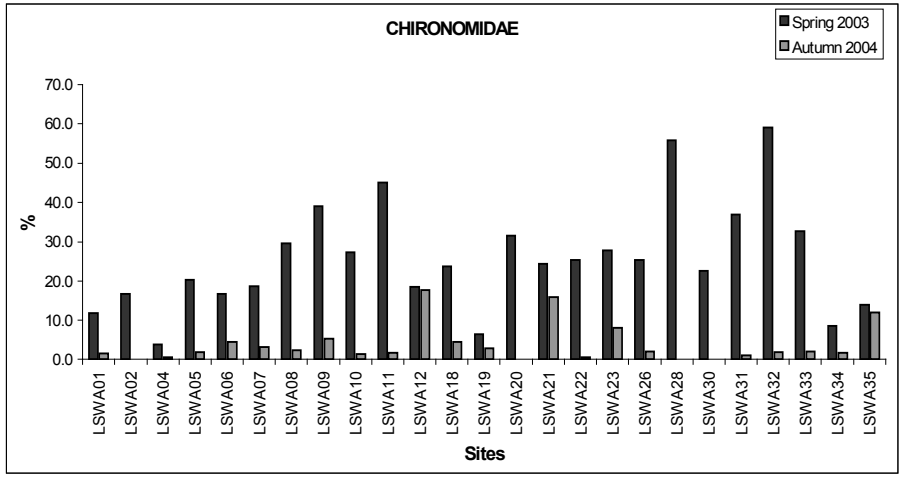
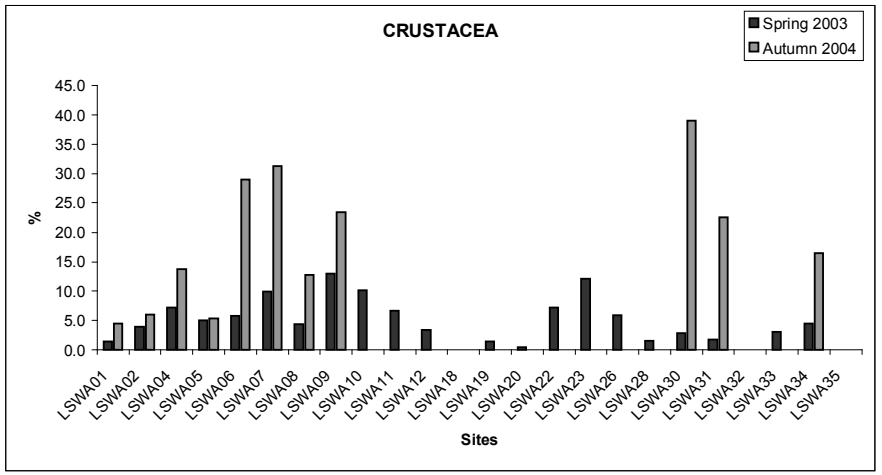
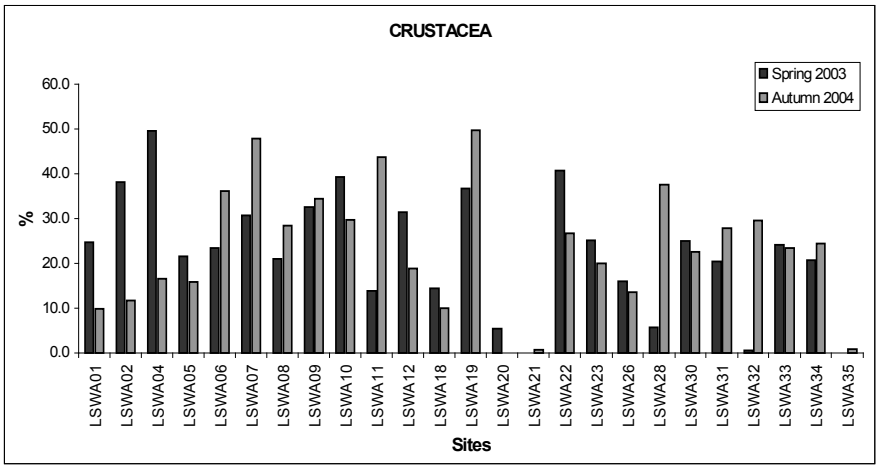
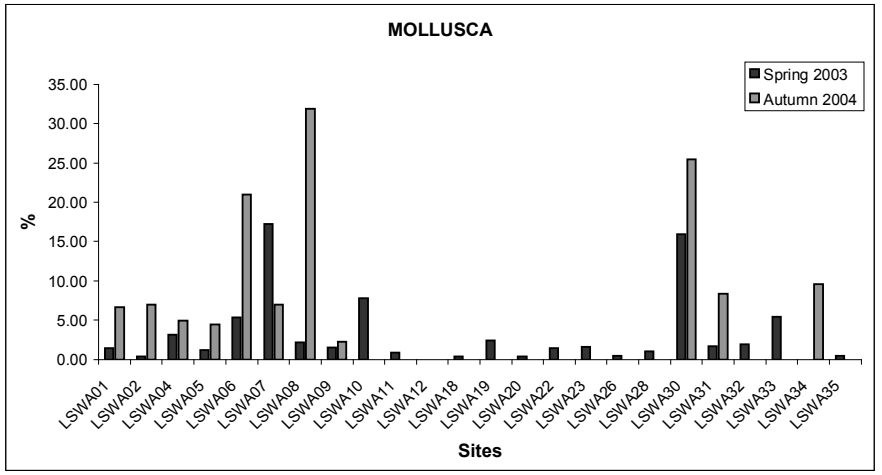


Figure 134: Numbers of flies (Diptera) and midges (Chironomidae) as a proportion of the total number of taxa collected in the riffle and edgewater habitat at each site in the Little Swanport catchment.

Riffle | **Edgewater**







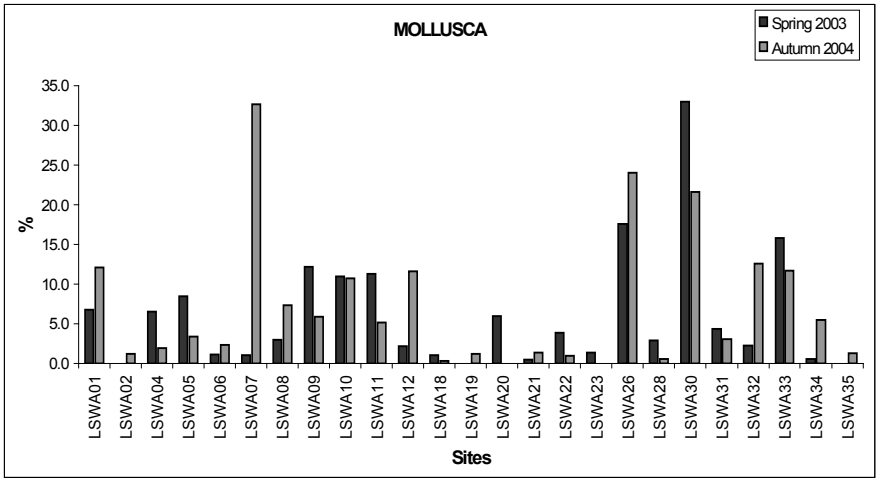


Figure 135: Numbers of Crustacea and Mollusca as a proportion of the total number of taxa collected in the riffle and edgewater habitat at each site in the Little Swanport catchment.

5.2.3 Multivariate analysis

Combined season data

At the dissimilarity level of 0.72, the UPGMA classification clearly distinguishes riffle samples from edgewater samples. (Figure 136). These groups are also separate in the ordination plot (Figure 137). Three groups can be distinguished in the edgewater samples. In the cluster analysis, Pages Creek east of Big Lagoon (LSWA28) and Rocka Rivulet (LSWA21) are separate from other sites and site groups, whilst the edge sample from the Little Swanport River at Pine Hill (LSWA07) was more closely related to riffle samples than to other edgewater samples. Group 1 consists of two sites in the uppermost reaches of the Little Swanport River mainstream (LSWA11 and 12) as well as tributary sites on Crichton Creek (LSWA32) Nutting Garden Rivulet (LSWA30 and 31) and Pages Creek (LSWA26). Sites in the lower to mid reaches of the Little Swanport River, together with sites on Eastern Marshes Rivulet (LSWA 22 and 23), Green Tier Creek (LSWA19) and Ravensdale Rivulet form a large group (Group 2) with smaller internal groupings. Group 3 is a small group consisting of sites on Pepper Creek (LSWA18), Buxton River (LSWA35) and Lisdillon Rivulet (LSWA34).

Fewer sites are included in the classification of the riffle data, as only sites for which riffle samples were collected in both seasons were considered for this analysis. The UPGMA classification for the riffle data distinguishes two groups of sites. The smaller of the two groups is composed of a site on Nutting Garden Rivulet (LSWA 30) and the edgewater sample from the Little Swanport River at Pine Hill (LSWA07). The remainder of the sites form the second group, with sites in the lower to middle reaches of the Little Swanport River (LSWA01 to 08) forming a tight internal cluster reflecting the homogeneous nature of the macroinvertebrate community at these sites. These sites are hydrologically similar to each other in that they have flow, and therefore sufficient riffle habitat throughout most of the year. As a consequence, samples from these sites are characterised by having a higher proportion of flow dependant taxa or 'flow obligates' such as mayflies, stoneflies, water pennies and some caddisflies than other tributary sites at which flow is more intermittent. These sites are also located within the geomorphic zones 3 (partly confined) and 4

(confined), indicating that there may also be some geomorphic influence to this structural similarity.

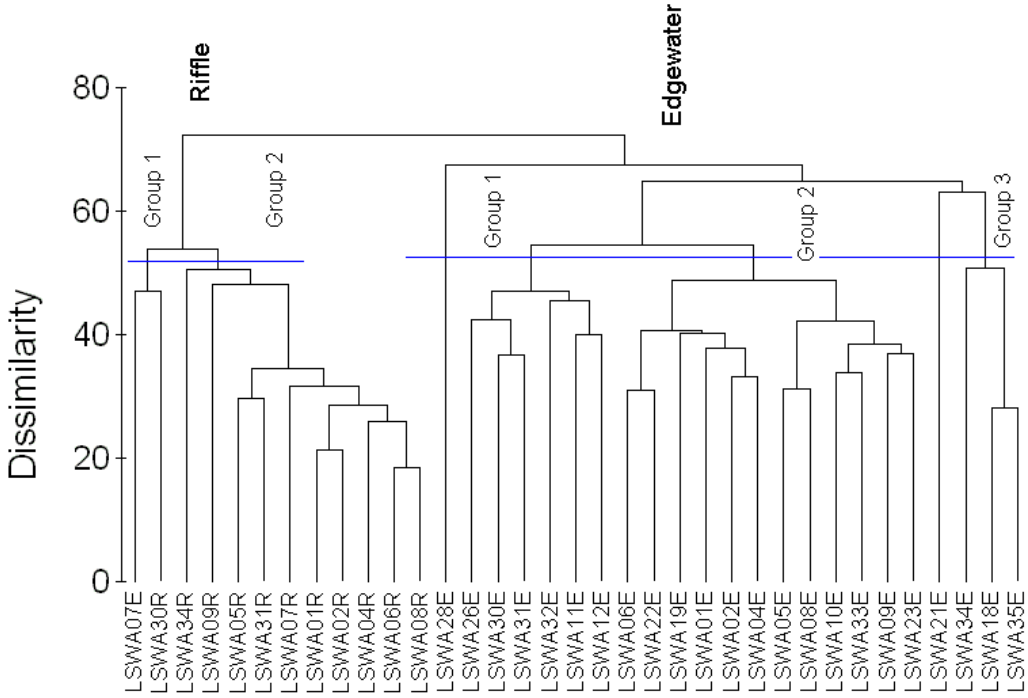


Figure 136: UPGMA classification of the combined season data.

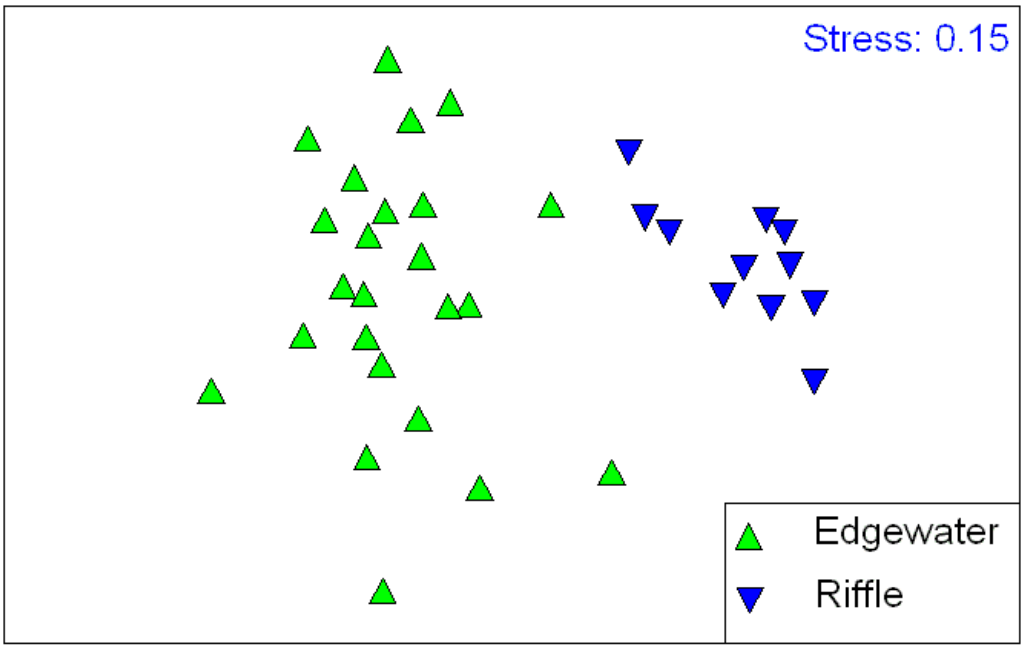


Figure. 137: MDS ordination of the combined season data.

Spring 2003 data

The UPGMA classification for the spring 2003 data distinguishes two major groups separating riffle from edgewater macroinvertebrate samples at a dissimilarity level of 0.74 (Figure 138). The edgewater sample from Buxton River (LSWA35), which was the least diverse edgewater sample collected (11 taxa) fell outside these two main groups.

Three groups are apparent in the classification of the edgewater samples. However, the classification of the spring 2003 data produced groupings different in composition to the groupings generated by the combined season data. Only 10 sites maintained the same site groups (43% similarity) with most sites swapping from Group 1 of the combined season classification to Group 2 in the spring 2003 classification. Group 1 contains sites in the mid and upper reaches of the Little Swanport mainstream as well as tributary sites on Eastern Marshes Rivulet (LSWA22 and 23), Ravensdale Rivulet (LSWA33), Pages Creek (LSWA26) and Green Tier Creek (LSWA20) (Figure 140). This group comprises of sites where the riparian zone has suffered noticeable disturbance through clearing for grazing or invasion by exotic species. These sites occur in the slower flowing reaches of the little Swanport catchment and tend to have a higher proportion of macrophyte cover.

Group 2 contains sites in the lower reaches of the Little Swanport mainstream and sites on Nutting Garden Rivulet (LSWA30 and 31), Pepper Creek (LSWA18) and Green Tier Creek (LSWA19). These sites are characterised by a high proportion of native riparian vegetation with little intrusion by exotic species. The edgewater habitat at these sites consists of leaf packs and other detritus derived from the riparian vegetation which tends to support a different suite of macroinvertebrate taxa from those sites dominated by macrophytes. Despite this, the two groups had a similar mean number of taxa.

Group 3 comprises of two sites - Crichton Creek (LSWA32) and a site in the upper reaches of Pages Creek (LSWA28). In addition, the edgewater samples from two sites- Rocka Rivulet (LSWA21) and Lisdillon Rivulet (LSWA 34) were located in the lower half of the dendrogram, indicating that they were more similar to the riffle samples than to other edgewater samples.

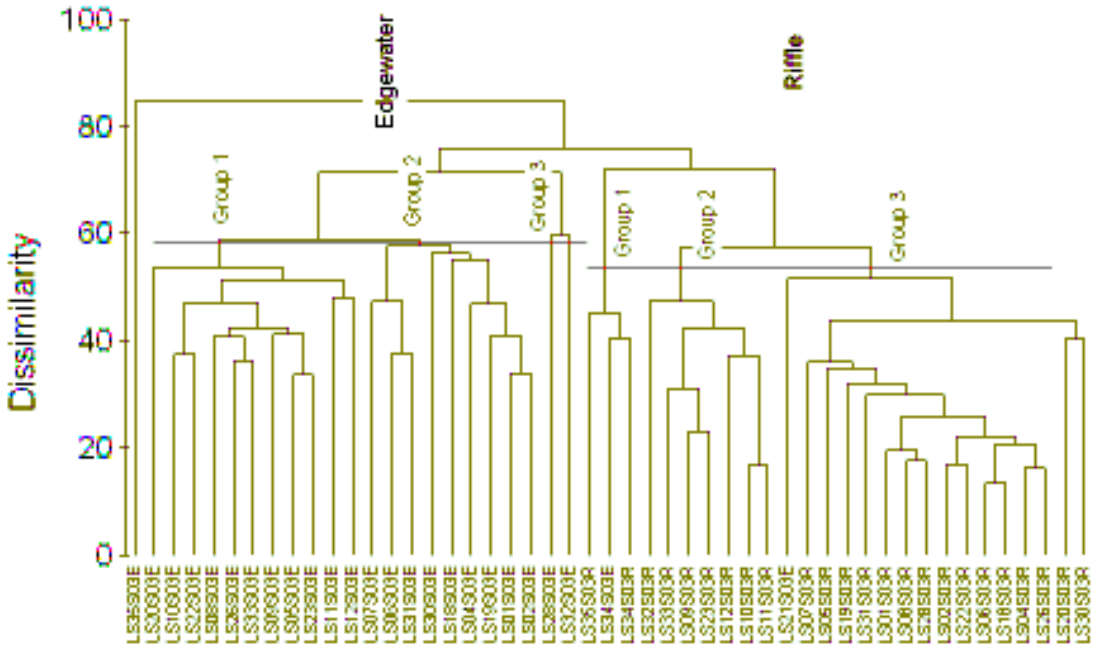


Figure 138: UPGMA classification of the spring 2003 data.

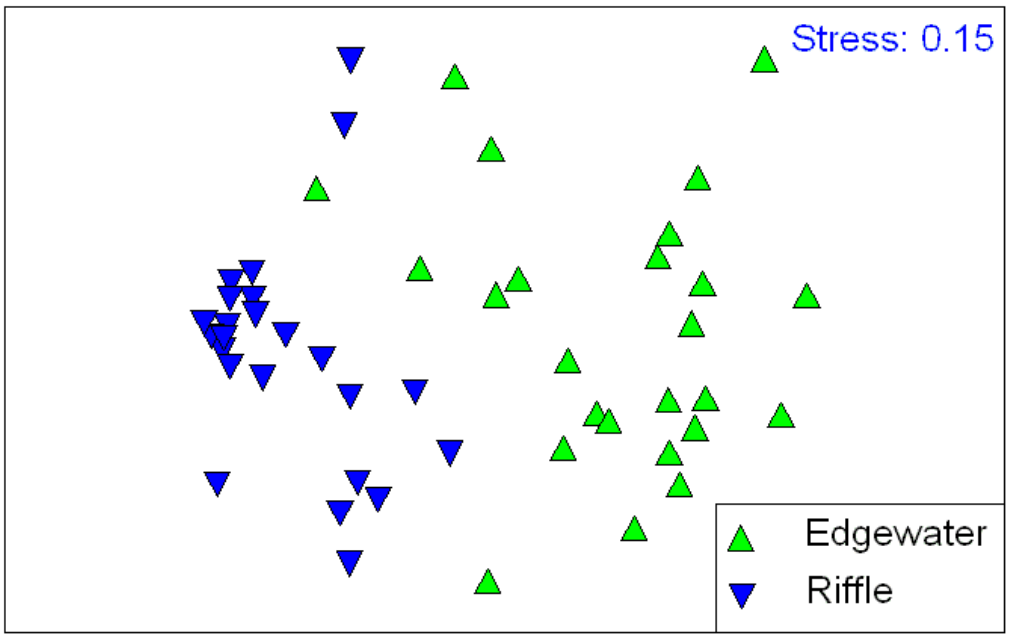


Figure. 139: MDS ordination of the spring 2003 data.

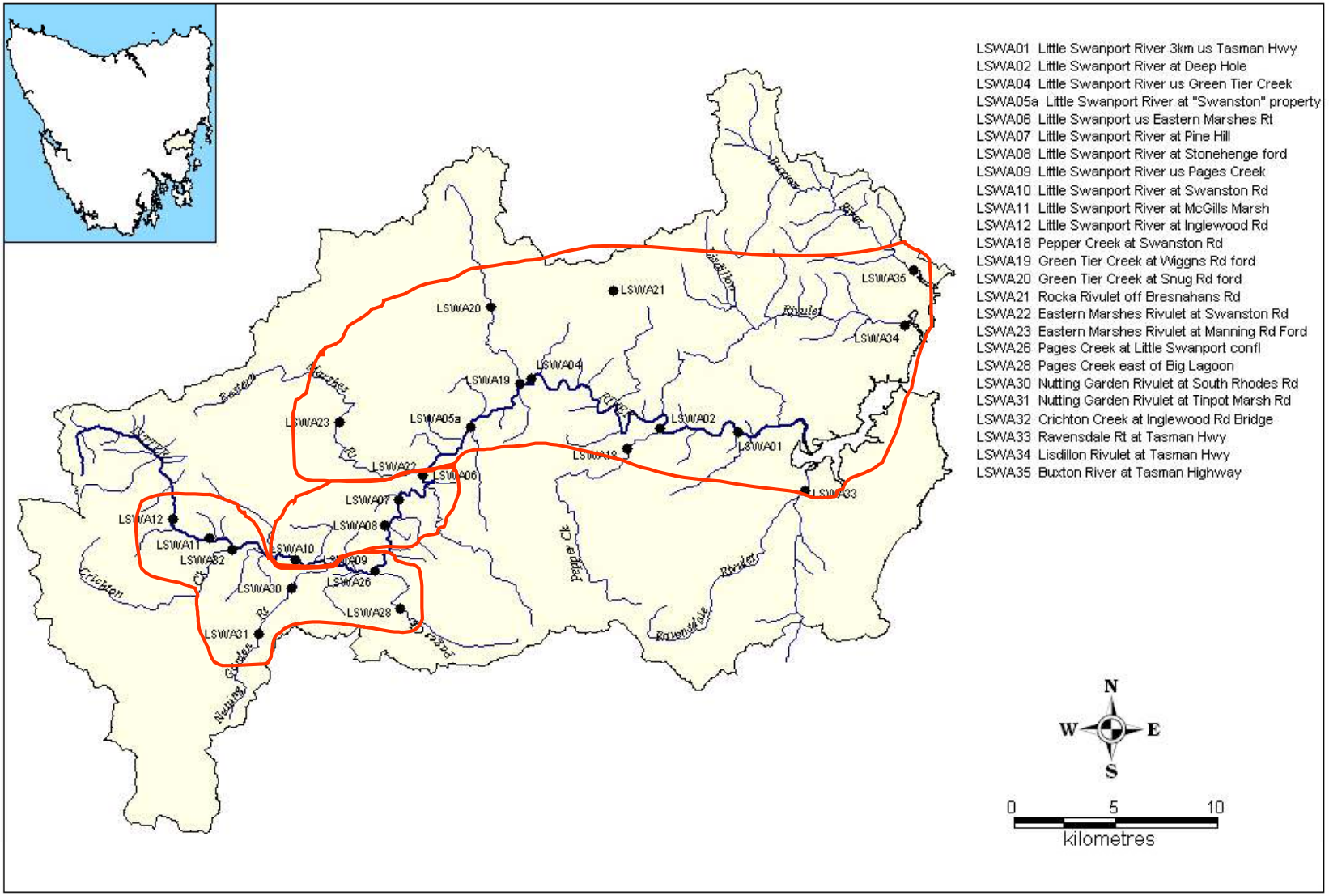


Figure 140: Catchment map displaying UPGMA site groups for the spring 2003 edgewater samples.

For the riffle habitat, three groups are apparent. Buxton River (LSWA35) and Lisdillon Rivulet form a small group (Group 1) which is clearly separated from the other groups at a dissimilarity level of 0.72. Group 2 contains sites in the upper reaches of the Little Swanport River (LSWA09-12), Ravensdale Rivulet (LSWA33) Crichton Creek (LSWA32) and Eastern Marshes Rivulet (LSWA23). This group is similar to Group 1 of the edgewater classification with 7 of the 8 sites retaining the same group membership (87.5% similarity). Whilst the groupings generated by the edgewater data are correlated with land use, riparian vegetation and the type of edgewater habitat, the classification of the riffles appears to be more related to hydrological factors, particularly the intermittency of flow (see below).

With the exception of the Little Swanport River upstream of Pages Creek (LSWA09), flow in Group 2 sites is intermittent, resulting in isolated pool formation following cessation of flow. A direct consequence of this is the loss of suitable riffle habitat, particularly for flow dependant taxa or "flow obligates", deterioration of water quality and alteration of food resources. Other taxa that are less flow-dependant ("flow facultatives") are able to use the pools as refugia to survive this periodic dewatering. Following the resumption of flow, recolonisation of the riffle habitat is relatively rapid with a distinct and predictable sequence of biota. Recolonisation by fauna from refugia is an important mechanism in this recovery. In many of the Group 2 sites, the macroinvertebrate fauna is dominated by early colonisers such as bloodworms (Chironomidae) and blackfly larvae (Simuliidae) whilst flow dependant and/or pollution sensitive taxa such as mayflies, stoneflies and caddisflies are found in very low numbers or are conspicuously absent. As a consequence, sites in this group have lower taxon richness than other sites (average 15.2).

Autumn 2004 data

The UPGMA classification for the autumn 2004 data clearly distinguishes edgewater samples from riffle samples at a dissimilarity level of 0.8. Three groups can be distinguished in the edgewater samples (Figure 141). In the cluster analysis, Pages Creek, east of Big Lagoon (LSWA28) and Rocka Rivulet (LSWA21) are clearly separated from all other sites and site groups. Tributary sites on Crichton Creek (LSWA32), Nutting Garden Rivulet (LSWA30 and 31) and Pages Creek (LSWA26)

form a group (Group1) with the two most upstream sites on the Little Swanport mainstream (LSWA11 and 12). Group 2 is formed by the sites in the middle to upper reaches of the Little Swanport River mainstream (LSWA06 –10) plus the upper site on Eastern Marshes Rivulet (LSWA23). Group 3 consists of sites on the Little Swanport River mainstream and tributaries in the lower part of the catchment as well as non-tributary sites on Ravensdale Rivulet (LSWA34) and Buxton River (LSWA35).

Classification of the autumn data produced groupings different in composition to the groupings generated by the spring 2003 data, with nearly half of the sites changing group membership. However the site groupings are more geographically distinct than the spring 2003 data, clearly separating the upper, middle and lower catchment (Figure 141) which broadly reflect, riparian vegetation and land use patterns within the catchment.

Fewer sites are included in the classification of the riffle data, since riffles were not present at many of the tributary sites and sites in the upper reaches of the Little Swanport River (LSWA10, 11 and 12). The autumn 2004 dataset distinguishes three groups at a dissimilarity level of 0.5. Group 1 consists of two sites on Nutting Garden Rivulet (LSWA30 and 31). These sites are moderately diverse having 26 and 19 taxa respectively and are characterised by high numbers of hydrobiid snails, ceinid amphipods and blackfly larvae (Simuliidae). Group 2 consists of Lisdillon Rivulet (LSWA34) and the Little Swanport River upstream of Pages Creek (LSWA09). In autumn 2004, the riffle habitat at these sites was marginal due to low flow. The macroinvertebrate samples contained many taxa which are commonly found in the edgewater habitat such as planorbid snails, freshwater shrimps, predatory diving beetles (Dytiscidae) caenid mayflies, hydroptilid caddisflies and midges of the subfamily Tanypodinae.

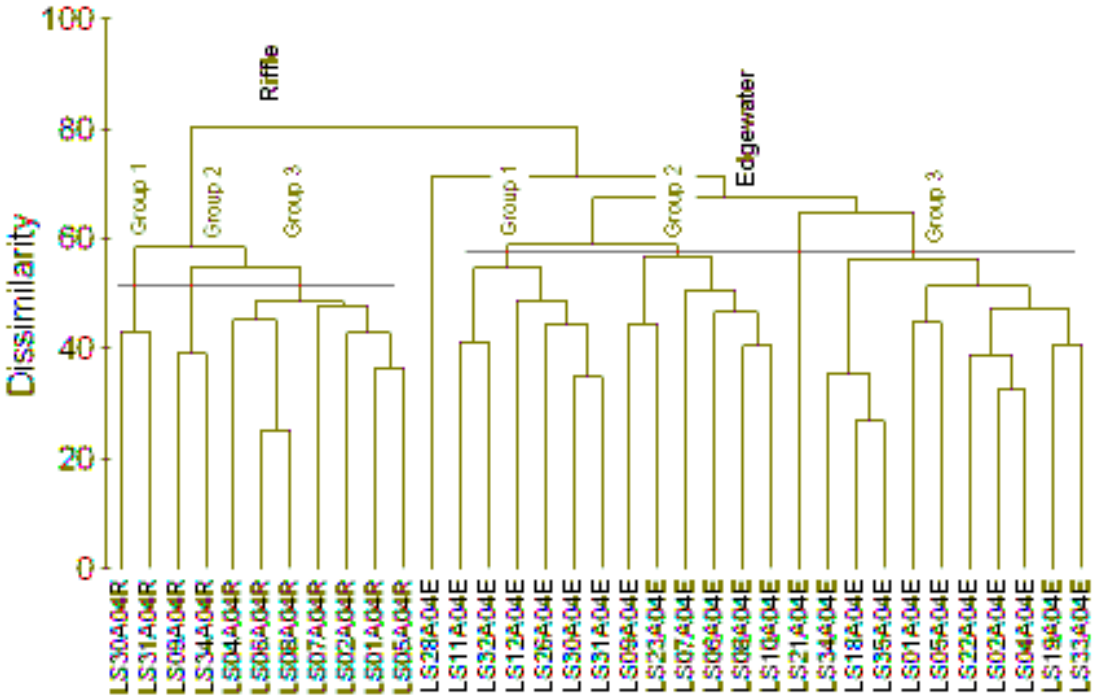


Figure 141: UPGMA classification of the autumn 2004 season data.

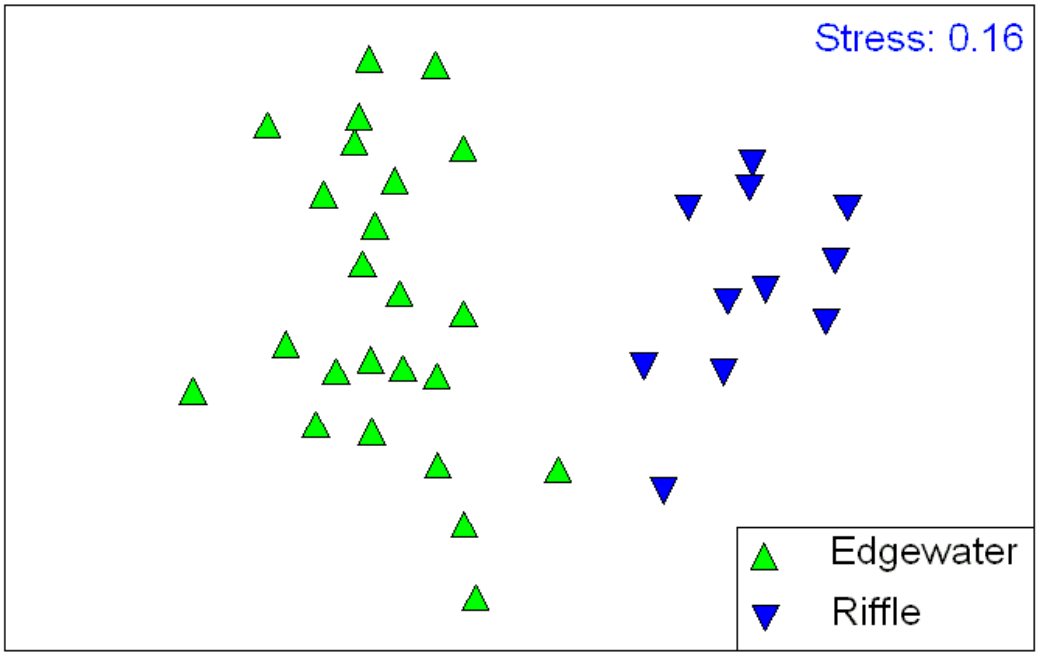


Figure. 142: MDS ordination of the autumn 2004 data.

The remaining group (Group 3) contains sites on the Little Swanport mainstream (LSWA01 to 08). The mainstream sites cluster tightly within this group reflecting their homogeneous nature relative to the overall range of sites. This group has a higher mean number of taxa than the other groups and the macroinvertebrate samples

contain taxa more typical of the riffle habitat such as water pennies (Psephenidae) riffle beetle adults and larvae (Elmidae), dragonfly larvae (Telephlebidae) and midges of the subfamily Orthocladiinae. As with the spring riffle data, flow appears to be the primary driver for the site groupings.

5.2.4 AUSRIVAS analysis

Spring 2003

AUSRIVAS outputs for the edgewater habitat classed 19 of 25 sites (76%) as equivalent to reference (Band A). Six sites (LSWA05, 11, 12, 28, 32,and 34) were classed as significantly impaired (Band B) with OE scores ranging from 0.66 to 0.81 indicating a substantial loss of taxa (19-34%) relative to reference sites (Table 33 and Figure 143). Inspection of the diagnostic data shows that taxa expected to occur but not collected at these sites included pea shells (Spaeriidae), marsh beetles (Scirtidae), biting midges (Ceratopogonidae), gripopterygid and notonemourid stoneflies and caddisflies of the family Philorheithridae and Leptoceridae. Despite many of the sites having high conductivity levels, the AUSRIVAS outputs indicate that the lower river health ratings are due to factors other than water quality. At many of these sites, the riparian zone is extremely modified, having either been cleared for grazing or dominated by exotic species such as gorse which limits the amount and character of instream woody material (a food source or habitat refuge for many of the aforementioned taxa). The lower AUSRIVAS scores therefore are more likely due to limited habitat availability.

In contrast to the edgewater habitat, AUSRIVAS outputs for the riffle habitat classed only 2 sites- Nutting Garden Rivulet at South Rhodes Rd (LSWA30) and Ravensdale Rivulet (LSWA33) as equivalent to reference (Band A). Fifteen of the 24 sampled sites (63%) were assessed as significantly impaired (Band B) and 7 sites (29%) were assessed as severely impaired (Band C) (Table 33). Sites assessed as severely impaired had OE scores ranging from 0.39 to 0.54 and were located predominantly in the upper part of the catchment (Figure 143). Taxa predicted to occur but not collected at these sites included marsh beetles (Scirtidae), riffle beetle larvae (Elmidae), craneflies (Tipulidae), baetid and leptophlebiid mayflies and caddisflies of

the families Calocidae, Conoesucidae and Leptoceridae. Four of the seven sites (LSWA11, 12, 28 and 32) were also determined by the edgewater model to be significantly impaired. However degradation of the riffle habitat is related more to hydrological factors particularly flow variability. With the exception of the site at Nutting Garden Rivulet at Tinpot Marsh Rd (LSWA31), flow at the other sites is intermittent, resulting in the loss of suitable riffle habitat for mayflies, stoneflies, riffle beetles and other flow dependent taxa for long periods throughout the year.

Table 33: AUSRIVAS outputs for sites in the Little Swanport catchment.

			Riffle		Combined Season		Edgewater		Combined Season	
Code	**Name**	**Season**	**OE50**	**Band**	**OE50**	**Band**	**OE50**	**Band**	**OE50**	**Band**
LSWA01	Little Swanport River 3km u/s of Tasman Hwy	Spring 2003	0.67	B	0.7	B	1.07	A	0.99	A
		Autumn 2004	0.85	B			0.73	B		
LSWA02	Little Swanport River at Deep Hole	Spring 2003	0.68	B	0.65	B	0.85	A	0.95	A
		Autumn 2004	0.76	B			0.57	B		
LSWA04	Little Swanport River us Green Tier Creek	Spring 2003	0.72	B	0.88	A	1.02	A	1.01	A
		Autumn 2004	0.86	A			0.74	B		
LSWA05	Little Swanport River at "Swanston" property	Spring 2003	0.67	B	0.68	B	0.79	B	1.01	A
		Autumn 2004	0.75	B			0.96	A		
LSWA06	Little Swanport River us Eastern Marshes Rivulet	Autumn 1998		NS		NS	Out Exp		Out Exp	
		Spring 1998	0.8	B			0.85	A		
		Spring 2003	0.57	B	0.83	B	0.91	A	1.07	A
		Autumn 2004	0.81	B			1.06	A		
LSWA07	Little Swanport River at Pine Hill South	Spring 2003	0.65	B	0.82	B	0.91	A	0.95	A
		Autumn 2004	1	A			0.64	B		
LSWA08	Little Swanport River at Stonehenge ford	Spring 2003	0.58	B	0.6	C	1.07	A	1.07	A
		Autumn 2004	Out Exp				1.06	A		
LSWA09	Little Swanport River us Pages Ck confluence	Spring 2003	0.82	B	0.7	B	0.86	A	0.89	A
		Autumn 2004	Out Exp				0.85	A		
LSWA10	Little Swanport River at Swanston Rd	Autumn 1998		NS		NS	0.95	A	Out Exp	
		Spring 1998		NS			0.92	A		
		Spring 2003	0.67	B		NS	0.86	A	1.13	A
		Autumn 2004		NS			0.95	A		
LSWA11	Little Swanport River at McGills Marsh	Autumn 2004		NS		NS	0.53	B	0.77	B
		Spring 2003	0.44	C			0.7	B		
LSWA12	Little Swanport River at 2nd Inglewood Rd Bridge	Spring 2003	0.54	C		NS	0.81	B	Out Exp	
		Autumn 2004		NS			0.95	A		
LSWA18	Pepper Creek at Swanston Rd	Autumn 1998		NS		NS	0.92	A	1.14	A
		Spring 1998		NS			0.97	A		
		Spring 2003	0.69	B		NS	0.91	A	1	A
		Autumn 2004		NS			1.02	A		
LSWA19	Green Tier Creek at Wiggins Rd. ford	Spring 2003	0.53	C		NS	0.92	A	1.05	A
		Autumn 2004		NS			0.78	B		
LSWA20	Green Tier Creek at Snug Rd Ford	Spring 2003	0.82	B		NS	0.96	A		NS
LSWA21	Rocka Rivulet off Bresnahans Rd	Spring 2003		NS		NS	1.01	A	0.73	B
		Autumn 2004		NS			0.56	B		
LSWA22	Eastern Marshes Rivulet at Swanston Rd.	Spring 1998		NS		NS	0.71	B		NS
		Spring 2003	0.45	C		NS	0.96	A	0.99	A
		Autumn 2004		NS			0.68	B		
LSWA23	Eastern Marshes Rivulet at Manning Rd. Ford	Spring 2003	0.58	B		NS	0.82	A	0.83	B
		Autumn 2004		NS						
LSWA26	Pages Creek at Little Swanport confluence	Spring 2003	0.67	B		NS	1.02	A	0.98	A
		Autumn 2004		NS			0.81	B		
LSWA28	Pages Creek east of Big Lagoon	Spring 2003	0.54	C		NS	0.66	B	0.9	A
		Autumn 2004		NS			0.53	B		
LSWA30	Nutting Garden Rivulet at South Rhodes Rd.	Spring 2003	0.96	A	0.65	B	1.01	A	0.96	A
		Autumn 2004	0.62	B			0.85	A		
LSWA31	Nutting Garden Rivulet at Tinpot Marsh Rd	Spring 1998	0.71	B		NS	0.97	A		NS
		Spring 2003	0.46	C	0.45	C	0.91	A	0.9	A
		Autumn 2004	0.55	C			0.93	A		
LSWA32	Crichton Creek at Inglewood Rd Bridge	Spring 1998	0.59	B		NS	0.3	C		NS
		Spring 2003	0.39	C		NS	0.81	B	Out Exp	
		Autumn 2004		NS			Out Exp			
LSWA33	Ravensdale Rivulet at Tasman H'way	Autumn 1998		NS		NS	Out Exp		Out Exp	
		Spring 1998		NS			0.43	C		
		Spring 2003	0.92	A		NS	0.91	A	0.94	A
		Autumn 2004		NS			0.72	B		
LSWA34	Lisdillon Rivulet at Tasman Hwy	Autumn 1998		NS		NS	0.69	B	1.18	X
		Spring 1998	0.96	A			1.18	A		
		Spring 2003	0.57	B	0.74	B	0.81	B	0.84	B
		Autumn 2004	0.81	B			1.04	A		
LSWA35	Buxton River at Tasman Tasman Hwy	Autumn 1998		NS		NS	0.97	A	0.91	A

NS – Not sampled
Out Exp – Outside the experience of the model

Autumn 2004

Twenty four sites were assessed in autumn 2004 as Green Tier Creek at Snug Road ford (LSWA20) was dry. Of these, 11 or 46% were equivalent to reference site condition (Band A) and 11 sites were assessed as significantly impaired (Band B). Sites at Eastern Marshes Rivulet at Mannings Road ford (LSWA23) and Crichton Creek at Inglewood Road Bridge (LSWA32) had conductivity levels which were under-represented in the reference dataset for the autumn edgewater AUSRIVAS model and were found to be "outside the experience of the model". In general, river health was poorer in autumn 2004 with 14 sites experiencing a decrease in OE scores compared to spring 2003. At 9 of these sites the magnitude of the decrease was sufficient to shift the sites from Band A to Band B. Expected taxa which were collected in spring 2003 and not autumn 2004 included predatory diving beetles (Dytiscidae), water boatmen (Corixidae), leptophlebiid and notonemourid mayflies and midges of the subfamily Tanypodinae and Chironominae.

Due to low flows in the Little Swanport catchment, sufficient riffle habitat for sampling was available at only the lower to mid reaches of the Little Swanport River (LSWA01 – 09), Nutting Garden Rivulet (LSWA30 and 31) and Lisdillon Rivulet (LSWA34). Of these, the Little Swanport River upstream of Green Tier Creek and at Pine Hill (LSWA04 and 07) were assessed as equivalent to reference. Four sites on the Little Swanport mainstream (LSWA01, LSWA02, LSWA05 and LSWA06) as well as Nutting Garden Rivulet at South Rhodes Road (LSWA30) and Lisdillon Rivulet were significantly impaired, and 2 sites (LSWA08 and 09) were outside the experience of the model due to high conductivity levels. Interestingly, despite the lower flows and poorer water quality, there was an increase in the number of taxa collected and a corresponding increase in OE scores in all but one site, compared to the spring 2003 season. Expected taxa collected in autumn 2004 but not present in spring 2003 included riffle beetle adults and larvae (Elmidae), mayflies and caddisflies of the families Hydropsychidae and Leptoceridae.

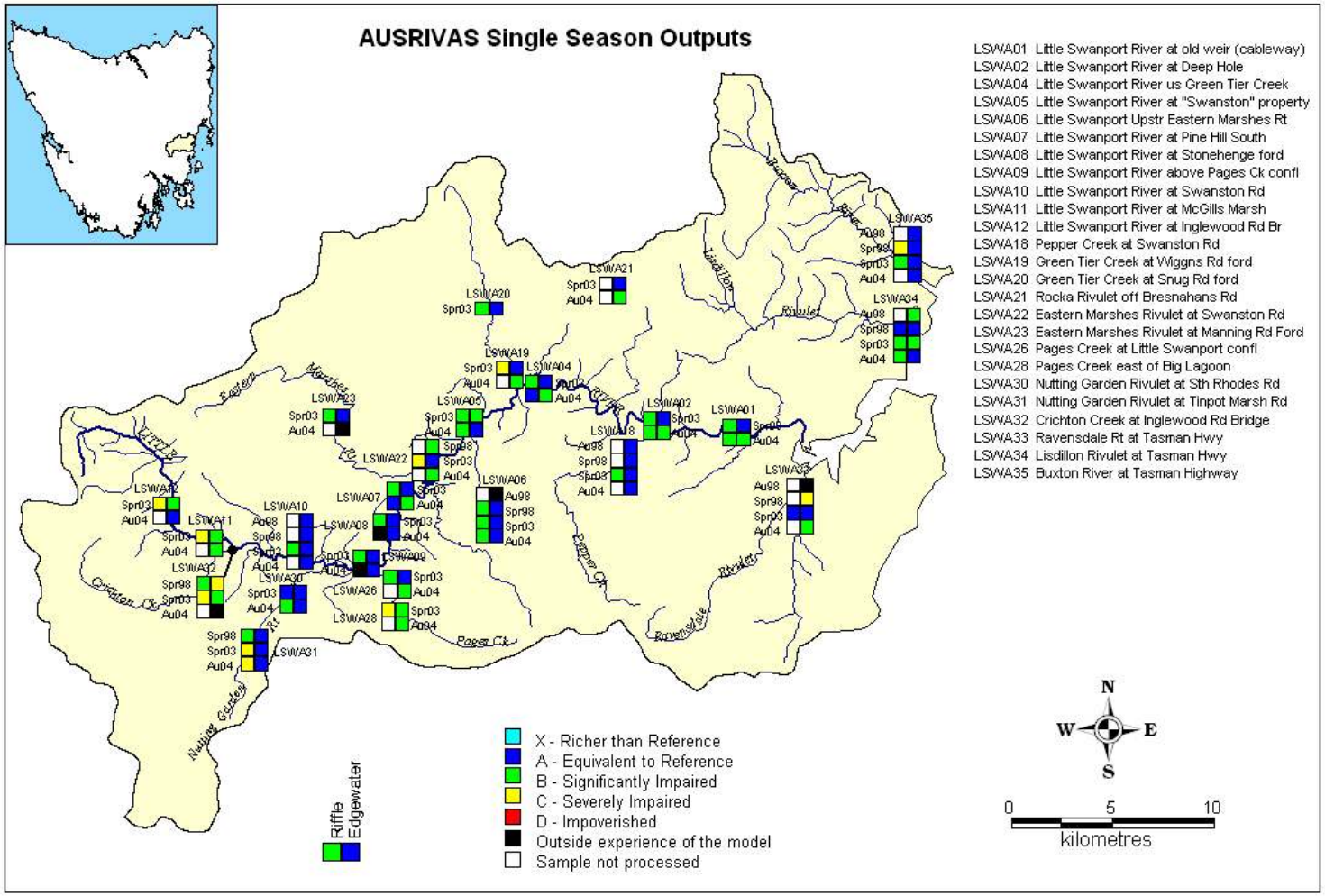


Figure 143: Single season AUSRIVAS outputs for sites in the Little Swanport catchment.

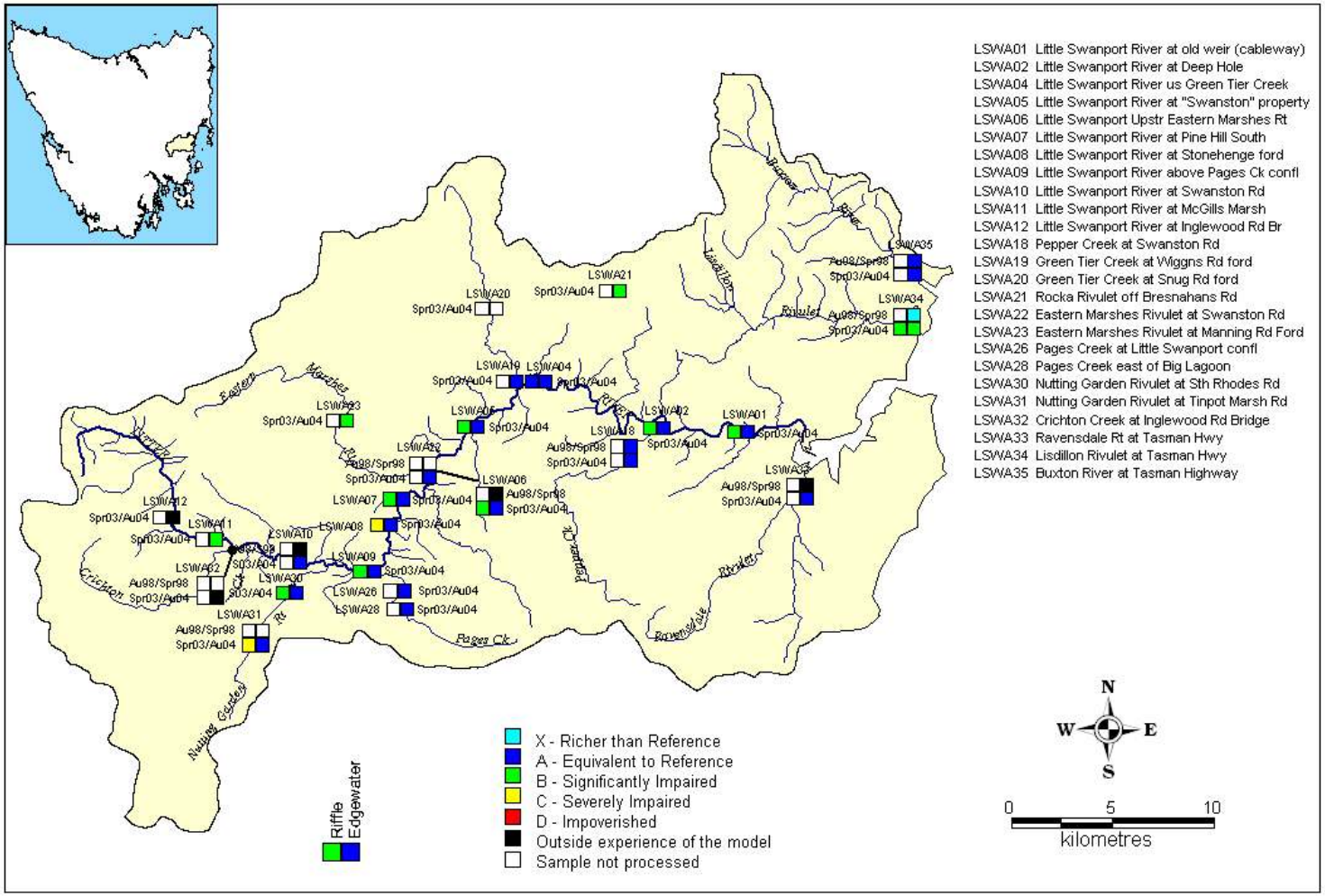


Figure 144: Combined season AUSRIVAS outputs for sites in the Little Swanport catchment.

Combined season

It is generally believed that macroinvertebrate assemblages are best characterised by combining data collected from two seasons. Combining seasonal data increases the taxa observed at a site in two ways. Firstly, as with any increased sampling effort, more habitat is sampled and therefore more taxa are collected; secondly, because of the variability in life cycles and turnover in different macroinvertebrate groups, some taxa are collected in one season but not in another. Larger taxa lists provide more taxa for predictions, making the combined season models more robust to small sampling variations in collected taxa. A larger list of taxa also increases the chance of detecting an impact because a larger range of taxa will provide a wider range of responses to more types of pollutants (Barmuta *et al*., 1998). The drawback of this approach is that two seasons worth of data need to be collected before an assessment can be made. This is particularly relevant in catchments such as the Little Swanport River where some of streams may be intermittent. Because of this, 13 sites could not be sampled in autumn 2004 due to insufficient riffle habitat.

For the sites where riffle habitat could be sampled during autumn 2004, combined season AUSRIVAS outputs classed only a single site – the Little Swanport River upstream of Green Tier Creek – as equivalent to reference. Eight sites were classified as significantly impaired (Band B) and 1 site – Nutting Garden Rivulet at Tinpot Marsh Road –as severely impaired (Band C).

The combined season AUSRIVAS model for edgewaters classed 18 sites (72%) as equivalent to reference and 3 sites as significantly impaired (Figure 144). The Little Swanport River at lower Inglewood Rd (LSWA12) and Crichton Creek at Inglewood Road bridge (LSWA32) were found to be outside the experience of the model due to high conductivity levels. An assessment could not be made for Green Tier Rivulet at Snug Road (LSWA20), as this site only has one season of data. Generally the pattern of river health assessed by the combined season edgewater model is similar to that generated by the spring edgewater model.

5.3 Discussion

Measurement and characterisation of the fish and macroinvertebrate community structure provides a biological approach for understanding the natural patterns of change and the degree of anthropogenic impacts on rivers in the Little Swanport catchment. The condition of the river environment varies considerably throughout the catchment from near pristine to highly degraded areas where agricultural activities appear to have a negative impact on the health of riverine communities. Sections of the Little Swanport River and associated tributaries have been extensively modified since European settlement. Natural habitat and water quality have been altered by land use, particularly from agricultural activities in the upper reaches of the Little Swanport River and on many of the tributaries. This is reflected in the lower diversity and abundances of fish and macroinvertebrate faunas and poorer AUSRIVAS scores in these areas. Interpretation of the AUSRIVAS outputs indicates that habitat modification, water quality degradation, or both negatively affect macroinvertebrate communities at many sites. Impacts from the physical degradation of instream and streamside habitat are often compounded by poor water quality, particularly in the upper catchment (see Chapter 4.1). Generally, water quality degradation tends to accumulate along a rivers length so that damage suffered at one part is compounded further downstream by additional impacts. However, because the physical nature of the landscape in the middle and lower catchment has prevented significant land use and riverine disturbance, this is not the case in the Little Swanport catchment. This has ensured that there is no general trend of decreasing taxon richness from the upper to the lower reaches of the catchment.

A number of water quality issues have been highlighted in the Little Swanport catchment (see Chapter 4), and these are strongly linked to the ephemeral nature of the hydrology and the intensity of land use. This has produced large variations in dissolved oxygen and turbidity, high conductivity and elevated nutrient concentrations.

Aquatic organisms become stressed when concentrations of dissolved oxygen fall below 6 mg/L (ANZECC, 1992) and are likely to become stressed by large daily changes that were typical of disturbed sites in the upper catchment. While this is at

least partly due to the ephemeral nature of the streams in the upper catchment, which at times are reduced to isolated pools that are susceptible to stagnation, organic enrichment may also be a factor, particularly where stock access is unrestricted. In these situations, excess nutrients can promote vigorous algal growth which can have a profound effect on macroinvertebrate community structure. Because blooms are often of a few or a single species of algae, the food resource for algal grazers and scrapers (snails, gripopterygid stonefly larvae, and some beetles and mayflies) can become very restricted, and the prolific growth of these can also reduce available habitat for other species.

Electrical conductivity in streams is closely related to catchment geology and the influence of groundwater, although their effects can be exacerbated by land clearing and irrigation practices (Davies, 2002). In the Little Swanport River electrical conductivity is highest in streams of the upper catchment, where levels above 2000 µS/cm were recorded. Such levels may cause stress to instream fauna (Metzling, 1993), most particularly salt-sensitive taxa such as mayflies and gastropods (Allan, 2006).

Whilst these measures of water quality give some indication of the environmental condition of a particular site, they do not give insight into the long-term biological health of a stream. The results from macroinvertebrate sampling show that land use, and impacts on the condition and extent of the riparian zone and instream habitat also have a strong influence on river health. Habitat degradation was evident at many sites throughout the upper and middle catchment of the Little Swanport River, in many cases took the form of eroded bank, instream sedimentation, channelisation, and the presence of exotic weed species in the riparian zone.

The quality of aquatic habitat is closely linked to riparian vegetation (Cummins, 1993). The type of vegetation along river banks can strongly influence stream morphology, including width and cross-sectional shape, by binding bank material and preventing bank slumping (Bessell-Browne, 2000). Vegetation type also affects the extent of trailing bank vegetation, the interception of sediment from runoff, water temperature and primary production through shading, and the deposition of

allochthonous organic material. Native riparian vegetation contributes large woody debris (branches or whole trees) to the stream, and this forms a major structural component of the stream morphology, and serves as an important link between terrestrial and aquatic systems (Hilderbrand *et a*l. 1997). Degradation of the riparian zone often leads to edgewater habitat destruction and loss of the natural buffer against contamination. This is a common feature of streams draining the upper catchment of the Little Swanport River. Sediment from bank erosion, often exacerbated by unrestricted stock access, and runoff from cleared land and from gravel roads has in many places blanketed the stream and degraded habitat at many sites. This is often compounded the prolific growth of Cumbungi (*Typha latifolia*) and other aquatic weeds which have responded to increased light levels and nutrient input to streams.

However, a significant factor in structuring fish and macroinvertebrate communities within the Little Swanport catchment is flow. Hydrological characterisation of the Little Swanport catchment (see Chapter 2) has shown that flows are naturally variable in this catchment, and that cease-to-flow periods are a natural part of the flow regime, although in the upper reaches of the Little Swanport River cease-to-flow periods have been modified. Flow generated disturbances such as floods and droughts periodically disrupt aquatic macroinvertebrate communities. (Lake, 2000). The contrasting states of flood and drought in many parts of the Little Swanport catchment means that streams fluctuate between being highly connected (during floods), to being highly disconnected (during droughts). The degree of connection between waterbodies on both a spatial and temporal scale strongly influences community composition (Sheldon, 2006).

During floods, rapidly moving water exerts high shear forces that suspend sediments, move and redistribute substrate materials, scour and abrade the streambed, move detritus and kill and displace biota. Floods have a significant influence on temporarily reducing species richness and total numbers of individuals but recovery to pre-flood conditions is generally rapid (Boulton and Lake, 1992). The availability of suitable refugia in streams may be a critical measure of the levels of resilience and resistance to high flow disturbance. (Brooks and Boulton, 1991). However recolonisation may also occur by drift, movement from the hyporheic zone and by adult (aerial) dispersal. Some species, notably simuliids and chironomids colonise bare patches rapidly

whereas grazers and predators are slow and steady colonisers. This is illustrated by observations in the Little Swanport catchment where the abundance of these two taxa was much higher in the spring 2003 sample (which followed high winter flows) than in the autumn 2004 sample.

The Little Swanport catchment is also subject to seasonal droughts in which water flow and availability fall to low levels for prolonged periods of time. This is particularly the case in the tributaries to the main river. There are both direct and indirect effects of drought on stream ecosystems. Direct impacts are those caused by loss of water and flow and a reduction in available habitat. Indirect effects include the deterioration of water quality, alteration of food resources and a change in the intensity of specific interactions (Lake 2003). As water flow declines, water temperature, conductivity and nutrient concentrations may start to rise. Simultaneously, especially in pools, deoxygenation may occur. Once flow stops, shallow sections such as riffles and runs disappear and streams become a series of disconnected pools. With a lack of flowing water, filterer and grazer densities are often greatly reduced and there is an increase in predator densities. At many sites at which the riffle habitat disappeared in the autumn 2004 season, odonatan nymphs comprised more than 15% of the total number of taxa collected in the edgewater samples. As flow decreased in riffles, there was an observed increase in taxa that are more tolerant of physicochemical extremes. These taxa generally prefer slower flowing water and include tanypod chironomids. Caenidae, Hydrophilidae, freshwater shrimps (Atyidae) and eusirid amphipods whilst numbers of flow dependant taxa such as baetid and leptophlebiid mayflies, and some families of stoneflies and caddisflies were markedly reduced or conspicuously absent.

Faunal recovery to pre-drought conditions may occur by 5 mechanisms: movement from subsurface refugia, hatching or reactivation of drought resistant life stages, upstream movement, downstream migration by drift and aerial recolonisation (Lake, 2000). However, recovery after drought may take considerable time and the faunal composition and dynamics are more unpredictable than recovery after floods because the effects of drought are thought to be more species-specific.

Due to the hydrologically variable nature of the Little Swanport River, cyclical changes in macroinvertebrate community composition are observed at many sites. The constant adaptation of the macroinvertebrate fauna to flow induced disturbances may be a reason for the lack of consistency in site groupings between seasons in the multivariate analyses and also has implications for AUSRIVAS outputs. It has been suggested (Schofield and Davies, 1996) that the AUSRIVAS approach to assessing the health of ephemeral streams should be undertaken with caution, as the predictive models have been based largely on perennially flowing streams. Thus while the model results for the Little Swanport catchment are showing broad patterns of 'riverine health' throughout the catchment, they may not effectively discriminate between naturally occurring flow disturbances and anthropogenic impacts. This is particularly relevant for the riffle habitat which is generally more dynamic. A recommendation from this study is that the resolution of the models be improved through the incorporation of additional ephemeral river sites into the reference dataset, and an examination of the potential for use of hydrological descriptors as predictor variables for the AUSRIVAS models.

Despite natural flow variability being a significant factor in structuring macroinvertebrate communities, the AUSRIVAS outputs have identified parts of the Little Swanport catchment that are in poor ecological condition due to physical degradation of instream habitat and deterioration of water quality. Erosion is a problem in the upper part of the catchment. Runoff from cleared surrounding land carries sediment and nutrient and has led to the loss of habitat within the stream. Most of the riparian vegetation in the upper reaches of the Little Swanport River and associated tributaries has been cleared. The lack of a riparian zone, coupled with the practice of allowing cattle direct access to streams have led to poor habitat and degraded water quality. Better management of the surrounding land and rehabilitation and protection of the riparian zone are necessary to improve overall stream health in the Little Swanport catchment.