MANNINGHAM BIOSITES

MANNINGHAM CITY COUNCIL

SITES OF (BIOLOGICAL) SIGNIFICANCE REVIEW

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November 2004

Front Cover: Fringed Helmet Orchid (*Corysanthes fimbriata*). “an uncommon species of sparadic distribution in Victoria” (Backhouse and Jeans 1995).
Listed as rare on the Victorian Rare or Threatened species list.
Recorded from one Manningham biosite.
Image supplied by Justin Welander

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Preface

This Site of (Biological) Significance (SOS or Biosites) Review is the culmination of a process initiated in 1992 with the commissioning of a Botanical and Zoological study east of the Mullum Mullum Creek in the then City of Doncaster and Templestowe. With the addition of Wonga Park further east following the 1996 Local Government amalgamations, a second study was commissioned to extend the previous work to the new eastern boundary. A third study, commissioned by the North Eastern Region of Councils (NEROC) and published in 1997, added value by documenting the fauna inhabiting remnants within Manningham along the Yarra River.

In the political and budgetary context of the time, these studies were useful and clearly progressed biodiversity conservation planning within the municipality on a number of fronts. The creation of an Environmental Significance Overlay (ie. ESO2) in the Planning Scheme is a notable example. However, the limitations of these studies have long been acknowledged. (Excluding the NEROC study), firstly, only private land was targeted, and then only a very limited number of properties determined by owner consent. Secondly, only vascular flora and vertebrate fauna were considered (although it should be noted that habitat was incorporated as vegetation communities). And third, no survey was undertaken west of the Mullum Mullum Creek.

By filling in the geographic gaps and widening the scope of this study to include other elements of the biota such as macrofungi, select invertebrates and bryophytes (mosses and liverworts), it is hoped not that the significance determination process is comprehensive nor in any way concluded, but rather that it represents the beginning of a commitment to fully appreciate and conserve the richness and value of Manningham's natural heritage and biodiversity.

The project fell broadly into three phases: an initial mapping exercise to determine where all the habitat is and what condition it is in (this information was placed on Council's GIS – Eview); secondly, collation of all existing sources of biological information plus gathering some new information, and finally undertaking a new Biosites classification using the State Government's Biosites Criteria.

This report provides: a general background on the physical, biophysical and cultural history (land use) of the municipality; a description of the habitat mapping results; a summary of existing information on various elements of the biota; presentation of the Biosites classification; and finally discussion on conservation management issues.

In using this report, I would suggest beginning by examining the Biosites classification maps in conjunction with Sects. 11 and 12 and use the other sections as a reference to clarify the intent or meaning of specific details. The technical information (especially the species lists) has been structured to encourage ongoing contributions by highlighting where information is missing or inadequate. I hope this project aids the local community to grow its knowledge and understanding of Manningham's biodiversity and in doing so help to conserve the area's significant natural assets.

Paul Foreman
November 2004

Acknowledgements

The contribution of the following people and organisations is acknowledged in preparing this report:

- Alan Yen and John Wainer for their authorative knowledge of the municipality's invertebrates
- Alastair Traill, Paul Irvine, Alan Morgan and Siobahn Hedderman, Allan and Lynette Flett, Marie Gammon, Christine and Paul Wynne for access to their properties
- Karen Lester, Anne Denis, Gemma Phelan, Andrew Corrick, Nevil Amos and David Cameron at DSE
- Bruce Fuhrer for his authorative knowledge of the municipality's macrofungi
- Cam Beardsell and David van Bockel of Warrandyte State Park
- Charlene Kent and Jian Yen for assistance with the invertebrate study
- Richard Marchant of Museum Victoria for assistance with the Primer multivariate analysis undertaken in the invertebrate section
- Chris Tzaros of Birds Australia
- David Meagher for his authorative knowledge of the municipality's bryophytes
- Everybody in the Economic and Environmental Planning Unit at MCC, especially Cathy Willis and Samantha Bradley
- Jane Pammer, Sharon Mason and Rosemary Buxton of the Bushland Management Team in MCC's City Parks Unit for information about local environmental monitoring
- Kieren Croker and other environment staff at Melbourne Water
- Lauren Koehler of the Royal Melbourne Institute of Technology for assisting with data entry
- Lesley Rowland and Lynda Chambers from the Bureau of Meteorology
- Neil Christie and Jason Davey in MCC's GIS section
- Roger Collins, Paul Molan and Teresa Dominik for facilitating the project through Council
- Val Stajsic, Catherine Gallagher and Neville Walsh at the National Herbarium of Victoria

Abbreviations

ABRS	Australian Biological Resources Study
API	Aerial Photographic Interpretation
AROT	Australian Rare or Threatened species
ASL	Above Sea Level
BP	Before Present
BIP	Biodiversity Incentive Program
CAMBA	China-Australia Migratory Bird Agreement
CBD	Central Business District
DNRE	Department of Natural Resources and Environment
DSE	Department of Sustainability and Environment
EA	Environment Australia
EPA	Environment Protection Authority
EPBC	Environment Protection and Biodiversity Act 1999 (Commonwealth)
ERZ	Environmental Rural Zone
ESO	Environmental Significance Overlay
EVC	Ecological Vegetation Class
FFG	Flora and Fauna Guarantee Act 1988 (Victoria)
FIS	Flora Information System
GIS	Geographic Information System
GW	Green Wedge
HaHa	Habitat Hectares (Net Gain)
HaS	Habitat Score (Net Gain)
IBRA	Interim Biogeographical Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
LEAF	Local Environmental Assitance Fund
MY	Million Years
MCC	Manningham City Council
NEROC	North Eastern Region of Councils
PC	Park Care
PCC	Projected Crown Cover (Trees)
ROT	Rare or Threatened species (at National or State level)
RPDG	Research Planning Design Group
SOS	Sites of (Biological) Significance
FNCV	Field Naturalist Club of Victoria
VPP	Victorian Planning Provisions
VROT	Victorian Rare or Threatened species
WSP	Warrandyte State Park (Parks Victoria)
USF	Urban Stream Frontage

Summary

Manningham City Council, occupying ~113 square kilometres and almost entirely within 30 km of the centre of Melbourne, spans the suburbs of Bulleen, Doncaster, East Doncaster, Templestowe, Lower Templestowe, Donvale, Warrandyte, Park Orchards and Wonga Park and parts of Mitcham, North Ringwood and Warrandyte South. On average, the municipality receives between ~675 and ~875 mm of rainfall per annum and is predominantly composed of Palaeozoic marine sedimentary rocks forming a low elevation, flat and undulating plain and ranges of dissected hills on the margin of the eastern Victorian ranges (see Sect. 2 and 3).

The western half of the study area was almost entirely cleared for agriculture (particularly for orchards) from about 1870 and extensively urbanized during the second half of the 20th century and today supports little remnant indigenous habitat. In contrast, the eastern half – an area that has been actively protected from intensive urbanization since the 1970's - supports the majority of Manningham's remaining bushland (see Sect. 4). Three major biological significance studies have been carried out within the municipality since 1992. Whilst these made a vital contribution to knowledge of Manningham's biodiversity assets, information gaps have long been recognized – a deficiency this Sites of (Biological) Significance (SOS or Biosites) Review aims to begin to address (see Sect. 1).

The Biosites Review was broken up into three broad phases: firstly, a detailed survey of the distribution and condition of all remnant indigenous vegetation; secondly the collation of existing and new biological information; and thirdly the formal identification and classification of all Biosites using the proposed Biosites Criteria developed by the State Government (see Sect. 5 to 12).

The remnant vegetation survey involved the production of a detailed map using remote sensing techniques and digitisation for use on Council's GIS - Eview. This data included Ecological Vegetation Class (EVC) classifications as well as Conservation Status at the Bioregional level based on information provided by the State Government and required for the application of the Net Gain Framework, now an incorporated document in the VPPs. This information has also been useful for strategic planning and has already been used in the preparation of vital plans such as the Draft Green Wedge Strategy. This detailed mapping was considered the necessary first step in the Biosites classification process as the data provided by the State under estimated the area of remnant habitat in Manningham by as much as 60% (see Sect. 5).

Whilst it was determined that 37.5% of the study area still supported remnant bushland of some kind – mainly on private land - a significant proportion was classified as threatened and there was considerable evidence of continued decline as is consistent with similar landscapes throughout Victoria. In fact, about one third of Manningham's bushland is in such poor health, a considerable effort will be required to prevent much of it from quickly disappearing. If current management practices persist, it is predicted there could be a contraction in the order of 25% by 2030. These figures exclude revegetation, even with indigenous species, as there is little evidence that these areas have become or will become comparable habitat in its own right. Such plantations are mainly in parks along the Yarra River downstream of Pound Bend, and cover a very small area of the municipality (see Sect. 5).

This network of remnant habitat was then divided into 35 discrete sites based on fragmentation patterns and consideration of past studies. In order to describe ecologically meaningful boundaries, this process deliberately ignored land tenure and excluded the most degraded habitat (see Sect. 5, 11 and 12). A new classification process – the proposed Biosites Criteria developed by the State – involved the application of 32 sub-criteria under five broad criteria: ecological integrity and viability; richness and diversity; rarity/conservation status of assets; representativeness of type; and scientific and educational value (see Sect. 11).

Data from a range of sources was collated and collected to facilitate this classification. In the case of vascular plants and vertebrate fauna, considerable information was already available through the Flora Information System and the Victorian Wildlife Atlas respectively. However, for other elements of the biota, namely bryophytes (mosses and liverworts), macrofungi and invertebrates, little data existed and expert consultants were commissioned to undertake limited survey. David Meagher of Zymurgy Consultants was used for bryophytes, Bruce Fuhrer was used for macrofungi and Alan Yen and John Wainer of the Department of Primary Industries were used for select invertebrates (ants and butterflies) (see Sect. 8 to 10).

Despite the heavy destructive toll of past land use – particularly agriculture and urbanization – Manningham still supports a great diversity of indigenous habitat and organisms. Fifteen of the 16 original EVCs still occur within the municipality, although a third of these are only represented by small remnants in very degraded

condition. A total of over 1600 indigenous taxa (~species) were recorded: 717 vascular flora (mainly flowering plants); 297 vertebrate fauna (mainly birds); 75 bryophytes (mainly mosses); 420 macrofungi (mainly fungi with gills); and ~300 invertebrates (incl. butterflies, ants and aquatic macro-invertebrates). Whilst for some groups these figures are likely to be reasonably accurate, for others, especially invertebrates, these figures are certainly underestimates. As this type of work is rarely undertaken elsewhere, it is difficult to make benchmarking comparisons with other, similar areas, but these results are probably typical of bushland of this size, type, condition and context (see Sect. 6 to 10).

Both the bryophyte and invertebrate sections begin to investigate their potential use as bio-indicators in the Manningham context. Bio-indicators highlight relationships between various attributes of the groups and general environmental patterns and/or health. Ant species richness was correlated with EVC patterns and level of disturbance and similarly bryophyte richness (especially mosses) was linked to habitat types and their degree of disturbance. More ant species were recorded in drier EVCs, whilst conversely more mosses were found in wet EVCs. In both cases fewer species were recorded from degraded areas, irrespective of habitat type (see Sect. 8 and 10).

On the basis of rare or threatened data, vertebrate fauna are the most significant group in the biota, with about 15% of the fauna listed at either the State or National level. Although a systematic assessment of local extinction levels was beyond the scope of this study, there is evidence that a significant proportion of the biota is now locally rare or is likely to have already disappeared. This situation appears to be particularly acute for vascular flora and bryophytes (see Sect. 6 to 8).

Nine of the 32 sub-criteria were not used at all in the classification due to a lack of information, although previous classifications were based on a much narrower range of criteria. Of the 35 sites identified in this Review, all or part of 29 had been previously classified – 13 of Regional Significance and 16 of State Significance. Using the proposed Biosites Criteria, these classifications either remained the same or were elevated to the next highest level such that 6, 23 and 6 are now considered to be of National, State and Regional Significance respectively. No sites were considered to be of Local Significance. All of the new Nationally Significant sites were based on the presence of Type localities (ie. locations of populations used for the first published species description) for various vascular plants, macrofungi, bryophytes and invertebrates. Otherwise the elevations from Regional to State Significance were driven by a range of sub-criteria including the presence of threatened EVCs (see Sect. 11 and 12).

More survey and study could result in further changes in this classification. Although demotions are possible, say with the confirmed extinction of threatened species for example, elevations are more likely especially with the identification of additional Type localities (the National Herbarium of Victoria estimates that only 20 of their Type collection has been databased to date). Also, methodological improvements in the Biosites Criteria could have implications for the classification of Biosites in Manningham (see Sect. 11 and 12).

The key threatening processes driving the on-going decline of remnant habitat are vegetation clearance (resulting from subdivision and other development), overgrazing by stock (particularly horses), pest plant and animal invasion, changes in burning regimes, soil erosion and changes in sub-catchment hydrology and finally, climate change. These threats contribute directly and indirectly to the loss of local biodiversity by impairing ecological processes, resulting in habitat loss and fragmentation and local species extinction (see Sect. 13).

The most ecologically effective conservation strategy must be based on restoring and maintaining ecological processes at the landscape level. By quantifying biodiversity on the basis of habitat diversity, area and condition, the long-term aim is to halt and reverse the current trend of decline and achieve a Net Gain in local biodiversity relative to 2000 levels by 2030. This could be delivered by resourcing a range of conservation management measures, especially on private land with more than 1 ha of remnant bushland, that are designed to significantly lift the condition of habitat on a property by property basis (see Sect. 13). In addition, the new information generated by this Biosites Review – more precise site locations, significance classifications and associated biological data – will be incorporated into the planning scheme as an amendment to the existing ESO overlay. This amendment will strengthen the statutory protection for remnant habitat and will minimize direct habitat loss (ie. land clearing) – a major component of the Net Gain vision (see Sect 13). Improving statutory enforcement, aimed at reducing illegal clearing, is also required as is recommended in the Draft Green Wedge Strategy.

1 Background

1.1 Introduction

The massive loss of indigenous ecosystems since the arrival and settlement of European migrants during the first half of the nineteenth century in Victoria has been extensively studied and discussed in the literature (Leigh *et al.* 1984; Woodgate and Black 1988; Scarlett and Parsons 1993; McDougall and Kirkpatrick 1994). According to the State Government "*66% of Victoria's native vegetation has been cleared as a result of the growth and economic development of the State*" (DNRE 2002a). The biological resources we rely on for food, medicines and a range of other essential products, the ecosystem services we need to maintain a clean, stable and safe environment in which to live, plus the social benefits that underpin our spiritual and cultural wellbeing, all flow from the planet's living capital or biodiversity. Whilst society has benefited from the economic development of the State it is important to stress that eroding natural capital does and can have negative impacts that need to be considered, monitored and managed.

In many respects Manningham City Council (MCC), on the north-east urban fringe of Melbourne, is a microcosm of the State. It is a region that has experienced great prosperity and development in part at the expense of environmental degradation to make way for gold mining, agriculture and urban expansion. Today, similar to Victoria as a whole, just over one third (37.5%) of the municipality's indigenous vegetation (or habitat) remains mainly in the east – a region often referred to as the Green Wedge (GW) (see Sect. 5).

A recent survey of local resident's attitudes towards Manningham's GW has demonstrated that most people are aware of the connection between healthy communities and a healthy environment. Almost three quarters of residents asked (72.2% of 486) either agreed or strongly agreed with the statement: "*preserving Melbourne's green wedge is important*"(RPDG 2002). Consequently, the Council has produced a Draft Green Wedge Strategy that in part aims to: "*protect and enhance biodiversity on public and private land*" (MCC 2004).

Whilst this is a logical and appropriate objective, it will be challenging to achieve. All the anecdotal evidence suggests that the continued decline in native vegetation evident at the State level (DNRE 2002a) is also occurring in Manningham.

Biodiversity in the Manningham context:
Biodiversity is often mistakenly regarded as synonymous with *species of flora and fauna* or perhaps more broadly the biota (all life on earth). However, a more ecologically accurate definition is even broader than this. The Commonwealth Government's official definition of the concept is: "*the variety of all life forms: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part*" (Source: Environment Australia website). Whilst this broad notion of biodiversity operates simultaneously at all scales, at the municipal level the concept of habitat is the most meaningful and useful approximation. In other words, in Manningham, biodiversity should be considered primarily a function of habitat heterogeneity, extent and condition – in short: bushland.

1.2 Study aim

This review aims to define, classify and describe all areas of biological or biodiversity significance within the municipality in order to provide the baseline information on which strategic biodiversity protection and enhancement planning and implementation will be founded.

1.3 Objectives

This review will build on the previous studies by:

1. Filling in the geographic gaps not covered by limited previous studies.
2. Updating all information and taxonomy for vascular flora and vertebrate fauna from relevant databases.
3. Incorporating additional elements of the biota that have previously been omitted such as macrofungi, select invertebrates (especially ants and butterflies) and bryophytes (mosses and liverworts).
4. Producing a municipal remnant indigenous vegetation map incorporating the State Government's statewide EVC coverage including Bioregional Conservation Status.

5. Appling the proposed Biosites Criteria (DNRE 2002b; DSE 2003a) including the listing of classification levels under each category.
6. Recommending appropriate statutory and strategic planning responses.

1.4 Previous biological studies – summary and deficiencies

Three primary Sites of (Biological) Significance studies have been undertaken within Manningham – all within the last decade or so:

1. Bedggood *et al.* (1992): east of the Mullum Mullum Creek to the former City of Doncaster and Templestowe boundary (along a line parallel with Old Warrandyte Road, Ringwood North and Haslams Track);
2. Bedggood *et al.* (1997): incorporation of the Wonga Park region following local government mergers in the mid-nineties;
3. Beardsell (1997): encompassing all remnant habitat along the entire length of the Yarra River within Manningham representing the southern boundary of a broad regional project covering several north-eastern municipalities; PLUS Beardsell (2002): a botanical significance assessment and vegetation community survey of those sites identified in Beardsell (1997) that comprise Warrandyte State Park (WSP). Note: Beardsell (1997) is often referred to as the North East Region of Councils (NEROC) study.

These three studies focused on indigenous vegetation, vascular flora (trees, shrubs, ferns, grasses and wildflowers etc.) and vertebrate fauna (birds, mammals, amphibians, reptiles, and fish). The NEROC study covered whole landscapes along the Yarra River corridor and included a detailed assessment of vegetation within WSP, while the two Manningham studies (Bedggood *et al.* 1992; 1997) focused exclusively on private land (Table 1.1).

The two private land projects identified and described 34 sites covering at least 777 hectares (~7% of Manningham). Most sites were classified as Regionally Significant using botanical criteria (28 sites) and 7 sites were classified as of State Significance using zoological criteria. The NEROC study identified 4 sites of State Significance using zoological criteria and the various sections of WSP were collectively classified as being of State Significance using botanical criteria.

In all three cases, due to limited funds or scope, no attempt was made to assess all remnant habitat within Manningham. Appropriately, only the larger, better known and most readily accessible sites where targeted. Consequently, there are both geographic and thematic gaps in the municipality's historic SOS coverage. The western half of the municipality, west from the Mullum Mullum Creek, as well as areas in between the larger sites in the east have been essentially missed. Thematically, other elements of the biota such as macrofungi, bryophytes, algae, lichens and invertebrates have been entirely omitted.

Some of these geographic gaps have been partially filled by a range of site-specific environmental assessments, mainly over the last 15 years or so. This work includes more than 50 property development and reserve management plans and a municipal roadside vegetation survey (Gannon *et al.* 2002) (see General References). The combination of these surveys and other sources of data such as incidental observations recorded by professional and amateur naturalists and lodged with the Victorian Wildlife Atlas and the Flora Information System (FIS), help to fill in these gaps.

Each of the three primary studies used slightly different classification criteria, although all were based on the following broad categories:

Botanical:

1. Cited botanical significance (ie. classification in previous studies or publications).
2. Population integrity and viability – intactness and abundance.
3. Richness and diversity - flora species and vegetation types.
4. Rarity – Rare or Threatened (ROT) flora species and vegetation types. This includes the significance of vegetation communities, plant species and the intactness of the vegetation.
5. Representativeness of site – ecosystem biodiversity.
6. Ecological processes - importance in maintaining existing ecological processes or natural systems at the Regional, State or National level and ecological importance of site.

Zoological:

1. Cited zoological significance (ie. classification in previous studies or publications).
2. Rarity – ROT fauna species.
3. Diversity – species assemblages and richness.
4. Representativeness – species assemblages and significant species.
5. Population density – viability and abundance.

In each study, for both botanical and zoological significance, the overall classification of each site was defined by the highest level achieved under any one category. With the exception of the NEROC and WSP studies, only this overall classification was recorded for each site.

The Biosites report for the Port Phillip and Western Port Catchment Management Area (DNRE 2002b) similarly only reports the overall site classifications. Incorporating WSP, this study identified, briefly described and classified 45 sites within Manningham including 10 of State significance and 1 of National significance (Yarra River between the Mullum Mullum Creek confluence and Longridge farm). As this report didn't list why each site obtained its classification and is essentially a collation of existing studies, it has not been used as a primary source in this study.

1.5 Study area location and surrounding municipalities

Occupying a total of ~113 square kilometres and straddling Melbourne's urban growth boundary, MCC lies between approximately 10 and 30 km east, north-east of the Melbourne General Post Office. It is surrounded by the municipalities of Banyule and Boroondara to the west, Nillumbik to the North, Whitehorse and Maroondah to the south, and Yarra Ranges to the east (Map 1.1).

Manningham's boundaries include the Yarra River spanning from the south-west to the north-east corner, Koonung Creek (coinciding with part of the eastern freeway) in the south and a series of arterial roads in the south-east and east including: Glenvale, Williams, Old Warrandyte, Holloway, Brushy Park and Lower Homestead Roads. The suburbs of Bulleen, Templestowe, Lower Templestowe, Doncaster, East Doncaster, Mitcham and Donvale are west of the Mullum Mullum Creek and Warrandyte, Warrandyte South, North Ringwood, Park Orchards and Wonga Park lie to the east (Map 1.2).

1.6 Political/statutory context

Under the Planning and Environment Act (1987), planning schemes in Victoria must seek "*to provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity.*" The details necessary for implementation of this objective are contained in a number of specified databases, plans and strategies.

These include:

1. The National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996).
2. Any strategy, relevant Governor-in-Council orders and Action Statements prepared under the Flora and Fauna Guarantee Act (1988).
3. Any relevant regional vegetation plans, and roadside management strategies, as well as special area plans approved under the Catchment and Land Protection Act (1994) (PPWCMA 2000).
4. Mapped information available from the Department Sustainability and Environment (DSE) to identify areas of significant native vegetation (eg. EVC and Biosites data).
5. Victoria's Native Vegetation Management – A Framework for Action (DNRE 2002a).
6. Habitats designated under the Convention on Wetlands of International Importance (the Ramsar Convention) or utilised by species designated under the Japan-Australia Migratory Birds Agreement (JAMBA) or the China-Australia Migratory Birds Agreement (CAMBA).

Melbourne 2030, a planning framework for sustainable growth and change across greater metropolitan Melbourne over the next 30 years, makes a direct reference to the need for "*complete mapping of biodiversity assets for existing and future urban areas, and to initiate protection and planning programs throughout the planning system*" (State of Victoria 2002). The plan makes a commitment to the "*reversal of the continuing loss of native vegetation, helping achieve a net gain through improvements and habitat creation*" via the implementation of the Net Gain Framework (DNRE 2002a). The plan further endorses the need to define and conserve Melbourne's radial Green Wedges by recommending the development of specific and comprehensive strategic conservation plans.

Manningham's non-urban areas review (RPDG 2002), commissioned by Council to advise on the strategic direction for the management of its GW, recommended a vision whereby: "*the enhancement of environmental values is the principal aim of all planning and management.*" Furthermore: "*measurable standards of environmental quality of the area are established and Council, public land managers report annually to the community about environmental condition against quantifiable elements.*" The mapping and description of Biosites represents a major foundation for this process.

A commitment to "*develop a GIS overlay map of native vegetation and habitat*" for Manningham has also been present in municipal corporate plans since 1999 (MCC 1999; 2000; 2001a; 2002; 2003).

This Review will help ensure Manningham complies with all relevant Local, Regional, State and National Biodiversity conservation strategies and plans.

2 Physical description of Manningham

2.1 Climate

Under the international climate classification scheme (Köeppen classification), the study area has a temperate climate based on temperature and rainfall as indicated by native vegetation. Under this scheme Manningham shares a similar temperate climate with most of south-eastern Australia and the whole of Victoria except for the north-west (Bureau of Meteorology website).

In general the study area experiences warm summers, cool winters and no dry season. Rainfall is uniform for areas below 800 mm per annum and winter dominant above this. Summer rainfall is generally low (Bureau of Meteorology website).

On the basis of rainfall data from permanent weather stations within a 20 kilometre radius of the Council Depot in Templestowe (10 stations in total), long-term mean annual rainfall varies across the study area along a uniform gradient from ~675 mm in the extreme west at Bulleen to ~875 mm in the far east (Wonga Park/Ringwood North) as well as the central south (Donvale/Mitcham) (Table 2.1; Map 2.1). The steepest gradient of change occurs in the Donvale area and the lowest is at Bulleen on the margins of the lowland plains that extend throughout Gippsland and into western Victoria. These data are derived from records collected since 1980. The majority of this rain falls as rainfall events of greater than 1 mm that occur on average between 100 and 125 days every year. The associated cloud cover restricts the duration of daily annual sunshine to between 5 and 6 hours (Bureau of Meteorology website).

Drought, defined when the annual rainfall drops below 80% of the long-term average, typically occurs every 6 and 7 years in Manningham, although the patterns are complex and there is evidence of a recent shift. For example at Mitcham, 6 out of the last 14 years have been drought years under the above definition. It is alarming to note that most of the region has, on average, received approximately 17% less annual rainfall in the last 7 years (1997-2003). The unprecedented nature of this dry spell suggests it is more likely a sign of climate change (possibly induced by global warming) rather than the result of the episodic droughts we are all familiar with (Table 2.1; Figure 2.1). The impact of possible global warming induced climate change (especially its impact on rainfall) is discussed in Sect. 13.

On the basis of records from four permanent weather stations close by (Melbourne CBD, Watsonia, La Trobe University at Bundoora and Scoresby Research Institute), frosts occur in the region on average between 6.5 and 15.9 days every year. Almost all of these events occur between the months of May and October, with the highest frequencies consistently falling in July. No data are available on severity.

2.2 Geology and geomorphology

Silurian

The oldest rocks evident in the study area are of Silurian origin, ~420 to 435 MY BP These rocks occur as very thick, ancient marine sediments accumulated in the Melbourne Basin (rift basins are elongated and depressed crustal units or blocks bounded by faults along the longest margins) during the upper and lower Silurian when Australia was part of the Gondwana super continent and the terrestrial land mass was located roughly where Antarctica is today and apparently populated with only very primitive vascular fern-like flora (Christophel 1993; Birch 2003). These deposits have been locally uplifted and significantly deformed by two major tectonic periods, one in the middle Devonian approximately 360 MY BP and another during the middle Cretaceous approximately 100 MY BP both of which were likely associated with the injection of nearby plutonic elements during the Devonian such as the granodioritic batholiths that today form much of the surrounding eastern ranges.

The lithology of the Andersons Creek and Dargile Formations is either massive siltstones interbedded with thin sandstones or laminated sandstones interbedded with massive siltstones and shales. Today the stratigraphy is roughly orientated north, north-east to south, south-west through the with a series of seven major broadly parallel anticlines and synclines through the western half and more confused, minor folding in the east. A series of minor fault lines, also parallel with the orientation of the stratigraphy, occur throughout with a major unconformity associated with the boundary between the Silurian and Devonian sediments called the Brushy Creek fault line – so named because it roughly parallels the course of the current creek (Department of Primary Industries website; Table 2.2).

These rocks are by far the dominant geological element of the region and are more or less throughout the study area. This system is often referred to as a dissected, plateau-like palaeosurface (so derived from the Palaeozoic origin of the bedrock sediments) called the Nillumbik terrain or Nillumbik palaeosurface and often has cappings of Tertiary sands and gravel. "*The surface of this Palaeozoic bedrock varies from deeply weathered regolith mantles of kaolinitic clay to fresher rock exposed by stripping. Streams of the Yarra system have cut into the plateau and partly removed a more complete Tertiary cover to produce the dissected terrain seen today.*" (Birch 2003).

There appears to be no relationship between the orientation of the bedrock stratigraphy and the general dentritic pattern of drainage with most of the major creeks flowing approximately in a south, south-east to north, north-west direction. This observation suggests that the general orientation of the Yarra River greatly influences that of its major tributaries (at least along this section). The Yarra River here passes through a fault controlled, gorge-like valley often referred to as the Warrandyte Gorge. The erosion and weathering processes of the palaeosurface suggests there is a general uniformity in the hardness or erodability of the Silurian bedrock. Presumably this process is also influenced by the gentle regularity of the palaeosurface gradient across the study area (Birch 2003). The lowest elevation occurs in the far south-west corner at ~20 m ASL on the margin of the lower Yarra River floodplains in Bulleen, whilst at river level in the Mount Lofty section of WSP in the far north-east, it is 60 m ASL. The highest elevation of 160 m ASL occurs at a couple of places along Yarra Road in Wonga Park in the far east and also just over the municipal boundary in Maroondah near Glenvale and Old Warrandyte Roads in Ringwood North.

Devonian

The Devonian marine sediments have a similar history to the adjacent and dominant Silurian rocks, however, they differ in being more massive or thin-bedded siltstones with only minor sandstones near the base. Only a small pocket of these rocks occurs in the far north-east corner of the study area, south of Mount Lofty along Brushy Creek in Wonga Park. These rocks effectively replace the Silurian sediments further west towards Coldstream and Yarra Glen at the foot of the Yarra Ranges but are also part of the palaeosurface that dominates the study area (Table 2.2).

Perhaps a more interesting, but only minor element of the study area's geology dating from the Devonian epoch is the felsic dyke represented by a ~1.2 km long south-west to north-east oriented linear outcrop roughly perpendicular to Brushy Creek at its confluence with the Yarra River in Wonga Park. It is of extrusive origin, consisting of quartz and/or felspar porphyry that was forced up from the earth's mantle shortly after the deposition of the encasing palaeosurface. It is unclear to what extent the subsequent uplifting and folding has contorted or altered the original orientation of this igneous structure (Table 2.2).

Tertiary

The only rocks dating from the end of this epoch (Pliocene; ~5 MY BP) occur as a small, flat cap up to 24 m thick at Doncaster Hill that is the remains of sand and gravel beds deposited during the subsequent erosion-deposition cycle (fluvial and lacustrine) following the retreat of the sea (Red Bluff formation or upper Brighton Group; Birch 2003). At the beginning of the Tertiary, as the continent drifted north and become more arid ~ 65 MY BP, Victoria was located at a latitude of about 60 degrees south (still relatively close to the remnants of the Gondwana super continent) and terrestrial areas were covered with *Nothofagus* dominanted rainforest vegetation. However, by the end of the Tertiary this mesic vegetation was being replaced by a more temperate flora including many important modern scleromorphic groups such as *Acacia* and *Eucalyptus* as well as many grasses (Poaceae) (Chistophell 1993; Douglas 1993; Table 2.2).

Quaternary

The present regime of oscillating glacial-interglacial climates and the associated sea-level changes at the continental margins (as well as volcanism – the New Volcanics – and tectonics) characterises the geological activity of the Quaternary (previous 2 MY BP). However, evidence of this epoch within the study area, is only represented by the fluvio-lacustrine or alluvial deposits associated with the Yarra River and its major tributaries. These deposits comprise gravels, sands and silts of very recent and slightly older origin. The latter are the higher-level alluvial terraces, the oldest of which (such as the Arundel Formation on the Maribyrnong River) contain fossil bones of extinct megafauna and Aboriginal stone artefacts. The formation of these terraces often correlates with glacial activity and represent discrete stages in valley development (Birch 2003). The recent floodplain, which comprises the majority of quaternary deposits in the study area, is associated with a complex mosaic of palaeochannels, billabongs, wetland depressions and floodlands (Table 2.2).

2.3 Soils and Landforms

For the purposes of sustainable agriculture and land use planning, the study area, especially in the non-rural eastern half (or Green Wedge), has been recently mapped and assessed for Land Capability (Hood and Crawford 2004). This work was based on a combination of previous studies (Maher 1978; White and Kelyneck 1985) and limited additional fieldwork. Based on a consideration of relief, position in landscape, geology, geomorphology and soil type, five primary landform/soil units were identified. Two additional units have been proposed for areas mainly in the western half of the study area where limited data are available (Table 2.3).

The seven soils and landform units are summaried below:

Soils on undulating or rolling rises of Silurian palaeosurface. Occurring on Silurian marine sandstones and siltstones, where slopes are < 25 degrees, and where the landscape consists of undulating to rolling rises (excluding gently sloping drainage lines), this unit is one the most abundant in the study area. Soils are typically yellow or brown Kurosols with a clear boundary between a clay loam surface soil over a clay sub-surface soil and often with a fine sandy or silty feel. Where the terrain is flat to gently undulating, such as in the western half of the study area, these soils are occasionally waterlogged due to a sub-surface soil with impeded permeability (Hood and Crawford 2004).

Soils on rolling and steep rises of Silurian palaeosurface. This unit occurs on Silurian marine sandstones and siltstones, where slopes are > 25 degrees and soils are shallow and often stony. In some instances the sub-surface rock has a very thin veneer of soil (eg. 0 to 5 cm). This unit is also very abundant in the study area, particularly in the more dissected eastern hills (Hood and Crawford 2004).

Soils on undulating rises of Devonian palaeosurface. The soils derived from Devonian marine sedimentary rocks are similar to those on the adjacent Silurian rocks. They have a very fine sandy, grey, light clay surface soil with a sharp boundary to a brown medium clay sub-surface soil with some evidence of imperfect drainage. This unit is restricted to the far north east of the study area, east of Brushy Creek near its confluence with the Yarra River in Wonga Park (Hood and Crawford 2004).

Soils on active river and creek floodplains. Soils for the Brushy Creek floodplain are relatively deep (>1.5 m), grey Dermosols (ie. Gradational soil) with a very fine, sandy clay loam surface soil which is gradually transitional to a grey, light to medium clay sub-surface soil. Although no data are available, it is likely the floodplain soils of the Yarra River and its other tributaries would be similar (Hood and Crawford 2004).

Soils on higher level alluvial terraces. Although no data are available for this unit, it is likely these soils would be related to those on active river and creek floodplains. These soils occur exclusively on alluvial terraces associated with the Yarra River.

Soils on non-marine Tertiary sediments. Although no data are available for this unit, similar soils occur in adjacent municipalities. Only one small example of this soil occurs in the study area on the crest of Doncaster Hill in Doncaster, which is now entirely urbanised.

Soils on gently sloping drainage lines of Silurian palaeosurface. Soils of ephemeral drainage lines on Silurian marine sandstones and siltstones with profiles that gradually change (ie. Dermosols/Gradational soil) from silty clay loam at the surface to clay in the sub-surface soil. These soils are scattered throughout the study area, particularly in the more dissected eastern hills. Hood and Crawford (2004) merged these soils (quoted from Maher 1978) with those of undulating or rolling rises of Silurian palaeosurface due to scale considerations.

Note that a soil and landform map has not been produced for this Biosites Review due to incomplete data coverage (although what is available can be viewed through Councils GIS - Eview). In general the geological uniformity of the study area emphasises the extent to which soil and landform types are correlated with vegetation patterns. Here, at low elevation on relatively flat terrain, factors such as rainfall, elevation and aspect are not as important in controlling plant moisture availability as elsewhere in the State. Position in landscape, soil type and flooding regimes are the most critical factors in the Manningham context. In general, the riparian zones, floodplains and gullies support the most mesic vegetation with the tallest canopy and shrub layer height. And conversely the ridgelines, with shallow soils that seasonally experience drought, tend to support much shorter forest or woodland, comprising plants with drought adaptions such as sclerophylly and microphylly.

2.4 Catchments (Hydrology)

The study area is located approximately in the middle-western part of the Yarra River Catchment. It lies entirely south of the Yarra River between Bulleen Park in Bulleen to the Mount Lofty section of WSP in Wonga Park. It comprises 6 sub-catchments named after the following tributaries: (running west to east) Koonung Creek, Ruffey Creek, Mullum Mullum Creek, Andersons Creek, Jumping Creek and Brushy Creek (MCC 2001b; Map 2.2). The Mullum Mullum Creek sub-catchment is the largest in Manningham (over 28%) and Brushy Creek is the smallest (nearly 8%) (Table 2.4). It should be noted that the sub-catchment boundaries are not literally correct close to the Yarra River. Melbourne Water recognise an additional sub-catchment in the study area called the Middle and Lower Yarra River that includes numerous small gullies and creeks that are not part of any of the major tributaries but flow directly into the Yarra River (see Sect. 3).

Broadly the Ruffey and Koonung Creek sub-catchments occur within the Gippsland Plains Bioregion that supports little remnant vegetation primarily due to intense urbanisation. The balance of the study area is within the Highlands – Southern Fall Bioregion where the bulk of Manningham's remnant vegetation occurs. Anderson's, Jumping, Brushy and Mullum Mullum Creek sub-catchments are regarded as the least modified of the six, although the first two contain the largest areas of remnant vegetation (MCC 2001b; Table 2.4).

Total water yields, in-stream pollution, sediment levels, degree of regulation (dams) and changes in flooding regimes are all factors that influence indigenous habitat and all have been modified to some degree by post-European settlement land use. Although factors outside the study area are obviously important (especially land use within the balance of the Yarra River catchment and the relevant sub-catchments), in general the degree of modification of each sub-catchment is proportional to hydrological health, especially water quality and therefore riparian biodiversity (MCC 2001b; Table 2.4).

At a landscape scale the Human Occupation variable introduced for the indigenous vegetation mapping in Sect. 5 is a useful way of considering the kind of change that most affects hydrology. This index ranks Jumping Creek as the least intensively used sub-catchment, followed by Brushy Creek and then Anderson's Creek. Despite the fact that the Mullum Mullum Creek sub-catchment has a large area of remnant bushland, a large portion of it is also intensively urbanised (Table 2.5).

Melbourne Water's Index of Stream Condition data, confirms that Anderson's and Jumping Creeks are the most healthy of the six sub-catchments. Out of the five ratings from Excellent to Very Poor, these two are given a rating of Moderate whilst the Mullum Mullum, Brushy and Ruffey Creeks are Poor and the Koonung is rated lowest at Very Poor. The Index of Stream Condition data incorporates "*five sub-indices and summarises the extent of change from natural or ideal conditions: (1) physical form (stream bank and bed condition, presence of and access to physical habitat, artificial barriers to fish migration); (2) streamside zone (quality and quantity of streamside vegetation and condition of billabongs); (3) hydrology (flow volume and seasonality of flow); (4) water quality (key water quality indicators); and (5) aquatic life (diversity of macroinvertebrates)*" (Melbourne Water website). This index incorporates a variety of important hydrological considerations relevant to biodiversity conservation such as catchment yields, damming and regulation, flooding frequency, soil erosion and pollution (Table 2.5)

All of these waterways are actively managed to improve the environmental quality of stormwater runoff, particularly from urban areas, with emphasis on minimising pollution levels entering the Yarra River. Whilst this management is focused on mitigating a wide range of stormwater threats (in priority order: Septic discharge and sullage; commercial runoff; up-stream inflows; unsealed road and eroding drain runoff; building site runoff; major road runoff; residential runoff; roadworks runoff; and residential development), these actions can also improve in-stream habitat values and thus encourage various indigenous flora and fauna such as Platypus (Pettigrove and Colman 1998; MCC 2001b).

3 Biophysical description of Manningham

3.1 Bioregions

Under the Interim Biogeographic Regionalisation of Australia (IBRA) (EA 2000) continental Australia has been divided into 85 Bioregions ranging from vast interior deserts covering millions of square kilometres (eg. Great Sandy Desert) to isolated patches occupying relatively small areas such as the Victorian Alps and Flinders Bioregions (the later covers Wilson's Promontory and Flinders Island in Bass Strait) in the south-east. Eleven of these cover the State of Victoria, eight of which are shared with adjacent States (see Map 3.1). For regionaplanning purposes, this broad, national coverage has been further subdivided into 354 sub-Bioregions. At least in the Victorian context this sub-bioregional stratification allows for a more meaningful discrimination between areas. In total 21 sub-bioregions are recognised in Victoria with the Victorian portion of the South Eastern Highlands divided along the Great Dividing Range into two: Highlands – Northern Fall and Highlands - Southern Fall. Likewise the South East Coastal Plain splits broadly into three with the Warrnambool and Otway Plains west of Port Phillip Bay and the Gippsland Plain to the east (see DNRE 1997b; Map 3.1).

The conceptual basis of the IBRA is as follows: "*it is the physical processes which drive ecological processes, which in turn are responsible for driving the observed patterns on biological productivity and the associated patterns on biodiversity*" (Thackway and Cresswell 1995). In practice the IBRA is a landscape approach to classifying land surface that combines regional and continental scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna (EA 2000).

In the Victorian context, "*biogeographic regions capture the patterns of ecological characteristics in the landscape, providing a natural framework for recognising and responding to biodiversity values. As Bioregions reflect underlying environmental features they can also be related to the patterns of [land] use and thus can be used to identify the relationship between many natural resource-based activities and biodiversity assets*" (NRE 1997b).

From this understanding it could be concluded that Bioregions (at the continental scale) denote areas of relative homogeneity in terms of landscape, and therefore, biodiversity features. In other words there is greater variation between Bioregions than within them. Whilst this is often true it isn't always true and it is useful to keep human interrelationships in mind when considering individual Bioregions and the discrimination between them (NRE 1997b). In this report, the concept of the Bioregion is largely used to impose a broader framework for considering the conservation of biodiversity in Manningham and for prioritising actions: with the vegetation patterns considered an approximation of biodiversity patterns and the degree of clearance a direct measure of the urgency to act in order to prevent further loss of biodiversity. In this way it is considered appropriate to act to prevent the further loss of any vegetation type in any Bioregion if it has been substantially depleted by human action.

As is mentioned earlier, the study area straddles two Bioregions. It is broadly split east-west into: South Eastern Highlands (Victorian sub-bioregion: Highlands – Southern Fall) and South East Coastal Plain (Victorian sub-bioregion: Gippsland Plains) respectively with the Mullum Mullum Creek roughly representing the boundary (Map 3.2). Being on the margins of both Bioregions, the general defining characteristics of each Bioregion may not be representative of those sections occurring within the study area. However, it will be instructive to consider how these regions are viewed in the National context.

Highlands – Southern Fall Bioregion

The South East Highland Bioregion is: "*Steep dissected and rugged ranges across southern and eastern Victoria and southern NSW. Geology predominantly Palaeozoic and Mesozoic rocks. Vegetation predominantly wet and dry sclerophyll forests, woodland, minor cool temperate rainforest and minor grassland and herbaceous communities. Large areas… were felled for fuel and timber for the mines during the gold rushes. Large areas have also been cleared in NSW for grazing or plantations*" (EA 2000).

Being right at the foothills of the eastern ranges on the fringe of the Gippsland and Victorian Volcanic Plain, this description doesn't seem particularly applicable to Manningham, however, apart from the reference to "*steep dissected, rugged ranges*", most of the remaining features are broadly appropriate. The study area largely supports dry sclerophyll forests and woodlands on Palaeozoic parent material with minor grassland/herbaceous communities and has been extensively used for mining and agriculture.

The division along the Great Dividing Range into a northern and southern fall is presumably driven by considerations of geography, catchment orientation (north vs. south running rivers) and to a lesser extent human land use with the Highlands - Northern Fall Bioregion being more intensively used and cleared for agriculture (~80% of the original area of habitat remains - Halley 2002).

Gippsland Plains Bioregion

The South East Coastal Plain is: "*undulating Tertiary and Quaternary coastal plains and hinterlands rising up to 200 m ASL. The climate is temperate with rainfall ranging from ~500 to 1100 mm. In some situations adjacent ranges produce a significant rainshadow affect. The highly variable parent material includes low calcareous dune formations with nutrient deficient soils, coastal limestones, swamplands with fertile peats, deeper soils of volcanic origin overlaying limestone and recent alluvium associated with rivers and streams. The vegetation includes lowland forests and open forests with shrubby or heathy understoreys, grasslands and grassy woodlands, heathlands, shrublands, freshwater and coastal wetlands, mangrove scrubs, saltmarshes, dune scrubs and coastal tussock grasslands, much of which has been extensively cleared for agriculture*" (EA 2000).

The division into three: Warrnambool Plains, Otway Plains and Gippsland Plains is based largely on geology with the Gippsland Plain comprising lowland coastal and alluvial plains characterised by generally flat to undulating terrain.

Although much of western section of the study area is of Palaeozoic geology, compared to the east the terrain is generally flat to undulating and different geological elements are appearing: with Quaternary alluvial geology along the Yarra River floodplain and a cap of Tertiary geology (coarse sands and poorly sorted gravels) on the top of Doncaster Hill. When compared with the landscape in the east, these changes are indicative of a shift into a different Bioregion.

The severe degree of habitat clearing in the western half of the study area (Sect. 4) is also consistent with the situation for the entire Bioregion with ~18.5% of the original area of habitat remaining. Similar figures emerge for each of the other sections of the South East Coastal Plain (Halley 2002).

3.2 Biophysical (Habitat) Regions

As the name suggests, these regions are built on consideration of both the biota (living) and physical (non-living) aspects of the landscape. Given the extensive post-European human impact within the study area, the biotic component has largely been considered in the pre-1750 context when the natural vegetation patterns were still in tact.

Within the Bioregional framework, the study area has been further divided into 5 Biophysical or Habitat Regions based largely on consideration of local patterns in geology and geomorphology, soils, vegetation, terrain and to a lesser degree, land management (broadly along a transect from west to east): (1) Lower Yarra Floodplains, (2) Lower Yarra Low Hills, (3) Ruffey/Koonung Low Hills, (4) Warrandyte Hills, and (5) Middle Yarra Floodplains and Low Hills (Table 3.1; Map 3.2).

Although the Highlands – Southern Fall Bioregion, dominated almost exclusively by the Warrandyte Hills Habitat Region, comprises the majority of the study area, the Gippsland Plains Bioregion supports a significant area of three Habitat Regions: Lower Yarra Floodplain, Lower Yarra Low Hills and the Ruffey/Koonung Low Hills (Map 3.2).

Lower Yarra Floodplains

This Habitat Region is exclusively associated with the lower reaches of the Yarra River along the western margin of the study area in Bulleen, Lower Templestowe and Templestowe. It occurs where the Yarra River flows out of the relatively narrow confines of its course through the Warrandyte Hills (including the Warrandyte Gorge) into an expansive, flat floodplain of recent alluvium (Map 3.2). Mean annual rainfall is below 700 mm and is one of the driest parts of the study area (see Sect. 2).

The Lower Yarra Floodplains is generally contiguous with the Yarra Lowland Alluvial Plains in Beardsell (2002) and its boundaries are defined by the extent of alluvium flanking the river course across the open plains (Map 3.2)

The soils of this Region are entirely *soils on active river and creek floodplains*, although no soil data is available specifically for this section of the Yarra River (see Sect. 2).

The dominant EVCs of the Lower Yarra Floodplains are Floodplain Riparian Woodland (EVC 56) bordering the Yarra River and its tributaries and Floodplain Wetland Complex (EVC 172) associated with billabongs. With minor exceptions, both are effectively confined to this Habitat Region and are classified as Endangered in the Gippsland Plains Bioregion (see Sect. 5 and 6). There is also some unclassified Core Habitat associated with the dam at Trinity Grammar School on Bulleen Road and unclassified Buffer Habitat is scattered throughout. A minor section of Riparian Forest (EVC 18) occurs along the last 2 kms of the Yarra River before it flows through the Warrandyte Hills Habitat Region.

Although this Habitat Region has not been intensively urbanised due to its vulnerability to flooding, it directly adjoins the suburbs of Bulleen and Lower Templstowe and has been extensively cleared, initially for agriculture, and is now predominantly an exotic grassland with a sparse cover of exotic trees used extensively as parkland for passive and active recreation. The Region is predominantly public land owned by the State Government (and managed by Parks Victoria – Westerfolds, Birrarrung, Bolin Bolin Billabong and Banksia Parks) and private land owned by the Council (Bulleen Park and Finn's Reserve) and various other organisations (eg. Veneto Club, Yarra Valley Country Club and Trinity Grammar School etc.).

Overwhelmingly, it is the Floodplain Riparian Woodland (EVC 56) that has been lost from in this Region. Only approximately 20% remains. Floodplain Wetland Complex (EVC 172), in contrast has faired reasonably well as all of the wetlands originally present are extant today, albeit in a modified and degraded condition especially with respect to flooding regimes and weed invasion. Bolin Bolin Billibong contains perhaps the best examples of both these EVCs, although considerable resources have been invested in recent years by Parks Victoria. This Habitat Region also supports large areas of revegetation plantations, especially in Birrarrung Park and other Parks Victoria managed reserves (see Sect. 5). As it is unclear how ecologically successful these projects have been, they have been excluded from any Biosites in this study.

Two Biosites have been identified within this Biophysical (Habitat) Region: all of Yarra (Biosite 31) and part of Westerfolds (Biosite 29) along the Yarra River. Yarra is classified as National Significance and Westerfolds is classified as State Significance (see Sect. 11 and 12).

Although little of the original area of habitat remains and the majority is primarily or significantly modified, these two sites (particularly Yarra) are of enormous strategic significance, especially for mobile, migratory fauna. This is primarily because of: (1) the presence of wetland habitats; (2) the narrowness of the Yarra River corridor along this section; and (3) its proximity to Port Phillip Bay and associated coastal/marine environments.

Lower Yarra Low Hills

Lower Yarra Low Hills is situated immediately east and marginally upslope of the Lower Yarra Floodplains above the recent alluvium in Bulleen, Lower Templestowe and Templestowe. It represents a low elevation, gently undulating form of the palaeosurface at the margins of the eastern ranges. Primarily on account of it's relief, this Habitat Region is entirely within the Gippsland Plains Bioregion (Map 3.2).

The eastern boundary of this Habitat Region is defined by the Bioregional boundary in Templestowe (roughly parallel with Fitzsimons Lane) and in Lower Templestowe and Bulleen the boundary lies roughly east and parallel to Thompsons Road where there is a transition to an expansive lowland plateau that extends through Doncaster into Donvale and southern Templestowe. In general the eastern boundary denotes broad changes in topography and rainfall. Topographically, this Habitat Region generally lies below an elevation of ~70 m ASL and is gently sloping and undulating. Mean annual rainfall is below 700 mm and is one of the driest parts of the study area (see Sect. 2).

The soils of this Habitat Region are predominantly *soils on undulating or rolling rises of Silurian palaeosurface* with minor occurrences of *soils on higher level alluvial terraces* (Westerfolds Park), although no soil data is available for this area (see Sect. 2).

The dominant EVCs of the Lower Yarra Floodplains are Plains Grassy Woodland (EVC 55) and Creekline Grassy Woodland (EVC 68) both of which are almost entirely located with Westerfolds Park. As with the Lower Yarra Floodplains, with minor exceptions, both of these are effectively confined to this Habitat Region and are classified as Endangered in the Gippsland Plains Bioregion (see Sect. 5 and 6). Another EVC, Riparian Woodland (EVC 641), also confined to this Habitat Region and once present along the lower portion

of Ruffey Creek, is today only represented by a minute remnant in Finn's Reserve right on the Yarra River. There is also some unclassified Buffer Habitat, mainly contained within Westerfolds Park.

With the exception of Westerfolds Park, a few minor public recreation reserves and small pockets of lower density subdivision, this entire Habitat Region has been extensively urbanised – forming the bulk of the suburbs of Bulleen and Lower Templestowe and is almost entirely devoid of indigenous vegetation. In fact, it is the most extensively cleared section of the study area.

Overwhelmingly, it is the Plains Grassy Woodland (EVC 55) that has been lost from in this Habitat Region. Only ~1% remains, as is consistent with lowland grassy ecosystems throughout south-eastern Australia. Even though the remaining EVCs associated with creeklines have not been depleted to this extent, the remnants are still very small and in a highly modified and degraded condition. Lower Yarra Low Hills supports relatively large areas of revegetation plantations established by Parks Victoria in Westerfolds Park (see Sect. 5).

Only one Biosite has been identified within this Habitat Region: part of Westerfolds (Biosite 29). Westerfolds is classified as State Significance (see Sect. 11 and 12).

Like the Lower Yarra Floodplain, this Habitat Region is of enormous strategic biodiversity significance, especially for mobile, migratory fauna. Westerfolds Park effectively represents the only habitat along this section of the Yarra River.

Ruffey/Koonung Low Hills

Ruffey/Koonung Low Hills is situated immediately east and marginally up slope of the Lower Yarra Low Hills, occupying an expansive lowland plateau that extends through Doncaster and East Doncaster into Donvale, Nunawading and southern Templestowe. A small, isolated pocket lies further east in Ringwood North in the headwaters of Anderson's Creek. This Habitat Region is a low elevation, gently undulating plateaued section of the palaeosurface at the margins of the eastern ranges with a small cap of fine to course Tertiary sandstone on the top of Doncaster Hill and recent Quaternary alluvium along the Koonung and Ruffey Creeks. Primarily on account of it's relief, this Habitat Region is entirely within the Gippsland Plains Bioregion (Map 3.2).

Its eastern boundary is entirely defined by the Bioregional boundary from Templestowe through to Donvale and Ringwood North. To the south, it corresponds with the municipal boundary, parallel to the eastern freeway. The western boundary is the edge of the plateau were it merges into the Lower Yarra Low Hills (Map 3.2).

In general the boundary with Warrandyte Hills denotes broad changes in geology, soil type, topography and land use. The geological shift is from lower to upper Silurian marine sediments, with the older rocks on the lower elevations being massive siltstones interbedded with thin sandstones and the slightly younger rocks being sandstones interbedded with massive siltstones and shales (Department of Primary Industries website). Topographically, the Habitat Region generally lies below an elevation of approximately 70 m ASL and is gently sloping and undulating. Mean annual rainfall rises uniformly from ~675 mm in the west to ~875 mm in the east at Donvale – the full range in rainfall across the municipality (see Sect. 2).

The soils of this Region are predominantly *soils on undulating or rolling rises of Silurian palaeosurface* with a minor occurrence of *soils on non-marine Tertiary sediments* at the crest of Doncaster Hill, although no soil data is available for this area (see Sect .2).

The dominant EVCs of the Ruffey/Koonung Low Hills are Valley Heathy Forest (EVC 127), Riparian Forest (EVC 18), Swampy Riparian Complex (EVC 126) and Valley Grassy Forest (EVC 47) most of which is located in the far east on the Mullum Mullum Creek within the vicinity of Hillcrest Reserve (where the Eastern Freeway tunnel is planned). Unlike the Habitat Regions to the west, all but one of these EVCs are widespread in the study area - Swampy Riparian Complex is restricted to the Koonung Creek valley. Another EVC, Swampy Woodland (EVC 937), restricted to a very small pocket in the Doncaster Golf Course, is also found nowhere else in the study area (see Sect. 5 and 6). All of these EVCs are listed as either Endangered or Vulnerable in the Gippsland Plains Bioregion. There is also some unclassified Buffer Habitat present, primarily in the Hillcrest Reserve area.

With the exception of the Doncaster Golf Course, Ruffey Lake Park and a number minor public recreation reserves, the entire Habitat Region is privately owned and has been intensively urbanised, forming the bulk

of the suburbs of Doncaster and East Doncaster, and supports a very low area of indigenous vegetation. Two pockets of lower density subdivision in Templestowe (along Foote Street and Reynolds Road) and large parts of Donvale, has allowed much of the remaining Buffer Habitat in the Habitat Region to persist, but this is in a very degraded condition. There is also an extensive network of open space associated with the Koonung Creek that supports a number of small urban bushland refugia.

Overwhelmingly, it is Valley Heathy Forest (EVC 127) that has been lost from this Habitat Region. Only approximately 3.5% remains. Although originally much less abundant in the Ruffey/Koonung Hills, a similar story applies for Valley Grassy Forest (EVC 47), Swampy Riparian Complex (EVC 126) and Swampy Woodland (EVC 937). Riparian Forest (EVC 18) along the Mullum Mullum Creek, also not very abundant prior to European settlement, has faired very well, with over 85% remaining. Grassy Woodland (EVC 175), the EVC that originally occupied the small Tertiary non-marine cap atop Doncaster Hill has been completely wiped out and is the only EVC in the study area to have become locally extinct. This Habitat Region supports relatively large areas of revegetation plantations mainly along the Koonung Creek (Parks Victoria, Melbourne Water and VicRoads) and in Ruffey Lake Park (Council) (see Sect. 5 and 6).

Six Biosites have been identified within this Habitat Region: most of Hillcrest Reserve/Chaim Court (Biosite 22); a minority of McIntrye Road (Biosite 19) and Anderson Creek/Colman Park (Biosite 27); most of Urban Miscellaneous (Biosite 35); and all of Ruffey (Biosite 30) and Koonung (Biosite 32). The former two are classified as of State Significance and the remaining three as of Regional Significance (see Sect. 11 and 12).

Like the Regions to the west, the Koonung/Ruffey Low Hills is of enormous strategic biodiversity significance, especially for mobile, migratory fauna. The network of remnant habitat and the riparian environment associated with Koonung Creek is a crucial alternative route from the Yarra River to the Mullum Mullum Creek headwaters. Also, the bushland associated with Hillcrest Reserve represents the last sizable remnant of indigenous habitat along the Mullum Mullum Creek before heading into the intensely urban suburbs of Nunawading, Mitcham and Ringwood in the City of Maroondah.

Warrandyte Hills

Warrandyte Hills is overwhelming the largest and most important Habitat Region in the study area. It occupies the entire extent of the Highland – Southern Fall Bioregion in the study area except for a very small section along Brushy Creek in Wonga Park (representing the Middle Yarra Floodplains and Low Hills). This Habitat Region covers the largest suburbs of Warrandyte, Warrandyte South and Wonga Park as well as parts of Park Orchards, Ringwood North, Donvale and Templestowe. It extends along about three quarters of the total length of the Yarra River and the primary internal boundary meanders through Donvale just north of the Hillcrest/Chaim Court Biosite through to Templestowe where it meets the Yarra River at the Fitzsimmons Lane bridge in between Westerfolds and Candlebark Parks.

This Habitat Region represents the bulk of the evenly sloping Silurian palaeosurface, generally comprising a landscape of relatively dissected low hills (as opposed to the plateau-like relief of the Koonung/Ruffey Low Hills). It contains the majority of the steepest terrain in the study area. Being crossed by three of the six major tributaries of the Yarra River within Manningham, Warrandyte Hills also contains significant Quaternary fluvial deposits both of a recent and older origin (Map 3.2).

Topographically, Warrandyte Hills covers almost the full range of the study area – from about 15 m ASL at the Fitzsimmons Lane Bridge to 160 m ASL along Yarra Road in Wonga Park. Mean annual rainfall is also equally variable and is more or less representative of the study area – ranging from ~700 mm at the Templestowe shopping centre to ~875 mm in Wonga Park just north of the Hochkins Ridge Flora Reserve on Holloway Road (see Sect. 2). Overall there is a very strong west to east rainfall gradient as for the Koonung/Ruffey Low Hills.

The soils of this Habitat Region are predominantly *soils on undulating or rolling rises of Silurian palaeosurface* in a complex mosaic with *soils on rolling and steep rises of Silurian palaeosurface*. Soils associated with streams, namely *soils on gently sloping drainage lines of Silurian palaeosurface* plus small patches of *soils on higher level alluvial terraces*, are common but far less abundant. Most of the existing soil data for the study area has been collected from the Warrandyte Hills and is therefore in this respect one of the most understood of the 5 Habitat Regions (see Sect. 2).

As would be expected from its size, the Warrandyte Hills supports the greatest area and variety of habitats in the study area. It supports significant areas of 7 of the study area's 16 EVCs. These include (in decreasing order of abundance): Grassy Dry Forest (EVC 22), Valley Grassy Forest (EVC 47), Creekline Herb-rich

Woodland (EVC 68), Riparian Forest (EVC 18), Herb-rich Foothill Forest (EVC 23), Valley Heathy Forest (EVC 127) and Escarpment Shrubland (EVC 895). Four of these (Grassy Dry Forest, Creekline Herb-rich Woodland, Herb-rich Foothill Forest and Escarpment Shrubland) are entirely restricted to this Habitat Region, including the most abundant EVC in the study area (Grassy Dry Forest). Grassy Dry Forest, Creekline Herb-rich Woodland and Valley Grassy Forest are scattered widely throughout the Warrandyte Hills, Riparian Forest is restricted to the Yarra River corridor and the three relevant major tributaries, Valley Heathy Forest only occurs as a small, isolated outlier along Knees Road in Park Orchards, Herb-rich Foothill Forest is predominantly found in the eastern half, east and north-east from the Warrandyte township and Escarpment Shrubland only occurs sporadically along the Yarra River corridor upstream from the Pound Bend area (see Sect. 5 and 6). The vast majority of the study area's unclassified Buffer Habitat and virtually all of it's unclassified Core Habitat, also occur in the Warrandyte Hills, the later concentrated in the far north-east between Stane Brae and Mount Lofty in WSP.

Three EVCs have been assigned a Conservation Status of Least Concern (Grassy Dry Forest, Riparian Forest, Herb-rich Foothill Forest) due to low levels of depletion and relatively high representation in conservation reserves within the Highland – Southern Fall Bioregion. The remaining 4 are classed as either Vulnerable (Valley Heathy Forest and Valley Grassy Forest) or Endangered (Escarpment Shrubland and Creekline Herb-rich Woodland) on account of very high depletion levels and relatively low representation in conservation reserves (Note that in some cases, threatened EVCs are naturally rare within the Highland – Southern Fall Bioregion) (see Sect. 5 and 6).

In terms of land use and tenure, Warrandyte Hills falls clearly into two groups: (1) the proportionately minor, intensively urbanised section west of the Mullum Mullum Creek and south of Warrandyte Road in Templestowe; and (2) the dominant non-urban areas, mainly east of the Mullum Mullum Creek. Although the former section has large areas of low-density residential subdivision and expansive areas of open space, especially along the Yarra River, it is not dissimilar in character to the three Habitat Regions of the Gippsland Plains Bioregion. In other words this section supports a very low area of indigenous vegetation scattered in a number of minor public recreation reserves predominantly owned by Council. The Council's Tikalara Park at the Mullum Mullum Creek confluence and Parks Victoria's Candlebark Park are the exceptions, but they still support a very low area of remnant indigenous habitat, usually in poor condition and have been significantly revegetated. As for the urbanised Habitat Regions, this section of the Warrandyte Hills also supports little unclassified Buffer Habitat.

The second section, east of the Mullum Mullum Creek, whilst still being predominantly freehold land, has an entirely different character primarily due to the general lack of intensive land use such as urbanisation. The relatively low levels of recent subdivision and the complete lack of it in some areas, has allowed forms of traditional broad-acre agriculture to persist and seen the rise of livestyle-based residential living, both of which can co-exist with indigenous habitat. This section supports a lower proportion of public open space represented by only a handful of small reserves and a number of large reserves concentrated along the Yarra River and Mullum Mullum Creek corridors. These larger reserves are amongst the biggest in the study area and being located in the least populated suburbs, support some of Manningham's most important remnant habitat. The standout reserve is WSP, which in Manningham consists of a system of 6 more or less discrete sections: (1) Pound Bend; (2) Fourth Hill and the Timber Reserve; (3) Haslam's Track; (4) Black Flat; (5) Jumping Creek, Blue Tongue Bend, Stae Brae and Yarra Brae; and (6) Mount Lofty in Wonga Park. With the possible exception of Mount Lofty, this reserve system supports many of the largest and least disturbed habitat remnants in the study area. Other notable reserves supporting important remnant habitat are owned by Council: One Hundred Acres, Currawong Bush Park and Bucks, Stintons and Colmans Reserves mainly located away from the Yarra River in Park Orchards and Warrandyte South. There are also some minor reserves and utility easements owned by VicRoads and Melbourne Water that support bushland.

Six of the seven EVCs in Warrandyte Hills (excluding Escarpment Shrubland) have been significantly depleted. Interestingly the most abundant EVCs have been depleted to the greatest extent: eg. 32.2% of Grassy Dry Forest remains. Presumably this is a reflection of the uniformity of the distribution of these EVCs and the uniformity of historical clearing patterns. Escarpment Shrubland is the only EVC to have apparently expanded in area post European settlement, although this is more likely a reflection of the structural domination of the disturbance-loving shrub, Burgan, especially along the Yarra River corridor. Escarpment Shrubland in its strict sense it likely confined to steep, rocky escarpments with shallow soils along the Warrandyte Gorge whilst today's ubiquitous Burgan dominated shrubland is probably a simplified anthropomorphic variant – a phenomenon that requires further investigation (see Sect. 5 and 6).

As with the western Habitat Regions, some revegetation plantations have been established along the Yarra River on Parks Victoria land at Candlebark Reserve, Tikalara Reserve and at Stanebrae and Mount Lofty in

WSP. Revegetation has been undertaken elsewhere in Warrandyte Hills but on too small a scale to map (see Sect. 5 and 6).

Twenty nine Biosites have been identified within this Biophysical (Habitat) Region: part of Hillcrest Reserve/Chaim Court (Biosite 22); most of McIntrye Road (Biosite 19); most of Mount Lofty (Biosite 1) and all of: Candlebark (Biosite 29); Mullum Confluence (Biosite 16); Green Gully (Biosite 34); Anderson Creek Road (Biosite 33); Currawong Reserve (Biosite 17); Buck Reserve/Donvale Christian School (Biosite 18); Rainbow Valley Road (Biosite 20); Oban Road (Biosite 21); Longridge Farm (Biosite 23); Naughton Avenue (Biosite 15); Tindals Hill (Biosite 24); Minter Court/Stintons Reserve (Biosite 13); One Hundred Acres (Biosite 14); Anderson Creek/Colman Park (Biosite 27); Pound Bend (Biosite 10); Fourth Hill (Biosite 11); Grandview Road (Biosite 12); The Vines Hill (Biosite 26); Black Flat (Biosite 4); Haslams Track (Biosite 5); Anzac Road (Biosite 6); Gatters Road (Biosite 8); Freyne Street (Biosite 7); Stane Brae/Blue Tongue Bend (Biosite 3); Kenilworth Avenue Hill (Biosite 25); Haven (Biosite 9); and Clifford Park/Bend of Isles (Biosite 2).

Most of these are classified as of State Significance with the exceptions being: Kenilworth Avenue Hill (Biosite 25) which is of Regional Significance; and Pound Bend (Biosite 10), Fourth Hill (Biosite 11), Stane Brae/Blue Tongue Bend (Biosite 3), and Clifford Park/Bend of Isles (Biosite 2) which are classified as National Significance (see Sect. 11 and 12).

The Warrandyte Hills contain the vast majority of Manningham's biodiversity values. Not only do the Habitat Region's 29 Biosites represent the bulk of the study area's remnant indigenous habitat they also represent a more or less continuous network of habitat that is of enormous strategic importance, especially for mobile, migratory fauna. The habitat networks along the major riparian zones (Mullum Mullum, Andersons and Jumping Creeks) link in most of the Warrandyte Hills sites with the primary strategic corridor along the Yarra River.

Middle Yarra Floodplains and Low Hills

The Middle Yarra Floodplains and Low Hills is located in the extreme north east of the study area in Wonga Park along the confluence of Brushy Creek with the Yarra River, on recent alluvium associated with Brushy Creek and part of the paleaosurface of Devonian origin. Although very small, it has been described as a separate Habitat Region on account of its unique Geology and very flat relief – being on the edge of a vast floodplain of the middle Yarra River that extends beyond Yarra Glen to the east and is now almost devoid of its original grassy forests, wetlands and floodplains (Map 3.2).

Topographically, the Region ranges from 50 m ASL at the Yarra River outflow to 70 m ASL on the adjacent low, undulating rises. Mean annual rainfall is ~850 mm and is one of the wettest parts of the study area (see Sect. 2).

The soils of this Habitat Region are *soils on active river and creek floodplains* (Brushy Creek) and immediately to the east, *soils on undulating rises of Devonian palaeosurface* (see Sect. 2).

The small pocket of remnant vegetation in the Middle Yarra Floodplains and Low Hills, located east of Witton's Reserve car park at the Yarra River confluence, consists of three EVCs in highly degraded condition. These are: Herb-rich Foothill Forest (EVC 23); Swampy Riparian Woodland (EVC 83); and Valley Grassy Forest (EVC 47). There is no other remnant vegetation in this Habitat Region (incl. unclassified Buffer Habitat). (Note that Herb-rich Foothill Forest was not originally within this Habitat Region and has only been included due to scale differences between the pre-1750 EVC mapping and that undertaken for this project) (see Sect. 5 and 6).

Herb-rich Foothill Forest has been assigned a Conservation Status of Least Concern and Swampy Riparian Woodland, Depleted. In both cases this is because of a low level of depletion and some representation in conservation reserves (although it should noted that Swampy Riparian Woodland is naturally rare in the Highlands – Southern Fall Bioregion). Valley Grassy Forest in contrast is classified as Vulnerable primarily due to a greater level of depletion.

This Habitat Region is almost entirely privately owned with the exception of Witton's Reserve and the Mount Lofty section of WSP owned by Council and the State Government (Parks Victoria) respectively. It is not coincidental that the bulk of the remnant vegetation in the Middle Yarra Floodplains and Low Hills is restricted to these public reserves.

Originally Swampy Riparian Woodland and Swampy Riparian Complex (EVC 126) dominated this Habitat Region. Only 10% of the former remains and Swampy Riparian Complex is now locally extinct. The Valley Grassy Forest is also close to local extinction (only 1.6% remains). A small area of revegetation has been carried out by Parks Victoria along Brushy Creek (see Sect. 5 and 6).

Only a small part of 1 Biosite has been identified within this Habitat Region: part of Mount Lofty (Biosite 1). Mount Lofty is classified as of State Significance (see Sect. 11 and 12).

4 Landuse and cultural History

4.1 Vegetation evolution and fire pre-history

By the middle Tertiary Period (~25 MY BP) Australia's last link with the Gondwanan super continent along the South Tasman Rise to Antarctica was finally broken allowing the flow of cold circumpolar currents. These geographical and climatic changes lead to changes in the floristic composition of the vegetation that are evident in the fossil record. There was a simultaneous loss of the dominance of rainforest taxa such as mesic *Nothofagus* species and a rise in the dominance of temperate taxa including scleromorphic groups such as *Acacia* and *Eucalyptus* as well as grasses (Poaceae) (Christophel 1993).

The following passage from Christophel (1993) points out that Victoria's modern vegetation, particularly the dominance of eucalypt forests and woodlands has only arisen in relatively recent times, although it is the culmination of a very long term evolutionary trend:

> "*By the end of the Miocene [6 MY BP] most of the floristic elements which are known in the modern flora were in existence in Victoria. General trends… continued through the Pilocene and Pleistocene [up until ~0.1 MY B.P] – rainforests become more restricted to coastal areas and xeromorphic elements took over in the drier central areas. It was only in the late Quaternary that the Eucalypt forests probably come to the prominence they enjoy today."*

It is interesting to note that the former evergreen forests of more mesic climates were probably not suddenly replaced by eucalypt woodlands, but were rather gradually replaced by intermediate drier rainforests (Sluiter and Kershaw 1981 quoted in Christophel 1993). Exactly what role fire played in this transitional process is unclear. Recent debate has suggested that up until the arrival of Aboriginal people from the north at some stage between 140,000 and 40,000 years BP, fire was relatively unimportant. For instance the noted naturalist, Tim Flannery, has suggested that "fire-stick" farming employed by modern Aborigines has been practiced from the beginning and radically transformed the landscape way before the arrival of Europeans (Flannery 1994). The extinction of the enigmatic Australasian megafauna such as the Diprotodon, which would have had a massive impact on vegetation, according to Flannery, can also be attributed to over hunting at the hands of Aborigines. Others have rejected this thesis (Benson and Redpath 1997; 1998) on the basis of lack of evidence and pose a more naturalistic and spontaneous process of evolution that saw the rise of complex fire/vegetation interrelationships and prolific speciation as the culmination of a long period of climate change driven by the gradual drift of the continent towards the equator. Under this model, Aboriginal people were relatively passive inhabitants of a well established ecology at the time of their arrival and at best have had only a minor impact on the nature of the landscape and its biota.

Whichever process has given birth to the modern flora and fauna of the region, at the time of the arrival of the first European colonists at the turn of the eighteenth century, the greater Melbourne region was a diverse, natural wilderness teeming with life. The bird life associated with Port Phillip and Western Port bays and the rivers and wetlands occupying the surrounding plains was a particularly outstanding feature. Flannery (2002) goes so far as to describe the region as the "Kakadu of the south". He bases his conclusions on the effusive accounts of Melbourne's natural environs by numerous explorers and settlers during the first half of the eighteenth century.

4.2 Pre-European (Indigenous) land use

There is evidence that aboriginal people have been permanently resident in the greater Melbourne area for possibly thousands of years. Archaeological investigations in the district has uncovered a range of artefacts and relicts such as stone scatters, scar-trees, campsites, corroboree and ceremonial sites, middens and even fishing infrastructure such as eeltraps made out of reeds. The open grassy plains and billabongs associated with the lower Yarra River around Bulleen, Heidelberg and Templestowe were particularly prized and intensively utilised (Pressland 1994; Ellender 1998). Useful introductions to the Aboriginal heritage of the Port Phillip region generally, and in particular how it relates to Manningham can be found in Ellender (1986) and Pertzel and Walters (2001).

Ethnobotanical research has indicated that a range of local plants were routinely used as a source of food (seeds, roots, fruits, gum, nectar and manna) for basket and implement manufacture as well as for use as medicine, string and adhesive (Gott 1989; Ellender 1998). Whilst dating studies of human remains and other artefacts elsewhere in Australia have indicated that humans have likely inhabited the mainland for up to tens

of thousands of years, evidence has emerged from oral history studies locally (eg. stories of the creation) that implies Aboriginal occupation of the Melbourne region may predate the inundation of the bays at the end of the last glacial period some 12,000 years BP (Ellender 1998).

Further evidence of the activities of Aboriginal people at the time of European settlement in and around the greater Melbourne region are provided by the testimonies of explorers, settlers and even escapee convicts. The story of William Buckley, who escaped from Point Nepean in 1803 and apparently integrated into local Aboriginal tribes and wandered around the western district for some thirty years before returning to civilisation, provides some extremely valuable insights into the culture and routines of Aboriginal tribes. Although controversial, Buckley's account describes hunting and ceremonial practices, food gathering procedures and other cultural activities in some detail that can be used to infer impacts on indigenous flora and fauna (Buckley 1996).

Many of the testimonies of the first European explorers and settlers reported evidence of extensive and frequent fires that were often attributed to Aborigines. Apart from the obvious applications of using fire to cook food and provide warmth, Aborigines apparently also used it for communication purposes, hunting (deliberately setting fire to an area to drive game out into the open), and "*it is also possible that they carried out regular burning to promote the growth of grass as a means of increasing the population of grazing animals which formed a substantial part of their diet*." (Bence 1989). The lowland plains associated with the Yarra River at Bulleen and Lower Templestowe were apparently frequently burnt for such purposes using low intensity fires and may have been at least in part responsible for maintaining and even creating the vast areas of grassland and savannah that many of the first Europeans effused about in their journals (Bence 1989).

What is clear is that Aboriginal people lived in the Melbourne area long before the arrival of Europeans. However, the exact nature, duration and consequences of their activities on the local landscape remains speculative. Whatever their impact was, it is now essentially an academic question and pales in comparison to the massive and intensive impacts perpetrated over the last 200 years since the arrival of European immigrants. Perhaps the primary purpose of pursuing this question of indigenous land use would be to develop and trial new systems of biodiversity conservation management (see Sect. 13).

4.3 Post-European land use

The arrival of European migrants saw an unprecedented impact on the local landscape and its biota. The detailed study of the location and condition of remnant habitat in Manningham contained in this report, shows that just over a third of the study area still supports remnant indigenous vegetation, most of which is in poor condition. Using the quantity and quality index developed recently by the State Government (whereby quality is based on comparisons with assumed pre-European settlement benchmarks (DNRE 2002a)), ~87% of Manningham's original biodiversity has been lost since the arrival of European migrants (see Sect. 5).

This massive transformation was caused by land clearing, cessation of burning, stock grazing, pest plant and animal invasion, and the removal of large trees resulting from: agriculture (cropping, orchard and pasture establishment), timber harvesting, gold mining and in more recent times, urbanisation.

Four main phases are relevant to an understanding of the total impact of European settlement on the local natural environment: Explorers and squatters (~1803 to 1839); first settlers, timber cutters and the gold rush (~1839 to 1870); orchardists (~1870 to 1945); and urbanisation (~1945 to present).

Explorers and squatters (~1803 to 1839)

It is unclear when the first Europeans entered the territory that is now Manningham, however, it is likely they were explorers and squatters moving along the Yarra River valley in search of fertile grazing country.

By the late 1830's squatters had claimed enormous landholdings for their sheep and cattle along the best stretches of the Yarra River. As was typical of the era, squatters were able to generate quick fortunes importing and breeding stock, grazing them on the fertile, grassy lowland plains with need of only very limited infrastructure before selling them for high prices to the rapidly developing new Port Phillip colony. It appears these initial holdings occupied the entire length of the Yarra River from Bulleen right through to Wonga Park and beyond by 1939 when one of the first detailed maps of the region was prepared by surveyor T.H. Nutt (Pertzel and Walters 2001).

"*The Wood brothers, John and William, are believed to be the first Europeans actually to settle in the Manningham region. John Wood occupied a site on the Yarra flats of Bulleen, while his brother William settled at Warrandyte*". The location of William Wood's station is shown on Nutt's 1939 map. "*The Ryrie brothers, William, Donald and James, held a grazing lease of 30,000 acres just beyond Gardiner's second run, in the area of Manningham called Wonga Park*." (Pertzel and Walters 2001).

Other prominent squatters worthy of mention at this time are Major Charles Newman, James Anderson and James Dawson. These pioneers took up land at the confluences of the Mullum Mullum Creek, Andersons Creek and Jumping Creeks respectively. Newman initially resided in a sod hut before constructing an Indian Bungalow-style home called Pontville that today still stands in Tikalara Park in Templestowe. Part of Anderson's holding was to later become the township of Warrandyte and Dawson owned and managed over 7,800 acres at Jumping Creek between 1845 and 53 (Ellender 1998; Pertzel and Walters 2001).

First settlers, timber cutters and the gold rush (~1839 to 1880)

By 1939 virtually all of the study area had been set out into blocks of around 640 acres each (1 square mile) for which exclusive "ownership" rights were offered in return for an annual lease of 10 shillings. Amongst the first to heed the call of the State in the Warrandyte area were timber cutters mainly servicing the local market for timber and firewood, and orchardists who grew a variety of crops also for local use. By the 1870's surveyors noted many huts scattered throughout but mainly along the major creeks and that vegetation clearing and cultivation was widespread. It is interesting to note that a large Aboriginal reserve was established at Pound Bend during this period (Ellender 1998).

Gold was found in Andersons Creek in 1851, initiating an intensive gold rush that lasted until 1870. By 1854 nearly 1000 men were seeking their fortune in gullies south of the township along Andersons Creek as far south as Hussey's Lane close to the border of Park Orchards and along the Mullum Mullum Creek to McIntyres Road also in Park Orchards. By 1856 the alluvial workings in the Warrandyte area were exhausted. Although most miners moved on, some stayed and eked out a living until about 1900 and became the pioneers of the Warrandyte township (Pertzel and Walter 2001). Large mine shafts were also sunk for quartz mining, and although they proved difficult to work for little return, they persisted a little longer than the alluvial workings. Some of these shafts are still evident today in WSP at Fourth Hill behind the Warrandyte township at Pound Bend and as far south as McIntryes Road in Park Orchards (Pertzel and Walters 2001). If the impact of gold mining in other parts of the State are anything to go by the entire area would have been quickly denuded of vegetation to service camp fires, to line mine shafts and to stoke boilers for driving primitive mining equipment. Pertzel and Walters (2001) provides an excellent introduction to the gold mining history of the region.

Orchardists (~1880 to 1945)

Although only a handful of orchards persist today, up until the post second world war period, the region was intensively farmed for a huge variety of orchard crops first introduced to the area by British and German immigrants in the 1850's. Initially modest acreages were established in the west (Templestowe, Bulleen and Doncaster) after clearing the "*native stringy bark, box and wattle*" (Pertzel and Walter 2001). Once local knowledge was established, success followed, which resulted in massive expansion from about the 1880's. By the turn of the century, in at least in the western half of Manningham, "*orchards stretched as far as the eye can see*" (Pertzel and Walters 2001). With very few exceptions, by this point almost all of the indigenous vegetation had been removed to make way for the orchard revolution. Orchards were also plentiful in the east at this time, but considerably less of the landscape had been cleared for their establishment. For instance, only a fraction of the land now forming the One Hundred Acres reserve in Park orchards was laid out with Orchards (Ellender 1998). Presumably the extra distance from the Melbourne markets and the relative unsuitability of the more dissected terrain in the east rendered expansion on the scale observed further west unviable.

Aerial photography dating from 1945 held by MCC clearly shows this massive disparity in orchard distribution between the west and east. At this time the Doncaster and Templestowe areas around where Ruffey Lake Park is situated today were almost entirely occupied by orchards, where as the Park Orchards and Warrandyte South areas, east of the Mullum Mullum Creek show large areas of remnant bushland and only a scattering of orchards or their remains.

Urbanisation (~1945 to present)

Following the second world war the cycle of selling orchards for residential purposes began. As the nearby suburbs expanded, much of the land simply became too valuable (increasing rates and property prices) for growing fruit and many orchardist secumed to the allure of subdivision. "*The orchards disappeared very quickly in the 1960's and 1970's. [Over this period] the population of Doncaster-Templestowe grew from 15,000 to 64,000 (the 2001 census puts Manningham's population at 112,000) and the orchards were reduced to 2,000 acres*." (Pertzel and Walter 2001). Today well over half of the study area has been intensively urbanised or otherwise subdivided for residential use (see Sect. 5) – a transformation from a predominantly agricultural landscape with scattered villages and bushland (mainly in the east) effectively within about 50 years. Although some minor subdivision continues, State planning laws designed to protect Melbourne's Green Wedges, establish from the 1970's, have effectively halted the radiating advance of urban sprawl.

4.4 Post-European fire history

In contrast to the paucity of knowledge regarding the nature and impact of fire on the landscape prior to European settlement and also before the arrival of Aborigines, there is considerable documentation of the occurrence of fire over the last 200 years or so. Right from the very beginning of European settlement fires of various kinds were reported and described. These ranged from natural bushfires started by lightening to those ignited by Aborigines and those resulting from the indifference of the new settlers to the potentially destructive force of uncontrolled wildfire.

"*The settlers didn't have to wait long before they were to experience the awesome might of an uncontrolled wildfire. On the 6th of February 1851 the State of Victoria was devastated by the greatest conflagration in its history up to that time, a conflagration that possibly exceeded even the holocaust of 1939*." (Bence 1989).

Bruce Bence's excellent history of fire in the Warrandyte area demonstrates clearly just how fire-prone the district was in the early years of settlement. "Bushfires were so common in the areas that a summer free from fires would have been unusual. Up until the 1939 fires, no less than 14 significant fires occurred in the Manningham area beginning with 'Black Thursday' in February 1851 (Bence 1989). The others occurred in: January 1857, February 1865, summer 1890, summer 1891, summer 1893, summer 1898, January 1905, January 1912, February 1913, February 1926 and February 1927. Many other fires occurred in the intervening years in the surrounding areas such as Kinglake and Healesville. Most of these fires burnt huge areas of bushland throughout the region often destroying the new settler's property (including stock) and frequently taking their lives. The 1927 fire for instance burnt out all of the country in Manninhgam east from about Andersons Creek. The January 1939 fires that ended up burning vast tracks of eastern and southern Victoria, burnt a large swath right through Manningham beginning just over the Yarra River near the Mullum Mullum Creek confluence through Warrandyte to Yarra Road in Wonga Park. Right from the very beginning "*the settlers realised that they had picked a harsh land to settle in, floods, fire and drought were part of their existence and if they were to live in the land they had to learn to cope with its extremes*." (Bence 1989).

As people were obviously preoccupied with surviving in such a dangerous environment, little attention was paid to the environmental toll of these conflagrations. Whilst burning in itself is not a bad thing, in fact it is arguably an essential ecological process, the frequency and intensity combined with other factors such as landscape fragmentation, are potentially problematic and environmentally damaging. A few minor passing references are made to the damaging toll of the fires on the region's flora and fauna. For instance: "*according to the people of Wonga Park who lived in the area at the time [of the February 1926 fire], the Koala never came back to the area after the 1926 fires*." (Bence 1989).

Thus was the attitude in the beginning. However, with the spread of their influence through agricultural and urban development, local communities became more organised and resourced such that the overt policy of aiming to suppress or eliminate all wildfire soon took hold – a strategy that has proven very successful, although it has failed to eliminate wildfires altogether. It seems, despite the sophistication of our modern fire fighting capacities and institutions, Bence's comments about learning to "cope with [the landscape's] extremes" is equally valid today.

Since the 1939 fires, only 3 major fires have occurred in Manningham: 1962 – Warrandyte, Park Orchards and Wonga Park; 1965 – Warrandyte; and 1969 – also in Warrandyte. The frequency of significant fire events has apparently shifted from about one every 6 to 7 years prior to 1940 to one every 21 years since. We have moved from a situation were there were possibly too many fires during the first 100 years immediately proceeding settlement to a period where fires are now uncommon and in some areas are

effectively absent. From an ecological perspective, both these regimes are problematic and has already likely contributed to the extinction of species and the general deterioration in ecosystem health and resilience. The reintroduction of fire in many areas of remnant habitat will be a necessary component of restoring and sustaining Manningham's natural heritage.

The following except from Gunderson and Holling (2002) explains the ecological folly of this strategy:

> *"[The] suppression of forest fires locally will cause an accumulation of fuel on the forest floor and an accumulation of tree biomass. When a fire event finally occurs, it will be hot and intensive, burning deep into the soil and affecting seed viability, micro-organisms, organic content and nutrients. An ecosystem that can withstand a small, low-intensity fire may be severely affected by a large, hot fire that can change soil conditions, affect water-holding capacity, and destroy, old seed-bearing trees that are important for the reorganisation phase. Hence suppression of disturbance can modify the essential preconditions for ecosystem redevelopment."*

Gill (1993) presents an overview of plant-fire ecology in the Victorian context. The affects of fire on ecosystems are fundamentally driven by frequency and intensity, which are in turn governed by climate and fuel. Plants, being sedentary, tend to exhibit two main responses to burning: they either resprout or germinate from seed – although many groups are capable of both (eg. eucalypts which actually encourage fire with volatile leaf-oil chemistry and prolific bark production). Fauna, as would be expected, have developed strategies for avoiding the flames by hiding or fleeing the heat. In the contemporary context, landscape fragmentation due to habitat destruction, plus the ravages of weeds and drought have served to negatively interfere with these ecologies.

5 Indigenous Vegetation Mapping

5.1 Introduction

One of the key assumptions behind this study is that at the local scale, biodiversity should be considered synonymous with indigenous vegetation. Remnant indigenous vegetation mapping provides a means by which local biodiversity resources can be explicitly defined in geographic terms. In other words vegetation mapping provides the basis for quantifying biodiversity as well as defining the boundaries of Biosites. And these boundaries in turn can be used to define spatially explicit statutory overlays that control the application of environmental law and regulation under the VPPs.

Manningham's current Environmental Significance Overlay (ESO 2) is inadequate because it is based on inadequate remnant vegetation mapping. All three previous SOS studies failed to achieve a comprehensive municipal coverage because each were limited in scope and/or resources.

With the introduction of Victoria's Native Vegetation Management – A Framework for Action (DNRE 2001a), there is now a requirement for Councils to maintain remnant vegetation databases that accord with statewide principles and standards. In particular this means mapping that at least includes classification of remnant vegetation into EVCs.

The first supposedly municipal wide vegetation mapping was only recently completed as part of the Port Phillip and Western Port vegetation mapping project (Oates and Taranto 2001). This project was in turn part of a broader program aimed at mapping extant and pre-1750 EVCs throughout the State at a scale of 1:100,000. Unfortunately, primarily due to scale issues, the data generated for Manningham was inadequate for strategic or statutory planning purposes (Note: comparisons have shown that Oates and Taranto (2001) underestimate the area of remnant indigenous vegetation within Manningham by up to 60%).

Previous detailed vegetation mapping/description (Beardsell 2002 for WSP and Bedggood *et al.* 1992; 1997 for selected private land) either pre-dated the development of the EVC concept and was descriptive only or was geographically limited.

Clearly more vegetation mapping was required to identify all remnant vegetation within Manningham and classify it at least to the standards required under Victoria's Native Vegetation Management – A Framework for Action. This includes determination of EVC and the Bioregional Conservation Status (DNRE 2001a).

Mapping to accurately identify the location and nature of remnant indigenous vegetation is the necessary first step in the review of Manningham's SOS.

5.2 Methods

A vegetation map was produced using an API-based remote sensing technique. The process involved the following steps: Determination of variables; API; Digitisation; Polygon attribution; and Field checking and validation.

Determination of variables

Eight variables (representing 85 categories) were selected on the basis of factors such as ease of determination using API and relevance to native vegetation ecology and management.

These are:

1. Landscape Unit is the classification of an area into broad categories based on consideration of: Indigenous Tree Crown Cover; Indigenous Vegetation Modification; Human Occupation and Exotic Tree/Shrub Cover.
2. Indigenous Tree Crown Cover is a measure of the proportion of an area occupied by indigenous tree crowns.
3. Indigenous Vegetation Modification is degree to which indigenous vegetation has been manifestly modified by human activity since European settlement. It is a relative index where by the least modified category is equivalent to the 'best' vegetation present within the study area. No vegetation within the study area is considered 'old-growth' or in 'pristine' condition – that is to say all vegetation in Manningham has been modified to some extent.

4. EVC is the classification of vegetation into one of 20 categories using pre-European settlement data supplied by DSE. Note that it was beyond the scope of this project to either test the accuracy of the data supplied or to develop a new municipal vegetation classification regime at either the EVC or subordinate levels (ie. Floristic Communities). In effect the main objective of this process was to transfer existing EVC data from the 1:100,000 scale down to a more useful municipal scale (1:7,000).
5. Dominant Indigenous Species lists the dominant indigenous tree and shrub species in terms of Percentage Projected Crown Cover (PCC). Most of the larger trees in the study area are eucalypts (disclimax grassland excluded).
6. Indigenous Tree Health is a measure of the proportion of the dominant indigenous species crowns that show clear signs of ill health or death.
7. Human Occupation is the degree to which an area is occupied by humans as measured by the density of residential housing and the size of allotments.
8. Exotic Tree/Shrub Cover is a measure of the proportion of an area occupied by exotic tree/shrub crowns.

Further detail for each of the variables is contained in Table 5.1 whilst the details for each of the 85 categories are listed and described in Appendix 5.1.

The group contains a mix of explicitly quantified, independent variables such as Indigenous Tree Cover and quality/judgement-based variables guided by a number of non-explicit considerations such as Indigenous Vegetation Modification.

Due to the scope and objectives of the project, and the nature of the landscape, Indigenous Tree Crown Cover, Indigenous Vegetation Modification and EVC were designated the primary variables in that they drove the delineation of polygon boundaries. All the other variables were secondary and largely descriptive, and consequently, the final polygon structure is not necessarily the best representation of these (secondary) variables at the scale used.

Aerial Photographic Interpretation, polygon attribution and field checking

The study area was divided into polygons using API, a process that involved the systematic examination of overlapping pairs of colour aerial photographs using a stereoscope. The photographs were taken in December 2000 at a scale of 1:7000.

Stereoscope use allowed for the identification of topography, tree height, crown width and condition, species identification, broad understorey structure, weediness and the presence of built structures. All line work was recorded in permanent ink on plastic overlays attached to each photo that delineated the central zone of minimal distortion (ie. ~60%).

Each polygon was coded with a unique number against which all 8 variables were recorded in an attribute table. A selection of polygons were then visited in the field to check the accuracy of the remotely sensed judgements. These selections were either representative landscapes, areas of complexity or where interpretation was otherwise problematic. In some instances, field checking revealed the necessity for either modifying, splitting or merging remotely sensed polygons.

Digitisation and data validation

The polygon data was then entered directly into ARCVIEW using on-screen digitisation whereby the line work was created manually using the mouse. Orientation was interactively maintained by displaying the same aerial photographs as a layer on screen. Attribution of polygons was achieved in the same process.

Once all the polygon data was created a number of validation tests were performed to ensure the attributes were correct and consistent. For instance, pre-1750 EVC data supplied by DSE was overlaid to ensure determinations were as accurate as possible at the modified municipal scale.

Risk Assessment

Of particular interest to this study is whether or not the broader trend of decline reported elsewhere in Victoria (DNRE 2002a) is relevant to Manningham and, if so, what is current rate of decline? The management of a shrinking or declining resource is quite a different exercise than managing one that is relatively stable or even expanding.

For the purposes of strategic planning, a crude vegetation dynamic model was developed by combining various elements of the indigenous vegetation theme with other spatial data and making a number of explicit assumptions.

The more complex models incorporate factors such as climatic patterns, global warming, gene flow, species extinction probabilities, human development patterns, fragmentation patterns, land use trends and even stochastic episodes like floods and so on. Such models are capable of impressive predicative power over long time frames but are expensive and time consuming to develop and are therefore beyond the scope of this project. However, it is still possible to draw some plausible and useful conclusions with the resources and tools available. For instance, if it is assumed that the current condition of vegetation/habitat is a consequence of the past impact of all of factors listed above, then it is not unreasonable to expect they will continue into the near future. Thus degraded vegetation present today is most likely to continue to degrade into the future and least degraded vegetation is less likely to decline or at least at a slower rate.

Decline is broadly defined as the process that results in the vegetation moving from a pristine (unmodified) condition to extinction and is correlated with an increasing operation of threats (ie. threat type, range and intensity). Thus risk of decline is inversely proportional to condition as categorized by degree of modification and the rate at which it is expected to decline in the future.

The process of decline is very much a contemporary phenomenon (post-European settlement) essentially charting the effect of retardating or terminating 'natural' ecological processes. Natural is understood as the regime of processes that brought about the evolution of habitat systems and underpin their dynamics in the pre-European context. It is assumed that natural is synonymous with sustainable.

We know that anthropogenic interference does and can result in habitat extinction because (a) direct and indirect habitat loss has already occurred in Victoria since European settlement on a massive scale, and (b) it can be imputed as a probable future consequence of currently observed dysfunction in the component parts of habitat (ie. populations unable to reproduce will eventually go extinct if trends are sustained).

Assuming minimal resources would be available to combat this decline and that least modified habitat requires the least management effort and attention in the short term, it follows that that portion of At Risk habitat most effectively and efficiently restored should become the strategic priority.

A risk of decline classification matrix was developed for all remnant vegetation with a PCC of >5% based on the Indigenous Vegetation Modification variable (Table 5.2). Vegetation was assigned greatest risk of decline status (Serious Risk) if it is in Primarily or Entirely Modified condition and at the opposite end, the lowest risk of decline status (Least Concern) was associated with the 'best' vegetation in Partially or Low Modified condition. At Risk status was assigned to all vegetation in between the two – ie. in Substantially Modified condition (also see Appendix 5.1 for definitions of Primary Variables).

Core/Buffer habitat and Biosite delineation

Perhaps one of the more important aspects of documenting Biostes is defining boundaries. Many past studies have strictly used the cadastre, whereby the extent of a single parcel of land denotes the extent of a site (Bedggood *et. al* 1992). In fragmented landscapes these sites may or may not exactly coincide with the edges of vegetation remnants. If there is heterogeneity within sites, this is either ignored or internal stratification is undertaken to denote clearings or obvious variations in condition or other characteristics (eg. Lorimer 2001). Where boundaries are diffuse, decision making becomes more subjective and may or may not be based on clearly articulated rules or guidelines.

The excessive preoccupation with land tenure within current planning processes is resulting in a kind of 'ecological segmentation' whereby habitat systems are subdivided into multitudinous (frequently very small) segments before issues and values are properly considered. Individual properties are effectively viewed in isolation and primarily on the basis of *in situ* values, rather than as part of a bigger whole that may span a much greater area. In this way planning processes often effectively ignore or overlook the bigger ecological picture. For example a small parcel on the margin of a Nationally Significant site is classified as of Local Significance if those values known to be present within the surrounding context are not directly observed on the subject land. The net effect of approving such losses, irrespective of the environmental concessions proposed (eg. tree planting or environmental management plans etc.), is the reduction in the size of a Nationally Significant site not just the loss of a Locally Significant site. This view is ecologically short sighted and illogical, as it will continue to facilitate the incremental loss of many of our most significant sites.

The fact that political or human boundaries are inconsistent or incompatible with those ecological has become a truism, even common sense, but it seems our planning systems remain archaic. Because of the nature of biodiversity, we cannot expect to fully or even adequately capture it within spatial explicit, short-term networks of significant sites, but we can improve on the ecological non-sense of existing regimes. The challenge is to develop new ways of defining biodiversity that are ecologically meaningful, but still compatible with planning systems. Inevitably there will be a need for compromise on both sides.

The following seven rules/principles were developed to guide the delineation of Biosites for this project (see Sect. 11):

1. Ignore land tenure during mapping procedures.
2. Ensure sufficiently detailed mapping is complete before attempting site delineation.
3. Develop explicit rules that determine site edges and apply them AFTER the vegetation mapping is complete.
4. In fragmented landscapes, the spatial patterning of the remnant vegetation should drive the configuration of sites.
5. Define a minimum remnant size for inclusion in and as a site.
6. Smaller remnants that are isolated but geographically clustered should be incorporated into a single site (especially if they are similar habitat).
7. Where larger areas of vegetation are transected by rivers, roads, easements or other curvilinear ecological barriers, these features should be used as “edges”.

The final number of sites will be a function of the scale of the project and the nature of the habitat within the study area. Although the network of sites resulting from the application of this regime will reflect a high degree of subjective judgement and the premises on which the decisions have been made would not have been rigorously tested, at least in the local context, the primary intension is to minimise ‘ecological segmentation’.

Whilst all remnant vegetation, even a single tree, is habitat in its own right and therefore of some value, not all of it could be regarded as significant on the scale from National down to Local. Indeed some of it is so degraded ecologically that it is not or barely mappable at the local scale. Consequently, the vegetation has been broadly divided into Core and Buffer Habitat whereby the former becomes the totality of the Biosites network and the later provides additional ecological support. Core Habitat is all areas with a PCC >25% in a highly variable state of modification (all categories except Entirely Modified/Urban) whilst Buffer Habitat has a PCC of 5% to 25% in up to Substantially Modified condition. In other words the Core Habitat areas have the highest Indigenous Tree Cover and is in the least modified state. All other areas, with <5% PCC, were classified as non-vegetation and excluded from the Core/Buffer network (Table 5.3).

The nomenclature is designed to reflect the presumed ecological functionality of the two zones: with Core Habitat representing those areas that support the majority of the study area’s biodiversity and Buffer Habitat providing additional (usually adjacent) habitat that tends to consist of the more common indigenous species supporting the ecological integrity of the Core Habitat. Under this framework, it is assumed that the Core Habitat would be of lesser value if the Buffer Habitat areas were absent and that all remnant indigenous vegetation, even individual trees, is of value and should be conserved.

5.3 Results

Polygon data

The digitisation process generated 1595 polygons covering a total area of 11264.58 ha or ~112.6 square kilometres. Three hundred and fifty (21.9% of 1595) polygons were field checked and validated with respect to both boundaries and attributes. The average polygon area was 7.05 ha with the majority (70.2 %) being $\leq$ 4 ha. It should be noted that the largest polygons ($\geq$ 50 ha) occurred in the urban areas generally west of the Mullum Mullum Creek or in the open agricultural areas of Wonga Park where there is little indigenous vegetation. Conversely, the smallest polygons (ie. greatest complexity) were appropriately amongst the Core Habitat, concentrated in the east (Figure 5.1; Map 5.1).

Landscape Units

The dominant landscape elements of the study area are the exotic and non-vegetation categories ranging from intense urban fabric mainly in the west through medium-density residential areas to unoccupied agricultural areas more prevalent in the east (Table 5.4; Map 5.2).

It is interesting to note that revegetation occupied just 1.1% of the study area, mainly along the Yarra River in State Government parks. Although this is likely to be an underestimate, as there are numerous plantings, particularly in the east that were too small to map, it does indicate that the scale of the revegetation effort is quite small at the landscape scale. Furthermore, even though no assessment was made of the ecological success of these projects, anecdotal evidence suggests it would be low and consequently these areas are classified under exotic vegetation.

The Indigenous Landscape Unit occupied only about a quarter of the study area (24.8%) mainly east from the Mullum Mullum Creek and along the Yarra River through Templestowe as Buffer Habitat was generally regarded as so degraded or modified that the exotic components are now effectively dominant (Table 5.4; Map 5.4).

Indigenous Tree Crown Cover

Broadly, under this variable, the study area can be divided into three divisions: Treeless areas (62.5%) with little or no indigenous habitat; timbered areas (36.2% - Sparse to Very High categories) with an Indigenous Tree Crown Cover of >5% PCC (in a widely varying state of modification); and small pockets of Indigenous Shrubland or Grassland (1.3%). The later two divisions represent, more or less, the totality of remnant indigenous habitat within the study area: 37.5% (Table 5.5; Map 5.3).

The Treeless areas or non-habitat are predominantly in the urbanised regions west of Mullum Mullum Creek and the vast majority (almost 90%) of all remnant habitat occurs to the east (Table 5.5; Map 5.3).

Within the timbered areas, generally the High and Very High categories represent the 'natural' variation in crown cover of bushland that is less modified or has been least disturbed in recent decades. Bushland in some of the larger reserves and freehold properties are good examples of this. The Moderate category is indicative of some kind of partial tree thinning or dieback typical of much freehold land. And the Sparse category is similar country, but in a worse state and is defined as Buffer Habitat (see Sect. 13).

The Indigenous Shrubland category is almost entirely Burgan (*Kunzea ericoides*) dominated vegetation common along the Yarra River corridor, particularly in the Wonga Park area. There is some speculation that this vegetation is in some respects adventive: either a post-settlement artefact or a 'natural' habitat type that has been spread by human activity (see Sect. 13).

Although it is likely there were areas of grassland or open grassy woodlands within the study area prior to European settlement, the Indigenous Grassland mapped here is almost certainly disclimax. It is a structural artefact resulting from the removal of trees and other woody elements by people (ie. clearing, grazing or slashing etc.). A whole range of indigenous graminoids and forbs can be encouraged or even spread under some forms of disturbance and are often found in some of the most modified landscapes such as urban residential nature-strips. These areas were generally not mapped due to their adventive origin, small scale, urban context and low plant species-richness (see Sect 13).

Indigenous Vegetation Modification

In terms of the degree to which vegetation has been modified, the majority of the study area (>80%) supports Entirely or Primarily modified landscapes or are characterised by a general absence of indigenous vegetation. Entirely Modified landscapes with intense urban and industrial fabric are (more or less) entirely devoid of bushland, whilst in Primarily Modified landscapes, consisting of a mix of urban, residential and undeveloped agricultural areas, bushland is common but not dominant (a cover of 30 to 40%). It is interesting to note that the urban and residential parts of these Primarily Modified landscapes support the highest indigenous tree cover, although the agricultural areas do have slightly more Core Habitat. Presumably this is a reflection of a general preference for subdividing timbered areas over cleared land. The low proportion of Core Habitat in these landscapes is indicative of the general incompatibility of bushland conservation with these more intensive forms of land use. However, this is not to say that bushland conservation is necessarily or always incompatible with agricultural or residential uses (Table 5.6; Map 5.4).

Only about a fifth of the study area (19.2%) supports remnant indigenous vegetation still in a reasonable or less modified condition, although a large proportion of this is still highly altered. Perhaps of more concern is that only <5% remains in the top, or in Least Modified condition. No indigenous bushland in the study area has been protected from the onslaught of post-settlement human land use. Changes in fire regimes, weed invasion, stock and pest animals, gold mining and timber cutting etc. have collectively exerted a massive impact on every hectare of indigenous vegetation (see Sect. 4; 6; 13).

Agricultural/non-residential landscapes are widespread in the east of the study area along with the less modified bushland remnants, where as the urban/industrial landscapes are predominantly in the west. Urban/residential landscapes are most widespread in the suburbs of Bulleen, Lower Templestowe, Doncaster and East Doncaster (Map 5.4).

EVC diversity and Conservation Status

Two separate EVC themes have been mapped by the State Government within the study area: (1) Pre-1750 or pre-European settlement, and (2) Extant (Oates and Taranto 2002). With some exceptions, it is assumed that extant vegetation simply represents a depletion of the original pre-1750 coverage due to post-European settlement habitat loss (Map 5.5; 5.6).

Pre-1750 mapping shows that the study area was once dominated by 16 EVCs, of which, Grassy Dry Forest, Valley Heathy Forest and Valley Grassy Forest were the most widespread. At this time, the 5 most common EVCs collectively covered almost 90% of the study area. The remaining habitat types tended to be present as small, discrete patches occupying a particular environmental niche, such as Swampy Riparian Complex on the middle Yarra River plains in Wonga Park east of Brushy Creek (Map 5.5; 5.6; Figure 5.2; see Sect. 6).

Comparison with the extant coverage shows that whilst only 1 EVC is now extinct (Grassy Woodland formerly on Doncaster Hill), and with the exception of Escarpment Shrubland (a form of which has apparently spread along the eastern half of the Yarra River), most of the remaining EVCs have been seriously depleted. For example only 4.1% and 1.1% of Valley Heathy Forest and Plains Grassy Woodland respectively remain primarily because they were disproportionately represented in the highly urbanised western suburbs of Bulleen, Templestowe, Lower Templestowe, Doncaster and East Doncaster. Grassy Dry Forest, dominant in the east, by contrast has faired relatively well (32.2% remaining) (Map 5.5; 5.6; Table 5.9).

Accordingly, it is not surprising that much of the extant vegetation is considered threatened at both the Local and Bioregional scales. Using a combination of pre-1750 distribution and depletion levels, at the municipal level, 12 of the 16 original EVCs are considered Endangered or Vulnerable; only 3 are thought to be of Least Concern. In other words, three-quarters of Manningham's habitat diversity is at risk of disappearing if present land use or other casual factors continue to operate (Table 5.9).

At the Bioregional level the situation is a little more complex, but just as sobering. The complexity is introduced because the study area inconveniently straddles two Bioregions: (1) Gippsland Plains, and (2) Highlands – Southern Fall (DNRE 1997) – broadly west and east of the Mullum Mullum Creek respectively (see Sect. 3). As the Highland – Southern Fall Bioregion encompasses the mountainous regions of eastern Victoria, south of the Great Dividing Range and north of the heavily utilised Gippsland Plains coastal hinterland, a significant differential exists between the two in terms of vegetation depletion levels, and for some EVCs, Conservation Status (Halley 2002). Within the Gippsland Plains, 15 (12 Endangered) of the study area EVCs are classified as threatened on the basis of depletion levels, rarity and reservation status. This compares with 10 (8 Endangered) within the Highlands – Southern Fall. Direct comparisons show that 6 EVCs have a different Conservation Status in the two relevant Bioregions, with the classification always less threatened in the Highlands – Southern Fall (Table 5.10; Map 5.7).

Application of EVC Bioregional Conservation Status classifications resulted in the remnant vegetation falling roughly into three categories: Endangered and Vulnerable EVC's; those of Least Concern; and the remaining third Unclassified. Not surprisingly all of the classified EVCs in the Gippsland Plains portion of the study area are Endangered and Vulnerable, where as in the eastern Highland – Southern Fall section, the majority of the remaining bushland is classified as of Least Concern (mainly Grassy Dry Forest). Despite this, the vast majority of the Manningham's threatened habitat still occurs in the east (Map 5.6; 5.7).

As is reflected in the Bioregional depletion data, the Gippsland Plains portion of the study area has been almost entirely cleared (<10% remains) whilst over half the area of the Highland –Southern Fall portion still supports indigenous habitat (>55%) (Map 5.6; 5.7).

Extant EVCs

Extant mapping shows that the study area is today composed of 15 EVCs, 4 of which are relatively widespread or well represented (ie. >200 ha) and the remaining 11 are rare and/or localised (4 < 10 ha) (Table 5.8; 5.9; Map 5.5). Interestingly the widespread EVCs: Grassy Dry Forest; Valley Grassy Forest; Creekline Herb-rich Woodland; and Riparian Forest represent a consistent topographical pattern (from ridgeline down to creek or river) that is typical of the area, especially in the east (see Sect. 6). Note:

Unclassified Buffer Habitat was not classified because of poor condition (usually no understorey), whilst Unclassified Core Habitat was not classified because the vegetation present didn't readily fall into the EVC categories described in Oates and Taranto (2001).

In general the more widespread an EVC the larger the range of condition categories represented (with a roughly normal distribution around the Significantly and Partially Modified categories) (Table 5.8). The key exception was Grassy Dry Forest, where over a third of the total area is in the 'best' (Low Modification) condition presumably because the EVC is most abundant on the least disturbed ridge tops. In contrast, most of the rarer EVCs occupied a narrower condition range, predictably biased towards the poorer end of the scale around Significantly and Primarily Modified. This is presumably due to the small size of the patches in which they occur and their proximity to residential development.

The formerly widespread Valley Heathy Forest is an interesting exception to these general observations. Not only has a disproportionately high area of this EVC been cleared post settlement, but today's reasonably large remnants (>110 ha) in the Donvale area are in unexpectedly poor condition. A possible explanation is that its natural distribution largely coincides with the recent spread of Melbourne's north-eastern suburbs. Unfortunately Valley Heathy Forest is poorly represented in the eastern half of the study area (Map 5.5).

Dominant Indigenous Species

Within the 775 polygons classified into EVCs, 24 species were recorded as dominating the vegetation present. Half of these are eucalypts and the remainder are large shrubs or small trees from a variety of families, but mainly wattles (*Acacia* sp.). As would be expected the eucalypts are the outstanding dominant feature of the region's remnant vegetation. In fact, Yellow Box, Red Box, Red Stringy-bark, Long-leaf Box and Candle-bark were recorded as the five most frequently recorded dominant species (Figure 5.3), with the former two being recorded in >50% of the classified polygons. The dominance of the box and stringy-bark eucalyptus reflects the abundance of Grassy Dry Forest and Valley Grassy Forest (see Sect. 6).

Despite the diversity of wattle, Burgan is by far the most frequently recorded dominant non-eucalypt. Presumably this is a reflection of divergent life-strategies. Burgan is a natural 'weedy' species that has tended to be greatly favoured by the types of frequent soil disturbance associated with post-settlement land management, especially along the Yarra River corridor, where as the hard-seeded wattles are better adapted to other kinds of disturbance such as fire.

Indigenous Tree Health

The vast majority of the remnant bushland in the study area is dominated by trees that are Unclassified or either in Poor or Fair health. The Unclassified areas are primarily Buffer Habitat usually supporting trees only and frequently suffering from minor to severe levels of die back due, in part, to the pressures of residential development or other forms of intensive land use. A small proportion of this category are grassland and shrubland remnants not dominated by eucalypts.

The balance is vegetation in Good health, and covering only about 15% of all remnant habitat, it is restricted to the western half of the study area amongst the larger bushland remnants such as the Stane Brae area and the Timber Reserve block of WSP (Table 5.11; Map 5.8). The patterning, dynamics and causes of tree dieback, especially amongst eucalypts is extremely complex and beyond the scope of this study. Certainly further investigations into local tree dieback are merited, but the only equivocal conclusion is that the majority of the bushland is suffering from some level of canopy ill health and/or decline.

Human Occupation

The Human Occupation variable largely reflects the planning scheme, with intensively urbanised and industrial areas in the Residential Zones west of the Mullum Mullum Creek and lower density residential areas in the east through Donvale, Park Orchards, Warrandyte South and Ringwood North. Scattered residences on larger allotments, often used for low intensity agriculture (eg. horses), are most common in Wonga Park and Warrandyte South within the Environmental Rural Zone (ERZ). And similarly the least occupied areas are in the ERZ or the Public Conservation and Resource Zone associated with WSP and along the Yarra River corridor (Table 5.12, Map 5.9).

When viewed in the context of the remnant habitat, a clear link between human occupation and indigenous habitat it evident. In other words more houses means less bush, irrespective of other forms of land management (eg. mining or agricultural history). Whilst the stark contrast between urban areas and

unoccupied areas appears self evident, they represent the extremes of a broader inverse trend with the intermediate section dominated by significantly degraded Buffer Habitat. Given that it would be impossible, if not prohibitively expensive, to attempt to remove people, houses and subdivisions, the current level of human occupation will determine the practical limits for bushland restoration. Thus Buffer Habitat in urban and light urban areas will inevitably be lost. This is a critical conclusion for developing strategic planning policies (see Sect. 13). Why invest limited funding in areas that are effectively doomed ecologically or could only be saved at tremendous cost and disruption? Unfortunately, large sections in Warrandyte, Wonga Park, Park Orchards and Donvale – as much as 50% of all remaining Buffer Habitat fall into this category.

Exotic Tree/Shrub Cover

Contrary to expectation, the patterning for Exotic Tree/Shrub Cover is not the inverse of bushland condition or Indigenous Tree Cover. In fact, the cover of exotic woody vegetation appears to be more related to the age and intensity of urban residential subdivision. With the exception of a number of large Parks Victoria revegetation plantations along the Yarra River (down stream of the Mullum Mullum Creek confluence), the highest Exotic Tree/Shrub Cover was observed in Donvale and Park Orchards where there has been a tradition of pine planting and there remains large enough allotments to support extensive, well established gardens (Table 5.13; Map 5.10).

Interestingly, the most recent and/or intense subdivisions typical of Doncaster and Templestowe for example, the most extensive areas of bushland in the east such as in WSP and private property in the Stane Brae region of Wonga Park all share a similarly low cover. In the later case, the bushland is sufficiently large, remote or undisturbed to remain relatively free of exotic woody weeds whilst the intensity of houses and associated infrastructure in urban areas simply does not allow for extensive gardens or they remain immature. In general Core Habitat tended to support few exotic woody plants, whilst Buffer Habitat tended to have an understorey of exotic pasture species and/or a sparse to moderate cover of exotic trees and shrubs.

Open parklands and paddocks dominated by exotic grassland vegetation with few or scattered exotic trees are present throughout the study area. Examples include Ruffey Lake Park in Doncaster, Westerfolds Park on the Yarra River in Templestowe and cleared agricultural pastures typical of Warrandyte South and Wonga Park (Table 5.13; Map 5.10).

Habitat Type (Core/Buffer)

Applying the criteria in Table 5.3, about one third of the 37.5% remaining indigenous habitat is Buffer Habitat that is too modified to be classified into an EVC or to be incorporated into a Biosite. Whilst it is unclear how much of this habitat can and will be conserved, at this stage it will be excluded from Manningham's network of Biosites. Therefore the total area of remaining significant bushland is technically only 24.8% - roughly a quarter of the study area and almost entirely east of the Mullum Mullum Creek (Table 5.14; Map 5.11).

Sites of (Biological) Significance or Biosites

On the basis of the criteria presented in Sect. 11, the Core Habitat areas were divided into 35 discrete sites ranging in size from ~442 ha (Biosite 3 – Stane Brae/Blue Tongue Bend) down to ~7 ha (Biosite 33 – Anderson Creek Road) with no one site exceeding the threshold of ~4% of the total study area. With the exception of a handful of very small, isolated sites in the urbanised western half of the study area, most of these sites are distributed in the east and along the Yarra River and average ~80 ha in area (Table 5.15; Map 5.12).

A significant number of Biosites are predominantly either At Risk or Serious Risk of further decline or support Endangered or Vulnerable EVCs (at the Bioregional level): 11 in the former category and 17 in the later (Table 5.15). Due to the different scales and methods used, there is no direct relationship between EVC Conservation Status and Risk Assessment. In other words sites with more threatened EVCs are not necessarily going to contain more vegetation at risk of immediate decline. In this study decline appears to be more related to Biosite size, proximity to residences and current/past land use practices. Size in particular appears to be a strong predictor of proportion of at risk vegetation above a site area threshold of ~100 ha (Fiqure 5.4). Below this threshold the relationship breaks down – either being entirely random or driven by more complex interrelationships.

Further details on the characteristics of each Biosite and the final classifications ranging from Local through to National Significance is contained in Sect. 11 and 12.

Risk Assessment

Over two thirds of all remaining habitat remains At Risk or Serious Risk of immediate decline. As would be expected, the best areas of Least Concern habitat, occur in the larger expanses of bushland characteristic of the eastern half of the study area and are almost absent from the urbanised west (Table 5.16; Map 5.13).

By definition, all Buffer Habitat is at Serious Risk, and sustaining this component of the landscape represents a considerable challenge. Perhaps a more useful aspect of this variable is the break down within the Core Habitat that make up the 35 Biosites. Whilst almost half is of Least Concern, significant areas are At Risk or Serious Risk of decline, and should represent a priority for strategic conservation planning (Table 5.16; Map 5.13).

Net Gain Framework and Landscape Index

The introduction of Victoria's Native Vegetation Management – A Framework for Action (DNRE 2002a) represented the first tentative steps towards developing a biodiversity accounting process underpinned by the Habitat Hectare (HaHa) index that attempts to quantify biodiversity by combining habitat area with condition (quality). Although the Net Gain Framework aims to achieve landscape level goals, in effect it is being interpreted primarily as a statutory tool – a process that aims to better manage the habitat losses routinely resulting under the VPPs.

However, even if all statutory losses ceased immediately, a landscape level Net Gain would not be achieved almost anywhere in the State (and especially on the urban fringe). Manningham is developing a implementation policy that aims to address both statutory habitat loss as well as all other losses, namely: ecological decline due to factors such as weeds, feral animals and stock grazing (MCC 2004). Necessarily, this policy highlights the need for benchmarking the biodiversity resource, and then tracking change and reporting progress against targets – a process that will require considerable planning and resourcing.

To show how this benchmarking process might work and how it might inform strategic planning as well as to demonstrate links with this Biosites Review, it will be illustrative to present an example: calculation of a Landscape (Habitat Hectare) Index.

The Landscape Index is essentially the summation of all HaHa within a specified landscape – in this case Manningham City Council. Crudely, assuming a uniform condition (of say a Habitat Score or HaS of 0.50), the Landscape Index would be 4223.58 x 0.50* = 2111.79 HaHa. However, in reality condition varies greatly and the landscape should be stratified accordingly. Using the Indigenous Vegetation Modification variable, and assuming an average HaS for each of the 6 categories, the Landscape Index is 1463.78 HaHa (Table 5.17). Whilst this number is likely a more accurate reflection of reality than the first, confidence in the result would be further improved with: (1) additional stratification using EVCs, and (2) replicated measurement of HaS in the field.

Acknowledging the limitations in the HaHa methodology, where ever practical it would be appropriate to incorporate suggested improvements to the field measurement of HaS (Parkes *et. al.* 2003; McCarthy *et. al.* 2004; Parkes *et. al.* 2004).

Periodic benchmarking also helps to describe dynamics. As is stated in the Net Gain Framework (DNRE 2002a), Victoria is currently still experiencing a "long term decline in the extent and quality of native vegetation" (pg 5). For the purposes of strategic biodiversity conservation planning it is critical to quantify the overall level, nature, spatial patterning and causes of this decline within specific landscapes. Combining the Landscape Index benchmark with decline rates and by factoring in other attributes of a landscape that define the natural limits in gains and losses, it is possible to develop a projection model. Such models can be used as a framework for local strategic planning targets as well as to measure progress against these targets over time (Figure 5.5). It is estimated that Manningham's network of remnant indigenous bushland is currently contracting by ~20 HaHa per annum. The primary factors in this decline are two fold: (1) sanctioned and illegal clearing (ie. tree and/or habitat removal for various forms of development or land management), and (2) ecological decay whereby the 'natural' processes of replenishment are terminated or retarded (see Sect 13). At this rate a quarter of Manningham's bushland will disappear by 2020 and a half by 2040 (Figure 5.5; Net Loss projection – red). Active intervention and management change at a landscape scale will be required to turn this negative slope into a horizontal line (Status Quo projection – black) and finally into a positive (Net Gain projection – green). Anything above the black line will represent a Net Gain.

The maximum gain possible is restrained by the total area of habitat remaining as well as the extent to which it can be practically enhanced (assuming revegetation of entirely cleared land is technically or economically prohibitive). In contrast, the maximum loss possible is likely limited by the presence of a number of large conservation reserves such as WSP. While the full enunciation of any future projection model would be far more sophisticated, this simple example illustrates the possibilities of the concept. It underlines the necessity of somehow or another off-setting a known annual loss of habitat if landscape level Net Gain is to be achieved. Further data collection will help focus the conservation effort. Prudent planning would first ensure minimisation of loss (especially statutory loss) and secondly ensure that all on-ground habitat improvement works are as effectively and efficiently planned and executed as possible (Figure 5.5; see Sect. 13).

5.4 Discussion

On the surface, Manningham's 37.5% remnant bushland coverage seems high, especially when compared with surrounding municipalities a similar distance from the Melbourne CBD such as Knox, Maroondah, Whitehorse, Banyule, and Boroondara. The total area of remnant vegetation in any condition within Maroondah for instance is only 4.9% (Lorimer 1997) and for most of the others the figure is even less. Although the data are not available, the situation in Nillumbik and Yarra Ranges, two very large municipalities off to Manningham's north-east and east and predominantly outside Melbourne's urban margins, is very different. These municipalities have huge expanses of remnant habitat that extend up into the eastern highlands. Manningham's good fortune in having such a relatively high proportion of remnant bushland is a product of its unique position straddling the urban growth boundary. It is a municipality of great contrasts: half urban, half rural/residential and it's remnant bushland is simply a reflection of this mix of land use. As would be expected the urban areas are almost devoid of bushland, like Maroondah and Banyule, while the non-urban area or GW in the east is dominated by bushland just like most of Nillumbik and Yarra Ranges (see Sect. 13).

It is important to see these figures as a snap shot and that vegetation, landscapes and ecosystems are nothing if not dynamic. As implied in the Net Gain Framework (DNRE 2002a), the general statewide trend for vegetation is one of decline and Manningham is no exception. Confirmation of this conclusion is revealed in two key statistics: firstly, about one third of the bushland is so degraded that it is essentially a thin cover of eucalypts with virtually no indigenous understorey and secondly, less than half of the balance is at risk of degrading in the immediate future. The net result of this situation is that relatively unmodified, healthy bush occurs across only ~11% of the municipality. This is an alarming situation. Although many of these sites coincide with some of the region's most important reserves such as One Hundred Acres and WSP, it is more illustrative to point out that they are also usually the largest, least subdivided and developed sections of the landscape. This 'big is better' feature of remnants in fragmented landscapes has been innumerably observed throughout southern, temperate Australia. Other remnant attributes of note include shape, connectedness and degree of isolation. Whilst collecting further data on the relevance or otherwise of these issues would be informative, the priority in Manningham is to curtail decline. So dire is the situation that it is estimated that the contraction in Manningham's bushland could be in the order of 50% by 2040. Theoretically, at this rate, virtually the entire network of bushland in Manningham could disappear before the end of this century, whether or not it is reserved (Sect. 13).

6 Vegetation types and Vascular flora

6.1 Methods

Analyses undertaken in this section have been based on existing data sets – primarily the FIS, curated by DSE – plus a range of localised, public and private, site-specific survey reports (see General References). This was due to limitations in the scope and duration of the project combined with the enormous quantity and quality of existing data in comparison to any other comparable geographic area in Victoria (David Cameron pers. comm.). It was considered prudent to not duplicate past effort and any additional field data collection was restricted to filling in geographic and thematic gaps by compiling site specific species lists.

All site-based data from within the Ringwood 1:100,000 mapsheet was supplied by DSE under a Data Exchange Agreement as of May 2003 and placed in ARCVIEW for spatial analyses. These data were variously filtered for the purposes of vegetation (EVC) description using the following criteria:

1. Municipal boundary: all sites outside the study area were excluded (although a 1 km buffer zone was included to capture any species occurring on Manningham's margins).
2. Extant vegetation: data stratified into Non-vegetation, Buffer and Core Habitat categories.
3. Sample type: all non-quadrat data such as incidental herbarium records (ie. not representative of indigenous habitat at a particular location) were excluded.
4. Date: all data greater than 50 years old were excluded for the purposes of EVC descriptions (Note: even though some species may have been last recorded from a site decades previously, it is considered likely present if habitat remains. Presumably the probably this is true is inversely proportional to the degree to which the habitat has declined in the intervening years.)

In the absence of a formalised classification process for determination of EVCs and subordinate Floristic Communities, in this study, the classification of quadrat data was undertaken as a process of spatial assignment using ARCVIEW. As EVC classification is a statewide framework on which significant statutory policy has been based (DNRE 2002a), independent vegetation classification would only be useful for assessing variation within EVCs. Relative heterogeneity, would suggest complexity that may represent discrete Floristic Communities such as those described for WSP by Beardsell (2002), although this would be difficult to confirm without undertaking an assessment of EVCs throughout the entire Bioregion. Unfortunately comparison with standard EVC descriptions (presented in Oates and Taranto (2002)) proved problematic because the results were not entirely data-based, but have been included for reference (Appendix 6.2; see Sect. 13). All taxonomy follows DSE (2003) and Ross and Walsh (2003).

6.2 Results and Discussion

Existing data

A total of 1024 point-samples, consisting of 16,974 individual plant records, were extracted from the FIS. These samples ranged from records of individual plant specimens lodged at the State Herbarium (Prefix H in the FIS) to lengthy species lists (maximum of 187 taxa) and quadrats collected from a range of public and private sources dating back to the 1960's. The abbreviated dataset utilised for the EVC descriptions totalled 393 quadrats comprising 11,190 individual plant records – these were the quadrats that directly coincide with extant remnants (see Appendix 6.1). A total of 253 quadrats occur in Core Habitat (Table 6.1). A further 836 point-samples, consisting of 16,277 individual plant records, located within an 1 km buffer area immediately outside the municipality were also extracted from the FIS. In total 1,860 point-samples, consisting of 33,251 individual plant records were used to construct the complete municipal vascular plant list (see Appendix 6.1).

Sixty localised, site-specific surveys as well as public and private reports were identified as containing records of vascular plants that could be used to add to individual Biosite lists and the overall species richness list for the study area. These reports have been incorporated in General References.

Vegetation diversity

On the basis of pre-1750 vegetation mapping (Oates and Taranto (2001)), 15 of the original 16 EVCs are present within the study area today (see Sect. 5). These are described in detail in Appendix 6.2 under the sections: MCC Distribution; Position in landscape; Geology/Landsystems/Soils; Ecological notes; Structural and floristic description; and Comparison with general description.

Whilst the general structural and floristic descriptions of these EVCs within the greater Port Phillip and Westernport region are broadly indicative of those within Manningham, there are significant differences. In fact, only 7 of the 15 extant EVCs appear to reasonably match the general descriptions provided for each in Oates and Taranto (2001). The remainder are either: (1) too degraded in Manningham to allow a comparison (4 EVCs); or (2) the descriptions in Oates and Taranto (2001) are confused or too incomplete to draw any meaningful conclusions (1 EVC); or (3) the vegetation is atypical and may represent either another described or undescribed EVC or Floristic Community (3 EVCs) (Table 6.2).

The EVCs in the first category are Riparian Forest, Grassy Dry Forest, Floodplain Riparian Woodland, Swampy Riparian Woodland, Valley Heathy Forest, Creekline Herb-rich Woodland and Floodplain Wetland Complex. Swampy Riparian Complex is the only EVC in the second category and Herb-rich Foothill Forest, Valley Grassy Forest and Escarpment Shrubland are in the third category. Further community sampling, classification and mapping would be required to clarify the classifications of at least the three atypical EVCs and due to a lack of information, it may not be possible to confidently classify any the 5 remaining degraded EVCs (Table 6.2).

Vascular Flora diversity

A total of 1,098 vascular plant taxa are recorded in Manningham from all sources. This diversity comprises 124 families across four broad divisions: Monocotyledons, Dicotyledons, Ferns and Fern Allies and Gymnosperms (Table 6.3; 6.4).

The Dicotyledons followed by the Monocotyledons clearly dominant the region's flora – comprising 97.5% of all recorded taxa. The balance comprise 2 Gymnosperm taxa, both of which are exotics of the Cupressaceae and 25 taxa of Ferns and Fern Allies which are, in contrast, all indigenous (Table 6.3). In terms of both richness as well as abundance the Ferns and Fern Allies are only a minor component of the region's flora – a situation that may have greatly changed since European settlement.

A total of 717 taxa (65.3%) are regarded as indigenous within Victoria and Manningham, 364 taxa (33.2%) are exotic or naturalised and 17 taxa (1.5%) are considered both naturalised and indigenous, although the majority in this later category are likely naturalised in Manningham and some are considered rare or threatened elsewhere (eg. Sticky Wattle).

A total of 124 taxa across all groups are unclassified or were not classified lower than the generic level and the dominance of Monocotyledons and Dicotyledons persists across all but the naturalised category, which are exclusively Dicotyledons (Table 6.3).

A disproportionately high number of Monocotyledons are listed as rare or threatened at either the State or National level. A total of 34 taxa (3.1%) are listed as rare or threatened at the State level (VROT) and 12 taxa (1.1%) are likewise at the National level (AROT) (Table 6.3).

The dominant families in the flora are, in decreasing richness: Poaceae (grasses), Asteraceae (daisies), Orchidaceae (orchids), Fabaceae (peas), Cyperaceae (sedges), Myrtaceae (eucalypts and tea-trees) and Mimosaceae (wattles). This combination is typical of regional vascular floras throughout temperate south-eastern Australia. Of these, Poaceae, Asteraceae and Fabaceae have a large exotic element (up to ~50% of all taxa). The Orchidaceae is the only family in this top 7 that is exclusively indigenous and which also has the greatest number of rare or threatened taxa at the State level. There is also a disproportionate number of taxa considered both naturalised and indigenous in Victoria in Myrtaceae and Mimosaceae. Presumably this is a reflection of the widespread horticultural use of eucalypts and wattles in the region. As would be expected, the number of unclassified taxa is broadly proportional with family size (Table 6.4).

With the exception of Brassiceae, Geraniaceae (geraniums etc.) and Phormiaceae (lilies), taxa listed as rare or threatened at the State or National level are mainly within the top 7 families, although Orchidaceae and Cyperaceae are particularly well represented. The Warrandyte region is well known for its diversity of orchids, but unfortunately this family features prominently in the rare or threatened and extinction lists. Whilst this to some extent is due to greater local knowledge of the group, it is also a reflection of the extraordinary diversity and great sensitivity to habitat degradation.

No taxa recorded within Manningham are known to be endemic to the study area - as would be expected given the ubiquity of the habitat types elsewhere in the south and east of the State. A number of taxa, especially orchids, are known to be endemic to Victoria – for example the Wine-lipped Spider Orchid is

restricted to the Melbourne region and a few isolated populations in the south-west of the State (Backhouse and Jeans 1995).

Rare or threatened species (included those extinct)

Of the 49 VROT and AROT taxa historically recorded in Manningham and the 1 km buffer area, 4 are naturalised in the study area (weeds), 10 are not contained within the municipal boundary and 12 are thought to be locally extinct (Appendix 6.3). This is an extinction rate of about 34% and leaves a balance of 23 State or Nationally (7 species) significant species. At the State level 1 is Endangered, 4 Vulnerable, 9 Rare, 1 Depleted and 8 are Insufficiently Known, whilst at the National level, 1 is Endangered, 2 Vulnerable, 2 Rare and 2 are Insufficiently Known (see Ross and Walsh 2003 for full definitions of each category). Note that extinction within the study area has only been systematically assessed for listed rare or threatened taxa (Appendix 6.3).

Eight of the 12 Extinct taxa are orchids all of which were formerly recorded from the greater Warrandyte area and immediate surrounds. The local extinction of some of these species is linked to habitat loss and fragmentation resulting from residential subdivision and development during the second half of last century (see Beardsell 2002). Two species have disappeared along with the grassy habitat in the western half of the study area, namely: Basalt Peppercress (Doncaster and Bulleen) and Pale Grass-lily (Templestowe). Both of these species have not been collected or recorded for over a century and probably disappeared very early on with the rapid expansion of orchards in the later part of the nineteenth century (see Sect. 3). The remaining two species, Slender Bitter-cress and Round-leaf Pomaderris were probably only represented by very small populations – perhaps only a handful of individuals.

Matted Flax-lily, known from a single record along a gully-line in Candlebark Reserve in Templestowe, is the only Nationally Endangered species in the study area. Known only from a scattering of highly threatened grassland and grassy woodland habitats mainly in the Victoria Volcanic Plains Bioregion, it is also listed as Endangered at the State level (Appendix 6.3).

Four species are listed as Vulnerable at the State level: Forest Bitter-cress from Jumping Creek Reserve, Bacchus Marsh Vanish Wattle from the top of Fourth Hill, Austral Crane's-bill from Pound Bend and Arching Flax-lily in various localities stretching from Pound Bend Reserve to Blue Tongue Bend north of the Jumping Creek car park (all of which are sections of WSP) (Beardsell 2002). Bacchus Marsh Vanish Wattle is listed as vulnerable and Arching Flax-lily is Insufficiently known Nationally (Appendix 6.3).

The 9 State listed Rare species are scattered more widely in the study area, although most are contained within one or more sections of WSP and in immediately surrounding private land. Velvet Apple-berry, Fringed Helmet-orchid, Dandenong Range Cinnamon Wattle, Bearded Greenhood, Slender Style-wort and Sharp Midge-orchid are scattered in a number of sites from Pound Bend Reserve through Fourth Hill and the Common to Clifford Park in Wonga Park (Beardsell 2002). Dandenong Range Cinnamon Wattle and Bearded Greenhood are Nationally listed as Rare and Sharp Midge-orchid has an Insufficiently Known status at the National level. The remaining three species are: Veined Fringe-sedge from Bolin Billabong in Bulleen (Beardsell 2002), Green Scentbark scattered along bushland associated with the Mullum Mullum Creek in Donvale and Park Orchards and Pale-flower Crane's-bill, known only from remnant bushland south of the recent Reynolds Road upgrade in Templestowe (Appendix 6.3).

Slender Sword-sedge is the only State Depleted species and is scattered over ten localities mainly in WSP from Pound Bend through to Mount Lofty in Wonga Park (Beardsell 2002).

The final category of Insufficiently Known at the State level similarly includes species recorded within WSP. Fertile Finger-orchid, Eastern Tiny Greenhood, Tall Club-sedge, Green-top Sedge, Matted Water Starwort, and Tussock Sedge are all recorded from various locations from Pound Bend through to Stane Brae in Wonga Park. River Swamp Wallaby-grass, which is also listed as Vulnerable Nationally, is "locally common along the Yarra River with Bolin Billabong being the Type locality (Beardsell 2002) (Appendix 6.3).

6.3 Discussion

The 1,098 listed taxa (717 indigenous) represents ~22.4% of the state's flora – 4,900 accepted taxa are included in the most recent census of the vascular plants of Victoria (Ross and Walsh 2003). Compared to many parts of the State this is a relatively rich flora. For example, a study of the former Birchip Shire in the State's north west recorded less than 400 indigenous species in an area of 2,700 square kilometres – over

24 times the size of Manningham – although this region has well under 5% remaining habitat, has been far less intensely studied and represents a very different ecosystem (Foreman and Bailey 1995).

Another example closer to home is Maroondah City where just over 431 indigenous taxa have been recorded (Lorimer 1997). Although Maroondah is a considerably more urbanised municipality and about half Manningham's size, it supports approximately 60% of the diversity in 93% less bushland.

These examples highlight the non-linear relationship between habitat area and plant richness and that comparsons are to a certain extent invalid because every landscape is unique. Although in general larger areas tend to support more species, very small areas can be remarkably rich – a feature that is a reflection of the diversity of habitat types present and the condition of the remnants involved. All things being equal, in terms of vascular species richness and vegetation, Manningham is probably typical of the lowland, dry sclerophyll forests and woodlands throughout Victoria.

7 Vertebrate fauna

7.1 Methods

Analyses undertaken in this section have been based on existing data sets – primarily the Victorian Wildlife Atlas, curated by DSE – plus a range of localised, public and private, site-specific survey reports (see General References). Note that similar comments in the vascular flora section regarding the project scope also apply here.

All data from within the study area and its immediate surrounds were supplied by DSE and placed in ARCVIEW for spatial analyses. These data were variously filtered for the purposes of site descriptions using the following criteria:

1. Municipal boundary: all sites outside study area were excluded (although a 1 km buffer zone was included to capture any species occurring on the margins of Manningham).
2. Extant vegetation: data stratified into Non-vegetation, Buffer and Core Habitat categories.

7.2 Results

Existing data

A total of 32,034 individual wildlife records were extracted from the Wildlife Atlas for the purposes of this study. Roughly half of these records (50.3%) were from within the municipal boundary and the remainder in the 1 km buffer area immediately outside it. The former data set was used to construct the complete municipal vertebrate fauna species list (see Appendix 7.2; Table 7.1).

Sixty localised, site-specific surveys, public and private reports were identified as containing records of vertebrate fauna that could be used to add to individual Biosite lists and the overall species richness list for the study area. These reports have been incorporated in General References.

Vertebrate fauna diversity

A total of 325 vertebrate fauna taxa are recorded in Manningham from all sources. This diversity comprises 8 broad groups: birds (birds, water birds and territorial/large nesting birds), mammals (excluding bats), reptiles, amphibians, fish and bats. A selection of large freshwater crustaceans (crayfish, yabbies and sprimp) are also included on the Victorian Wildlife Atlas and are recorded within the study area – 4 extra species in total (Table 7.1).

Birds are clearly the most diverse group in the study area with 216 species recorded (66.4% of the total vertebrate fauna), 13 of which are introduced. This is followed by: reptiles (8.9%), mammals (8.6%), fish (6.5%), amphibians (4.9%) and bats (4.6%) (Table 7.1; Appendix 7.2).

Overall the exotic element in the fauna is low (8.6%) – this compares with 34.7% amongst the vascular flora. With the exception of one water bird (Mallard), these exclusively comprise birds, mammals and fish.

Although birds dominate the fauna, this group comprises only half the species listed as rare or threatened at the State level. The balance is evenly distributed amongst the remaining groups. In total, 48 species (14.8%) are listed as rare or threatened in Victoria. At the National level, six species are listed – two birds (Regent Honeyeater and Swift Parrot), two fish (Australian Grayling and Macquarie Perch), one amphibian (Growling Grass Frog) and 1 bat (Grey-headed Flying-fox) (Table 7.1; Appendix 7.1).

Seven birds, mainly waterbirds, are protected under two international agreements with Japan (JAMBA) and China (CAMBA) for the protection of migratory birds (Great Egret, Cattle Egret, Latham's Snipe, White-throated Needletail, Fork-tailed Swift, Marsh Sandpiper and Red-necked Stint) (Table 7.1; Appendix 7.1; 7.2).

No taxa recorded within Manningham are known to be endemic to the study area or Victoria as would be expected given the ubiquity of the habitat types elsewhere in the south and east of the state.

Rare or threatened species (included those extinct)

Of the 58 VROT and AROT taxa historically recorded in Manningham and the 1 km buffer area, 10 are not contained within the municipal boundary and 4 are thought to be locally extinct (Grey-crowned Babbler, Australian Grayling, Murray Cod and Painted Honeyeater) (Table 7.1; Appendix 7.1; 7.2). This leaves a balance of 44 State or Nationally (6 species) Significant species in the study area. At the State level 2 are Critically Endangered, 10 are Endangered, 18 are Vulnerable, 12 are Lower Risk – Near Threatened, 1 is Likely Threatened and 1 is Insufficiently Known, whilst at the National level, 1 is Critically Endangered, 2 are Endangered and 3 are Vulnerable (see Appendix 7.2 for definitions of each category). Note that extinction within the study area has only been systematically assessed for listed rare or threatened taxa (Appendix 7.2).

On the basis of the Victorian Wildlife Atlas records, the local extinctions have occurred at various times in the last 10 years or so. The Grey-crowned Babbler, last recorded from the Ruffey Lake area during the second world war is likely to have disappeared with the loss of the last of the region's open, grassy habitat typical in the west during rapid post-war urbanisation. Australian Grayling and Murray Cod were last recorded from the Yarra River downstream of Warrandyte at the turn of the 20th century and up until the 1970's respectively. Painted Honeyeater was last observed at Tindals Hill in Warrandyte in the 1980's (Appendix 7.1).

The two State Critically Endangered species are Regent Honeyeater and Intermediate Egret. Regent Honeyeater has mainly been recorded from the west of the study area and along the Yarra River, where it is now likely extinct due to habitat loss. This migratory species with a preference for Box-Ironbark Forest is now greatly reduced in range with only a handful of recent records east of Mullum Mullum Creek. The Intermediate Egret, which is common in northern Australia but uncommon in the south-east, has only been recorded once in the lower Yarra River floodplain and wetlands (Morcombe 2000).

Excluding the Extinct Grey-crowned Babbler and Murray Cod, the Endangered species are the birds: Australasian Bittern, Barking Owl, Blue-billed Duck and Swift Parrot; the amphibians: Bibron's Toadlet and Warty Bell Frog (Growling Grass Frog); the fish: Freshwater Catfish, Macquarie Perch and Murray Cod; and the reptile: Broad-shelled Tortoise. All four birds are associated with various habitats along the Yarra River, although there are some important records of Swift Parrot further south such as at One Hundred Acres Reserve. Both the amphibians are found in suitable wetland habitat scattered throughout the study area such as Currawong Bushland Park in Templestowe and Hillcrest Reserve in Donvale. Both fish species are found in suitable habitat along the Yarra River, although Macquarie Perch have been most frequently recorded in recent decades. The Broad-shelled Tortoise was recorded once in 1991 on the Yarra River near Petty's orchard adjacent to Candlebark Park in Templestowe (Appendix 7.1).

Excluding the extinct Australian Grayling and Painted Honeyeater the Vulnerable species are the reptile: Tree Goanna; the mammals: Brush-tailed Phascogale and Common Dunnart; the birds: Australasian Shoveler, Baillon's Crake, Great Egret, Hardhead, Lewin's Rail, Musk Duck, Royal Spoonbill, Powerful Owl, Black Falcon, Grey Goshawk, Square-tailed Kite, Diamond Firetail and Speckled Warbler; the bat: Grey-headed Flying-fox; and the amphibian: Southern Toadlet. The Tree Goanna has been recorded once from the Mount Lofty and Bend of Isles regions close to the Yarra River. The Brush-tailed Phascogale or Tuan has been frequently recorded from over 50 sites almost exclusively in the north-east of the study area whilst the ironically named Common Dunnart was recorded once from the Wonga Park township area in the mid 1980's and may well now be locally extinct. Half of the birds are water birds recorded primarily in the lower reaches of the Yarra River, although there are exceptions; notably – Great Egret along Mullum Mullum Creek and Royal Spoonbill at the Jumping Creek confluence. The remainder are birds and larger territorial birds recorded from various locations, with Square-tailed Kite for instance recorded from Hillcrest Reserve during the 1980's and Powerful Owl being frequently recorded east from Mullum Mullum Creek. The remaining species, the Grey-headed Flying-fox has been primarily recorded along the Koonung Creek in the last decade or so and the Southern Toadlet is scattered in suitable wetland habitat associated with the Yarra River and its major tributaries (Appendix 7.1).

With the exception of the bat: Large-footed Myotis and the reptile: Glossy Grass Skink, the Lower Risk – Near Threatened species are all birds or water birds. These include the birds: Hooded Robin, Spotted Quail-thrush, Brown Treecreeper, Black-eared Cuckoo and Brown Quail and the water birds: Azure Kingfisher, Latham's Snipe, Nankeen Night Heron, Pied Cormorant and Whiskered Tern. The Large-footed Myotis is only recorded from the Grandview Road Biosite in Warrandyte South on Andersons Creek and from near Pound Bend in WSP, whilst the Glossy Grass Skink was recorded in 1991 from Bolin Billabong in Bulleen. The Lower Risk birds are scattered throught the municipality with Spotted Quail-thrush being occasionally recorded from the eastern half during the 1970's and 80's. Brown Treecreeper was last recorded in the

1930's and is possibly now locally extinct. Similarly the water birds were recorded from suitable wetland habitat throughout the study area, although the Whiskered Tern was recorded only once in 1991 at Bolin Billabong and probably represents an opportunistic or anomalous record.

Common Bent-wing Bat, recorded from sites at Pound Bend, Anderson's Creek and Parson's Gully between 1961 and the early 90's, likely includes the Southern and Eastern Bent-wing Bats, which are listed as Endandered and Vulnerable in Victoria respestively.

River Blackfish is the only Insufficiently Known species in the study area – recorded from 12 sites along the lower reaches of the Yarra River down stream of the Ruffey Creek confluence from the 1960's through to the late 90's, although there is the odd record from near the Warrandyte Township.

7.3 Discussion

The vertebrate fauna of Manningham (including all exotic species) represents about 28.2% of that for the State (~1,154 recognised taxa recorded in the Victoria Wildlife Atlas). Proportionally in each group this comprises: ~41% of the Victoria's inland and marine birds; ~18.5% of the Victoria's terrestrial and marine mammals; ~17.7% of Victoria's reptiles; ~8.9% of Victoria's freshwater and marine fish; ~36.4% of Victoria's amphibians; and ~46.8% of Victoria's bats.

Whilst Manningham represents only a very small proportion of the State's area, it has a significant representation of the Victoria's vertebrate fauna. The birds and bats, that predominantly inhabit forest and woodland habitats make the major contribution as would be expected given the nature of the natural environment and the high mobility of these animals. The general lack of wetland environments and their poor current condition means that relatively few fish and amphibian species have been recorded in the area. Only a few reptiles have been recorded, as would also be expected given the continental gradient ranging from high diversity in central Australia to low diversity in coastal and temperate regions. Likewise mammals are also not rich in the area.

As with the vascular flora, Manningham supports significantly more vertebrate fauna species in every group than surrounding comparable municipalities such as Maroondah, Whitehorse and Boroondara. An equivalent SOS study (Lorimer 1997) in Maroondah for instance identified a total of 127 birds, 24 mammals (including bats) and 9 amphibians.

8 Bryophyte species (mosses and liverworts) and Biosites

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8.1 Introduction

Bryophytes (mosses, liverworts and hornworts) are true plants and make a large contribution to biodiversity in all ecosystems, typically accounting for 20 to 30% of the total indigenous plant diversity at any one site. In general they colonise and stabilise disturbed soil, provide habitat for many invertebrates (especially juvenile forms), form suitable habitat on otherwise inhospitable substrates for the germination and growth of vascular plant seeds, modify the flow of water on the soil surface, provide nesting materials for birds and small mammals and perform other ecological functions. But despite their diversity, abundance and ecological roles, they have been largely ignored in SOS classification and biodiversity planning, especially at the local government level.

Although the taxonomic classification of bryophytes is well understood, there have been few studies in Australia on the ecology of particular groups or species. This study was directed at investigating what controls patterns in the urban fringe context, particularly correlations with EVC patterns and microhabitat (especially along a moisture gradient) and correlations with disturbance or degree of modification. Is it fair to make assumptions about the bryophyte flora on the basis of the type and condition of indigenous vegetation?

A particular aim was to establish baseline information on the bryophyte flora within Manningham and ensure that it is considered in the process of identifying, describing and classifying Biosites.

8.2 Methods

Representative sites in different vegetation types, with different levels of disturbance, were surveyed for bryophytes (mosses, liverworts and hornworts) during 2003 in order to determine the species present, the significance of the species and the sites at which they occur (Table 8.1). Suitable sites were identified from vegetation and disturbance maps.

The survey technique involved identifying microhabitats at each site and thoroughly searching a representative sample of each habitat at the site. These fell into two broad groups: biotic and abiotic.

Biotic microhabitats
- eucalypt trees (search to shoulder height only)
- non-eucalypt trees (search base, mid-trunk and any accessible canopy)
- non-eucalypt shrubs (search base, stems and branches of mature shrubs)
- native grass tussocks (search soil and litter beneath mature tussocks)
- logs and fallen branches (search all surfaces; pay particular attention to rotting timber in shade)
- introduced grasses (search among grasses, looking especially for pleurocarpous or shade-loving species)
- old charred wood (search for *Cephaloziella*, etc.)
- old dung (inspect for *Tayloria*, etc.)

Abiotic microhabitats
- burnt soil (search for *Ceratodon*, *Funaria*, etc.)
- exposed soil (search exposed soil, including drying or dried mud; pay particular attention to exposed soil in permanent shade, and to soil under shrubs)
- streams (search submerged rocks in streams, and stream banks, plus floating or attached aquatics)
- rocks and boulders (search all exposed surfaces and overhangs; pay particular attention to submerged rocks in streams and to rocks in permanent shade)
- concrete, brick, etc. (search exposed surfaces, including mortar)
- ponds and dams (search for aquatic species and species on drying edges)
- hollows, burrows and shafts (search internal walls as far as possible)

All species found were recorded in a field book, and voucher specimens were collected of any specimen not readily identified in the field. These specimens were identified later in the laboratory by microscopic examination.

Appropriate voucher specimens have been prepared for lodgement in the National Herbarium of Victoria. Collections were made under permit 10002287 issued by DSE. One unidentified specimen is to be forwarded to an expert on the particular genus for investigation.

8.3 Results

Flora diversity

A total of 78 species of bryophytes were recorded comprising: 60 indigenous mosses, 3 exotic mosses and 15 indigenous liverworts. No exotic liverworts were recorded, although one unidentified species might turn out to be introduced. No hornworts were found. This diversity represents approximately 12% of the known moss flora of Victoria and 7% of the known liverwort flora.

The mosses are represented by 44 genera (in 19 families) with the most diverse examples being *Fissidens*, *Barbula*, *Rosulabryum* and *Tortula*. Likewise the liverworts are represented by 12 genera (in 10 families), with *Frullania* being the most diverse group (Appendix 8.1).

EVC patterns

Fifty five sites covering 9 of the more common EVCs were surveyed. Moss richness ranged from 2 to 43 species, and liverwort richness ranged from 1 to 12 species.

A strong relationship between richness of both groups and EVC as driven by position in the landscape and moisture content was observed. Riparian Forest supported the greatest richness of bryophytes (65 species) followed by Valley Grassy Forest (38 species), Grassy Dry Forest (29 species), Creekline herb-rich Woodland (28 species), Valley Heathy Forest (26 species) and Escarpment Shrubland (18 species). This gradation directly matches the typical moisture-driven patterning in vegetation from permanent river or stream upslope to low ridgelines and exposed escarpments identified in Sect. 5 and 6 (see Appendix 8.1; Graph 8.1).

The low richness in Herb-rich Foothill Forest is probably a reflection of a greater level of disturbance than the dominant vascular flora present suggests. Species that grow only on mature shrubs (e.g. *Frullania clavata*), non-eucalypt trees (e.g. *Orthotrichum tasmanicum*) or mature grass tussocks (e.g. *Plagiothecium denticulatum*) are highly sensitive to vegetation clearance and fire, all of which are likely to have been common in this EVC after European settlement. Trampling by cattle and sheep might also have eliminated some bryophyte species.

The extremely low richness of bryophytes in Swampy Riparian Woodland and Swampy Riparian Complex, both closely related to Riparian Forest, probably relates to the paucity of undisturbed sites rather that any natural ecological relationships – as is pointed out in Oates and Taranto (2002) (see Sect. 5 and 6). These EVCs also offer fewer stable natural microhabitats for bryophytes than Riparian Forest, and few lowland bryophyte species are adapted to survival in waterlogged soils.

As would be expected the exotic landscapes inspected support an extremely low richness of bryophytes, with only 5 mosses and no liverworts recorded. Presumably due to the very low exotic presence in the flora, no clear patterns were evident although it is interesting to point out that none of the exotic sites surveyed supported exotic species. In fact, the three introduced species were most consistently present in some of the better remnants of Riparian Forest and Grassy Dry Forest. These species are not primary colonisers of disturbed sites. Rather, they require a well-established and fairly dense grassy ground layer before they will colonise, and are therefore more likely to be invaders in areas where their ecological niche is available but not filled. The indigenous moss *Eurhynchium praelongum* grows in the same habitats, and where present may outcompete the introduced species and prevent them from colonising. The few species found in badly degraded sites are either opportunistic primary colonisers such as *Campylopus introflexus* and *Triqeutrella papillata*, or hardy species with a wide ecological tolerance, such as *Polytrichum juniperinumi and Chiloscyphus semiteres*.

Modification patterns

A very clear inverse relationship is evident in the modification pattern for at least the most common and best sampled EVCs. With the exception of Valley Grassy Forest, bryophyte richness is highest in the least modified vegetation (using the Indigenous Vegetation Modification index) and drops off markedly as degree of modification increases (see Table 8.2; Graph 8.2). This change is so marked that for the 5 most common EVCs, only between 5 and 36% of the species richness recorded in the least modified vegetation remains in the primarily modified (agricultural) remnants.

EVC bryophyte floristics

The type of data collected, and the manner in which it was collected, does not enable a formal analysis of EVC bryophyte floristics to be made. However, some general observations can be made. Bryophytes generally thrive in moist environments, and become less common and less diverse, although still quite abundant, in drier environments. In addition, the ratio of liverworts to mosses generally increases as the water availability increases. Thus it is to be expected that drier EVCs such as Grassy Dry Forest will have a lower bryophyte diversity and abundance than wetter EVCs such as Riparian Forest.

A further determinant of species diversity is the number of microhabitats available. This is because many species favour particular microhabitats, and struggle to survive or cannot survive at all in others. For example, there is a distinct group of species that occur only on rock, and another that occurs only in flowing, unpolluted fresh water, and another that occurs only on drying mud. EVCs that are naturally depauperate in microhabitats, such as Swamp Riparian Woodland, would therefore be expected to support fewer bryophyte species.

Similarly, EVCs from which microhabitats have been lost, for example through fire, vegetation clearance, removal of fallen timber or clearing of rocks, will be depauperate in bryophytes because very few species growing on those microhabitats will be able to survive on the remaining substrates. Disturbance that results in the exposure of fresh soil will lead to a short-term influx of colonising bryophytes, but unless the soil exposure is maintained (as in a road cutting) these bryophytes will disappear as vascular species colonise the soil and leaf litter builds up.

Significant species

Several species and one subspecies should be considered to have local significance because of their apparent rarity in the study area. These species are:

Cyptodon muelleri is known from a single site in Riparian Forest. This species is an epiphyte on older shrubs and non-eucalypt trees, and would be very vulnerable to fire. In the past its abundance would also have been reduced by vegetation clearance.

Hypnodendron vitiense is a moss that grows in wet forest and rainforest, but also occurs in wet gullies in drier forests. It grows on wet rock and soil in this habitat, and is particularly prone to disturbance that changes the water level or humidity. It is known from only one other site in the Melbourne Study Area. Beyond the Melbourne Study Area it is very common in undisturbed forest creeks.

Hypnum cupressiforme* var. *mossmanianum is a rarer variety of an otherwise common moss. The large golden form (var. *lacunosum*) is common throughout Manningham in grassy and heathy understoreys. The very fine, almost hair-like variety *mossmanianum* is restricted to damp habitats such as creeklines in wet forest. A single occurrence was recorded during the survey.

Macrocoma tenue* subsp. *tenue is the only subspecies of this moss occurring in Australia. It is an epiphyte in dry to wet forests and woodlands. Overall it is quite common, but it is very vulnerable to fire, clearance and other vegetation disturbances, and it is not surprising that it is rare in Manningham.

Orthotrichum tasmanicum is also an epiphytic moss that is common elsewhere in dry to wet forests and woodlands. It too is very vulnerable to fire, clearance and other vegetation disturbance.

Wijkia extenuata is a mat-forming moss normally found in wet forest and rainforest. It is very rarely found in drier situations, and its presence indicates dampness at the site throughout most of the year. It is normally epiphytic on bark or rotting timber, rarely growing on soil. In its one known occurrence in Manningham it is growing on soil and rotting timber on the ground.

Zygodon intermedius is another epiphytic moss that is common elsewhere. It occurs in damp to wet woodlands and forests, and in rainforest. Like *Macrocoma* and *Orthotrichum* it is vulnerable to fire, vegetation clearance and other disturbances.

Aneura alterniloba is a thallose liverwort restricted to rocks and soil in shaded creeklines. It is particularly vulnerable to creekline disturbance such as vegetation clearance or changes in water level or water quality.

Cephaloziella hirta is a minute leafy liverwort that grows on logs and clay banks in dry to damp sclerophyll forest. It is rather uncommon throughout its range in south-eastern Australia, but is easily overlooked. It is vulnerable to fire and log removal, but is capable of colonising exposed clays. It ought to be more common than supposed, but was found at only one site during this survey and must be treated as locally rare.

Heteroscyphus* cf *argutus was initially thought to be *H. argutus* but it differs clearly in several microscopic characters. At present it is treated as an unknown species. A specimen has been forwarded to Dr. John Engel at the Field Musuem, Chicago, for analysis. This species might have been overlooked in the past, or it might be a previously unrecognised introduction. If it is a native species, its significance might extend to State or National Significance.

Metzgeria furcata is an epiphytic thallose liverwort that occurs on older non-eucalypt trees and shrubs. Like other epiphytic bryophytes it is vulnerable to fire, vegetation clearance and other disturbances. It is normally restricted to damp to wet woodland and forests, and rainforests.

Type localities

One Type locality, for the Victorian endemic moss *Tortella dakinii*, was identified from the Type description published in the *Victorian Naturalist* and data maintained with the Type specimen in the National Herbarium of Victoria, Melbourne. This locality (Pound Bend, Biosite10) was inspected and found to still support the species, although in very small numbers. The species has been reported from other sites outside Manningham.

Two other Type locality records have been identified from the National Herbarium databases: *Fossombronia truncata* – Jumping Ck Reserve (1982) and *Dawsonia longiseta* – Doncaster (1888). The former species may now be extinct in Manningham and the later site has been destroyed.

Expected species, not recorded

A number of species that are common in similar undisturbed vegetation communities elsewhere in Victoria were not found. Table 8.3 lists the 24 mosses and 17 liverwort species expected for the region, but were not found during survey. It is unlikely many of these species would be found with further searching. The absence of these species, or at least their lack of abundance, is noteworthy as it indicates that none of the vegetation types surveyed is in good condition in relation to bryophyte flora.

Introduced species

Three bryophytes recorded during the survey are introduced to Australia: *Barbula unguiculata*, *Brachythecium albicans* and *Pseudoscleropodium purum*.

Barbula unguiculata is an introduction from the Northern Hemisphere. It occurs in dry woodland and forests with a grassy understorey, and seems to be associated with grazed areas. Although it might be widespread in such areas it does not appear to invade other habitats. Capsules are common, so spreading by spores must be common. Because of the small size of this species and its similarity to native species, eradication is impractical.

Brachythecium albicans is also an introduction from the Northern Hemisphere, and is associated with areas where stock have been grazed. It forms silky mats among grasses, usually in damper locations. It is a potentially invasive species of all grassy areas. It is very common in all grassy habitats south of the divide in Victoria, and also occurs in heathy areas. Capsules are rare, so spreading is probably by fragmentation and subsequent regeneration. Local eradication is possible by spraying with glyphosate, but careful identification is required. Total eradication is unlikely to be achieved.

Pseudoscleropodium purum is an introduction from Europe. It occurs in grassy habitats and is aggressively invasive. In Victoria it is now widespread and has become a potentially serious environmental weed. Capsules are unknown in Australia, so spreading is probably entirely by fragmentation and subsequent regeneration. Local eradication is possible by spraying with glyphosate, provided some training in distinguishing it from native species is undertaken. Total eradication is probably impossible.

Sites of bryophyte significance

Of the sites surveyed that are not within conservation reserves, two are considered to be of significance at the Local and Regional level. These are Stane Brae (Creekline Heathy Woodland) and Freyne Street (Riparian Forest). Both sites support species that are locally significant, and both support an aggregate of bryophyte species that represent probably the best examples of remnant bryophyte flora in these vegetation communities anywhere within the Melbourne region.

None of the sites surveyed were of State or National Significance with respect to the bryophyte flora.

8.4 Discussion/Recommendations

Bryophytes make a significant contribution to the indigenous plant diversity in natural ecosystems. Their diversity and abundance varies naturally according to natural characteristics of ecosystems, such as water availability, shade, and number of microhabitats available. However, they are vulnerable to common post-settlement disturbances, such as vegetation clearance, grazing, the removal of fallen timber, altered fire regimes, and deterioration in stream water quality. This vulnerability is reflected in the lower than expected diversity at most sites investigated in this survey where disturbance has been significant.

Manningham's bryophyte flora is relatively depleted compared to typical examples of similar vegetation distant from the intensive impacts of the urban fringe. Two outstanding sites and species were found, but only one site is considered to have Local or Regional Significance.

Manningham's EVCs appear to be generally good predictor of bryophyte richness, which is probably controlled mainly by how position in the landscape affects moisture content. There is a very strong gradient of floristic change along a topographic transect from permanent watercourses to ridge tops and escarpments.

Likewise, vegetation condition as described by broad structural and vascular floristic parameters, such as the Indigenous Vegetation Modification index used in this study, appears to be a good predictor of bryophyte richness and composition.

Management recommendations are as follows:

- Ensure that remnant understorey and microhabitats are retained and protected in Category 5 and 6 sites for all EVCs.
- Restore riparian vegetation with suitable examples of Creekline Grassy Woodland, Riparian Forest and Swampy Riparian Woodland.
- Restore microhabitats such as natural rock and fallen timber in Category 5 and 6 sites, where it can be identified that these have been removed.
- Ensure that at least some fallen timber is left on the ground in all EVCs.
- Investigate the potential to reintroduce bryophyte species to restored sites or Category 5 and 6 sites, where species are absent or do not return after restoration of the site.
- Develop a control strategy to eliminate *Pseudoscleropodium* from areas of ecological significance.
- Take steps to ensure that the owners or managers of the Biosites where significant species occur are aware of the significance of the site, and provide support to manage them appropriately.

9 Macrofungi

9.1 Introduction

Fungi are a ubiquitous and diverse component of the biota, but poorly understood and frequently over looked because: fungi are mainly below ground (ephemeral, with short-lived fruiting bodies); macrofungi taxonomy is poorly resourced; specimens are difficult to collect and preserve; and identification based on microscope features (spores and gills) is difficult.

The following excerpt from the Australian Biological Resources Study series Fungi of Australia summaries the broad and important role of fungi in ecosystems:

> "Fungi are… ubiquitous in the Australian environment, having often unseen but major impacts on most ecosystems. In freshwater, marine and terrestrial environments they mediate recycling of nutrients through the breakdown of plant and animal matter. They play a crucial role in the nutrient and water relationships of many plants through their symbiotic mycorrhizal associations with roots. Their other major association, with algae in the formation of lichens, is well known. Conversely, many fungi are pathogens of plants with some like smuts, rusts and mildews having major economic impacts on crop plants, and others such as *Phytophthora* ravaging native ecosystems. Fungi also interact with insects and other animals in a multitude of ways. Many are pathogenic, some provide a key food source, others are toxic. A number of microfungi are specialists commensals of herbivores, living in their gut and undertaking the crucial breakdown of cellulose. Humans and fungi also interact in a multi-facetted way. Some macrofungi are used as food and some microfungi mediate its production. A number of fungi cause diseases in humans, and many are toxic" (ABRS 1996).

Macrofungi is used here to distinguish between the mushroom-like organisms that people commonly encounter in the environment, especially in the wetter months with microscopic fungi such as smuts and rusts for instance that are also prolific but are usually invisible to the naked eye.

Bruce Fuhrers recently revised Field Companoin to Australian Fungi provides an excellent introduction to structure and behaviour of macrofungi:

> "Although fungi are included in the plant kingdom, they differ fundamentally from our usual idea of plants. Fungi lack chlorophyll (the compound that gives plants their characteristic green colour and photosynthetic capacity) and are unable to manufacture their own food. Their reproductive units are spores, not seeds. On germinating the spores give rise to filamentous cells called primary hyphae. Compatible primary hyphae of the same species unite to form secondary hyphae which grow to form the mycelium or fungus body. The mycelium give rise to the fruiting body, which is the part of the fungus usually observed. The fruiting bodies of fungi may be regarded as the equivalents of the flowers of higher plants. Their function is to produce spores and to provide the mechanical means for spore distribution. The fruiting bodies also provide us with the information necessary for identifying the different species" (Fuhrer 2001).

The Warrandyte area is perhaps one of the most studied parts of Australia, in terms of macrofungi, primarily due to the efforts of nearby resident, Bruce Fuhrer. He has been exploring WSP in particular for decades and has produced innumerable spectacular photographs of the local macrofungi flora, many of which have been used in his publications. Bruce has been singularly responsible for most of the information contained in this section. In fact, it is unlikely anything about macrofungi would have been included in this study without Bruce's contribution.

The aim of including this section into the Biosites Review is to establish the consideration of macrofungi as a routine aspect of Biosites classification and highlight their importance in remnant ecosystems. Establish both a general framework for talking about the group in the context of biodiversity conservation as well as baseline data on which further work can build.

9.2 Methods

The study area list of macrofungi was compiled from a combination of: (1) two historical sources – the Macrofungal Survey Project for WSP (Cameron *et al.* 1996) and incidental lists compiled for both WSP and other sites by Bruce Fuhrer; and (2) additional survey of selected sites by Bruce Fuhrer during 2003. The

later survey involved the compilation of a site list whilst walking a transect through those portions of selected sites considered likely to support the greatest richness of macrofungi species. In general the characteristics of 'likely' areas were sheltered, moist locations visually assessed as being in a least modified/disturbed condition. Where field identification was not possible, specimens were collected and dried and otherwise prepared for determinations (ie. using gill maps and microscope preparation). Selected specimens were sent to taxonomic mycologists and lodged at relevant herbaria.

Primarily on account of resource limitations, macrofungi taxonomy is incomplete and uneven, although the Australian Biological Resources Study (ABRS) Fungi of Australia project aims to rectify this situation. Most of the taxonomic references used in compiling the Manningham macrofungi list have been published under this series (Bruce Fuhrer pers. comm.). Where taxonomy is currently inadequate (eg. *Mycena* and *Cortinarius*) it has not been possible to classify a large proportion of the species observed in the study area. However, in order to preserve as much information as possible, an attempt has been made to label undescribed or unclassified taxa with a distinguishing and brief descriptive epithet. It is acknowledged that many of the unclassified taxa may be eventually absorbed into other fully described taxa in the list and that some may be recognised as entirely new species.

9.3 Results

Flora diversity

A total of 420 taxa, representing 14 broad groups were recorded from 7 of the 35 defined Biosites (see Table 9.1; Appendix 9.1). The richest broad groups were: Fungi with gills; Cup fungi and relatives; Woody pore fungi; Coral fungi; Fleshy pore fungi; Jelly fungi; and Leather/shelf fungi (collectively 95% of the total flora, although the first of these was overwhelming the dominant group, representing 68%).

This flora comprises 144 genera over at least 36 family groups. The eleven largest genera, all of which are in the Fungi with gills group, and ranging from 32 down to 7 taxa each are respectively: *Mycaena; Cortinarius; Hygrocybe; Russula; Agaricus; Amanita; Entoloma; Dermocybe; Laccaria; Marasmius;* and *Lepiota*. Only three species are regarded as exotic (Flay Agaric, Death Trap and Saffron Milk Cap) and once again these are all from the dominant Fungi with gills group (see Table 9.1; Appendix 9.1).

For a variety of reasons discussed in the methods, over a third of the taxa recorded (145) were not classified to a species level and 22 taxa are regarded as undescribed species. The Fungi with gills group disproportionally makes up the vast majority of taxa in both of these categories. In fact, all the undescribed taxa are in this group (see Table 9.1; Appendix 9.1).

On the basis of Bruce Fuhrer's extraordinary local knowledge, all species were classed into one the following groups: Common; Uncommon; Rare and Endemic to Manningham. The definitions of these are self evident, except that the final category, Endemic to Manningham, is possibly only true for quite few species (9 in total – also in the Fungi with gills group) because so little exploration and collecting has been undertaken elsewhere in similar habitats in Australia. It is interesting to note that most species (350 species) are listed as being either uncommon or rare in Manningham. This is likely due to their preference for relatively restricted wet habitats, habitat loss and the general tendency for macrofungi to be scarce or cryptic and hard to find (see Table 9.1; Appendix 9.1).

Ecological patterns

Although data has not been collected, the vast majority of the macrofungi species records contained in this report were from 5 EVCs: Riparian Forest, Creekline Herb-rich Woodland, Valley Grassy Forest and Escarpment Shrubland. Unclassified Core Habitat (Indigenous Shrubland) closely related to Escarpment Shrubland associated with the Yarra River corridor was also a rich source of macrofungi.

In general all of these EVCs share the characteristic of supporting sheltered, moist microhabitats at ground level such as dead wood, tree bases, grass tussocks and moss beds. Water is crucial to the germination of spores as well as the growth of hyphae and the mycelium. Although the paucity of distribution data does not give an adequate picture of their distribution, macrofungi have a relatively wide geographic distribution and are found over a wide range of habitats (Fuhrer 2001). In Manningham, relatively few species are found in the drier environments such as the Grassy Dry Forest that occupies the dry ridgelines. In general the richest variety of macrofungi in the local context are found in the wetter parts of the landscape – in gullies, riparian zones and other sheltered microenvironments. In some cases (most notably Riparian Forest and Creekline

Herb-rich Woodland) this is due to proximity to permanent and semi-permanent watercourses in combination with a reasonable cover of tall shrubs such as Burgan and the eucalypt canopy.

Significant species

The following macrofungi species are regarded as being of significance at least within the context of Manningham and possibly further a field (see Table 9.1; Appendix 9.1).

Dermoloma sp. 2 (Stane Brae/100 acres): An apparently undescribed taxon only recorded in Manningham from private property at Stane Brae and at the One Hundred Acres Reserve in Park Orchards. Specimens and photographs collected and held by Bruce Fuhrer.

Hygrocybe acrohastata: A described species that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious or caespitose on soil amongst moss. Specimens and photographs collected and held by Bruce Fuhrer.

Hygrocybe fuhreri: A species described after Bruce Fuhrer in Young (2000) and for which the Jumping Creek area is a Type locality, that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious in moss and litter in eucalypt woodland. Specimens and photographs collected and held by Bruce Fuhrer.

Hygrocybe leucogloea: A described species that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious or caespitose in moss amongst litter. Specimens and photographs collected and held by Bruce Fuhrer.

Hygrocybe saltorivula: A described species that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious amongst deep moss and litter in eucalypt woodland. Specimens and photographs collected and held by Bruce Fuhrer. The name of this species has been derived from its Type locality at Jumping Creek: Latin, saltus – to jump; Latin, rivulus – a small stream.

Hygrocybe sp. 5 (JCR 1): An apparently undescribed taxon that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious in moss under K*unzea ericoides*. Specimens and photographs collected and held by Bruce Fuhrer. Note: "During this study, three collections made from the Jumping Creek Nature Walk area were considered to be new species but were found to consist of only two or three basidiomes which is considered insufficient material for a valid description and deposition of a suitable Type. These collections have provided well defined characters for two taxa. The descriptions are provided here to facilitate further studies" (Young 2000).

Hygrocybe sp. 6 (JCR 2): An apparently undescribed taxon that has only been recorded from WSP at Jumping Creek and Black Flat, both of which are close to the Yarra River. Gregarious in moss. Specimens and photographs collected and held by Bruce Fuhrer. Note: see comments above from Young (2000).

Hygrocybe virginea: Recorded from Black Flat only, this described species, apparently incorporating two subspecies (var. *virginea* and *fuscecens*), is gregarious amongst leaf litter and moss and also under Burgan. Specimens and photographs collected and held by Bruce Fuhrer.

Mycaena sp. 7 (red gill edge): An apparently undescribed taxon only recorded in Manningham from WSP at Jumping Creek and Black Flat. Specimens and photographs collected and held by Bruce Fuhrer.

Type localities

The following taxa, all collected by Bruce Fuhrer from the Jumping Creek area in WSP, have been used in the preparation of a recent revision of the family Hygrophoraceae (Young 2000). Examination of material of the following five taxa were recorded in the descriptions of a variety of additions to the family: *Hygrocybe austropratensis; Hygrocybe leucogloea; Hygrocybe psittacina* var. *perplexa; Hygrocybe virginea* var. *virginea;* and *Hygrocybe virginea* var. *fuscescens*. These do not have Type status but are nevertheless important in the taxonomic description of these species. Although no comments are made on the conservation status of any of these new species in this monograph, the Manningham occurances for three may well be the only records beyond the Type locations which occur in NSW.

The Jumping Creek populations of four taxa collected by Bruce Fuhrer: *Hygrocybe cheelii* (identical to Holotype); *Hygrocybe acrohastata* (Holotype); *Hygrocybe fuhreri* (Holotype); and *Hygrocybe saltorivula*

(Holotype), do represent Type populations as documented in Young (2000). The Holotype specimens for each are held at the National Herbarium of Victoria (MEL). These Types are clearly extant an can be used in the Biosites classification to support a listing of the greater Stane Brae/ Blue Tongue Bend (3) as being of National Significance (see Sect. 11; 12)

Sites of macrofungi (mycological) significance

Of the 7 assessed sites, 3 were found to be of particular note: Stane Brae/Blue Tongue Bend (Biosite 3), Black Flat (Biosite 4) and One Hundred Acres (Biosite 14) in Park Orchards. WSP in general has been regarded as a hot spot for macrofungi and the former 2 sites represent the cream for WSP in Manningham namely the sheltered Riparian Forest along the Yarra River north and south of the Jumping Creek Car Park up to Blue Tongue Bend and similar environments further down stream past the Jumping Creek confluence. The first of these is particularly outstanding with 333 taxa recorded including most of the study area's most important records, including all of the Type locatities listed above. It is hard to say why this area is so outstanding, although it is possibly the result of a coincidence of moist habitats in a relatively undisturbed condition close to people who are interested in macrofungi. The fact that Bruce Fuhrer has been able to go back to Jumping Creek time and time again over many years, really establishing an intimate understanding of the area, has probably made all the difference, but at this stage we just don't know due to lack of information.

9.4 Discussion

Although no comparisons are possible, it is reasonable to suggest that Manningham has amongst the highest known richness of macrofungi species of any equivalent area in the State. There is no doubt that this is parimarily due to the type and condition of the municipality's most significant areas of remnant habitat, namely the Jumping Creek and Blue Tongue Bend areas of WSP. However, it is also on account of Bruce Fuhrer and the fact that so little distribution data are available for macrofungi throughout the State. Projects such as FungiMap have been established by Royal Botanic Gardens in an attempt to improve this situation. "Current research in many areas, especially conservation, is being hampered by lack of basic knowledge of our fungi" (FungiMap wetsite).

The macrofungi flora is more than half as rich as that vascular flora (see Sect. 6) and greater than that of the vertebrate fauna (see Sect. 7) – two groups that have been exhaustively collected in the area and are well understood. This is clearly a significant component of the biota that has been hitherto ignored in biological inventories and significance classifications. With the fortuitous contribution by Bruce Fuhrer, the addition of macrofungi in Manningham's Biosites Review has been very successful. Not only has a baseline data set of the macrofungi flora been established, but this new information has helped some sites to achieve a higher classification than would otherwise be the case (Stane Brae/Blue Tongue Bend (Biosite 3) has been elevated from State to National Significance because of the *Hygrocybe* Type locations at Jumping Creek). Publication and desemination of this information will also raise the profile of this important group of organisims in the consciousness of the local community.

Unlike the bryophyte and invertebrate sections, where useful environmental indicator relationships where identified, no ecological analyses were undertaken for macrofungi. This is not to suggest that such relationships do not exist, nor that they would not be useful, it was just behond the scope of the current project to undertake this research. Acecdotal evidence suggests that the better habitats tend to have the greater richness of macrofungi – a thesis worthy of further investigation.

This Biosites Review represents the first opportunity to begin incorporating a consideration of macrofungi into strategic conservation planning. The fact that its inclusion has proven so fruitful in Manningham is encouragement for others to do likewise. It is intended to not only include all macrofungi data relevant to the Biosites classifications in with any proposed planning scheme amendments, but to also incorporate this group of organisms into municipal environmental monitoring, education and habitat management programs.

10 Invertebrates

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10.1 General Introduction

Invertebrates – animals without backbones – dominate the animal Kingdom in terms of number of species and number of individuals. On a global perspective, there are about 1.5 million described species of animals, but the number of undescribed species is currently in the realm of educated 'guesstimates'; these figures range from 5-80 million species, of which over 99% are invertebrates. In Australia, there are approximately 100,000 described invertebrate species and an estimated 200,000 species remain to be described (Yen & Butcher 1997).

This massive number of invertebrate species has conflicting consequences. On one hand, the large number of species (most of which are small in body size; have life history stages that are morphologically distinct; and have few readily available identification guides) puts invertebrates in the 'too hard' basket, and they have often been ignored in environmental planning. On the other hand, the diversity of invertebrates provides a readily usable resource for environmental monitoring. The importance of including invertebrates is justified by the range of different ecological functions in which they are involved that are essential for ecological sustainability. These functions include pollination, decomposition of organic matter, predation, parasitism, herbivory, seed harvesting, scavenging, and also they are the food items of the diverse insectivorous vertebrate fauna.

10.2 Invertebrate information for Manningham

Historical data

There has never been a broad baseline study or inventory of invertebrates within Manningham. Consequently, available information is based on: (1) institutional studies based on specific developments (e.g. the Eastern Freeway extension); (2) early naturalist observations; and (3) tertiary student projects. Historical data is often considered vague because exact locality data are absent from old specimens. For example, some early collections only have broad locations such as "Victoria" or "Melbourne" as their location.

In recent years, freshwater invertebrate monitoring sites have been set up and used by both Melbourne Water and the Environment Protection Authority (EPA). As this project is about terrestrial invertebrates, freshwater information is limited to information provided by the EPA (summarised in Appendix 10.1). The EPA has monitored aquatic invertebrates at 13 locations within Manningham. These sites are not regularly monitored and the years that samples were taken varied according to the location. Most sites were sampled in 1994 and 1995, with a spring and a late summer/early autumn sample at each location. Two collecting methods were used: hand sweep nets and kick samples. A total of 198 species of aquatic invertebrates were collected by the EPA (Appendix 10.1). The majority of these species were immature stages (especially Coleoptera (beetles), Diptera (flies), Odonata (dragonflies and damselflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).

The main invertebrate collectors were members of the Field Naturalist Club of Victoria (FNCV) and the Victorian Entomological Society. Some of the results of their excursions are available in their journals *The Victorian Naturalist* and the *Victorian Entomologist*. In *The Victorian Naturalist*, there is a report on the FNCV excursion to Warrandyte in November 1893 on which 100 species of beetles were collected. Several species of butterflies observed and flies, wasps, ants and spiders seen or collected were noted but not listed (French & Frost 1894). Barnard (1928) also recorded sawfly larvae swarms in Wonga Park.

The *Victorian Entomologist* records an excursion to Stane Brae in Warrandyte on 19 October 1986, and lists pupae of three species of butterflies, adults of five species of butterflies, adults of two species of moths, one species of Neuroptera, and 22 species of beetles (not all identified to species) (Carwardine & Faithfull 1987). Burns (1990) incorrectly relates the occurrence of the Yellow spot jewel butterfly (*Hypochrysops byzos hecalius*) from Pound Bend in Warrandyte, but it was found on *Pomaderris aspera* along the Yarra River in the western end of the Jumping Creek Reserve (Braby 1991). This is the first record of this primarily montane taxon from the metropolitan area.

The Museum Victoria Bioinformatics web site on butterflies is a database of butterflies held by Museum Victoria, CSIRO Australian National Insect Collection in Canberra, and several well known butterfly collectors. This has been searched for butterfly occurrences according to suburbs, and a total of 46 species has been recorded from suburbs within Manningham (Appendix 10.1).

Type localities

Examination of the Type catalogue at Museum Victoria has found that six species of insects have their Type localities within Manningham:

- *Austratrichia neboissi* (Trichoptera). Yarra River, Wonga Park. 1976.
- *Perga nemoralis* (Pergidae, Hymenoptera). Wonga Park, no date.
- *Stigmodera militaris* (Buprestidae, Coleoptera). Wonga Park, 1921.
- *Schaufussia mona* (Coleoptera). Warrandyte, 1925.
- *Cicadetta celis* (Hemiptera). Warrandyte, 1961.
- *Phaenocarpa persimils* (Hymenoptera). Templestowe, 1973.

At this stage, none of these species are known to be of conservation significance. Unfortunately, due to the vague location references, it is not possible to confidently assign these Types to specific sites in Manninghams network of remnant bushland and have not been used in the BIOSITES classification (see Sect. 11 and 12).

Recent studies

The most intensive invertebrate work has been associated with the extension of the Eastern Freeway. This has involved the study before the extension was built in the region from Balwyn to Ringwood (Yugovic *et al.* 1990) and subsequent studies on the extension from Springvale Road to Ringwood (Hinkley & Yen 2000; IPM Technologies Pty Ltd 1999a, b; Wainer *et al.* 2000; Van Praagh *et al.* 2000).

A total of 20 butterfly species were recorded in 1999 and 2000 at three sites between Springvale Road and Ringwood. Two of these sites, Hillcrest and Chaim Court, are in Manningham (IPM Technologies Pty Ltd 1999a; Van Praagh *et al.* 2000).

In the survey conducted by Yugovic *et al.* (1990), specimens of the Coconut Ant (*Papyrius* sp.) were collected at Hillcrest and Chaim Court. This ant species nests in tree stumps or logs in open, sunny and dry aspects of eucalypt woodland with a wattle understorey. Its common name is due to the coconut-scented odour produced by anal gland secretions. The significance of this ant is that it is sometimes associated with one of Victoria's threatened species of butterflies, the Small Ant-blue (*Acrodipsas myrmecophila*), as well as other butterflies such as the Fiery Jewel (*Hypochrysops ignita*) and possibly the Large Ant-blue (*Acrodipsas brisbanensis*). The larvae of the Small Ant-blue dwell within the nests of the Coconut Ant, and they are presumed to feed on the ants. There is an old record of the Small Ant-blue from the Ringwood region (McCubbin 1971), and the presence of the Coconut Ant at Hillcrest and Chaim Court in 1989 raised hope that the Small Ant-blue would also occur there. As the latter is a difficult species to locate, the chances of finding it would be greater if nests of the Coconut Ant were located first. In Victoria, the Small Ant-blue is currently only known from Mt Piper (near Broadford) (Britton *et al.* 1995). Wainer *et al.* (2000) conducted a pitfall trap and direct search survey for the Coconut Ant at 14 sites within the Hillcrest and Chaim Court Bushland Areas in December 1999, but no specimens were found.

In mid January to mid February 1999, four sites within the Eastern Freeway extension area were surveyed for carabid beetles: (1) near Springvale Road, (2) west Hillcrest-Petty's area; (3) Hillcrest; and (4) Chaim Court (IPM Technologies Pty Ltd 1999b). This survey yielded five species of carabid beetles (*Notonomus philippi*, *Notonomus gravis*, *Eurylchnus blagravei*, *Promecoderus* sp. 1 and Harpaliinae sp. 1). A total of 52 specimens were collected, of which 36 were *N. philippi*. The significant environmental aspect of this survey is that *N. gravis* is a grassland species that is primarily found to the west of Melbourne, while *N. philippi* is a woodland species found to the east of Melbourne. It is likely that *N. gravis* has moved east in response to woodland clearing and replacement by grasslands (even exotic grasses). All the *N. gravis* were located at the Springvale Road site – an area of grassland (IPM Technologies Pty Ltd 1999b).

10.3 The use of invertebrates in assessing SOS

There has been a tendency not to include invertebrates in assessing sites of significance unless they are threatened species. The reasons for this are the lack of background baseline information about most invertebrates (hence it is difficult to make comparative judgements between sites) and the relevance of certain criteria to invertebrates. For example, with vascular plants and vertebrates, two major criteria used are threatened species and species richness. For invertebrates, there are relatively few listed threatened species (again because of the lack of information) and most sites have a large numbers of invertebrate species (making species richness a not so useful criterion).

Yen and Butcher (1997) evaluate criteria for using invertebrates to assess SOS. This involves assessing sites using criteria similar to those used for the Register of the National Estate. They are either: (1) taxon based (species richness; presence of localised endemics; presence of threatened species or communities; and scientific significance); (2) site based (Type locality; important site for a biological phenomenon associated with the life history such as hill-topping for butterflies; representative habitat; important educational site; and critical habitat for invertebrates). This approach relies on having data to see whether it fulfils the criteria outlined above, and in some cases, the measures are relative and decisions are very subjective (e.g. is species richness a good measure to compare different sites).

In the case of Manningham, where invertebrate data are depauperate, it is proposed that an indicator approach be developed to assess site type and quality. By defining the site factors in which we are interested, it is possible to select appropriate invertebrates as indicators. The attributes of potential indicators are (Yen & Butcher 1997):

- Ecologically and functionally important;
- Diverse, providing a good range from which to choose suitable taxa;
- Many species are habitat specific;
- Many species are abundant and relatively easy to collect;
- Species are relatively easy to identify.

Either the single species or species assemblage approach can be taken. The use of a single species has limited potential in the broader Manningham context, and the species assemblage approach is more appropriate. This involves either selecting known taxonomic groups (e.g. orders or families) or a mixture of different groups that represent a range of different trophic groups. Butterflies and ants are considered to have the most potential for assessing Biosites in Manningham, but for different reasons.

Butterflies

Butterflies are arguably the best known group of insects in Australia. Practically all species have been described, and thus can be assigned a scientific name. There are about 400 species in Australia, and 46 species have been recorded in the Manningham region (Appendix 10.1). The immature stages of most butterfly species are plant feeders, so there is some dependency upon vegetation. Furthermore, the larvae of some species are also dependent upon species of ants, to the extent that some species live in the ant nests.

Butterflies are useful in assessing Biosites in that they are: (1) relatively large bodied (adults) and easier to locate; (2) taxonomically well known; and (3) have popular appeal to the public and have potential for volunteer-based monitoring programmes.

Some species display the phenomenon of hill topping, where males defend territories at the top of hills to attract females. Such sites have important biological significance for butterflies. All butterflies in Manningham are native species except for the introduced Cabbage White Butterfly.

Ants

In contrast, there are many undescribed species of ants in Australia – an estimated 1500 species. However, they are one of the ecologically dominant groups of invertebrates in Australia because they prefer drier and more open habitats – characteristic of much of the continent. There is one known introduced species in Manningham, the Argentine ant, and it is because of this species that a study has been undertaken on ants in part of the WSP (Bothwell 2000). This study found 62 species at ants, including the Argentine ant. The study found that Argentine ants had dispersed from the ranger's station area to cover a region of 7 hectares and that the total ant species richness was reduced.

The composition of ant faunas (communities) is useful in determining habitat condition. This idea was initially proposed by Greenslade (1979) on the basis that the ants living together within a particular habitat will interact through predation or competition. As there are generally many different species of ants within each particular habitat, the composition of the ants (the communities) can reflect habitat factors and disturbances to these factors. The ants can be assigned to various functional groups, and the composition of the functional groups within the habitat provides an indication of the ecology of the habitat.

The basis of the functional group classification is that community composition is heavily influenced by one group of ants – the Dominant Dolicherinae (genera such as *Iridomyrmex*). They are abundant, aggressive diurnal species that compete with each other to such an extent that their colonies occupy mutually exclusive areas on the ground. The distribution of these colonies sets up a pattern in space and time in which other ant species have to fit in. Associated with the Dominant Dolicherinae are the Associated subordinate Camponotinae (*Camponotus*, *Polyrachis*) which nest in areas between Dominant Dolicherinae nests. There are several other specialised ant functional groups (Climate specialists, Cryptic species, Solitary foragers/specialist predators, and Generalised myrmecines). The last group as species that are not closely adapted and are unspecialised catholic feeders; they are flexible in their foraging time and can occupy a wide variety of habitats. They are opportunists and can exploit resources not intensively used by other ants (especially new and ephemeral resources).

Andersen (1990) proposed a recipe to use ant communities to evaluate changes in Australian ecosystems, and this has been recipe has been subsequently modified (Andersen 1997). The responses of ant functional groups to environmental stresses (moisture, nutrients, temperature) and disturbance makes them useful as predictors of ant community structure. The functional group approach has worked best at revegetation associated with mining site rehabilitation; analogous to tree clearing associated with urbanisation. Native vegetation modification leads to reduced ant diversity and altered community composition and are most useful in situations where there has been substantial change in ground-layer habitat structure in forests. Reanalysis of Eastern Freeway pitfall trap ants showed that native vegetation had more species of ants than degraded and exotic vegetation sites, but more importantly, the reduced number or absence of species in the functional groups in the degraded and exotic vegetation sites (Yugovic *et al.* 1990)

A list of ant genera that could be found in Manningham according to their functional groups is provided in Table 10.1 (the assignment of genera is based on Andersen 1990; 1995).

10.4 Methods

Yen (2003a) proposed a standard sampling protocol to use two groups of invertebrates for site assessment: ants and butterflies. Ants were collected by pitfall trapping and data analysed using a recently developed simplified functional group protocol. Ants were identified to morphospecies on a presence/absence basis to elucidate species richness, species assemblages and functional groups. Due to the close relationship between butterflies and ants, and in some cases, an additional interaction with ants, a butterfly inventory was also undertaken including sites of biological phenomenon significance if found (e.g. hill topping site for butterflies).

The sites selected represented the major EVCs within Manningham, and site quality was defined as EVCs with different understorey qualities (Table 10.2). The assumption of this proposal is that most of the Manningham region was originally covered with native forests (different EVCs), and that with European settlement, this has been simplified (by urbanisation, agriculture, horticulture, pasture). Consequently, invertebrate groups such as butterflies and ants should reflect the gradient of change from forest to urban. By selecting sites from north to south in Manningham, it may be possible to determine whether the following changes can be detected by butterflies and ants: Habitat type (structure) – change or simplification (exotic to native); EVC (type, condition); Geographical variation (north to south); and Island effect (fragmentation) (north to south, east to west).

Environmental factors were assessed at each site to ascertain the effects of spatial variation in local topography (especially gully/ridge differences), and habitat complexity (overstorey, understorey and ground factors).

At each site, habitat variables (overstorey, understorey and ground layer cover, litter cover and depth, bare ground, other ground variables) were measured in order to develop a habitat complexity index to determine the correlation between habitat factors and the invertebrates collected.

Site quality is pre-determined based on the Indigenous Vegetation Modification variable (Sect. 5). Good quality sites were assessed on the basis of relative lack of disturbance while poor sites were completely alienated (very small disturbed remnants surrounded by alienated habitat or completely exotic).

Each EVC was sampled from November 2003 to February 2004 to inventory ants (pitfall trapping). This involved putting in sets of pitfall traps for a period of 5 days (4 nights) to 7 days (6 nights). Test tube pitfall traps in plastic pipe sleeves with three centimetres of ethylene glycol as a killing agent and preservative were used in a 2 x 5 traps configuration with 3 m between each trap. This involved 21 sites in 13 locations (Table 10.2).

In total of 210 pitfall traps were run and the contents of the pitfall trtaps were washed in water and the specimens stored in 70% ethanol. All specimens were identified to the order level and ants were identified to morphospecies level.

The ordinal and ant data were analysed using Primer. Ordinations graphs were prepared for untransformed ordinal data, and for untransformed and log (n+1) transformation for the ant data. The ordinal and ant compositions were tested by regression for significance with the environmental data.

Butterfly inventories were conducted in a subset of the proposed sites and involved direct searching on a timed search basis. Each EVC was included in the survey. The information obtained is seen as a basis for developing a species list over several years.

10.5 Results

Invertebrate Orders

A total of 7,031 invertebrates from 21 orders were collected in the pitfall traps. The number of orders found at each site varied from 9-13; this was not related to EVC or site condition, so ordinal richness is not an important factor in assessing site significance. The numbers of individuals and percentage composition are presented in Table 10.4. As pitfall trapping is selective, it is best to omit certain orders from further analysis because their presence is incidental (adult stages of aquatic insects), is not totally sampled (mites), flying insects are attracted to traps (flies, non-ant Hymenoptera), or whose abundance is determined by factors such as recent rainfall (Collembola).

In relation to EVC, ants were the dominant group of invertebrates at 16 of the 21 sites. They dominated all sites in the Valley Heathy Forest, Valley Grassy Forest, and Grassy Dry Forest. They dominated 2 of the 4 Riparian Forest sites and 2 of the 3 Creekline Herb-rich Woodland sites. With the two Riparian Forest sites, amphipods and isopods dominated in the more disturbed sites. Ants were not the dominant group in the three exotic sites (urban garden, exotic grassland and grazed pasture).

At least two introduced invertebrate species were found to be amongst the more dominant groups. The European earwig (*Forficula auricularia*) was prominent in Grassy Dry Forest (Biosite 21, Oban Road), Valley Grassy Forest (Biosite 4, Black Flat) and Creekline Herb-rich Woodland (Oban Road), while the Portuguese millipede (*Ommatoiulus moreletti*) was prominent in Riparian Forest (Black Flat and Biosite 22, Hillcrest Reserve/Chaim Court), Creekline Herb-rich Woodland (Oban Road) and Valley Grassy Forest (Biosite 28, Candlebark). It is uncertain whether the Isopoda (slaters) collected were introduced or native species.

Of the 21 sites, 15 were dominated by ants. The sites not dominated by ants were either the non-native vegetation sites (urban garden, mowed grassland and grazed pasture) or one of the wetter (Riparian Forest or Creekline Herb-rich Woodland) sites.

When the ordinal composition (all data) was ordinated using Primer, the RF sites were the only ones that weakly separated into a distinct group (Fig. 10.1). However when the similarities were analysed, there were no significant relationships between the ordinal composition, and the EVCs and Indigenous Vegetation Modification Index.

Ants

Number of species

A total 2,557 individual ants belonging to 46 morphospecies were collected in pitfall traps from the 21 sites (Appendix 10.1).

There were significant differences between EVCs and exotic sites in terms of the number of ant species. The drier sites (VGF, GDF and VHF) had the highest number of species and fewer species were recorded in wetter sites (RF and CHW). The least number of species were recorded from the heavily disturbed sites. (Table 10.5; Figure 10.2).

Percentage composition

In terms of abundance, six species of ants dominate the collection (Appendix 10.1). These six species constitute 69.53% of the ants captured: *Rhytidiponera* sp. 1 was by far the most dominant species (29.25%), followed by *Pheidole* sp. 2 (12.94%), *Iridomyrmex* sp. 2 (8.45%), *Iridomyrmex* sp. 1 (6.73%), *Aphaenogaster* sp. 1 (6.53%) and *Rhytidiponera* sp. 2 (5.57%). Dominance in terms of abundance does not necessarily equate to a wider distribution (in terms of number of field sites in which each species was collected), although for the six dominant species, the number of field sites in which they were collected was 21, 10, 6, 9, 7 and 10 respectively (Figure 10.3). Clearly the dominant *Rhytidiponera* sp. 1 dominated in terms of abundance and was found in all sites. Yet 11 ant species were low in total abundance (all less than 4% of composition) but occurred in 6-13 of the sites; for example, *Prolasius* sp. 1 constitued only 3.44% of individuals and was found in 13 sites and *Crematogaster* sp. 1 constituted 3.82% and occurred in 12 sites.

Ordination of untransformed data indicates that Valley Heathy Forest sites and the three exotic sites separate out from the other sites (Figure 10.4). When data are transformed with log x+1, the three exotic sites stand very much apart from the others (Figure 10.5).

Based on ant species composition, the ant functional group results did not reveal any significant trends in relation to functional group structure and either EVC or level of disturbance (Table 10.6; 10.7). Three trends would have been expected (Hoffman & Andersen 2003): (1) a higher proportion of DD (Dominant Dolicherinae) and HCS (Hot Climate Specialists) in forests with low levels of disturbance; (2) a higher proportion of O (Opportunist) and GM (Generalised Myrmecines) in disturbed habitats; and (3); and fewer CS (Cryptic Species) and SP (Specialist Predators) in disturbed habitats. It was not possible to distinguish any trends in the functional group results that would support these three contentions. There are two possible reasons for this: (1) the very disturbed sites had only one site assessed, so the results would not have included variation between sites in each type of disturbance; and (2) the low number of Specialist Predators may indicate a level of disturbance in the past.

Butterflies

Only 7 species recorded compared to the 46 known to occur in Manningham (Yen 2003). Most observed are more common and widespread species, including the introduced Cabbage White Butterfly, *Pieris rapae*. One species, the Common Grass Blue (*Zizina labradus*) is a native species that is characteristic of grasslands; it is a native species that has adapted to exotic grasses (including lawns) (Table 10.8).

The low number of species reflects seasonal factors (even a comprehensive survey during 2003-2004 would not have resulted in observing the 46 known species), but more importantly, reflects the time required to obtain more comprehensive butterfly data.

10.6 Discussion/conclusions/recommendations

This component of the study was an attempt to include terrestrial invertebrates into the Biosites Review by focussing on ants and butterflies. While recognizing that broader landscape features, such as native vegetation will be the major driving force in determining Biosites, invertebrates can contribute in the following ways:

1. Scientifically significant invertebrate taxa (whether it is based on conservation status, Type locality, biogeographical uniqueness, or some other criterion such as Gondwanan origin);
2. Invertebrates as indicators; and
3. Invertebrates involved in sustainable ecological functions.

With the method adopted to collect ants (pitfall trapping), a broad range of ground active invertebrates were collected. These were identified to the order level and assessed on the basis that if significant differences could be found between sites at this level of identification, it would provide a very rapid and effective measure. The ordinal results did not provide any information that could be used for Biosites classification because the fauna was dominated by a small number of orders with either large numbers of species or large numbers of individuals with fewer species.

The results indicated that ants dominated the fauna at 15 of the 21 sites. The only sites that ants did not dominate were three of the six wetter sites (Riparian Forest and Creekline Herb-rich Woodland), where other orders associated with wetter environments (Isopoda and Amphipoda) were found to dominate, and at the three very disturbed sites (exotic grassland, grazed pasture and urban garden).

The dominance of the ground dwelling fauna at most sites supports the contention that they are one of the most important ecological groups in the Australian environment.

In this study, the first and most simple measure, species richness, provided the clearest results. The number of ant species was related to EVC (there was an increase in the number of ant species from the wetter Riparian Forest and Creekline Herb-rich Woodland) to the drier EVCs (eg. Grassy Dry Forest) and also the level of severe habitat modification (fewer ant species in the exotic grassland, grazed pasture and urban garden sites). There is probably also a vegetation type by disturbance factor relationship, but it was not possible to assess the disturbance contribution when considering difference levels of disturbance within a particular EVC. It is important to remember that in this study, no exotic ant species were collected. The exotic Argentine ant, *Linepithema humile*, is known to occur at Warrandyte (Bothwell 2000), but was not collected at the sites assessed. Any future studies using ant species richness must consider whether exotic species are involved.

The ant fauna was dominated by a small number of widespread and abundant species such as *Rhytidiponera* sp. 1. This species in particular is known to colonise disturbed sites, and its widespread occurrence only supports the observation that much of the Manningham region suffers from disturbance.

Only a small number of butterfly species were recorded in this study. This reflects the fact that a large amount of time is required to undertake comprehensive butterfly records: visits to the site over different times of the day and on several occasions over their flight seasons. This is an area that still has great potential in contributing to Biosites and has great potential for a monitoring program run on a community basis.

This study has shown that ants are a very dominant force in the natural environment. Only one of the three measures suggested gave results that could contribute to assessing Biosites. The value of ants as an indicator will increase as more data is obtained from different sites. A full seasonal study would provide more insight into ant ecology. The factor still missing is a more detailed assessment of how environmental factors affect ants.

11 Sites of Significance (Biosites)

11.1 Introduction and What is Biological Significance?

Both the former SOS studies (Bedggood *et al.* 1992; 1997) used an unclear range of criteria to categorise each site from Local to National significance broadly under the categories of Botanical and Zoological significance including the presence of listed threatened species (ie. at the National, State and even Regional levels). In a similar study, north of the Yarra River (Beardsell 1997), 54 criteria were used: 7 under habitat significance and 47 under fauna significance (Beardsell 1997). The latest draft protocol for Victoria, the proposed Biosites Criteria (DSE 2003; Appendix 11.3) lists 32 sub-criteria under the following 5 criteria:

1. Ecological integrity and viability (13 sub-criteria),
2. Richness and diversity (3 sub-criteria),
3. Rarity/Conservation status of assets (10 sub-criteria),
4. Representativeness of type (2 sub-criteria), and
5. Scientific and educational value (4 sub-criteria)

According to this protocol, 'the overall significance of a site will be assigned on the basis of the *highest single asset rating* applying within the site". In other words if a Biosite, for example, obtains the highest rating of National Significance under only a single sub-criterion, the site is automatically denoted as being of National Significance over all (DSE 2003). All sites classified using proposed Biosites Criteria (DSE 2003) are referred to as 'Biosites'.

> "'Biological significance' is a ranking of the contribution that biological assets of a site make towards the maintenance of Victoria's native biodiversity. The assessment and classification of biological (= biodiversity) significance is one aspect of the assessment of conservation values. Two of the major roles of conservation assessment are (a) identifying priority areas for conservation management action and reservation, and (b) incorporating biological conservation objectives into regional and local planning procedures (Margules and Usher, 1981)." (DSE 2003)

This protocol, which discusses the ecological basis of biological significance in an international context, comments that:

> "It consolidates and revises existing criteria, which have been used incompletely and on an *ad hoc* basis into a single, recommended set. The document includes guidelines that are intended to standardise the delineation of sites based on the principle that **practically all native biodiversity has some level of conservation significance**. A methodology for deriving a significance rating for a site based on the individual assets present is proposed [based on a] comprehensive set of criteria." (DSE 2003). **Emphasis added**

Examples of the 'incomplete' use of criteria for classifying significance in this instance are the clear emphasis on fauna and faunal habitat in the case of the NEROC study (Beardsell 1997) and, as mentioned earlier, a lack of clarity on how the determinations were made on the other two studies (Bedggood *et al.* 1992; 1997). Undoubtedly consideration was given to a range of site attributes or assets, but usually only specific mention is made of the presence of rare or threatened species at the Regional to National level – which under the proposed Biosites Criteria falls exclusively under the "Rarity/Conservation status of assets" criteria.

Although a version of the proposed Biosites Criteria was included as an appendix in a recently published list of significant sites in the Port Phillip and Westernport region (DNRE 2002b), it is unclear how the criteria were used as the detailed classifications for each site were not included in the report – and thus it is impossible to discover why a particular site is classified as it is. The aim of this Biosites Review is to attempt to classify all sites under as many of the 32 sub-criteria as the availability of data allows – with each of the additional elements of the biota being considered (such as bryophytes and macrofungi) representing an additional thematic consideration under each of the relevant sub-criteria. In short, significance determination is a critical step in our practical response to biodiversity conservation.

11.2 Site selection methods

The method employed in this Biosites Review for delineating site boundaries has been presented in Sect. 5. Seven key rules were used in the development of the network of sites presented and were based on the methods in the proposed Biosites Criteria (DSE 2002):

"Sites boundaries should identify rational environmental units within which the significant assets of the site may be effectively maintained and managed. In the majority of cases this could be achieved through the maintenance of biophysical integrity within drainage sub-catchments (Parkes 1990). Parkes (1990) considered that the site must include, as a minimum, 'wherever possible all the values [assets] that have led to the area being designated, plus whatever additional area is necessary to give those values adequate likelihood of long-term survival'. This need for biologically meaningful boundaries needs to be balanced with the need for boundaries that are easily identifiable in the field and on the ground. Such boundaries on larger sites in intact sub-catchments might be, for example, the ridgelines dividing the sub-catchments. In variegated, fragmented landscapes the boundaries of sites might often relate to artificial features of the landscape, such as property boundaries, roads, or the extent of patches of remnant native vegetation, or a combination of these. It is here that the decisions about delineation of site boundaries on the ground and the technical requirements of annotating and mapping those boundaries for inclusion on hard copy maps and a GIS layer are most apparent. The mapping of site boundaries will be easier and more precise where existing linework can be used. **In fragmented landscapes the biophysical integrity of the landscape is already compromised. The boundaries of sites in these areas are best defined as the boundaries of remnant vegetation or other habitat, taking note of property or tenure boundaries where they are relevant to the management of the site.** The practical minimum area for a site of biological significance identifies the extent of the occurrence of all the significant assets (or their habitat) for which the site is valued". **Emphasis added.**

Considerable attention was also placed on the definition of previously recognised sites in the study area, although the primary consideration was the spatial patterning of remnant habitat as is highlighted above for fragmented landscapes such as is found in Manningham. In this way previously enormous sites have been broken down into more accurately defined, ecological meaningful and manageable entities or very small sites were merged into larger sites as appropriate.

11.3 The criteria

Ecological integrity and viability (13 sub-criteria),

The following excerpt summarises the conceptual background and intent of this criteria:

"Ecological integrity and viability are among the most important criteria in determining site significance, but they are also the most difficult and contentious elements to assess. Sites with high ecological integrity are usually in a mostly natural state over a sufficiently large area to allow ecological processes to remain relatively intact and to be independent of the surrounding area. Ecological viability and integrity are valued for their contribution to long-term conservation aims. The greater these values, the less management is needed to maintain biodiversity in an area and the greater will be the proportion of the original diversity present, including the large number of species of which we know little or nothing. Naturalness has aesthetic values, and in increasingly fragmented and modified landscapes, naturalness may also be increasingly valued because of its rarity and as a reference with which to compare more modified habitats" (DSE 2003).

A total of 13 sub-criteria were used in the assessment under two sections: (1) naturalness and extent of native habitat; and (2) the importance of maintaining natural ecological process or systems. The second section includes criteria relating to the breeding, nesting, nursery and roosting sites of communal breeding, territorial or migratory/nomadic species and primarily relates to birds. It also includes consideration of sites as climatic and long-term ecological refugia (past or present), as strategically important corridors as well as importance/potential for future ecological restoration (Appendix 11.1 to 11.3).

Richness and diversity (3 sub-criteria),

The following excerpt summarises the conceptual background and intent of this criteria:

"This criterion applies to sites that are important because of the richness or diversity of any of their biological attributes. Biodiversity is a function of a variety of environmental factors, and is also a function of size: large areas generally have a greater diversity than small areas. In applying this criterion, areas that are more heterogeneous than other areas of similar size should be given a higher significance" (DSE 2003).

A total of 3 sub-criteria were used in the assessment under two sections: (1) sites with high species richness and diversity; and (2) sites with endemic taxa. It is under this criterion that additional information on the diversity of other groups of the biota such as macrofungi and bryophytes can add value to the significance classification (Appendix 11.1 to 11.3).

Rarity/Conservation status of assets (10 sub-criteria),

This criterion applies generally to indigenous taxa that are listed as rare or threatened from the Local, through to the National level. As this information is only available for limited groups it really only applies to vertebrate fauna and vascular flora. The concept of rarity can also apply to other attributes such as exceptional size or age of plants or communities (DSE 2003).

A total of 10 sub-criteria were used in the assessment under four sections: (1) formal listings of conservation status; (2) migratory or mobile species listed under international treaties (eg. Ramsar Convention); (3) conservation status of EVCs or Floristic Communities; and (4) exceptional age of habitat or communities. The introduction of Bioregional and State Conservation Status listing for EVCs with the Net Gain Framework (DNRE 2002a), adds considerable value to the classification of sites. It was not possible to make any meaningful statements about habitat depletion or reservation levels previously (Appendix 11.1 to 11.3).

Representativeness of type (2 sub-criteria), and

The following excerpt summarises the conceptual background and intent of this criteria:

> "This criterion relates to sites that best represent the characteristics of an ecological community or the variation within it. One site could represent one or more communities. A site can qualify as a significant representative of its type following a comparison with other sites of the same type, considering such factors as: natural attributes (including flora, fauna and indirectly soils, landforms and geology); abundance and distribution of the type; and degree of homogeneity or variability of the type over its range. The relative significance and extent of such a site will also depend on condition and integrity, including a consideration of size, shape and location as they affect viability. Since these criteria are meant to identify representative examples, only then is the minimum set approach justifiable. Only the best examples in Victoria should be included under this criterion. It is likely as a result that they will already be included under other criteria relating to rarity and or condition" (DSE 2003).

A total of 2 sub-criteria were used in the assessment and relate specifically to the typicalness of EVCs or to the presence of unusual variations that are documented (Appendix 11.1 to 11.3).

Scientific and educational value (2 sub-criteria)

The following excerpt summarises the conceptual background and intent of this criteria:

> "This criterion differs from the other criteria in that scientific and educational values are indirect; that is, they are not intrinsic to the flora and fauna. Instead, these values lead to improved knowledge, which enables management to be more sympathetic to other values of the site, or those of other sites. Scientific values are considered separately from educational values, although a site can have both. Educational values may be useful only for education, whereas scientific values can relate directly to biodiversity conservation values" (DSE 2003)

A total of 4 sub-criteria were used in the assessment under three sections: (1) sites that are important for ecological research; (2) Type localities; and (3) sites that demonstrate or document evolutionary processes (Appendix 11.1 to 11.3).

See Appendix 11.3 for a listing of the complete Biosites criteria used in this report.

11.4 Results

Criteria and sub-criteria

A total of 23 of the 32 criteria were used in the classification of the 35 defined Biosites within the study area. These comprise 9 of the 13 sub-criteria under ecological integrity and viability, all 3 sub-criteria under

richness and diversity, 7 of the 10 sub-criteria under rarity/conservation status of assets and all 4 sub-criteria under scientific and educational value. Neither of the sub-criteria under representativeness of type were used primarily due to the lack of data at the Bioregional, State or National level. In general, the lack of data or meaningful data was the reason why 9 sub-criteria were not used at all in this classification. In all but four cases where a classification was undertaken (one sub-criterion under richness and diversity and 3 under rarity/conservation status of assets) there were specific limitations in data availability in up to 10 of the 35 sites (Table 11.1; Appendix 11.2).

The highest classifications obtained under each of the sub-criteria used were fairly evenly distributed across the 4 criteria with 5 sub-cirteria achieving a Nil Significance classification; 5 a Local Significance classification; 12 a State Significance classification; and 1 a National Significance classification. Although many Regional Significance ratings where achieved, this was never the maximum rating under any sub-criteria (Table 11.1; Appendix 11.2).

Of the 1120 significance classifications possible, 29.3% (328) where not classified due to the lack of available or meaningful data. With the exception of State Significance there was a general inverse relationship along the gradation from Nil to Nationally Significant, with 47.1% obtaining a Nil Significance classification, 9.6% with a Local Significance rating, 5.4% with a Regional Significance classification, 8.0% with a State Significance classification and 0.5% with a National Significance rating (Table 11.1; Figure 11.1).

Site Classifications

As mentioned earlier the overall site classification is equivalent to the highest classification obtained under any sub-criteria. From the 3 previous SOS studies all or part of 29 of the 35 sites defined in this study were classified on the basis of Botanical and Zoological Significance into 13 Regionally Significant sites and 16 of State Significance (Table 11.1). In the case where one large site from a previous study has been stratified into a number of smaller Biosites for this classification, the highest rating obtained for the Biosite as a whole is applied to each of the sub-sections. In the reverse case, where only a small section of a larger Biosite defined under this Review has been examined under previous studies, the highest rating for the sub-section applies to the new large site (Map 11.1).

Under this classification, 6 of the 35 Biosites obtained a National Significance classification, 23 a State Significance classification, 6 a Regionally Significant classification and none were classified as having Local or No Significance. Whilst many of the Biosites retained the same maximum classification as determined in previous studies (10 Biosites – see Table 11.1), the remainder obtained a higher rating: either changing from Regional to State Significance (13 Biosites) or from State to National Significance (6 Biosites). All of the six entirely new Biosites, all west of the Mullum Mullum Creek and closely associated with the urban suburbs away from the Yarra River, obtained a Regional Significance rating (Maps 11.2 – 11.7).

The Nationally Significant classifications were all obtained under the Scientific and educational value criteria on account of the presence of Type localities – the locations of populations of organisms used to make collections of specimens used to describe new species. This data was obtained from the National Herbarium of Victoria (vascular plants, macrofungi and bryophytes) and the Museum of Victoria (vertebrate fauna and invertebrates). A total of 13 Type records were identified through the former source (Note that databasing of Type collections held at MEL is only partially complete c. 20% so these 13 records may represent only a small proportion of all Types collected within the Manningham municipality) and 6 records from the later – all invertebrates mainly from the Warrandyte and Wonga Park areas. Whilst exact details are available for the plants, this was not always the case for invertebrates. Consequently, only where Type locatities coincide with extant habitat has a National Significance classification been obtained.

11.5 Discussion

It is reasonable to expect that with a more thorough assessment of significance, more sites will be classified to a higher rating as has been the case in Manningham. However, these results are not set in concrete – for three key reasons: (1) Further survey and study could result in further changes; (2) Ecosystems are dynamic things and will change over time; and (3) Any methodological improvements could have implications for the classification of Biosites in Manningham.

More information will allow use of the 29.6% of the classification method not used in this Review. This would involve the use of criteria and sub-criteria not used at all in this instance as well as the application of those used across all Biosites. An example of the former is developing models to assess Biosites as climatic and

long-term ecological refugia and for the later, collating vascular flora and vertebrate fauna species richness data for every Biosite. In addition, collating such information for other elements of the biota such as macrofungi, bryophytes and invertebrates could also alter the significance classification outcomes.

It is important to point out that for this information to be valid it must be up to date. The current trend of ecological decline in such landscapes means we can have less confidence that old information still applies to particular sites. The destruction and degradation of habitat results in local species extinctions and records for even common species will decline rapidly in value with age. This highlights the need for an on-going commitment to collecting, collating and interpreting biological information at the local level. Not only does this help to make our understanding of the significance of sites accurate, it is also useful for tracking change – be it further decline, stability or improvement.

A final issue relates to the limitations of the classification methodology used. Given the method is still being developed it is likely changes will be made, not only with respect to the application of our current knowledge, but also, in the long-term, with the acquisition of new knowledge. Although beyond the scope of this study, the proposed Biosites Criteria needs to be more extensively trialled and critiqued to ensure it is ecological rigourous and therefore politically acceptable and useful. There is evidence from its application in this case of some internal inconsistency that may need to be investigated. This relates to the probability of obtaining a particular classification level under any one sub-criteria at any one site within a landscape. Ideally this should follow the natural sequence: probability of N < probability of S < probability of R < probability of L where N, S, R and L represent National, State, Regional and Local Significance classifications respectively.

12 Site classifications and descriptions

12.1 Site summaries

This section is derived from Appendix 11.1 (see this key for definition of all acronyms). The summaries are structured into two sections – (1) a plain english description outlining the Biosites location, key attributes and why it has been classified as significant; and (2) a technical summary of the Biosites classification listing the criteria and sub-criteria under which the site have been classified and the evidence used. It is envisaged that both sections can be directly transferred into other reports to demonstrate the significance of a particular Biosite. All results are spatially represented in Maps 11.1 to 11.7 and the 35 individual Biosite maps.

Mount Lofty, Biosite 1; State Significance (3 Sub-Criteria)

Description:

Mount Lofty (Biosite 1) comprises 50.82 ha of Unclassified Core Habitat, Escarpment Shrubland (E), Riparian Forest (LC), plus a small area of Swampy Riparian Woodland (D) and Herb-rich Foothill Forest (LC) and is located in the extreme north-east of Manningham on the Yarra River at the Brushy Creek confluence. It occupies a narrow north-south oriented ridgeline bounded by a major bend in the Yarra River that comprises part of the Warrandyte Gorge. The Biosite runs along the river north from Wittons Reserve and carpark at the end of Reserve Road in Wonga Park almost to the canoe launching ramp at the car park at the end of Lower Homestead Road. With the exception of the bushland on Wittons Reserve itself (which is owned by Council) and two small patches of vegetation extending onto private land adjacent to Brushy Creek, the site is entirely within the Mount Lofty block of WSP owned by the State and managed by Parks Victoria. The reserve was formerly cleared for agriculture and since it was purchased for conservation in 1997, there has been an active program of habitat conservation and indigenous revegetation. A total of 63 vascular flora species have been recorded for this Biosite (For a complete list see Appendix 6.1).

The Mount Lofty Biosite represents a small portion of Site 59 in Beardsell (1997; 2002), which was classified as State Significance (under both Botanical and Zoological criteria) and partially overlaps with Site 6, along Brushy Creek in Bedggood *et al.* (1997), which was classified as (High) Local Botanical Significance and State Zoological Significance. Using the Biosites criteria, Mount Lofty is also classified as State Significance under three sub-criteria (DNRE 2002b): Sub-criteria 1.3.2. and 1.3.3. As the Mount Lofty block of WSP may with suitable habitat rehabilitation form an important additional area of habitat or strategically important corridor (Note: there are State threatened species down and upstream that may colonize if habitat restored/created – which is considered realistic because it is within WSP); and 5.1.1.3. As the riparian environs are long-term monitoring/benchmark sites under the WSP Draft Management Plan and the EPA's "environmental health of streams in the Yarra River Catchment" monitoring program. This Biosite is also classified as Regional Significance under three sub-criteria and Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, State**
  - Sub-Criteria 1.1.1., **L**, Yarra River, Brushy Creek
  - Sub-Criteria 1.2.5., **R**, Yarra River corridor
  - Sub-Criteria 1.2.6., **R**, Yarra River corridor
  - Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in WSP
  - Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in WSP
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, Regional**
  - Sub-Criteria 3.2.3., **R**, Herb-rich Foothill Forest (EVC 23); Riparian Forest (EVC 18); Swampy Riparian Woodland (EVC 83). Escarpment Shrubland (EVC 895) questionable – See Sect. 6.
- **Criteria 4, Representativeness of type, Nil**

Criteria 5, Scientific and educational value, State

Sub-Criteria 5.1.1.3., **S**, Core Site in WSP Draft Management Plan – Riparian environs only. Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PC: Yarra River at Brushy Creek confluence) Source: EPA 2000.

Clifford Park/Bend of Isles, Biosite 2; National Significance (1 Sub-Criteria)

Description:

Clifford Park/Bend of Isles (Biosite 2) comprises 158.47 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V), Escarpment Shrubland (E), Riparian Forest (LC), Unclassified Core Habitat and small areas of Creekline Herb-rich Woodland (E) and Herb-rich Foothill Forest (LC) and is one of the largest Biosites in the municipality. It is located in the north-east of Manningham in Wonga Park along the Warrandyte Gorge section of the Yarra River spanning from the Brushy Creek confluence at Wittons Reserve and car park through Bend of Isles to roughly west of the Watsons Creek confluence flowing in from the north. The bulk of the Biosite is the Yarra Brae block of WSP which is owned by the State and managed by Parks Victoria, with significant private holdings at Clifford Park (The Scout Association of Australia (Vic)) and immediately south of the major ridgeline at Yarra Brae farm, along Clifford Drive and Davis Road East. Three small discrete patches, along Davis Road West and in the Wonga Park Township at Violet and Bessa Courts, are also included as part of Clifford Park/Bend of Isles. A total of 185 vertebrate fauna, 97 vascular flora and 1 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Clifford Park/Bend of Isles Biosite represents a portion of Site 59 in Beardsell (1997; 2002), which was classified as State Zoological Significance and Regional Botanical Significance and partially overlaps with Sites 4, 7 and 10 in Bedggood *et al.* (1997), which were similarly classified. Using the Biosites criteria, Clifford Park/Bend of Isles is classified as National Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the Stane Brae block contains the extant Type localities of three invertebrates (an aquatic macroinvertebrate, a wasp and a butterfly) and possibly one vascular plant (Graceful Leek-orchid). This Biosite is also classified as State Significance under five sub-criteria, Regional Significance under four sub-criteria and Local Significance under four sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, National

Criteria 1, Ecological integrity and viability, State

Sub-Criteria 1.1.1., **L**, Yarra River
Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
Sub-Criteria 1.2.1.2., **S**, Barking Owl, end; Powerful Owl, vul; Whistling Kite
Sub-Criteria 1.2.5., **R**, Yarra River corridor
Sub-Criteria 1.2.6., **R**, Yarra River corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Regional

Sub-Criteria 2.1.1., **R**, Vert: 185; Vas: 97; Mfungi: 1; Invert: N/D; Bry: N/D
Sub-Criteria 2.3., **R**, Seven EVCs represented

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vert: Regent Honeyeater, End; Growling Grass Frog, Vul
Sub-Criteria 3.1.2., **S**, Vert: Nankeen Night Heron, lr; Brush-tailed Phascogale, vul, Lis; Spotted Quailthrush, lr; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Regent Honeyeater, cen, Lis; Growling Grass Frog, end, Lis; Barking Owl, end, Lis; Hooded Robin, lr, Lis; Pied Cormorant, lr; Common Dunnart, vul; Great Egret, vul, Lis; Southern Toadlet, vul; Speckled Warbler, vul, Lis; Tree Goanna, vul. Vas: Slender Sword-sedge, d; Slender Stylewort, r

Sub-Criteria 3.1.3., **S**, Regent Honeyeater, End, cen, Lis; Growling Grass Frog, Vul, end, Lis; Barking Owl, end, Lis

Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164). Escarpment Shrubland (EVC 895) questionable – See Sect. 6. And Valley Grassy Forest (EVC 47) in borderline condition.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, National

Sub-Criteria 5.2., **N**, Invert: Austratrichia neboissi (Trichoptera). Yarra River, Wonga Park. 1976; Perga nemoralis (Pergidae, Hymenoptera). Wonga Park, no date; Stigmodera militaris (Buprestidae, Coleoptera). Wonga Park, 1921 (Source: Museum of Victoria; Alan Yen pers. comm.). Vas: Prasophyllum pyriforme, Wonga Park, Doncaster (1931) (Source: National Herbarium of Victoria)

Stane Brae/Blue Tongue Bend, Biosite 3; National Significance (1 Sub-Criteria)

Description:

Stane Brae/Blue Tongue Bend (Biosite 3) comprises 442.47 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V), Creekline Herb-rich Woodland (E), Unclassified Core Habitat, Riparian Forest (LC), and small areas of Escarpment Shrubland (E) and Herb-rich Foothill Forest (LC). It is by far the largest Biosite in Manningham and occupies a significant portion of the Yarra River in Wonga Park from roughly the Watson Creek confluence via Blue Tongue Bend to the Jumping Creek confluence on Jumping Creek Road at the border with Warrandyte. To the south the Biosite is bounded by Jumping Creek Road and Hartley Road roughly represents its' eastern extremity. Although the Jumping Creek and Stane Brae blocks of WSP represent a significant proportion of Stane Brae/Blue Tongue Bend ajoining the Yarra River, the majority of the Biosite is freehold land. By far the largest of the private properties is 'Stane Brae', of which the bushland section is protected under a Trust For Nature Conservation Covenant. Dozens of additional freehold parcels are clustered along Jumping Creek Road, Stane Brae Court and Hartley Road including Yarra Brae farm at the end of Hartley Road. A total of 116 vertebrate fauna species, 295 vascular flora species and 333 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Stane Brae/Blue Tongue Bend Biosite represents a portion of Site 59 in Beardsell (1997; 2002), which was classified as State Zoological and Botanical Significance and significantly overlaps with Site 1 in Bedggood *et al.* (1997), which was classified as (High) Regional Botanical Significance and State Zoological Significance. The far south western portion of the Biosite at the Jumping Creek confluence partially overlaps with Site 2 in Bedggood *et al.* (1992), which was classified as Regional Botanical and Zoological Significance. Using the Biosites criteria, Clifford Park/Bend of Isles is classified as National Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the Jumping Creek block contains the extant Type localities of eleven macrofungi species (all fungi with gills) and one liverwort. This Biosite is also classified as State Significance under six sub-criteria, Regional Significance under five sub-criteria and Local Significance under five sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State

Max under current Classification, National

Criteria 1, Ecological integrity and viability, State

Sub-Criteria 1.1.1., **L**, Yarra River, Jumping Creek

Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat

Sub-Criteria 1.2.1.2., **S**, Powerful Owl, vul

Sub-Criteria 1.2.5., **R**, Yarra River corridor

Sub-Criteria 1.2.6., **R**, Yarra River corridor

Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, State

Sub-Criteria 2.1.1., **R**, Vert: 116; Vas: 295; Mfungi: 333; Invert: N/D; Bry: N/D
Sub-Criteria 2.2., **S**, Mfungi: Dermoloma sp. 2 (Stane Brae/100 acres), (MCC No. 343); Hygrocybe acrohastata, (MCC No. 359); Hygrocybe fuhreri, (MCC No. 362); Hygrocybe leucogloea, (MCC No. 364); Hygrocybe saltorivula, (MCC No. 366); Hygrocybe sp. 5 (JCR 1), (MCC No. 367); Hygrocybe sp. 6 (JCR 2), (MCC No. 368); Hygrocybe virginea, (MCC No. 369)
Sub-Criteria 2.3., **R**, Seven EVCs represented

Criteria 3, Rarity/Conservation status of assets, State
Sub-Criteria 3.1.1., **S**, Vas: Sharp Midge-orchid, K; Arching Flax-lily, K
Sub-Criteria 3.1.2., **S**, Vert: Nankeen Night Heron, lr; Spotted Quailthrush, lr; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Brushtailed Phascogale, vul, Lis. Vas: Sharp Midge-orchid, r; Fringed Helmet-orchid, r; Swamp Diuris, v, Lis; Slender Sword-sedge, d; Slender Stylewort, r; Cream Spider-orchid, e; Tall Club-sedge, k; Matted Water-starwort, k; Slender Tick-trefoil, k; Velvet Apple-berry, r; Fisch's Greenhood, r; Forest Bitter-cress, v; Arching Flax-lily, v
Sub-Criteria 3.1.3., **R**, Nankeen Night Heron, lr; Spotted Quailthrush, lr; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Brushtailed Phascogale, vul, Lis
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47). Escarpment Shrubland (EVC 895) questionable – See Sect. 6.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, National
Sub-Criteria 5.1.1.3., **S**, Core Site in WSP Draft Management Plan
Sub-Criteria 5.2., **N**, Mfungi: Hygrocybe austropratensis; Hygrocybe cheelii (identical to Holotype); Hygrocybe leucogloea; Hygrocybe psittacina var. perplexa; Hygrocybe virginea var. virginea; Hygrocybe virginea var. fuscescens; Hygrocybe acrohastata (Holotype); Hygrocybe fuhreri (Holotype); Hygrocybe saltorivula (Holotype); Hygrocybe sp. 5 (JCR 1) (undescribed); Hygrocybe sp. 6 (JCR 2) (undescribed) (Source: Young 2000). Bryo: Fossombronia truncata, Jumping Creek Reserve (1982) (Source: National Herbarium of Victoria)

Black Flat, Biosite 4; State Significance (4 Sub-Criteria)

Description:

Black Flat (Biosite 4) comprises 72.41 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V), Riparian Forest (LC), Creekline Herb-rich Woodland (E), and small areas of Unclassified Core Habitat, Escarpment Shrubland (E) and Herb-rich Foothill Forest (LC). It is located on the Yarra River entirely within Warrandyte from near the Jumping Creek confluence to the Parsons Gully confluence at The Island. The Biosite is primarily west of Tills Drive, north of the Ringwood to Warrandyte Road and west of Nelson Drive (running north from Jumping Creek Road). With the exception of the Black Flat block of WSP along the river and accessed by Tills Drive, this Biosite is predominantly on half a dozen freehold land parcels that span over a ridgeline from the Yarra River to Parsons Gully. A total of 68 vertebrate fauna species, 132 vascular flora species and 74 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Black Flat Biosite represents a portion of Site 58 in Beardsell (1997; 2002), which was classified as Regional Zoological and Botanical Significance and substantially overlaps with Site 2 in Bedggood *et al.* (1992), which was classified as Regional Botanical and Zoological Significance. Using the Biosites criteria, Black Flat is classified as State Significance under four sub-criteria (DNRE 2002b): Sub-Criteria 2.2. As nine endemic macrofungi species (fungi with gills) are found only at this site or a small group of sites within Victoria, but also interstate; Sub-Criteria 3.1.1. As known habitat for two nationally listed threatened taxa (Swift Parrot, End and Arching Flax-lily, K); Sub-Criteria 3.1.3. As high quality habitat for a State threatened listed species (Swift Parrot, End, end); Sub-Criteria 3.2.3. As contains three EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland; Valley Grassy Forest; and Escarpment Shrubland). This Biosite is also classified as Regional Significance under five sub-criteria and Local Significance under four sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
Criteria 1, Ecological integrity and viability, Regional

Sub-Criteria 1.1.1., **L**, Yarra River, Jumping Creek
Sub-Criteria 1.2.5., **R**, Yarra River corridor
Sub-Criteria 1.2.6., **R**, Yarra River corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, State

Sub-Criteria 2.2., **S**, Mfungi: Hygrocybe acrohastata, (MCC No. 359); Hygrocybe fuhreri, (MCC No. 362); Hygrocybe leucogloea, (MCC No. 364); Hygrocybe saltorivula, (MCC No. 366); Hygrocybe sp. 5 (JCR 1), (MCC No. 367); Hygrocybe sp. 6 (JCR 2), (MCC No. 368); Hygrocybe virginea, (MCC No. 369); Mycaena sp. 7 (red gill edge), (MCC No. 427)
Sub-Criteria 2.3., **R**, Seven EVCs represented

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vert: Swift Parrot, End. Vas: Arching Flax-lily, K
Sub-Criteria 3.1.2., **R**, Vert: Nankeen Night Heron, lr; Powerful Owl, vul, Lis; Swift Parrot, end, Lis; Brushtailed Phascogale, vul, Lis. Vas: Slender Sword-sedge, d; Tussock Sedge, k; Slender Stylewort, r; Matted Water-starwort, k; Slender Tick-trefoil, k; Arching Flax-lily, v
Sub-Criteria 3.1.3., **S**, Swift Parrot, End, end
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47). Escarpment Shrubland (EVC 895) questionable – See Sect. 6.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Regional

Sub-Criteria 5.1.1.3., **R**, Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PD: Yarra River at Warrandyte Bridge) Source: EPA 2000.

Haslams Track, Biosite 5; State Significance (2 Sub-Criteria)

Description:

Haslams Track (Biosite 5) comprises 89.92 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V), and small areas of Riparian Forest (LC), Creekline Herb-rich Woodland (E), and Herb-rich Foothill Forest (LC). It occupies the landscape from Parsons Gully on the Warrandyte to Ringwood Road over a ridgeline to Jumping Creek, south from Jumping Creek Road.The southern boundary is roughly parallel with Sulva Road and only extends east of Haslams Track in a couple of places. Two small discrete patches, between Hooper and Jumping Creek Roads and in Parsons Gully on the Warrandyte to Ringwood Road are also included as part of Haslams Track. The majority of this Biosite comprises the Haslams Track block of WSP (also known as 'the Common') with significant extensions onto free hold land throughout, especially in the northern half near Jumping Creek and Jumping Creek Road and in Parsons Gully south from the intersection with Johansons Road. A total of 47 vertebrate fauna species, 91 vascular flora species and 3 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Haslams Track Biosite represents a portion of Site 58 in Beardsell (1997; 2002), which was classified as State Zoological and Botanical Significance and slightly overlaps with Site 2 in Bedggood *et al.* (1997), which was classified as (High) Regional Botanical Significance and State Zoological Significance. A parcel of freehold land on Jumping Creek Road also partially overlaps with Site 18 in Bedggood *et al.* (1992), which was classified as Regional Botanical Significance. Using the Biosites criteria, Haslams Track is classified as State Significance under two sub-criteria (DNRE 2002b): Sub-Criteria 3.1.1. As known habitat for one nationally listed threatened taxon (Dandenong Range Cinnamon Wattle, R); Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under three sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State

Criteria 1, Ecological integrity and viability, Local

Sub-Criteria 1.1.1., **L**, Jumping Creek
Sub-Criteria 1.2.5., **L**, Jumping Creek corridor
Sub-Criteria 1.2.6., **L**, Jumping Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vas: Dandenong Range Cinnamon Wattle, R
Sub-Criteria 3.1.2., **R**, Vert: Brushtailed Phascogale, vul, Lis. Vas: Tussock Sedge, k; Sharp Midge-orchid, r; Velvet Apple-berry, r; Dandenong Range CinnamonWattle, r
Sub-Criteria 3.1.3., **R**, Brushtailed Phascogale, vul
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Regional

Sub-Criteria 5.1.1.3., **R**, Melbourne Water monitoring point for Jumping Creek. Physical data combined with biological data to derive the Index of Stream Condition

Anzac Road, Biosite 6; State Significance (1 Sub-Criteria)

Description:

Anzac Road (Biosite 6) comprises 45.87 ha of Valley Grassy Forest (V) and small areas of Herb-rich Foothill Forest (LC), Grassy Dry Forest (LC), Riparian Forest (LC) and Creekline Herb-rich Woodland (E). Located in the middle of the eastern section of Manningham on Jumping Creek, across the Wonga Park and Warrandyte South boundary, this Biosite straddles Anzac Road, spanning from Hillcrest Road along a ridgeline to the east across to Haslams Track in the west. The site extends no further south from about Sulva Road and not beyond the Hooper Road T junction in the north. With the exception of very small sections of road reserves, this site is entirely on about 20 parcels of freehold land. A total of 67 vertebrate fauna species and 27 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Anzac Road Biosite represents a portion of Site 2 in Bedggood *et al.* (1997), which was classified as (High) Regional Botanical Significance and State Zoological Significance. Using the Biosites criteria, Anzac Road is classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under one sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State

Criteria 1, Ecological integrity and viability, Local

Sub-Criteria 1.1.1., **L**, Jumping Creek
Sub-Criteria 1.2.5., **L**, Jumping Creek corridor
Sub-Criteria 1.2.6., **L**, Jumping Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State
Sub-Criteria 3.1.3., **R**, Royal Spoonbill, vul
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Freyne Street, Biosite 7; State Significance (4 Sub-Criteria)

Description:

Freyne Street (Biosite 7) comprises 109.79 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V), Herb-rich Foothill Forest (LC), Creekline Herb-rich Woodland (E) and Riparian Forest (LC). Located in the middle of the eastern section of Manningham mainly east from Jumping Creek (the Wonga Park and Warrandyte South boundary), this Biosite lies within the area roughly defined by Brysons, Hillcrest, Hooper and Yarra (northern section) Roads and Launders Avenue close to the Wonga Park township. With the exception of very small sections of road reserves and Wonga Park Reserve, this site is entirely on about a few dozen parcels of freehold land. A total of 109 vertebrate fauna species and 276 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Freyne Street Biosite represents a portion of Sites 2 and 8 in Bedggood *et al.* (1997), which were classified as (High) Regional Botanical Significance and State Zoological Significance. Using the Biosites criteria, Freyne Street is classified as State Significance under four sub-criteria (DNRE 2002b): Sub-Criteria 3.1.1. As known habitat for two nationally listed threatened taxa (Growling Grass Frog, Vul. Vas: Sharp Midge-orchid, K); Sub-Criteria 3.1.2. As known habitat for nine FFG listed or State threatened species (Vert: Bibron's Toadlet, end; Diamond Firetail, vul, Lis; Brushtailed Phascogale, vul, Lis; Nankeen Night Heron, lr; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Growling Grass Frog, end, Lis; Pied Cormorant, lr. Vas: Sharp Midge-orchid, r); Sub-Criteria 3.1.3. As high quality habitat for a State threatened species (Bibron's Toadlet, end); Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under one sub-criteria and Local Significance under seven sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State
Criteria 1, Ecological integrity and viability, Local
Sub-Criteria 1.1.1., **L**, Jumping Creek
Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
Sub-Criteria 1.2.5., **L**, Jumping Creek corridor
Sub-Criteria 1.2.6., **L**, Jumping Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Criteria 2, Richness and diversity, Regional
Sub-Criteria 2.1.1., **R**, Vert: 109; Vas: 276; Mfungi: N/D; Invert: N/D; Bry: N/D
Criteria 3, Rarity/Conservation status of assets, State
Sub-Criteria 3.1.1., **S**, Vert: Growling Grass Frog, Vul. Vas: Sharp Midge-orchid, K
Sub-Criteria 3.1.2., **S**, Vert: Bibron's Toadlet, end; Diamond Firetail, vul, Lis; Brushtailed Phascogale, vul, Lis; Nankeen Night Heron, lr; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Growling Grass Frog, end, Lis; Pied Cormorant, lr. Vas: Sharp Midge-orchid, r
Sub-Criteria 3.1.3., **S**, Bibron's Toadlet, end
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Gatters Road, Biosite 8; State Significance (1 Sub-Criteria)

Description:

Gatters Road (Biosite 8) comprises 49.24 ha of Valley Grassy Forest (V) with relatively minor areas of Creekline Herb-rich Woodland (E), Riparian Forest (LC) and Grassy Dry Forest (LC). Located on the southern margin of the eastern section of Manningham on Jumping Creek (north from the boundary of Wonga Park with Warrenwood and Croydon Hills), this Biosite roughly spans from Brysons Road (between the intersection with Hillcrest Road and Jumping Creek) east to Gatters Road with a couple of outliers in a minor gully south of the transmission lines. With the exception of a small Melbourne Water drainage reserve on Jumping Creek right on the municipal boundary and small sections of road reserve, this site is entirely on about a few dozen parcels of freehold land. A total of 26 vertebrate fauna species and 45 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Gatters Road Biosite represents a portion of Site 2 in Bedggood *et al.* (1997), which was classified as (High) Regional Botanical Significance and State Zoological Significance. Using the Biosites criteria, Gatters Road is classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Local Significance under two sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.1., **L**, Jumping Creek
  - Sub-Criteria 1.2.5., **L**, Jumping Creek corridor
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

Haven, Biosite 9; State Significant (1 Sub-Criteria)

Description:

Haven (Biosite 9) comprises 91.70 ha of Valley Grassy Forest (V), Grassy Dry Forest (LC) and Herb-rich Foothill Forest (LC), with a small patch of Creekline Herb-rich Woodland (E). Located on the far eastern margin of Manningham near the intersection of Holloway and Brushy Park Roads in Wonga Park, this Biosite extends along Valley Road, north to Pinewood Cresent and almost across to Yarra Road. With the exception of small sections of road reserve, this site is entirely on about a few dozen parcels of freehold land the most notable of which is the large area of bushland (~25 ha) owned by Melbourne Christian Fellowship extending north from the Haven Conference Centre. A total of 106 vertebrate fauna species and 188 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Haven Biosite represents a portion of Site 3 and 5 in Bedggood *et al.* (1997), which were classified as (High) Regional Botanical Significance and (potentially) State Zoological Significance. Using the Biosites criteria, Haven is classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under two sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State?
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Nil**
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.2., **R**, Vert: Great Egret, vul, Lis; Musk Duck, vul
  - Sub-Criteria 3.1.3., **R**, Great Egret, vul, Lis; Musk Duck, vul
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Pound Bend, Biosite 10; National Significance (1 Sub-Criteria)

Description:

Pound Bend (Biosite 10) comprises 82.17 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V) and Riparian Forest (LC), with small areas of Herb-rich Foothill Forest (LC) and Escarpment Shrubland (E). Located on the middle, northern margin of Manningham on almost entirely within Bound Bend on the Yarra River at Warrandyte, this Biosite comprises four sections: the largest area along Pound Bend Road, a small area of steep riverside vegetation north from Everade Drive, the river front vegetation through the Warrandyte Township and the riparian vegetation associated with the final section of Andersons Creek at its confluence with the Yarra River. With the exception of three parcels of freehold land within Pound Bend (including the Kew District Scout Association) and Stiggart Reserve on Yarra Street owned by Council, this site is almost entirely on public land. The largest of these is the Pound Bend block of WSP which is owned by the State and managed by Parks Victoria. A total of 92 vertebrate fauna species, 180 vascular flora and 4 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Pound Bend Biosite represents a portion of Site 58 in Beardsell (1997; 2002), which was classified as State Zoological and Regional Botanical Significance and significantly overlaps with Site 10 and 5a in Bedggood *et al.* (1992), which was classified as Regional Botanical and Zoological Significance. Using the Biosites criteria, Pound Bend is classified as National Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the Pound Bend block contains the extant Type locality of one moss species. This Biosite is also classified as State Significance under two sub-criteria, Regional Significance under four sub-criteria and Local Significance under four sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, National
Criteria 1, Ecological integrity and viability, Regional
- Sub-Criteria 1.1.1., **L**, Yarra River, Andersons Creek
- Sub-Criteria 1.2.5., **R**, Yarra River corridor
- Sub-Criteria 1.2.6., **R**, Yarra River corridor
- Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
- Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
- Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, State
- Sub-Criteria 3.1.1., **S**, Vert: Regent Honeyeater, End. Vas: Arching Flax-lily, K
- Sub-Criteria 3.1.2., **R**, Vert: Brushtailed Phascogale, vul, Lis; Powerful Owl, vul, Lis; Azure Kingfisher, lr; Regent Honeyeater, cen, Lis; Common Bentwing Bat, Cmp, Lis. Vas: Round-leaf Pomaderris, v; Slender Sword-sedge, d; Velvet Apple-berry, r; Slender Bitter-cress, k; Green-top Sedge, k; Slender Tick-trefoil, k; Arching Flax-lily, v; Austral Cranesbill, v; Slender Stylewort, r
- Sub-Criteria 3.1.3., **S**, Regent Honeyeater, End, cen, Lis
- Sub-Criteria 3.2.3., **R**, Grassy Dry Forest (EVC 22); Herb-rich Foothill Forest (EVC 23); Riparian Forest (EVC 18). Escarpment Shrubland (EVC 895) questionable – See Sect. 6. And Valley Grassy Forest (EVC 47) in borderline condition.

Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, National
- Sub-Criteria 5.2., **N**, Bryo: Tortula dakinii, Pound Bend (1951) (Source: National Herbarium of Victoria)

Fourth Hill, Biosite 11; National Significance (1 Sub-Criteria)

Description:

Fourth Hill (Biosite 11) comprises 259.01 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V) and Creekline Herb-rich Woodland (E) with small areas of Herb-rich Foothill Forest (LC) and is the second largest Biosite in Manningham. Located roughly in the middle of the eastern section of the municipality between Andersons Creek and the Warrandyte Township, this Biosite does not extend east of the Ringwood to Warrandyte Road nor west of Yarra Street and the Goldfields Plaza. Fourth Hill is broadly split into public and freehold land, respectively: the Fourth Hill block of WSP, owned by the State and managed by Parks Victoria and numerous private holdings along Web Street, Ringwood to Warrandyte Road and the eastern end of Gold Memorial Drive. The Andersons Creek frontage is managed as a partnership between Melbourne Water and Parks Victoria. A total of 127 vertebrate fauna species, 225 vascular flora and 3 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The Fourth Hill Biosite represents a portion of Site 58 in Beardsell (1997; 2002), which was classified as State Zoological and Regional Botanical Significance and also overlaps with Sites 5a, 5b, 17, 19, 20, 21 in Bedggood *et al.* (1992), which were classified as Regional Botanical and Zoological Significance. Using the Biosites criteria, Fourth Hill is classified as National Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the Fourth Hill block contains the extant Type localities of two invertebrate species. This Biosite is also classified as State Significance under four sub-criteria, Regional Significance under one sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, National

- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
  - Sub-Criteria 1.2.5., **L**, Andersons Creek corridor
  - Sub-Criteria 1.2.6., **L**, Andersons Creek corridor
  - Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would make a minimal improvement in the strategic value of site and/or such restoration is unrealistic (freehold land)
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.1., **S**, Vas: Wine-lipped Spider-orchid, K; Arching Flax-lily, K; Large White Spider-orchid, R; Bacchus Marsh Varnish Wattle, V
  - Sub-Criteria 3.1.2., **S**, Vert: Brushtailed Phascogale, vul, Lis; Common Bentwing Bat, Cmp, Lis; Nankeen Night Heron, lr; Southern Toadlet, vul; Speckled Warbler, vul, Lis; Powerful Owl, vul, Lis; Mountain Galaxias, ins, Lis. Vas: Slender Stylewort, r; Tussock Sedge, k; Sharp Midge-orchid, r; Arching Flax-lily, v; Bacchus Marsh Varnish Wattle, v; Southern Spider-orchid, k; Wine-lipped Spider-orchid, v; Large White Spider-orchid, r; Fertile Finger-orchid, k; Eastern Tiny Greenhood, k
  - Sub-Criteria 3.1.3., **R**, Brushtailed Phascogale, vul, Lis; Nankeen Night Heron, lr; Southern Toadlet, vul; Speckled Warbler, vul, Lis; Powerful Owl, vul, Lis
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, National**
  - Sub-Criteria 5.1.1.3., **S**, Core Site in WSP Draft Management Plan; Melbourne Water monitoring point for Andersons Creek. Physical data combined with biological data to derive the Index of Stream Condition
  - Sub-Criteria 5.2., **N**, Invert: Schaufussia mona (Coleoptera). Warrandyte, 1925; Cicadetta celis (Hemiptera). Warrandyte, 1961 (Source: Museum of Victoria; Alan Yen pers. comm.)

Grandview Road, Biosite 12; State Significance (1 Sub-Criteria)

Description:

Grandview Road (Biosite 12) comprises 132.39 ha Grassy Dry Forest (LC), Valley Grassy Forest (V) and Creekline Herb-rich Woodland (E). Located roughly in the middle of the eastern section of the municipality between Andersons Creek (Gold Memorial Drive) and the Minter Court drainage and transmission easement in Warrandyte, this Biosite does not extend east of the Ringwood to Warrandyte Road or west of Harris Gully Road. Grandview Road largely consists of private land with only a few scattered public reserves such as the Andersons Creek frontage at the eastern margin owned by the State and managed by Melbourne Water. Council owns a small 6.1 ha reserve on Husseys Lane, adjacent to Andersons Creek that is largely used by local equestrian clubs. A total of 74 vertebrate fauna species and 139 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Grandview Road Biosite incorporates all of Site 5b in Bedggood *et al.* (1992), which was classified as Regional Zoological and Botanical Significance. Using the Biosites criteria, Grandview Road is classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under five sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State

- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
  - Sub-Criteria 1.2.6., **L**, Andersons Creek corridor and Warrandyte/Park Orchards Ridge
  - Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.2., **R**, Vert: Powerful Owl, vul, Lis; Pied Cormorant, lr; Largefooted Myotis, lr; Great Egret, vul, Lis
  - Sub-Criteria 3.1.3., **R**, Powerful Owl, vul, Lis; Pied Cormorant, lr; Largefooted Myotis, lr; Great Egret, vul, Lis
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

Minter Court/Stintons Reserve, Biosite 13; State Significance (1 Sub-Criteria)

Description:

Minter Court/Stintons Reserve (Biosite 13) comprises 138.39 ha of Grassy Dry Forest (LC), Valley Heathy Forest (E), Valley Grassy Forest (V) and Creekline Herb-rich Woodland (E). Located roughly in the middle of the municipality between the Minter Court drainage and transmission easement and Stintons Road in Warrandyte (plus a small part of Park Orchards), this Biosite does not extend east of Andersons Creek, or west of Stintons Reserve. With the exception of the drainage easements along the northern and western margins and scattered roadsides, Minter Court/Stintons Reserve entirely comprises private land. Only the Council owned Stintons Reserve is managed in part for biodiversity conservation with a significant patch of vegetation in it's north-east corner. A total of 72 vertebrate fauna species and 137 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Grandview Road Biosite incorporates all of Sites 4, 9, 14 and 23 in Bedggood *et al.* (1992), which were classified as Regional Zoological and Botanical Significance. Using the Biosites criteria, Minter

Court/Stintons Reserve is classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains three EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland, Valley Grassy Forest and Valley Heathy Forest). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under five sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
  - Sub-Criteria 1.2.6., **L**, Andersons Creek corridor and Warrandyte/Park Orchards Ridge
  - Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.2., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.3., **L**, Mix of relatively low modification and degraded habitat. Restoration of habitat in cleared or degraded areas would make a minimal improvement in the strategic value of site and/or such restoration is unrealistic (freehold land)
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.2., **R**, Vert: Powerful Owl, vul, Lis; Azure Kingfisher, lr
  - Sub-Criteria 3.1.3., **R**, Powerful Owl, vul, Lis; Azure Kingfisher, lr
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47); Valley Heathy Forest (EVC 127)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

One Hundred Acres, Biosite 14; State Significance (3 Sub-Criteria)

Description:

One Hundred Acres (Biosite 14) comprises 45.59 ha Grassy Dry Forest (LC), Valley Grassy Forest (V) and Creekline Herb-rich Woodland (E) with two small areas of Unclassified Core Habitat in the south-east corner. Located roughly in the middle of the municipality in Park Orchards on Andersons Creek, this Biosite is predominately the Council owned One Hundred Acres Reserve and is bounded by Berringa, Vincent, Arundel, Knees, Falconer and Ringwood to Warrandyte Roads. With the exception of a small creek frontage and the Ringwood to Warradyte road reserve, Minter Court/Stintons Reserve entirely comprises private land, although the One Hundred Acres Reserve is managed primarily for biodiversity conservation. A total of 132 vertebrate fauna species, 147 vascular flora species and 39 macrofungi species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 9.1 respectively).

The One Hundred Acres Biosite incorporates all of Site 5 in Bedggood *et al.* (1992), which was classified as Regional Zoological and Botanical Significance. Using the Biosites criteria, One Hundred Acres is classified as State Significance under three sub-criteria (DNRE 2002b): Sub-Criteria 3.1.2. As known habitat for six FFG listed or State threatened species (Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Spotted Quailthrush, lr; Hardhead, vul; Hooded Robin, lr, Lis); Sub-Criteria 3.1.3. As high quality habitat for a State threatened listed species (Swift Parrot, End, end); and Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Nil**
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.2., **S**, Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Spotted Quailthrush, lr; Hardhead, vul; Hooded Robin, lr, Lis
  - Sub-Criteria 3.1.3., **S**, Swift Parrot, End, end, Lis

Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Local

Sub-Criteria 5.1.1.4., **L**, Bird Surveys – Murray Bourchier

Naughton Avenue, Biosite 15; State Significance (3 Sub-criteria)

Description:

Naughton Avenue (Biosite 15) comprises 42.21 ha of Grassy Dry Forest (LC) and Valley Grassy Forest (V) with small areas of Escarpment Shrubland (E) and Riparian Forest (LC). Located roughly in the middle of the municipality on the northern boundary in Warradyte, this Biosite is immediately west of Pound Bend and consists of two sections: one on the Yarra River straddling Naughton Avenue and the other on Alexander Road, north of Warrandyte High School. The former block is part WSP owned by the State and managed by Parks Victoria, and the balance numerous parcels of freehold land, and the later section is entirely freehold with only a small Council reserve (0.6 ha) located in a gully on Alexander Road. A total of 109 vertebrate fauna species and 57 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Naughton Avenue Biosite represents part of Site 1 in Bedggood *et al.* (1992), which was classified as State Zoological Significance and Regional Botanical Significance. It is also part of Site 57 in Beardsell (1997; 2002), which was classified as State Zoological and Regional Botanical Significance. Using the Biosites criteria, Naughton Avenue is classified as State Significance under four sub-criteria (DNRE 2002b): Sub-Criteria 3.1.1. As known habitat for two nationally listed threatened species (Macquarie Perch, Cen and Swift Parrot, End); Sub-Criteria 3.1.2. As known habitat for six FFG listed or State threatened species (Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Latham's Snipe, lr; Grey Goshawk, vul; Macquarie Perch, end, Lis); Sub-Criteria 3.1.3. As high quality habitat for a State threatened listed species (Swift Parrot, End, end); and Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Escarpment Shrubland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under three sub-criteria and Local Significance under four sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State

Max under current Classification, State

Criteria 1, Ecological integrity and viability, Regional

Sub-Criteria 1.1.1., **L**, Yarra River

Sub-Criteria 1.2.5., **R**, Yarra River corridor

Sub-Criteria 1.2.6., **R**, Yarra River corridor

Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vert: Macquarie Perch, Cen; Swift Parrot, End

Sub-Criteria 3.1.2., **R**, Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Latham's Snipe, lr; Grey Goshawk, vul; Macquarie Perch, end, Lis

Sub-Criteria 3.1.3., **S**, Swift Parrot, End, end, Lis

Sub-Criteria 3.2.3., **S**, Valley Grassy Forest (EVC 47). Escarpment Shrubland (EVC 895) questionable – See Sect. 6.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Nil

Mullum Confluence, Biosite 16; State Significance (8 Sub-Criteria)

Description:

Mullum Confluence (Biosite 16) comprises 85.34 ha of Valley Grassy Forest (V), Riparian Forest (LC) and Grassy Dry Forest (LC) with small areas of Creekline Herb-rich Woodland (E). Located roughly in the middle of the municipality on the northern boundary at the confluence of the Mullum Mullum Creek with the Yarra River primarily in Templestowe, this Biosite is located north of the Council Depot and the Templestowe Electricity Terminal Station and roughly bounded by Target Road, the Yarra River and Monckton Road. The Domain subdivision, accessed off The Parkway, is surrounded by this Biosite. Mullum Confluence is primarily public land owned by the State and managed by Parks Victoria, although there are significant areas of private land owned by Council (Tikalara Park and The Domain Wetlands), Powernet Pty Ltd and the Roselea Estate off Kearney Lane. A total of 124 vertebrate fauna species and 152 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Mullum Confluence Biosite represents part of Sites 1 and 6a in Bedggood *et al.* (1992), which were classified as State Zoological Significance and Regional Botanical Significance. It is also part of Site 57 in Beardsell (1997; 2002), which was classified as State Zoological Significance. Using the Biosites criteria, Mullum Confluence is classified as State Significance under 8 sub-criteria (DNRE 2002b): Sub-Criteria 1.2.1.2. As known breeding site for Black Falcon, Barking Owl and Grey Goshawk, all Victorian threatened territorial species with a large home range; Sub-Criteria 1.3.2. As cleared and degraded habitat which may with suitable habitat reconstruction or rehabilitation work form an important additional area of habitat; Sub-Criteria 1.3.3. As cleared and degraded habitat which may with suitable habitat reconstruction or rehabilitation work form a strategically important corridor; Sub-Criteria 3.1.1. As known habitat for four nationally listed threatened species (Vert: Regent Honeyeater, End; Swift Parrot, End; Australian Grayling, Vul; Growling Grass Frog, Vul); Sub-Criteria 3.1.2. As known habitat for 18 FFG listed or State threatened species (Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Latham's Snipe, lr; Azure Kingfisher, lr; Growling Grass Frog, end, Lis; Great Egret, vul, Lis; Speckled Warbler, vul, Lis; Regent Honeyeater, cen, Lis; Musk Duck, vul; Barking Owl, end, Lis; Australasian Bittern, end, Lis; Bluebilled Duck, end, Lis; Australian Grayling, vul, Lis; Baillon's Crake, vul, Lis; Black Falcon, vul; Lewin's Rail, vul, Lis. Vas: Slender Sword-sedge, d); Sub-Criteria 3.1.3. As high quality habitat for three State threatened listed species (Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis; Growling Grass Frog, Vul, end, Lis); Sub-Criteria 3.2.3. As contains one EVC that has a High or Very High Conservation Status (Valley Grassy Forest); and Sub-Criteria 5.1.1.4. As a site of long-term research on ecology and natural history (Australian Platypus Conservancy monitoring point). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under two sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, State**
  - Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek
  - Sub-Criteria 1.2.1.2., **S**, Black Falcon, vul; Barking Owl, end; Grey Goshawk, vul;
  - Sub-Criteria 1.2.5., **R**, Yarra River corridor
  - Sub-Criteria 1.2.6., **R**, Yarra River corridor
  - Sub-Criteria 1.3.1., **L,** Predominately cleared
  - Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland
  - Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.1., **S**, Vert: Regent Honeyeater, End; Swift Parrot, End; Australian Grayling, Vul; Growling Grass Frog, Vul
  - Sub-Criteria 3.1.2., **S**, Vert: Powerful Owl, vul, Lis; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Latham's Snipe, lr; Azure Kingfisher, lr; Growling Grass Frog, end, Lis; Great Egret, vul, Lis; Speckled Warbler, vul, Lis; Regent Honeyeater, cen, Lis; Musk Duck, vul; Barking Owl, end, Lis; Australasian Bittern, end, Lis; Bluebilled Duck, end, Lis; Australian

Grayling, vul, Lis; Baillon's Crake, vul, Lis; Black Falcon, vul; Lewin's Rail, vul, Lis. Vas: Slender Sword-sedge, d

Sub-Criteria 3.1.3., **S**, Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis; Growling Grass Frog, Vul, end, Lis

Sub-Criteria 3.2.3., **S**, Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, State

Sub-Criteria 5.1.1.4., **S**, Australian Platypus Conservancy monitoring point (Williams 2004)

Currawong Reserve, Biosite 17; State Significance (5 Sub-criteria)

Description:

Currawong Reserve (Biosite 17) comprises 99.47 ha of Riparian Forest (LC), Creekline Herb-rich Woodland (E), Valley Grassy Forest (V) and Grassy Dry Forest (LC) and is located on the Mullum Mullum Creek close to the centre of Manningham. It straddles the boundary of East Doncaster and Warrandyte and runs from Reynolds Road (near the intersection with Springvale Road) through to Warrandyte Road at the Deep Creek Reseve. This Biosite is dominated by a series of Council owned reserves including Currawong Bush Park (largest at ~60 ha) and the Mullum Mullum Stage 1 Linear Reserve, with areas of subdivided (and partly developed) freehold land to the east of Currawong Bush Park at the end of Amersham Drive, Limassol Court and Flannery Court. A total of 84 vertebrate fauna, 238 vascular flora and 42 invertebrate fauna (indigenous) species have been recorded for this Biosite (For complete lists see Appendices 7.2, 6.1 and 10.1 respectively).

The boundaries of Currawong Reserve roughly coincide with those for Site 6b and 13 in Bedggood *et al.* (1992), which were classified as Regional Zoological and Botanical Significance. Under this classification Currawong Reserve has been effectively elevated to State Significance under 5 sub-criteria (DNRE 2002b): Sub-criteria 3.1.1. As known habitat for one nationally listed threatened species (Vert: Growling Grass Frog, Vul); Sub-criteria 3.1.2. As known habitat for 3 FFG listed or State threatened species (Vert: Growling Grass Frog, end, Lis; Great Egret, vul, Lis; Southern Toadlet, vul); Sub-criteria 3.1.3. As high quality habitat for a State threatened listed species (Growling Grass Frog, Vul, end, Lis); Sub-criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Valley Grassy Forest and Creekline Herb-rich Woodland); and Sub-criteria 5.1.1.4. As a site of long-term research on ecology and natural history (Australian Platypus Conservancy monitoring point). This Biosite is also classified as Regional Significance under one sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna): Regional

Max under current Classification: State

Criteria 1, Ecological integrity and viability: Local

Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek

Sub-Criteria 1.2.5., **L**, Mullum Mullum Creek corridor

Sub-Criteria 1.2.6., **L**, Mullum Mullum Creek corridor

Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity: Nil

Criteria 3, Rarity/Conservation status of assets: State

Sub-Criteria 3.1.1., **S,** Vert: Growling Grass Frog, Vul

Sub-Criteria 3.1.2., **S,** Vert: Growling Grass Frog, end, Lis; Great Egret, vul, Lis; Southern Toadlet, vul

Sub-Criteria 3.1.3., **S,** Growling Grass Frog, Vul, end, Lis

Sub-Criteria 3.2.3., **S,** Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type: Nil

Criteria 5, Scientific and educational value: State

Sub-Criteria 5.1.1.4., **S**, Australian Platypus Conservancy monitoring point (Williams 2004). MCC monitoring?

Sub-Criteria 5.1.1.3., **R**, Melbourne Water monitoring point for Jumping Creek. Physical data combined with biological data to derive the Index of Stream Condition. Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PW: Mullum Mullum Creek at Warrandyte Road Bridge) Source: EPA 2000.

Buck Reserve/Donvale Christian School, Biosite 18; State (1 Sub-Criteria)

Description:

Buck Reserve/Donvale Christian School (Biosite 18) comprises 69.14 ha of Valley Grassy Forest (V), Riparian Forest (LC) and Grassy Dry Forest (LC) with small areas of Creekline Herb-rich Woodland (E). This site is located roughly in the middle of the municipality running east from the Mullum Mullum Creek between Reynolds and Tindals Roads in Donvale. There are two small discrete patches east of the intersection of Harris Gully and Tindals Roads in Warrandyte, and a Council reserve at the end of Twyford Close in East Doncaster. With the exception of a small section of frontage along the Mullum Mullum Creek in Bucks Reserve (owned by the State and managed by Melbourne Water), this Biosite entirely consists of private land owned predominantly by Council (Bucks Reserve, Red Box Hill and the various sections of the Mullum Mullum Stage 2 Linear Reserve) and individuals (the Pambara Court subdivision). The Red Box Hill section was formerly part of the Donvale Christian School. A total of 84 vertebrate fauna species and 283 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Buck Reserve/Donvale Christian School Biosite incorporates all of Site 6c in Bedggood *et al.* (1992), which is classified as Regional Zoological and Botanical Significance. Using the Biosites criteria, Buck Reserve/Donvale Christian School has been effectively elevated to State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland and Valley Grassy Forest). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State

Criteria 1, Ecological integrity and viability, Local

Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek
Sub-Criteria 1.2.5., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.2.6., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.2., **R**, Vert: Great Egret, vul, Lis; Hardhead, vul. Vas: Green Scentbark, r
Sub-Criteria 3.1.3., **R**, Great Egret, vul, Lis; Hardhead, vul
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Nil

McIntrye Road, Biosite 19; State Significance (3 Sub-Criteria)

Description:

McIntyre Road (Biosite 19) comprises 59.14 ha of Valley Grassy Forest (V), Grassy Dry Forest (LC) and Valley Heathy Forest (E) with small areas of Unclassified Core Habitat, Creekline Herb-rich Woodland (E)

and Riparian Forest (LC). Located just below the middle of the municipality on the Mullum Mullum Creek roughly between Tindals Road and Park Roads straddling the boundary between Park Orchards and Donvale, this site doesn't extend further east of the transmission lines that parallel the orientation of the creek. There are several discrete sections west of the creek including: a small area of disclimax grassland in a Council reserve at the end of One Tree Hill, bushland spanning from Flora Road to McGowans Road, a large linear remnant along Park Road that extends from the Whitefriars Carmelite Monastery at the intersection of Heads Road almost to Conos Court and two small patches adjoining the creek north of Conos Court. Apart from small sections of road reserve and sections of frontage owned by the State and managed by Melbourne Water, this Biosite entirely consists of private land including a number of Council owned reserves (including One Tree Hill Reserve, the parcel on the intersection of Conos Court and Park Road and a recent strip of bushland east of the creek arising from the Nengerman Court subdivision). The average size of the private land parcels (supporting remnant vegetation) is ~0.5 ha west of the creek and ~2.0 ha to the east. A total of 96 vertebrate fauna and 189 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The McIntyre Road Biosite incorporates all of Site 6d in Bedggood *et al.* (1992), which was classified as Regional Zoological and Botanical Significance. Under this classification McIntyre Road has been effectively elevated to State Significance under 4 sub-criteria (DNRE 2002b): Sub-criteria 3.1.1. As known habitat for one Nationally listed threatened species (Vert: Growling Grass Frog, Vul); Sub-criteria 3.1.2. As known habitat for 10 FFG listed or State threatened species (Vert: Powerful Owl, vul, Lis; Greyheaded Flyingfox, vul; Southern Toadlet, vul; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Regent Honeyeater, cen, Lis; Barking Owl, end, Lis; Common Bentwing Bat, cmp, Lis. Vas: Green-top Sedge, k; Green Scentbark, r); Sub-criteria 3.1.3. As high quality habitat for two State threatened listed species (Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis); and Sub-criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Valley Grassy Forest and Creekline Herb-rich Woodland). This Biosite is also classified as Regional Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State

- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek
  - Sub-Criteria 1.2.5., **L**, Mullum Mullum Creek corridor
  - Sub-Criteria 1.2.6., **L**, Mullum Mullum Creek corridor
  - Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.2., **S**, Vert: Powerful Owl, vul, Lis; Greyheaded Flyingfox, vul; Southern Toadlet, vul; Nankeen Night Heron, lr; Swift Parrot, end, Lis; Regent Honeyeater, cen, Lis; Barking Owl, end, Lis; Common Bentwing Bat, cmp, Lis. Vas: Green-top Sedge, k; Green Scentbark, r
  - Sub-Criteria 3.1.3., **S,** Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis
  - Sub-Criteria 3.2.3., **S,** Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

Rainbow Valley Road, Biosite 20; State Significance (1 Sub-Criteria)

Description:

Rainbow Valley Road (Biosite 20) comprises 123.28 ha of Grassy Dry Forest (LC) and Valley Grassy Forest (V) with small areas of Unclassified Core Habitat and Creekline Herb-rich Woodland (E). Located below the middle of the municipality just east of the Mullum Mullum Creek roughly between Tindals Road and Park

Roads in Park Orchards and Donvale, this site extends east of the transmission lines that parallel the orientation of the creek out to Stintons Reserve and Stintons Road. The most easterly point is on Orchid Court opposite Domeney Reserve. With the exception of the north-south drainage easement (owned by the State and managed by Melbourne Water) and small sections of road reserve, this Biosite entirely consists of private land of varying size. The only Council owned reserves include the Alan Morton Reserve on Park Road and a small parcel of bushland on Orchid Court. A total of 60 vertebrate fauna species and 154 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Rainbow Valley Road Biosite incorporates all of Sites 15 and 24 in Bedggood *et al.* (1992), which were classified as Regional Botanical Significance. Using the Biosites criteria, Rainbow Valley Road has been effectively elevated to State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains one EVC that has a High or Very High Conservation Status (Creekline Herb-rich Woodland). This Biosite is also classified as Local Significance under five sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.1.2., **L**, >100 ha of contiguous habitat
  - Sub-Criteria 1.2.6., **L**, Donvale/Park Orchards/Warrandyte Ridge
  - Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
  - Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

Oban Road, Biosite 21; State Significance (2 Sub-Criteria)

Description:

Oban Road (Biosite 21) comprises 89.31 ha of Grassy Dry Forest (LC), Valley Grassy Forest (V) and Creekline Herb-rich Woodland (E) with small areas of Riparian Forest (LC). Located at the middle of the southern boundary of Manningham running east from the Mullum Mullum Creek roughly from the Whitefriars Carmelite Monastery and Park Road across to the Glenvale Road municipal boundary, this site is bisected by the transmission line that parallels the orientation of the creek and the Oban Road gully-line. There are two small discrete patches created by the electricity easement on the hilltop south of Oban Road, at the end of Harris Road in Donvale. With the exception of the north-south drainage easement (owned by the State and managed by Melbourne Water) and small sections of road reserve, this Biosite entirely consists of private land of generally small size. A total of 49 vertebrate fauna species and 109 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Rainbow Valley Road Biosite incorporates all of Sites 6e, 11 and 12 in Bedggood *et al.* (1992), which were classified as Regional Zoological and Botanical Significance. Using the Biosites criteria, Rainbow Valley Road has been effectively elevated to State Significance under two sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains one EVC that has a High or Very High Conservation Status (Creekline Herb-rich Woodland); and Sub-criteria 5.1.1.4. As a site of long-term research on ecology and natural history (Australian Platypus Conservancy monitoring point). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional

Max under current Classification, State

Criteria 1, Ecological integrity and viability, Local

Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek
Sub-Criteria 1.2.5., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.2.6., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.2., **R**, Vert: Great Egret, vul, Lis. Vas: Green Scentbark, r
Sub-Criteria 3.1.3., **R**, Great Egret, vul, Lis
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164)

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, State

Sub-Criteria 5.1.1.4., **S**, Australian Platypus Conservancy monitoring point (Williams 2004)

Hillcrest Reserve/Chaim Court, Biosite 22; State Significance (6 Sub-Criteria)

Description:

Hillcrest Reserve/Chaim Court (Biosite 22) comprises 91.55 ha of Valley Heathy Woodland (E), Riparian Forest (LC) and Valley Grassy Forest (V) with a small area of Creekline Herb-rich Woodland (E) and Swampy Riparian Complex (E). Located at the middle of the southern boundary of Manningham on the Mullum Mullum Creek in Donvale, this Biosite extends roughly from the Heads Road Bridge, via Hillcrest Reserve to the Deep Creek Road Bridge and Glenvale Road. It extends west almost to Park Road where the Eastern Freeway will be extended into a tunnel designed to minimise disturbance to the Mullum Mullum Creek corridor. Much of the land directly above the proposed tunnel route has been been purchased by VicRoads in recent years and will be managed for conservation. The balance consists of either public land owned by the State and managed by Parks Victoria or Melbourne Water (drainage easement) or private land including a Council reserve. A large area of bushland adjoining the tunnel easement (especially off Craig Road) and comprising numerous generally small parcels is also privately owned. A total of 132 vertebrate fauna and 254 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The boundaries of Hillcrest Reserve/Chaim Court roughly coincide with those for Site 63 and 22 in Bedggood *et al.* (1992), which were classified as Regional Zoological and Botanical Significance. Under this classification Hillcrest Reserve/Chaim Court has been effectively elevated to State Significance under 6 sub-criteria (DNRE 2002b): Sub-criteria 1.2.1.2. As known breeding site for Square-tailed Kite, a Victorian threatened territorial species with a large home range; Sub-criteria 3.1.1. As known habitat for one nationally listed threatened species (Vas: Sharp Midge-orchid, K); Sub-criteria 3.1.2. As known habitat for 8 FFG listed or State threatened species (Vert: Great Egret, vul, Lis; Southern Toadlet, vul; Nankeen Night Heron, lr; Bibron's Toadlet, end; Squaretailed Kite, vul, Lis; Powerful Owl, vul, Lis. Vas: Green Scentbark, r; Sharp Midge-orchid, r); Sub-criteria 3.1.3. As high quality habitat for one State threatened listed species (Bibron's Toadlet, end); Sub-criteria 3.2.3. As contains 5 EVCs that have a High or Very High Conservation Status (Creekline Herb-rich Woodland, Riparian Forest, Valley Grassy Forest, Valley Heath Forest and Swampy Riparian Complex); and Sub-criteria 5.1.1.4. As a site of long-term research on ecology and natural history (Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment"). This Biosite is also classified as Regional Significance under one sub-criteria and Local Significance under six sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State

Criteria 1, Ecological integrity and viability, State

Sub-Criteria 1.1.1., **L**, Mullum Mullum Creek

Sub-Criteria 1.2.1.2., **S**, Square-tailed Kite, vul
Sub-Criteria 1.2.5., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.2.6., **L**, Mullum Mullum Creek corridor
Sub-Criteria 1.3.1., **L**, Strategic restoration of habitat would only be of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.2., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)
Sub-Criteria 1.3.3., **L**, Mix of relatively degraded habitat. Restoration of habitat in cleared or degraded areas would result in a minimal increase in habitat area of local importance and/or such restoration is unrealistic (freehold land)

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vas: Sharp Midge-orchid, K
Sub-Criteria 3.1.2., **S**, Vert: Great Egret, vul, Lis; Southern Toadlet, vul; Nankeen Night Heron, lr; Bibron's Toadlet, end; Squaretailed Kite, vul, Lis; Powerful Owl, vul, Lis. Vas: Green Scentbark, r; Sharp Midge-orchid, r
Sub-Criteria 3.1.3., **S**, Bibron's Toadlet, end
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Riparian Forest (EVC 18); Valley Grassy Forest (EVC 47); Valley Heath Forest (EVC 124). Swampy Riparian Complex (EVC 126) classification uncertain – see Sect. 6.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, State

Sub-Criteria 5.1.1.3., **R**, Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PV: Mullum Mullum Creek at Quarry Road Bridge) Source: EPA 2000. Vicroads monitoring??
Sub-Criteria 5.1.1.4., **S**, Australian Platypus Conservancy monitoring point (Williams 2004).

Longridge Farm, Biosites 23; State Significance (2 Sub-Criteria)

Description:

Longridge Farm (Biosite 23) comprises 22.60 ha Valley Grassy Forest (V), Grassy Dry Forest (LC) and Riparian Forest (LC) and is one of the smallest Biosites in Manningham. Located at the middle of the northern boundary of Manningham in the Yarra River bend west of Pound Bend in Warrandyte, it is accessed from Alexander Road. Although there are two discrete sections, one either side of the bend, the entire Biosite is public land owned by the State and managed by Parks Victoria.

The Longridge Farm Biosite incorporates part of Site 1 in Bedggood *et al.* (1992), which was classified as State Zoological and Regional Botanical Significance. It is also part of Site 57 in Beardsell (1997; 2002), which was classified as State Zoological Significance. Using the Biosites criteria, Longridge Farm has been classified as State Significance under two sub-criteria (DNRE 2002b): Sub-Criteria 1.3.2. As cleared and degraded habitat which may with suitable habitat reconstruction or rehabilitation work form an important additional area of habitat; and Sub-Criteria 1.3.3. As cleared and degraded habitat which may with suitable habitat reconstruction or rehabilitation work form a strategically important corridor. This Biosite is also classified as Regional Significance under three sub-criteria and Local Significance under two sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State

Max under current Classification, State

Criteria 1, Ecological integrity and viability, State

Sub-Criteria 1.1.1., **L** , Yarra River
Sub-Criteria 1.2.5., **R**, Yarra River corridor
Sub-Criteria 1.2.6., **R**, Yarra River corridor
Sub-Criteria 1.3.1., **L**, Predominately cleared
Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland
Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland

Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, Regional
Sub-Criteria 3.2.3., **R**, Riparian Forest (EVC 18); Valley Grassy Forest (EVC 47)
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Tindals Hill, Biosites 24; State Significance (1 Sub-Criteria)

Description:

Tindals Hill (Biosite 24) comprises 9.98 ha of Grassy Dry Forest (LC) and is one of the smallest Biosites in Manningham. This site is located close to the middle of the municipality on a ridgeline in between the Mullum Mullum and Andersons Creeks right on the intersection of Warrandyte and Tindals Roads in Warrandyte. It is split into two discrete sections: the largest part centred around the Wildflower Reserve and the other to the south-east of the intersection of Wildflower Court and Timbertop Ridge. The core of the first section is comprised partly of public land owned by the State and partly private land owned by Council. The Diane Court reserve, immediately to the north over Warrandyte Road, is owned by VicRoads along with the road reserve between Warrandyte and Melbourne Hill Roads, running down hill towards Goldfields Plaza. All these areas are managed by Council as part of the greater Tindals Hill Wildflower conservation reserve. One small area of degraded bushland runs off to the west on private land. A total of 18 vertebrate fauna species and 154 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Tindals Hill Biosite incorporates all of Sites 7 and 8 in Bedggood *et al.* (1992) which were classified as Regional Zoological and Local Botanical Significance. Using the Biosites criteria Tindals Hill has been effectively elevated to State Significance under one sub-criteria (DNRE 2002b): Sub-criteria 3.1.1. As known habitat for one Nationally listed threatened species (Vas: Sharp Midge-orchid, K). This Biosite is also classified as Regional Significance under one sub-criteria and Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
Criteria 1, Ecological integrity and viability, Nil
Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, State
Sub-Criteria 3.1.1., **S**, Vas: Sharp Midge-orchid, K
Sub-Criteria 3.2.3., **R**, Grassy Dry Forest (EVC 22)
Criteria 4, Representativeness of type, Nil,
Criteria 5, Scientific and educational value, Local
Sub-Criteria 5.1.1.4., **L**, Vegetation monitoring management comparisons at Tindals Wildflower Reserve undertaken by Jane Pammer, Rosemary Buxton and Sharon Mason

Kenilworth Avenue, Biosite 25; Regional Significance (1 Sub-Criteria)

Description:

Kenilworth Avenue (Biosite 25) comprises 38.08 ha of Grassy Dry Forest (LC) and Valley Grassy Forest (V) with small areas of Creekline Herb-rich Woodland (E) and Herb-rich Foothill Forest (LC). It is located in the far east of the municipality on a ridgeline in between Jumping and Brushy Creeks right on the intersection of Brysons and Homestead Roads, and Yarra Road in Wonga Park. The southern margin is defined by St Johns Road. The Biosite is split into two discrete sections: the largest part centred around Kenilworth Avenue and the other to the south of St Johns Road. With the exception of various sections of road reserve, this Biosite entirely comprises small parcels of private land associated with the Kenilworth subdivision.

The Kenilworth Avenue Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Kenilworth Avenue has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains 3 EVCs that have a Medium Conservation Status (Grassy Dry Forest, Valley Grassy Forest and Creekline Herb-rich Woodland). This Biosite is also classified as Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil
Max under current Classification, Regional
Criteria 1, Ecological integrity and viability, Local
Sub-Criteria 1.2.6., **L**, Wonga Park Ridge
Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, Regional
Sub-Criteria 3.2.3., **R**, Grassy Dry Forest (EVC 22); Valley Grassy Forest (EVC 47); Creekline Herb-rich Woodland (EVC 164) very small area.
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

The Vines Hill, Biosites 26; State Significance (1 Sub-Criteria)

Description:

The Vines Hill (Biosite 26) comprises 46.31 ha Valley Grassy Forest (V) and Grassy Dry Forest (LC) with small areas of Creekline Herb-rich Woodland (E). It is located on the southern margin of the municpalitiy's east on a ridgeline in between Jumping and Andersons Creeks between Croydon and Brysons Roads in Warrandyte South, south of Sulva Road. The southern margin is defined by the municipal boundary. The Biosite is split into four discrete sections: the largest on Anzac Road parallel to a gully that flows north into Jumping Creek, another off Brumbys Road, a third on the Yarra Valley Hills Winery, accessed from Delanys Road and the smallest patch immediately east of the winery dam. With the exception of various sections of road reserve, this Biosite entirely comprises private land. A total of 43 vascular flora species have been recorded for this Biosite (For complete lists see Appendice 6.1).

The Vines Hill Biosite incorporates part of Sites 2 and 9 in Bedggood *et al.* (1997) which were classified as State Zoological and (High) Regional Botanical Significance. Using the Biosites criteria, Vines Hill has been classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains 2 EVCs that have a High or Very High Conservation Status (Valley Grassy Forest and Creekline Herb-rich Woodland).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, State
Criteria 1, Ecological integrity and viability, Nil
Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, S
Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47)
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Andersons Creek/Colman Park, Biosite 27; State Significance (1 Sub-Criteria)

Description:

Andersons Creek/Colman Park (Biosite 27) comprises 48.01 ha of Valley Grassy Forest (V), Grassy Dry Forest (LC) and Creekline Herb-rich Woodland (E) with small areas of Swampy Riparian Complex (E) and Valley Heathy Forest (E) in the south on Andersons Creek. It is located on the southern margin of the municpalitiy's east and spans from Andersons Creek were it immediately adjoins the Ringwood to Warrandyte Road (from the One Hundred Acres Reserve to south of the intersection with Milne Road) across to the boundary parallel with Old Warrandyte Road. Andersons Creek/Colman Park occupies parts of three suburbs: Park Orchards, Warrandyte South and Ringwood North. The Biosite doesn't extend further north than Croydon Road at Colman Park. The Biosite is split into three discrete sections: the largest on Andersons Creek and parallel to the Ringwood to Warrandyte Road, another in a gully-line draining into Andersons Creek running east from the end of D'assisi Court, and a third based around Colman Park either side of Colman Road. The Andersons Creek section consists of stream frontage and Road Reserve, public land owned by the State but managed by Melbourne Water and Council, and adjacent private land especially at The Tree Line, running upto to the intersection of Hall Road. The Colman Park section is entirely private land with about half (north of Colman Road) owned by Council. The gully-line east of D'assisi Court

comprises Melbourne Water managed (State) public land and patches of adjoining private land to the east and west. A total of 86 vascular flora species have been recorded for this Biosite (For complete lists see Appendice 6.1).

The Andersons Creek/Colman Park Biosite incorporates part of Sites 5c and 16 in Bedggood *et al.* (1992), which were classified as State Zoological and Regional Botanical Significance. Using the Biosites criteria, Andersons Creek/Colman Park has been effectively elevated to State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains 4 EVCs that have a High or Very High Conservation Status (Valley Grassy Forest, Valley Heathy Forest, Swampy Riparian Complex and Creekline Herb-rich Woodland). This Biosite is also classified as Local Significance under two sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional
Max under current Classification, State
- **Criteria 1, Ecological integrity and viability, Local**
  - Sub-Criteria 1.2.5., **L**, Andersons Creek corridor
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164); Valley Grassy Forest (EVC 47); Valley Heathy Forest (EVC 127); and Swampy Riparian Complex (EVC 126)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Local**
  - Sub-Criteria 5.1.1.4., **L**, Vegetation monitoring management comparisons at Colman Reserve undertaken by Jane Pammer, Rosemary Buxton and Sharon Mason

Candlebark, Biosite 28; National Significance (1 Sub-Criteria)

Description:

Candlebark (Biosite 28) comprises 47.56 ha of Valley Grassy Forest (V) and Grassy Dry Forest (LC), Creekline Herb-rich Woodland (E) and Riparian Forest (LC). Located on the northern margin of the municpalitiy just west of the Mullum Mullum Creek confluence in Templestowe, this Biosite occupies the area north of Porter Street and Newmans Road, east of Fitzsimons Lane up to the Yarra River and as far west as a line parallel to Monckton Road. The area consists of a series of small hills and gullies that drain directly into the Yarra River but are mapped as part of the Ruffey Creek sub-catchment. Candlebark is split into six discrete sections: the largest two of which are along the Yarra River and close to Fitzsimons Lane in Candlebark Park with the balance in the west including a patch of degraded Valley Grassy Forest surrounding the dam at Pettys Orchard, and small patches at the intersection of Monckton and Watties Roads, off Timothy Court and along O'Briens Lane. Candlebark Park is public land owned by the State and managed by Park Victoria, Petty's Orchard is also public land but managed privately under a lease arrangement, and the remaining patches are entirely private land except for small sections of road reserve. A total of 113 vertebrate fauna species and 126 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Candlebark Biosite represents part of Site 57 in Beardsell (1997), which was classified as State Zoological Significance. Using the Biosites criteria, Candlebark has been effectively elevated to National Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the area contains the extant Type locality of one invertebrate (a wasp). This Biosite is also classified as State Significance under 6 sub-criteria, Regional Significance under 2 sub-criteria and Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, National
- **Criteria 1, Ecological integrity and viability, State**
  - Sub-Criteria 1.1.1., **L** , Yarra River
  - Sub-Criteria 1.2.6., **R**, Yarra River corridor
  - Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland

Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vert: Growling Grass Frog, Vul. Vas: Matted Flax-lily, E

Sub-Criteria 3.1.2., **S**, Vert: Great Egret, vul, Lis; Powerful Owl, vul, Lis; Hardhead, vul; Growling Grass Frog, end, Lis; Musk Duck, vul; Baillon's Crake, vul, Lis; Broadshelled Tortoise, end; Australasian Shoveler, vul; Latham's Snipe, lr; Lewin's Rail, vul, Lis; Murray Cod, end, Lis. Vas: Matted Flax-lily, e; Tussock Sedge, k; Slender Tick-trefoil, k

Sub-Criteria 3.1.3., **S**, Growling Grass Frog, Vul, end, Lis; Broadshelled Tortoise, end; Murray Cod, end, Lis.

Sub-Criteria 3.2.3., **S**, Creekline Herb-rich Woodland (EVC 164). Valley Grassy Forest (EVC 47) in marginal condition.

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, National

Sub-Criteria 5.1.1.3., **R**, Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PG: Yarra River at Fitzsimmons Lane Bridge) Source: EPA 2000.

Sub-Criteria 5.2., **N**, Invert: Phaenocarpa persimils (Hymenoptera). Templestowe, 1973 (Source: Museum of Victoria; Alan Yen pers. comm.)

Westerfolds, Biosite 29; State Significance (5 Sub-Criteria)

Description:

Westerfolds (Biosite 29) comprises 36.71 ha of Floodplain Riparian Woodland (E), Riparian Forest (V), Creekline Grassy Woodland (E) and Plains Grassy Woodland (E). Located along the western half of the northern boundary, this Biosite is largely confined to Westerfolds Park in Templsetowe in between the Yarra River, Fitzsimons Lane and Porter Street (although it does continue further down stream from Porter Street to the Ruffey Creek confluence). Westerfolds comprises three discrete sections: the largest running along the full length of the Yarra, the next largest along Kestral Creek (which bisects the park and flows directly into the Yarra), and the smallest, a degraded clump of Plains Grassy Woodland on the hill top adjacent to the original homestead. Apart from the section down stream from Porter Street to the Ruffey Creek confluence, which is entirely on small parcels of private land, the entire site is contained within Westerfolds Park, which is owned by the State and managed by Parks Victoria. A total of 76 vertebrate fauna and 23 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Westerfolds site represents part of Site 34 in Beardsell (1997), which was classified as Regional Zoological Significance. Under this classification Westerfolds has been effectively elevated to State Significance under 6 sub-criteria (DNRE 2002b): Sub-Criteria 1.2.1.2. As known breeding site for Powerful Owl, a Victorian threatened territorial species with a large home range; Sub-criteria 1.3.2. and 1.3.3. As may with suitable habitat rehabilitation form an important additional area of habitat or strategically important corridor (Note: there are State threatened species down and upstream that may colonize if habitat restored/created – which is considered realistic because within Westerfolds Park); Sub-criteria 3.1.1. As known habitat for four nationally listed threatened species (Vert: Macquarie Perch, Cen; Regent Honeyeater, End; Swift Parrot, End; Australian Grayling, Vul); Sub-criteria 3.1.3. As high quality habitat for three State threatened listed species (Macquarie Perch, Cen, end, Lis; Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis;); Sub-criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Floodplain Riparian Woodland, Riparian Forest, Creekline Grassy Woodland, and Plains Grassy Woodland). This Biosite is also classified as Regional Significance under two sub-criteria and Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Regional

Max under current Classification, State

Criteria 1, Ecological integrity and viability, State

Sub-Criteria 1.1.1., **L** , Yarra River

Sub-Criteria 1.2.6., **R**, Yarra River corridor

Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland

Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, State

Sub-Criteria 3.1.1., **S**, Vert: Macquarie Perch, Cen; Regent Honeyeater, End; Swift Parrot, End; Australian Grayling, Vul

Sub-Criteria 3.1.2., **R**, Vert: Great Egret, vul, Lis; Powerful Owl, vul, Lis; Latham's Snipe, lr; Lewin's Rail, vul, Lis; Murray Cod, end, Lis; Swift Parrot, end, Lis; Regent Honeyeater, cen, Lis; Australian Grayling, vul, Lis; Macquarie Perch, end, Lis

Sub-Criteria 3.1.3., **S**, Macquarie Perch, Cen, end, Lis; Regent Honeyeater, End, cen, Lis; Swift Parrot, End, end, Lis;

Sub-Criteria 3.2.3., **S**, Floodplain Riparian Woodland (EVC 56); Riparian Forest (EVC 18). Creekline Grassy Woodland (EVC 68) and Plains Grassy Woodland (EVC 55) in marginal condition.

Criteria 4, Representativeness of type, Nil,

Criteria 5, Scientific and educational value, Nil,

Ruffey, Biosite 30; Regional Significance (1 Sub-criteria)

Description:

Ruffey (Biosite 30) comprises 7.35 ha of small areas of Valley Grassy Forest (V), Valley Heathy Forest (E), Swampy Riparian Complex (E) and Riparian Woodland (E) and is one of the smallest sites in Manningham. Located entirely along the length of Ruffey Creek in Doncaster, Templestowe and Lower Templestowe, It comprises three sections: one at the confluence with the Yarra River at Finns Reserve, another upstream of Foote Street at Saint Kevins School and finally in Ruffey Lake Park between King and George Streets. The Ruffey Lake Park section in turn comprises four discrete patches: one at the Boulevard picnic area, another two on the eastern margin of Ruffey Lake and another around the old quarry near the Victoria Street picnic area. Finns Reserve, off Wood Street in Lower Templestowe is part State owned public land and part private land owned by Council, both of which are managed by Coincil and Melbourne Water. The Saint Kevins School site is also part private and part public, with the streamside frontage managed by Melbourne Water. Ruffey Lake Park is entirely private land owned and managed by Council. A total of 50 vertebrate fauna species and 119 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Ruffey Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Ruffey has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains three EVCs that have a High or Very High Conservation Status (Valley Grassy Forest, Swampy Riparian Complex and Valley Heathy Forest).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil

Max under current Classification, Regional

Criteria 1, Ecological integrity and viability, Nil

Criteria 2, Richness and diversity, Nil

Criteria 3, Rarity/Conservation status of assets, Regional

Sub-Criteria 3.2.3., **R**, Valley Grassy Forest (EVC 47); Swampy Riparian Complex (EVC 126); Valley Heathy Forest (EVC 127) in very poor condition

Criteria 4, Representativeness of type, Nil

Criteria 5, Scientific and educational value, Nil

Yarra, Biosite 31; National Significance (1 Sub-Criteria)

Description:

Yarra (Biosite 31) comprises 67.25 ha of Floodplain Riparian Woodland (E) and Floodplain Wetland Complex (E) with very small areas of Plains Grassy Woodland (E), Creekline Grassy Woodland (E) and Unclassified

Core Habitat. Located in the far west of Manningham, exclusively along the Yarra River corridor, it spans from the Ruffey Creek confluence in Lower Templestowe downstream to the Koonung Creek confluence in Bulleen. The Biosite is almost entirely north and west of Templestowe and Bulleen Roads respectively. Yarra primarily consists of one discontinuous linear corridor along the Yarra River (three discrete sections) and a small section along the lower portion of Koonung Creek. A handful of outlying patches are scattered throughout at Bimbadeen Park, Birrarung Park and at Trinity Grammer School. The vast majority of this Biosite forms part of the Yarra River open space corridor consisting of a mosaic of private and public land. The public land sections are owned by the State and managed by Parks Victoria and include: Bolin Bolin Billabong, Banksia Park on Banksia Street, Birrarung Park and part of Finns Reserve. There is also a narrow river frontage through Heide Park and Art Gallery adjoining Banksia Park. The major freehold parcels include: Finns Reserve, Bimbadeen Park and Bulleen Park owned and managed largely by Council and properties owned by the Veneto Club, Trinity Grammer School, Carey Baptist Grammer, the Greek Orthodox Community and Yarra Valley Country Club. A total of 134 vertebrate fauna and 68 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Yarra site represents part of Sites 32, 33 and 34 in Beardsell (1997), which were classified as State Zoological Significance. Under this classification Yarra has been classified as State Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 5.2. As the area contains the extant Type locality of one vascular plant (a grass). This Biosite is also classified as State Significance under six sub-criteria, Regional Significance under two sub-criteria and Local Significance under one sub-criteria.

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), State
Max under current Classification, National

- **Criteria 1, Ecological integrity and viability, State**
  - Sub-Criteria 1.1.1., **L** , Yarra River
  - Sub-Criteria 1.2.6., **R**, Yarra River corridor
  - Sub-Criteria 1.3.2., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland
  - Sub-Criteria 1.3.3., **S**, State threatened species downstream (listed in Crit. 3.1 and 1.2) as well as upstream may colonize if habitat restored/created. Restoration realistic because in parkland
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, State**
  - Sub-Criteria 3.1.1., **S**, Vert: Macquarie Perch, Cen; Growling Grass Frog, Vul. Vas: River Swamp Wallaby-grass, V
  - Sub-Criteria 3.1.2., **S**, Vert: Growling Grass Frog, end, Lis; Musk Duck, vul; Glossy Grass Skink, lr; Whiskered Tern, lr; Latham's Snipe, lr; Macquarie Perch, end, Lis; River Blackfish, ins; Royal Spoonbill, vul; Pied Cormorant, lr; Nankeen Night Heron, lr; Great Egret, vul, Lis. Vas: River Swamp Wallaby-grass, k; Veiled Fringe-sedge, r; Matted Water-starwort, k
  - Sub-Criteria 3.1.3., **S**, Macquarie Perch, Cen, end, Lis.
  - Sub-Criteria 3.2.3., **S**, Floodplain Riparian Woodland (EVC 56); Floodplain Wetland Complex (EVC 172)
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, National**
  - Sub-Criteria 5.1.1.3., **R**, Environment Protection Authority – monitoring point for assessing the "environmental health of streams in the Yarra River Catchment" (PE: Yarra River at Banksia Street Bridge) Source: EPA 2000.
  - Sub-Criteria 5.2., **N**, Amphibromis fluitans (Bolin Bolin Billabong) (Source: Beardsell 2002)

Koonung, Biosite 32; Regional Significance (1 Sub-Criteria)

Description:

Koonung (Biosite 32) comprises 8.65 ha of Swampy Riparian Complex (E) and Valley Heathy Forest (E) and is one of the smallest sites in Manningham. Located entirely along the length of Koonung Creek in Doncaster, East Doncaster and Donvale, this Biosite comprises three sections: one off Brindy Court (off Whetherby Road), another at Boronia Grove Reserve near Blackburn Road, another between Blackburn Road and the Darval Court turn-around, and another east from Darval Court. All are very small remnants close to the Koonung and surrounded by open parkland or extensive revegetation undertaken by Melbourne

Water and Council. Part of an extensive Koonung Creek linear corridor, the Biosite consists of a mosaic of public land owned by the State and managed by either Melbourne Water or Council and private land owned and managed by Council. Some parcels are also owned by VicRoads and have been partly revegetated as part of the extension of the Eastern Freeway. A total of 21 vertebrate fauna species and 80 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Koonung Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Koonung has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains 2 EVCs that have a High or Very High Conservation Status (Swampy Riparian Complex and Valley Heathy Forest).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil
Max under current Classification, Regional
Criteria 1, Ecological integrity and viability, Nil
Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, Regional
Sub-Criteria 3.2.3., **R**, Swampy Riparian Complex (EVC 126); Valley Heathy Forest (EVC 127) in poor condition
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Andersons Creek Road, Biosite 33; Regional Significance (1 Sub-Criteria)

Description:

Andersons Creek Road (Biosite 33) comprises 6.85 ha of Grassy Dry Forest and Valley Grassy Forest (V) and is the smallest in Manningham. Located largely along Andersons Creek and Reynolds Roads in Doncaster East, it comprises four discrete sections: one at the intersection of Andersons Creek and Warrandyte Roads, at Prowse Reserve off Fernlea Cresent, opposite Jenkins Park at the intersection of Reynolds and Andersons Creek Roads (in two parts), and along Reynolds Road up hill from the intersection of Springvale Road. The two most extensive sections are public land road reserves managed by Council and the other two reserves are private land owned and managed by Council (Prowse Reserve) or public land owned by the State and managed by Council (reserve opposite The Pines shopping centre). A total of 23 vertebrate fauna species and 74 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Andersons Creek Road Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Andersons Creek Road has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains one EVC that has a High or Very High Conservation Status (Valley Grassy Forest).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil
Max under current Classification, Regional
Criteria 1, Ecological integrity and viability, Nil
Criteria 2, Richness and diversity, Nil
Criteria 3, Rarity/Conservation status of assets, Regional
Sub-Criteria 3.2.3., **R**, Valley Grassy Forest (EVC 47) in poor condition
Criteria 4, Representativeness of type, Nil
Criteria 5, Scientific and educational value, Nil

Green Gully, Biosite 34; Regional Significance (1 Sub-Criteria)

Description:

Green Gully (Biosite 34) comprises 11.32 ha of Creekline Herb-rich Woodland (E) and Valley Grassy Forest (V) with small areas of Grassy Dry Forest (LC) and Unclassified Core Habitat, and is one of the smallest sites in Manningham. Located along Green Gully, flowing north into the Mullum Mullum Creek near the Yarra River confluence at Tikalara Park, it comprises six discrete sections: two north of Websters Road, one in

between this road and Warrandyte Road at Aumann Nursery, another on the roadside opposite the Templestowe Business Park, another off Clontarf Cresent and the final patch south of Parter Street. The Tikalara patches are public land owned by the State and managed by Melbourne Water, Aumanns Nursey is freehold, the roadside patch is owned by VicRoads and managed by Council, and the remaining two sites in the Green Gully linear reserve are owned and managed by Council. A total of 28 vascular flora species have been recorded for this Biosite (For complete list see Appendix 6.1).

The Green Gully Road Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Green Gully has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains two EVCs that have a High or Very High Conservation Status (Valley Grassy Forest and Creekline Herb-rich Woodland).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil
Max under current Classification, Regional
- **Criteria 1, Ecological integrity and viability, Nil**
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, Regional**
  - Sub-Criteria 3.2.3., **R**, Valley Grassy Forest (EVC 47); Creekline Herb-rich Woodland (EVC 164) in poor condition
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

Urban Miscellaneous, Biosites 35; Regional Significance (1 Sub-Criteria)

Description:

Urban Miscelleaneous (Biosite 35) comprises 10.13 ha of Valley Grassy Forest (V), Creekline Herb-rich Woodland (E), Swampy Riparian Complex (E) and Swampy Woodland (E) and is one of the smallest sites in Manningham. Located throughout the intensively urbanised west in Doncaster and Templestowe, it comprises seven discrete sections: Zerbes Reserve on Blackburn Road Templestowe, owned and managed by Council; part of a water reserve behind the Donburn Shops owned and managed by Yarra Valley Water; the privately owned Doncaster Golf Course on Doncaster Road (two patches); a small wetland on Porter Street in Templestowe owned and managed by Council; a small patch of private Valley Grassy Forest on Reynolds Road; and the Council Reserves on Lynnwood Parade in Templestowe and Lawrence Street in Doncaster. A total of 32 vertebrate fauna species and 35 vascular flora species have been recorded for this Biosite (For complete lists see Appendices 7.2 and 6.1 respectively).

The Urban Miscelleaneous Biosite has not been previous classified for Botanical or Zoological Significance. Using the Biosites criteria, Urban Miscelleaneous has been classified as Regional Significance under one sub-criteria (DNRE 2002b): Sub-Criteria 3.2.3. As contains five EVC that has a High or Very High Conservation Status (Valley Grassy Forest, Swampy Riparian Complex, Valley Heathy Forest, Creekline Herb-rich Woodland and Swampy Woodland).

Summary of Biosites Classification:

Max cited Classification (Bot or Fauna), Nil
Max under current Classification, Regional
- **Criteria 1, Ecological integrity and viability, Nil**
- **Criteria 2, Richness and diversity, Nil**
- **Criteria 3, Rarity/Conservation status of assets, Regional**
  - Sub-Criteria 3.2.3., **R**, Valley Grassy Forest (EVC 47); Swampy Riparian Complex (EVC 126); Valley Heathy Forest (EVC 127); Creekline Herb-rich Woodland (EVC 164); Swampy Woodland (EVC 937) in very poor condition
- **Criteria 4, Representativeness of type, Nil**
- **Criteria 5, Scientific and educational value, Nil**

13 Conservation/sustainability Management

13.1 Introduction

As pointed out in Sect. 11, Biosites assessments are predominantly used to identify priority areas and improving on-ground procedures. In Manningham this Biosites Review is already being used for strategic action planning in particular through the Council's Draft Green Wedge Strategy (MCC 2004). This study provides the technical background on which this planning is based. The Draft Green Wedge Strategy is envisaged as a partnership between State and Federal Governments with Local Government taking a lead role in conserving local biodiversity, which in this context should be considered synonymous with local bushland or remnant indigenous habitat/vegetation. Obviously the conservation of biodiversity will require consideration and action beyond the local context and local Green Wedge Strategies should never be viewed as a panacea.

The alarming trend of on-going habitat loss is a reality in Manningham. If allowed to continue, this will probably not result in the absolute extinction of any organism, as the area in question is not large nor is it particularly unique. However, the current local character, natural heritage and environmental health of the municipality would be lost – values that Local Government is in the best position to champion and has a charter to protect. If local communities via Local Governments don't take responsibility to protect their local environment, then who else will?

13.2 Vision

In order for "the Manningham GW [to be] renowned for its sustainable management of land, biodiversity, cultural heritage, landscapes and lifestyles and be supported by active participation from the entire community for the benefit of future generations" (MCC 2004), it is clear our existing remnant habitat or bushland must be conserved and restored.

With the release of the Net Gain Framework (DNRE 2002a), the need to reverse the current trend of habitat decline was directly recognized within the VPPs for the first time. The innovative concepts and tools introduced with this Framework provide local communities for the first time with the means by which the admirable goals, such as that articulated in the vision statement above, could be achieved.

A parallel vision, particularly from the sustainable biodiversity, land and landscape perspective, would be: **to by 2030 achieve a Net Gain in indigenous habitat relative to 2000 levels and, as far as possible, in every preceeding year.** (Note: the aerial photographs used to derive the vegetation theme in this Biosites Review were taken in 2000).

Given that on current projections we are looking at losing about 25% relative to 2000 levels, this is clearly ambitious.

Once again using elements of the Net Gain Framework, this vision could be achieved via a combination of the following:

1. Ensuring the level of habitat loss via sanctioned and unsanctioned statutory processes (especially on private land) are absolutely minimised (avoided in the majority of cases).
2. Where ever losses do occur, that an appriopriate Net Gain off-set is identified and delivered in accordance with the Framework.
3. Introduce an incentive-based program aimed at restoring bushland to at least off-set the current annual decline in bushland condition and area within the municipality.

13.3 Threats and threatening processes

A case has previously been put (see Sect. 5) that there is currently a significant decline in the condition and area of remnant bushland in Manningham – the continuation of a process that began with the arrival of European migrants in the 19th century. The many causes of this historical decline have also been broadly discussed (see Sect. 4). But what processes, often referred to as threatening processes, are contributing to the current level of decline?

As implicated in the vision statement these fall into two broad categories: (1) direct losses resulting from sanctioned and unsanctioned habitat clearing, and (2) indirect losses that cause or contribute to a deterioriation in habitat condition that leads to habitat loss.

The former category covers all situations where habitat clearing is permitted through planning schemes (either via exemptions or where planning permits are issued) for a whole variety of land use and development purposes including residential subdivision, as well as illegal clearing that is tolerated, encouraged or overlooked via inadequate or non-existent enforcement of the planning scheme. The intense residential subdivision that rapidly expanded east after the second world war, is clearly an example of direct habitat loss, as by the time all houses are constructed virtually all bushland present is destroyed. Often it is only the larger, longer-lived plants such as the trees that can persist for some time, even decades, recreating the impression that bushland remains. This vegetation has often been mapped as Buffer Habitat in this study – of continuing utility for a range of hardy fauna only (particularly common birds). Good examples of this occur around the townships of Park Orchards and Warrandyte which were developed in the 1960's and 70's. Slightly older subdivisions established in similar situations north of the Yarra River in Eltham for instance, that now exhibit widespread tree dieback, clearly chart the future for Manningham's 'bushy' suburbs.

The second category differs from the former only in that there is usually no direct intent to clear habitat and is unfortunately far more difficult to manage. It is often thought that if planning controls where meticulous enough, strong enough and consistently adhered to, no further habitat decline would occur. Whilst historically, habitat clearing was the number one contributor to habitat decline throughout the State and indeed temperate Australia, this is no probably longer the case – not because it has been stopped – but because it has been overtaken by indirect losses.

Throughout Victoria "we still have a permanent loss of native vegetation estimated at ~2500 ha a year and the quality of the remaining native vegetation continues to decline." (DNRE 2002a). Whilst the type and magnitude of these corrosive processes vary from Bioregion to Bioregion, in the Manningham context they are as follows (in no particular order of priority or significance):

1. Overgrazing by stock (particularly horses) – A recent study of Land Capability in Manningham concluded that horses were not only the major variety of stock present, but paddocks were also frequently over stocked (Hood and Crawford 2004). Although this study did not investigate the impacts of stock on remnant bushland, overgrazing is incompatable with bushland conservation.
2. Pest plant and animal invasion – Noxious and environmental weeds have long been recognised as having a detrimental impact on indigenous habitat. These plants effectively out compete the indigenous species and replace habitat. Feral animals either have a similar type of impact as stock (eg. rabbits) or otherwise interfere with 'normal' ecological processes (eg. dogs, cats, foxes and european wasps).
3. Changes in burning regimes – Sect. 4 outlined significant changes in the interplay of fire with the landscape since the beginning of European settlement. Although fire history is not well understood prior to this period, the intensity and frequency of burning in an increasingly fragmented landscape over the first century of European habitation, combined with the effective elimination of fire in more recent times, has likely impacted upon the floristics, structure and reproduction of bushland.
4. Soil erosion, climate change and changes in sub-catchment hydrology – The daming and regulation of the Yarra River and its tributaries, climate change (eg. changes in temperature and rainfall) plus the widespread transformation to agricultural and urban land uses has resulted in soil loss and waterway pollution as well as a reduction in the frequency, nature and extent of flooding – all of which has impacted negatively on remnant habitat and biodiversity in general.

These indirect threats contribute to the loss of local biodiversity by impairing 'normal' ecological processes, resulting in local species extinctions, habitat loss and fragmentation. Habitat loss in turn leads to reduced landscape health as well as reduced resilience and productivity, affecting every component of the system: the rivers, the air and the land.

To illustrate the mechanisms by which these threats impair ecosystem processes essential for the maintenance of biodiversity, it is useful to briefly look at the reproductive strategies of plants for example under the impact of overgrazing by stock or rabbits.

As the vast majority of plants that dominate bushland are flowering plants, they need to regularly gain biomass, produce flowers, set viable seed, disperse mature seed, germinate and finally recruit adult individuals at about the same level as mortality in order to persist. If any stage in this reproductive process is completely or partially impared or if the mortality rate increases or both, and this is sustained, deaths will out

number births and the populations will eventually disappear. The smaller, short-lived species will drop out first, and the larger, long-lived plants will persist a little longer.

Some native plants however, can under some circumstances, positively benefit from human disturbances. Native tussock grasses such as Weeping Grass and Wallably Grasses for instance have likely been spread or have become more adundant than they were in their original natural habitat.

It also needs to be pointed out that most species, despite these apparent vulnerabilities, have evolved a range of clever defences and strategies that allow resilience. For instance the large seeds with thick seed-coats produced by many wattles allow a long-lived seed bank to accumulate such that even if an entire population is wided out by a flock of kangaroos or domestic stock for example, the population is capable of coming back sometime in the future when conditions are more suitable.

There are also other factors like the invasion of weeds or the exacerbating impacts of landscape fragmentation (for instance isolating discrete populations or eliminating pollinators) that further muddy the waters.

The first tell-tail signs of decline in vegetation are often subtle structural and floristic shifts: for instance a decline in the richness of native species, a loss of understorey shrubs or the increased cover of exotic species. The net affect is a kind of simplication or homogenisation of the vegetation whereby those species capable of surviving the new disturbance context will persist and even spread in some case, while those that are more sensitive will rapidly or gradually disappear. As the level and type of human impact is unevenly distributed, so too are the negative, corrosive impacts. Consequently some landscapes have survived quite well – often almost in tact, whilst others have almost disappeared altogether. This principle even applies at a local scale within particular landscapes and Manningham is a good example. Areas such as Fourth Hill or Blue Tongue Bend in WSP still support the least effected remnants of the pre-settlement ecosystem whilst those smaller remnants on the margins of the urban zones such as Templestowe or Park Orchards are extremely degraded.

13.4 Conservation strategies

Principles and background

Strategically there are a number of ways to approach the conservation of biodiversity at the local government level. Arguments have already been presented that make the case that priority must be placed on maintaining and restoring remnant indigenous habitat rather than focusing on revegetation or threatened species conservation or recovery. Whilst this approach is underpinned by understanding the threats to bushland, it is important to point out that these threatening processes must be strategically assessed according to their contribution to the ultimate aim. This may involve a review of how we currently consider and rate threats.

For example, it may be more effective and potentially cheaper to use fire rather than intensive techniques such as hand weeding to manage environmental weeds in bushland. Instead of aiming to remove all or particular perceived problematic weeds, it maybe be ecologically better to reintroduce burning – stimulating a whole range of other ecological benefits – whilst tolerating a certain level of weediness. Another example is focusing effort on removing, reconfiguring or reducing the grazing of horses and other stock in bushland rather than spending limited resources on the seemingly futile control of rabbits. In neither of these cases should traditional practices be ceased, rather they should be reviewed in light of new objectives. Instead of spending all of our biodiversity dollar on rabbits and Sweet Vernal Grass we should spend the limited resources on strategically restoring the health of bushland. Bushland conservation is our objective, not poisoning rabbits and not pulling weeds.

Another strategy popular in the community is revegetation. It is a reasonable response to the widely communicated fact that too much bushland and habitat has been cleared and continues to be cleared from the local to the global scale and that this has contributed to many environmental problems such as species extinctions, soil erosion, salinity and even climate change. Indeed what could be more simple than the notion of putting back what has been taken away. Although it can be argued that once native bushland has been destroyed it is gone, especially in highly fragmented landscapes, it is theoretically possible to re-establish habitat given enough knowledge, resources and time. Unfortunately we are currently deficient in all three of these areas.

The primary impetus for the commonly held perception that revegetation is the solution, is that most people see bushland simply as trees. When rainforest in the Amazon River Basin in Brazil or woodlands in Queensland or Mountain Ash forests in Tasmania are felled or cleared for instance, people often just believe it is trees that are being removed or destroyed, not ecosystems. It is this simplistic perception that feeds the impulsive tree planting solution response. In this way it is easy to reach the further conclusion that tree plantations are an acceptable (even comparable) substitute for lost bushland or habitat. If trees are the answer, even plantations established for commercial timber production based on exotic or native species are OK. Numerous studies have exposed these views as ecological non-sense (eg. Lindenmayer *et al.* 1999). The consensus amongst ecologists is that habitat is the only substitute for habitat and if we currently don't know how to recreate it we simply can't afford to loose. The fundamental point here relates to ecological processes – the vital sustaining processes that underpin all ecosystems. It is actually quite easy to put trees in the ground – we mastered this technological centuries ago. But its one thing to put plants in the ground, its quite another to recreate whole ecosystems.

The various conservation strategies can be summaried as: (1) Maintaining and restoring ecological processes, (2) Managing threatening processes, (3) Creating new habitat through indigenous revegetation and (4) Protecting threatened species. Although there are strengths and weaknesses in all, they are not mutually exclusive and all four (plus others) should be employed to a lesser or greater degree in any particular local landscape to achieve conservation. The fact that no one approach or no one organisation will embody the solution to the biodiversity conservation problem is stating the obvious. Partnerships and sophisticated cooperation will be an essential ingredient for success. So how do these relationships come about if they don't already exist and what role should local government actually play? These are difficult issues to address because our track record is not good – to date we have not been very affective at all in curtailing habitat decline. Obviously a great deal of innovation is required, but given that biodiversity conservation = habitat conservation in the local context, Local Government is ideally suited to be a major player in the solution.

Strategic conservation programs

Underlining the need for a genuine strategic focus in the effort, it is critical that any strategy endeavour to embrace the idea of economic efficiency – 'the biggest bang for the buck'. Conservation programs cannot be bogged down with trifling small properties that contribute little to conservation, however enthusiastic the owner may be. Programs must somehow find ways of involving and indeed harnessing the energy and good intent of such people and pointing it towards the greater goal. The same could be said of the commonly held perceptions about revegetation, especially in the urban context. Conservation programs must ensure that most of the resources end up where it counts – on properties that contain the majority of the remnant habitat and in the right form. An example of such strategic targeting would be structuring incentive programs around properties that support at least 1 ha of bushland, rather than people who are 'interested' in conservation, but own little or no habitat.

If all individual organisms form a small but tangible part of the global equation, it can readily be argued that all remnant habitat should be conserved, indeed a fundamental principle in the Net Gain framework (DNRE 2002a) is that 'all native vegetation has value'. However, there maybe a range of technical, ecological, political and economic reasons why this is too ambitious. The notion of significance has been introduced to prioritise how we value biodiversity and therefore apportion our investment towards conservation. A prudent conservation strategy must attempt to combine significance and threat/condition, aiming to conserve as much remaining habitat as possible in the first instance and eventually increase or restore it, on a path to a Net Gain at a range of scales.

Contrary to the convention of defining sites on the basis of tenure, this Biosites Review aims to use a landscape level, ecological approach driven by patterns of fragmentation. Whilst the boundary between habitat and non-habitat is frequently clear, there is also often a diffuse region of transition characterised by a very high degree of modification and as a result a very high vulnerability to further decline. In fact, most of this habitat is just remnant trees, devoid of any understorey. Even though it is assumed that this Buffer Habitat is not of sufficient quality to represent significant habitat, it supports the Core Habitat by providing additional habitat and ecological resources (eg. roosting, nesting and feeding opportunities for common fauna and may also help arrest tree decline in Core Habitat).

13.5 Recommendations

Whilst Local Government has an interest in all land within its jurisdiction (and indeed surrounding it), its influence on the direct management of habitat varies greatly depending on tenure. In order of decreasing

municipal control, the region's bushland falls into the following divisions: Council Land (freehold title), Roadsides, Private land and Other public land (eg. State Parks such as WSP). It is considered best to structure Council's conservation planning and program implementation efforts on this framework.

Private land (excluding Council owned titles),

Despite the limits of control, privately owned bushland represents the bulk of the remnant habitat within the municipality and is of critical strategic significance. The local authority's charter to administer the planning scheme under the Planning and Environment Act (1987) is a potentially powerful tool for positive change in the interest of the greater public good. Four key recommendations are suggested: Statutory review/update (eg. amending overlays); Conservation management incentives programs to facilitate habitat restoration; Environmental education via the existing Property Management Course and Conservation Covenants (including the concept of Revolving Funds).

Statutory review/update

Even though incentive-based measures will be the major strategic component of the Draft Green Wedge Strategy, there is obviously a significant role for statutory tools. In fact, it can be argued that statutory mechanisms for achieving conservation outcomes (especially in terms of preventing/minimising loss) will be crucial to the success of the Strategy. This is because most of the remnant habitat occurs on private land and the region is subject to intensive human use.

Recent developments suggest a review of existing statutory tools is necessary. Such a review would involve (1) updating relevant planning scheme overlays; (2) improving enforcement of existing statutory prescriptions and requirements (ie. improved staff training and internal processes); and finally (3) reviewing statutory prescriptions and requirements to introduce improvements.

Given that the current Environmental Significance Overlays were derived from incomplete SOS studies, there are substantial gaps in the statutory protection afforded. It has long been recognised and acknowledged that such deficiencies should be addressed in a future review.

An additional measure would involve a review of all statutory processes to ensure any indigenous tree or other vegetation loss feeds into the Net Gain objective outlined in the Draft Green Wedge Strategy. In this way all tree/vegetation losses would result in off-sets that would count towards annual Net Gain targets.

It is envisaged the planning scheme amendment would take the form of replacing or superseding the existing ESO whereby the network of 35 classified Biosites become the new ESO 2 schedule. Surrounding Buffer Habitat could be inserted into the planning scheme with minor amendments to existing Vegetation Protection Overlays or Significant Landscape Overlays.

Conservation management incentives – Farming Biodiversity

A number of financial assistance programs, at least in part designed to achieve biodiversity outcomes, currently operate within Manningham (mainly in the GW). Under the broad banner of the Biodiversity Incentive Program (BIP) these include: (1) Local Environment Assistance Fund (LEAF); (2) Park Care (PC); (3) Trust for Nature Conservation Covenant and Land for Wildlife rebates; and (4) Urban Stream Frontage (USF). Combined these funds facilitate a range of practical management activities such as rabbit baiting, education, weed control, fencing and revegetation etc.

In operation since 1995, BIP is today active on over 100 properties within the municipality, mostly in the GW. However, this only represents a relatively small proportion of the total number of properties supporting greater than 1 ha of remnant habitat (a total of 532 such properties occur in the GW, covering 1809 ha or ~50% of Manningham's bushland). Although no data exists on the extent of conservation management practised by property owners in the GW, the anecdotal evidence and recent vegetation mapping suggests it is still far from off-setting ongoing losses. In other words, somehow or another considerably more conservation management is required to prevent further habitat decline.

There are two possible reasons why BIP has not been as effective as hoped are: (1) limits in the scale of the program – especially with respect to personnel; and (2) limits in the amount of incentive funding available to individual property owners. To an extent, expenditure of biodiversity funds on issues and sites of low biodiversity value, as well as deficiencies in conservation management technology has exacerbated these problems. In response it is proposed to expand and restructure BIP by establishing a new initiative entitled

'Farming Biodiversity' (amongst other things). Introducing the language of farming or the industry of biodiversity is a deliberate attempt to highlight the importance of biodiversity to our economies and general wellbeing. By more tangibly rewarding the stewardship of biodiversity, it is hoped more conservation management will be practiced and sustained and a Net Gain can be achieved.

Farming biodiversity would work in tandem with the existing LEAF scheme. While LEAF will continue to provide direct financial support for on-ground management (dollar-for-dollar matching funds), Farming Biodiversity would introduce a new milestone-based financial reward for achieving and sustaining certain targets linked to the broader objective. Such rewards would be paid in proportion to the amount of biodiversity present plus the improvements delivered. If in any one year there is a demonstrable decline in condition, no reward would be paid. Furthermore, any contrivance to deliberately reduce habitat condition in one year in order to achieve a bonus in the next, would forfeit access to rewards.

Education (Property Management Course)

Another initiative under BIP is the Property Management Course based out of Currawong Bushland Park and facilitated by local expert management practicioners. Currently run three times a year as a series of evening lectures and weekend field trips, the course is targeted at GW properties supporting bushland and aims to teach the participants how to develop conservation management plans (including sustainable stock and pasture management). Whilst the course has proven successful in attracting significant numbers of the community, the proportion of total participation is low and the curriculum is in need of review and update. It is proposed to review the Property Management Course by: (1) eliminating all participation costs; (2) updating the structure and technical content of the course curriculum to incorporate recent information and technologies, plus better suit the needs and expectations of participants; (3) linking with tertiary and higher education institutions (including appropriate accreditation for use towards higher formal qualifications such as degrees or diplomas); and (4) integration with milestone requirements under Farming Biodiversity to ensure high and on-going participation.

Conservation Covenants, Revolving Funds and Bush Tender

At least two properties in Manningham are permanently protected with Trust for Nature Conservation Covenants – Stane Brae in Wonga Park (~118 ha) and John and Bev Hanson's property in Warrandyte (~4 ha). Using the Hanson land as a threshold/benchmark, on the basis of the recently complied vegetation mapping, over 120 properties (~980 ha) could be eligible for covenants, although realistically this number is likely to be less than 100. Never-the-less, Conservation Covenants, registered permanently on selected sections of freehold title are a powerful way of facilitating conservation without the typical costs and responsibilities of out right ownership. The philosophy behind the Trust for Nature covenants is to act to attract sympathetic owners and support appropriate biodiversity conservation stewardship. As covenants are normally created as voluntary agreements negotiated when conservation minded property owners approach the Trust, in the first instance, engaging in an active campaign of asking suitable owners to consider such a caveat, is likely to be fruitful. Potentially dozens of covenants could be established in a relatively short period, especially if the positive experience of the Hanson's, for instance, is championed. Furthermore, covenanted properties receive a significant financial rebate – currently a one-off grant of $35/ha of affected land, up to a maximum of $800. As recognition of the benefit of such permanent protection, this incentive should be continued and expanded. Potentially covenants could also be built into Farming Biodiversity as a milestone that would attract a financial reward.

An additional tool, related to covenants is the concept of the Revolving Funds. Established by Trust for Nature in the late 1980's and based on models from the United States, Revolving Funds are used to purchase land on the open market before being resold with a covenant on title. There is scope for the Council to either establish its own Revolving Fund using either Trust for Nature covenants or other mechanisms (eg. Planning and Environment Act (1987) or the Conservation, Forests and Land Act (1987)), or negotiate and sponsor a regional program under the Trust's existing program.

A third related measure is similar to the State Government's Bush Tender program whereby individual property owners "compete" for biodiversity management funds. The winning properties are those that can commit to offering the greatest biodiversity outcome for the least cost. Council could establish a municipal version of Bush Tender on a trial basis under Farming Biodiversity to assess its effectiveness in the local context, although it should be noted the concept has only been trialled with broad-acre properties in regional Victoria.

Council Land (private land),

Reserve management review

A review of the ownership and management of the Council's network of reserves could also deliver improved conservation outcomes – in the first instance by 'swapping' land with little or no conservation for that with known significant value (and preferably within the GW), and secondly by reviewing where bushland management is currently practiced. The newly completed vegetation mapping coverage will be useful in both cases.

This process would not only be useful in focusing attention on the 'best' reserves, but would also help in making more accurate assessments of biodiversity conservation expenditure by Council. Whilst many of the larger, more significant reserves already receive some attention, the nature and scale of this effort often needs to be stepped up. Some relatively minor urban sites are often over managed at the expense of parcels in the Green Wedge that are effectively neglected. It should be noted, however, that this situation is largely the result of under resourcing and poor prioritisation as one bush crew could not be expected to adequately manage so many small and widely scattered parks. In general bushland management of reserves in urban precincts should be phased out whilst simultaneously stepping up management of neglected sites within the GW.

In addition to determining which reserves should be managed and acquiring new ones, there is also the question of the management itself – namely evaluating cost effectiveness and the ecological outcomes. This process will involve a combination of assessing past activities as well as identifying technological innovations for new situations, such as operating at different scales or for new threats and management objectives.

A further benefit of this type of restructuring would be the capacity to report more explicitly and directly to Council and the community on biodiversity conservation expenditure. Currently it is virtually impossible to accurately pull this information out of the corporate management system, a situation that perpetuates serious misrepresentations about the biodiversity conservation effort. Many environmental activities routinely undertaken by Council staff, such as amenity tree planting and revegetation, are often incorrectly attributed to biodiversity conservation instead of landscaping, beautification and environmental health.

Reserve acquisition

Manningham City Council currently owns and managers over 300 public reserves, most of which occur west of the Mullum Mullum Creek in urban areas (it should be noted that in terms of area this split is roughly even). Whilst some of these western reserves do support remnant habitat, it is often small, isolated and significantly degraded. The remnant habitat at Ruffey Lake Park in Doncaster is a prime example. In contrast, the GW, where most of the best remaining habitat exists, has very few Council reserves. The better examples include: One Hundred Acres; Colman's Reserve; Currawong Bushland Park; Tindals Wildflower Reserve; and Bucks Reserve along the Mullum Mullum Creek.

Strategic acquisition to create new conservation reserves has long been an effective way of achieving conservation goals. Although the options for achieving this outcome are significantly expanded today, reserve acquisition still remains an important tool and one that is appropriate in Manningham. Due to the general absence of Council reserves in the Wonga Park area for instance, there is a case for the strategic acquisition of a private bushland property. Not only would this increase the extent of reservation, but it would also demonstrate the Council's commitment to and leadership of the broader biodiversity conservation effort.

Criteria for land selection would include: location; total area; habitat type and condition; threatened species; strategic ecological position; maintenance costs; and price.

Unless acquisition is required immediately for conservation or political reasons, the selected land could be purchased over the longer term using statutory overlays, as is common practice currently along the Mullum Mullum Creek.

Roadsides – Implement Roadside Conservation Management Strategy

In some parts of the state, roadsides can comprise the bulk of what remnant habitat remains. Even though this is not the case in the Melbourne region, roadsides never-the-less represent an important component within many municipalities. In particular they can represent important strategic ecological links between large nodes of remnant habitat. These 'corridors' are habitat in their own right and often provide the only

opportunity for both common and rare fauna, for instance, to move through the landscape. In this context strategic roadside habitat management should focus on both maintaining these existing values and enhancement through measures such as expansion (widening) primarily using restoration technologies.

As is proposed for freehold and reserve management, there is scope to align the management of roadside habitat with the Net Gain objectives. In particular any tree or vegetation losses resulting on roadsides as a result of sanctioned road upgrades or realignment, that are currently off-set with trees-for-tree plantings, could instead be delivered as habitat improvement.

The Roadside Conservation Management Strategy outlines the proposed biodiversity conservation management for Manningham's network of significant roadside habitat including measures that minimise impacts as well as proactive measures designed to strategically improve roadside habitat.

Other public land (incl. State Government)

By far the largest area of public open space supporting remnant habitat within Manningham is owned by State Government agencies and instrumentalities such as VicRoads, DSE (Parks Victoria) and Melbourne Water and comprise some of the municipality's most important Biosites. Strategic and cooperative programs relevant to public land are already in place. These include PC and USF grants whereby adjoining private landholders can apply to receive (matching) funding for appropriate conservation management activities such as soil stabilisation works, revegetation and environmental weed control. As these and other programs have been in place for some time and considerable funds have been spent, it would be appropriate to review their effectiveness. This would include consideration of remnant habitat mapping, the Biosites Review, the effectiveness of past activities, revision of those proposed for the future and the over all scale of the programs.

As well as reviewing the management of adjoining private land (including Council reserves) it would be appropriate to examine the management of State Government reserves themselves, in particular, to examine issues of management consistency, and develop cooperative partnerships designed to achieve greater landscape integration consistent with the Net Gain objectives (re: cost sharing and other efficiencies). Whilst there are a number of relevant informal liaison/discussion forums (eg. Middle Yarra Managers Group) there is a need to establish a process to facilitate more formal discussions.

General issues

Habitat corridors

Within Manningham, a number of strategic plans and regional environmental studies (eg. Beardsell 1997) identified the Yarra River, the Mullum Mullum Creek and the Park Orchards Ridge (linking the Mullum Mullum Creek with Fourth Hill on Andersons Creek) as the primary corridors of potential fauna movement at a regional scale. This is based on a number of assumptions about how fauna move, the most important of which are the spatial patterning of remnant habitat and proximity to water.

Like the concept of biodiversity, the notion of wildlife corridors is also highly scale dependent. A functional corridor for invertebrates, for instance, will be very different from that utilised by reptiles, arboreal mammals or large, predatory hollow-dependent birds. The detailed requirements will be dependent on the specific aspects of a species' ecology – niche, trophic position, morphology, size, social behaviour, breeding biology and so on, but in each case such corridors must be habitat its own right. Another consideration is how fauna actually moves between the locations that provide their requirements. Whilst many common birds can simply fly (sometimes quite large distances) between a feed tree and a roosting site, skinks are unlikely to venture far from the cover of ground litter.

Often the rather simplistic notion of 'linking' remnants by revegetating, more-or-less in a linear fashion, is likely to be ineffective because: (1) the habitat value (especially in relation to the target species) is limited or non-existent and/or (2) the spatial and structural configuration of the link is not consistent with how species move. In general created corridors probably act as a conduit for a small range of common fauna that may already exist in abundance in the surrounding landscape. The real test of the success of corridors must first be in attracting and maintaining populations of a wide range of (indigenous) species and secondly in supporting self-sustaining habitat that requires minimum management input.

In this context it would be appropriate to review the effectiveness of all so-called wildlife corridors within Manningham, especially those in linear parks. Most tree planting and revegetation is undertaken for amenity,

landscaping, environmental health and beautification purposes, not biodiversity conservation. This is a particularly important issue, as in relation to biodiversity conservation, the reality is contrary to popular perception that such tree planting is helping to prevent extinctions. In fact, as past SOS studies have demonstrated, biodiversity essentially resides in remnant indigenous vegetation that is almost entirely east of the Mullum Mullum Creek. If our aim is to conserve biodiversity, this bushland must be protected as a matter of urgency.

Monitoring and reporting – biodiversity indicators

A fundamental element of the Net Gain framework is establishing a program for the required monitoring and reporting of trends. To this end monitoring is proposed. Attributes would include: (1) establishing a network of permanent monitoring points; (2) annual or periodic collection of at least HaS condition and a photo-point; and (3) establishment of selected management exclusion 'controls'. It would also be appropriate to investigate the potential for collecting a wide range of additional, secondary thematic information such as problem weeds, dieback or invertebrates etc. Ant and bryophyte (especially mosses) species richness have been shown to be particularly good indicators of habitat type and condition. The annual or periodic assessment of the network could be condensed into a single Landscape Index expressed as HaHa (see Sect. 5).

Ecological Research in partnership with research institutions

It is critical that strategic planning decisions are informed as far possible by accurate and useful information and knowledge. In particular, there is an on-going need to establish research partnerships to address the following questions: (1) what is causing, controlling or inciting the biodiversity trends observed? and (2) what specific management actions, strategies or technologies could be employed to most efficiently and effectively aid in achieving our objectives? The success of our biodiversity conservation strategies will as much depend on developing a clear understanding of what we need to do and how it should be done as it does on effectively engaging the community.

Continue data collection and analysis

It is important to highlight that this Biosites Review should not in any way be viewed as a comprehensive or completed process. Ecosystems are complex and changing, especially in the context of the fringe of an urban metropolis and there will need to be an on going commitment to gathering (incl. commissioning), organising, analysing, interpreting and applying new information pertaining to Biosites. Information in this context has an expiry date and will need to be updated to be meaningful. Completely new information could result in changes to how the various Biosites are classified and ranked by expanding the number of sub-criteria used in the Biosites classification. For instance a reclassification of the municipality's EVCs and defining subordinate floristic communities would add value as well as obtaining data on macrofungi and invertebrates across all Biosites (see Sect. 11).

Disclaimer

This section does not represent a strategic planning document. It is important to note that many of these recommendations have only been written in general language and no attempt has been made to cost or rank them. These comments have flowed naturally from the process of undertaking this Biosites Review and represent a range of suggested responses that may or may not be adopted or implemented by Council. All actions and future commitments relating to this Biosites Review are contained in other strategies, particularly the Draft Green Wedge Strategy (MCC 2004).

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Tables

Table 1.1: Summary of Manningham's three primary historical SOS studies

Study	Bedggood *et al.* (1992)	Bedggood *et al.* (1997)	Beardsell (1997) (A) Beardsell (2002) (B)
Coverage within MCC (Suburbs)	Warrandyte, Warrandyte South, Donvale, Templestowe, Ringwood North, Park Orchards (Part)	Wonga Park, Warrandyte South (Part)	Yarra Corridor: Bulleen, Templestowe, Lower Templestowe, Warrandyte and Wonga Park (Part)
Sites (No)	24	10	7 (3 overlap with various sites in the other 2 studies)
Sites area (ha)	376.8 (15.7 average)	400.5 (40.1 average)	N/A
Tenure	Private	Private	All incl. WSP
Data sources	Field assessment and database analysis (Wildlife Atlas and FIS)	Field assessment and database analysis (Wildlife Atlas and FIS)	Field assessment and database analysis (Wildlife Atlas and FIS)
Themes	Indigenous vegetation, Vascular flora and Vertebrate fauna	Indigenous vegetation, Vascular flora and Vertebrate fauna	(A) Vertebrate fauna and fauna habitat. (B) Indigenous vegetation, and Vascular flora.
SOS Criteria	Botanical (5 criteria) and Zoological (several criteria) significance plus ROT species listed under the FFG or EPBC Acts.	Botanical (5 criteria) and Zoological (several criteria) significance plus ROT species listed under the FFG or EPBC Acts.	(A) 54 criteria were used: 7 under habitat significance and 47 under fauna significance. (B) 24 criteria were used.
SOS categories	Local, Regional, State, National.	Local, Regional, State, National.	Local, Regional, State, National.
SOS results (highest classification)	Botanical: 23 Regional Zoological: 1 State ROT: present at 5 sites	Botanical: 5 Regional Zoological: 6 State ROT: present at 5 sites	Zoological: 4 State (B) Botanical: 2 State (2 sites only) ROT: present at all sites

Table 2.1: Annual rainfall data for permanent weather stations within a 20 km radius of the MCC depot (Site: 86362)

Station No.	**86071**	**86362**	**86313**	**86035**	**86068**	**86074**	**86234**	**86351**	**86096**	**86066**	**86104**	**86303**		
Station Name	**Melbourne Regional Office**	**Templestowe (MCC Depot)**	**Warrandyte**	**Eltham**	**Viewbank**	**Mitcham**	**Croydon Council Depot**	**La Trobe University Bundoora**	**Preston Reservoir**	**Lilydale**	**Scoresby Research Institute**	**Glen Waverley Golf Course**	**All Stations**	**Closest to MCC**
No. of Observations	148	12	34	87	4	64	37	24	90	110	50	29		
Mean (mm)	653.6	736.2	799.2	744.0	669.4	864.9	903.8	683.7	672.0	899.3	888.3	845.6		
Median (mm)	649.7	739.4	799.8	733.6	658.2	857.4	882.0	699.0	682.2	901.2	885.9	852.2		
Lowest (mm)	332.3	519.2	526.8	414.0	526.8	541.8	570.5	401.2	374.6	544.6	512.8	578.3		
Highest (mm)	967.5	942.0	1033.8	1148.0	834.2	1288.0	1135.8	860.8	964.8	1326.7	1237.1	1154.8		
Pre 1997(Mean mm)	660.0	790.5	818.6	756.5	N/A	883.8	935.0	717.0	676.3	908.9	904.6	865.8	810.6	836.9
Post 1997(Mean mm)	525.7	669.5	708.5	600.9	669.4	710.9	770.1	602.9	621.5	758.8	768.7	782.2	682.4	688.2
%Reduction	20.3	15.3	13.5	20.6	N/A	19.6	17.6	15.9	8.1	16.5	15.0	9.6	15.6	17.3

Source: Bureau of Meteorology. See Map 2.1

Table 2.2: Summary of study area geology and geomorphology

Map Units	Formation	Epoch	Age MYBP	Lithology	Geomorphology	Distribution
Sla	Anderson's Creek Formation	Lower Silurian	435	Massive siltstones interbedded with thin sandstones	Uplifted, weathered, intensely folded and faulted marine sediments	Dominant geology of the study area in two major sections – one in the west covering Bulleen and into Templestowe as far as Westerfolds Park and the other occupying most of the centre of the study area from Doncaster and Donvale through Warrandyte and Park Orchards to Wonga Park
Sud	Dargile Formation	Upper Silurian	420	Laminated and current bedded sandstones interbedded with massive siltstones and shales	Uplifted, weathered, intensely folded and faulted marine sediments	Two major belts – one running through Doncaster to Templestowe from approx the Doncaster Hill area to Candlebark Park on the Yarra River and the other in the far east with its western margin running roughly parallel but west of Yarra Street up to Yarra Brae on the Yarra River
Dlh	Humevale Formation	Lower Devonian	395	Siltstone, massive to thin-bedded, with minor sandstone near the base	Uplifted, weathered, intensely folded and faulted marine sediments	Small pocket in far north east south of Mount Lofty roughly parallel with Brushy Creek in Wonga Park
Ddp	N/A	Upper Devonian	360	Quartz and/or Felspar porphyry	Intrusive, volcanic dyke	Small pocket in far north east south of Mount Lofty at the Brushy Creek confluence in Wonga Park
Tpr	Brighton Group (Red Bluff Sands)	Upper Tertiary (Pliocene)	5	Fine to coarse sands with poorly sorted gravels, poorly consolidated	Weathered marine sediments following the retreat of the sea	Small pocket in the south west in the top of Doncaster Hill in Doncaster
Qrt /Qpa	River formation	Lower Quaternary (Pleistocene)	1.8	High level alluvium; sand, silt, gravel	Fluvial and lacustrine: elevated river terraces	Scattered in small pockets along the Yarra River throughout the study area with the largest deposits in Templestowe at Westerfolds and Candlebark Parks
Qra	River formation	Upper Quaternary (Recent or Holocene)	0.1	Low level alluvium, beach sands	Fluvial and lacustrine: recently deposited river sediments	Widespread throughout study area along the Yarra River and its tributaries: Koonung, Ruffey, Mullum Mullum, Anderson's, Jumping and Brushy Creeks

Source: Department of Primary Industries website (on-line geology maps)

Table 2.3: Summary of study area Soil and Landform Units

	Landform/Soil Unit	Slope	Map Unit*	Soil	Source	Distribution
1	Soils on active river and creek floodplains	Flat	Unit 4	Grey Dermosols (Floodplain of Brushy Creek)	Hood and Crawford 2003; Maher 1978	Yarra River corridor and floodplains plus major tributaries: Koonung, Ruffey, Mullum Mullum, Anderson's, Jumping and Brushy Creeks
2	Soils on higher level alluvial terraces	Flat	N/A	No data available	No data available	Restricted to the Yarra River corridor only
3	Soils on rolling and steep rises of Silurian palaeosurface	>25°	Unit 2	Leptic Tenosols and Leptic Rudosols – shallow depth to rock (also minor occurance of Unit 1 soils but usually shallower)	Hood and Crawford 2003; Maher 1978	Widespread through the eastern half of study area (Presumably also minor occurances in the west)
4	Soils on Tertiary non-marine sediments	Flat to undulating	N/A	No data available	No data available	Doncaster Hill
5	Soils on undulating or rolling rises of Silurian palaeosurface	<25°	Unit 1	Yellow or Brown Kurosols (Yellow Dermosols less common)	Hood and Crawford 2003; Maher 1978	Widespread through the study area
6	Soils on undulating rises of Devonian palaeosurface	<25°	Unit 3	Brown Kurosols (little variation)	Hood and Crawford 2003; Maher 1978	Brushy Creek confluence
7	Soils on gently sloping drainage lines of Silurian palaeosurface	Flat to gently sloping	N/A	Dermosols (Gradational)	Maher 1978 and merged with Unit 1 in Hood and Crawford 2003	Seasonal, low gradient drainage lines or gullies throughout palaeosurface

Source: *Hood and Crawford 2003

Table 2.4: Sub-catchment size and habitat values within study area

Sub-catchments	Total Area (ha)	Total Area (%)	Non-vegetation (%Area)	Buffer (%Area)	Core (%Area)
Anderson's Creek	1779.01	15.8	24.3	30.1	45.7
Brushy Creek	839.46	7.5	47.0	21.3	31.6
Jumping Creek	1569.76	14.0	37.7	11.3	51.0
Koonung Creek	1555.05	13.8	96.6	0.4	3.0
Mullum Mullum Creek	3170.20	28.2	62.1	15.2	22.7
Ruffey Creek	2324.32	20.7	92.1	2.3	5.6
	11237.80	100.0			

Soure: Melbourne Water (MCC 2001b). See Map 2.2

Table 3.1: Summary of Biophysical (Habitat) Regions within study area.

Biophysical (Habitat) Regions	Area (ha)	Area (%)	%Core Habitat	%All Habitat	Bioregion
Ruffey/Koonung Low Hills	3160.59	28.1	4.2	9.6	Gippsland Plains
Lower Yarra Low Hills	907.73	8.1	3.0	4.7	Gippsland Plains
Warrandyte Hills	6832.15	60.7	37.2	55.2	Highlands – Southern Fall
Middle Yarra Floodplain and Low Hills	53.05	0.5	8.6	8.6	Highlands – Southern Fall
Lower Yarra Floodplain	296.05	2.6	26.0	29.6	Gippsland Plains
	11249.57	100.0			

Note: all data indicative only. See Map 3.2

Table 3.2: Sub-catchment modification based on the Human Occupation variable

Sub-catchments	Urban /Industrial(%)	Light urban (%)	Low density residences (%)	Scattered residences (%)	Adjacent residences (%)	Unoccupied /Large (%)	Ranking	Index of Stream Condition*
Anderson's Creek	0.3	25.1	14.5	21.1	23.7	15.2	3	M
Brushy Creek	2.8	12.8	7.1	20.9	31.7	24.6	2	P
Jumping Creek	0.0	5.1	4.7	35.2	22.5	32.5	1	M
Koonung Creek	79.5	0.0	0.1	0.0	5.4	15.0	6	VP
Mullum Mullum Creek	27.9	27.5	13.5	1.5	15.6	14.1	4	P
Ruffey Creek	59.9	11.7	2.4	0.0	6.4	19.5	5	P

Note: Shading denotes >20%. *Source: Melbourne Water website. See Map 2.2

Table 5.1: Structure of variables selected for native vegetation map production

	Variable Name	Database Label	Syntax /Format	No of Categories	Variable description
1	Landscape Unit	LAND_UNIT	Alpha ("A")	6	Dominant landscape characteristic of area
2	Indigenous Tree Crown Cover*	ITREE_COV	Numeric ("0")	8	Indigenous tree crown cover: 0 to 100%
3	Indigenous Vegetation Modification*	IVEG_MOD	Numeric ("0")	6	Based on a combination of estimated indigenous vegetation cover, exotic vegetation cover and the presence of evidence of direct human disturbance
4	EVC (presumed NRE classification)*	MAPPED_EVC	Alpha ("AAA")	20	EVC classification based on pre-1750 mapping in Taranto and Oates (2000)
5	Dominant Indigenous Species	DOM_IND_SP	Alpha ("AA" or "Aa" up to 5)	27	Most abundant eucalypt species, shrub species or ground cover
6	Indigenous Tree Health	ITREE_HTH	Numeric ("0")	4	Proportion of eucalypt dieback: 0 to 100%
7	Human Occupation	HUM_OCC	Numeric ("0")	6	Amount of human occupation based on a combination of allotment size and numbers of residences
8	Exotic Tree/Shrub Cover	ETREE_COV	Numeric ("0")	8	Exotic tree and/or shrub cover: 0 to 100%
				85	

Note: * = primary variables

Table 5.2: Risk of decline classification matrix showing definitions based on Indigenous Tree Cover and Indigenous Vegetation Modification.

Category	ITREE_COV*		IVEG_MOD*		Explanation	Rate of Decline
Serious Risk	>/=	4	<	4	Greater than equal to 5% PCC in Primarily or Entirely Modified condition	Rapid
At Risk	>/=	4	=	4	Greater than equal to 5% PCC in Substantially Modified condition	Moderate
Least Concern	>/=	4	>	4	Greater than equal to 5% PCC in Partially or Low Modified condition	Slow, negligible or zero
Non-vegetation	<	4	<	4	Less than 5% PCC in Primarily or Entirely Modified condition	Not Applicable

Note: * = Primary Variables. See Map 5.13

Table 5.3: Biosites delineation matrix showing definitions of Core and Buffer habitat based on Indigenous Tree Cover.

Category	ITREE_COV*		IVEG_MOD*		Explanation	BIOSITES
Buffer	=	4	<	5	5% to 25% PCC in up to Substantially Modified condition	Buffer area
Core	>	4	>	1	>25% PCC in less than Entirely Modified (Urban) condition	Biosites
	=	2 & 3			Indigenous grassland or shrubland	
Non-vegetation	=	1	<	4	<5% PCC in less than Substantially Modified condition	N/A

Note: * = Primary Variables; Shading denotes all Biosites. See Map 5.11

Table 5.4: Landscape Unit results

Categories*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)
Cleared	7	15.93	0.1	2.28
Exotic	551	5004.03	44.4	9.08
Indigenous	819	2790.29	24.8	3.41
Non-vegetation	139	3332.84	29.6	23.98
Revegetation	79	121.49	1.1	1.54
	1595	11264.58	100.0	7.06

Note: * = See Appendix 5.1 for Category definitions. See Map 5.2

Table 5.5: Indigenous Tree Crown Cover results and geographic spread

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (Ha)	West (%Area)	East (%Area)
Treeless	607	7040.84	62.5	11.60	44.8	17.7
Indigenous Shrubland	28	124.58	1.1	4.45		
Indigenous Grassland	14	19.53	0.2	1.39		
Sparse	169	1432.81	12.7	8.48	3.9	33.6
Moderate	190	627.28	5.6	3.30		
High	409	1272.15	11.3	3.11		
Very High	178	747.40	6.6	4.20		
	1595	11264.58	100.0	7.06		100.0

Note * = See Appendix 5.1 for Category definitions. See Map 5.3. Shading denotes the relative proportion of treeless and at least sparse canopy cover west and east of the Mullum Mullum Creek.

Table 5.6: Indigenous Vegetation Modification results and habitat spread

Categories*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Non-vegetation (%Area)	Buffer (%Area)	Core (%Area)
Entirely (Urban/Industrial)	208	3875.10	34.4	18.63	93	7	-
Primarily (Urban/Residential)	165	2223.13	19.7	13.47	60	29	11
Primarily (Agricultural/Non-residential)	611	3001.39	26.6	4.91	71	16	13
Significantly	348	944.89	8.4	2.72	-	2	98
Partially	202	672.14	6.0	3.33	-	-	100
Low	61	547.92	4.9	8.98	-	-	100
	1595	11264.58	100.0	7.06			

Note * = See Appendix 5.1 for Category definitions. See Map 5.4. Shading denotes proportion in each category across habitat types.

Table 5.7: EVC results – Bioregional Conservation Status

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Gippsland Plains (%)	Highlands – Southern Fall (%)
Endangered	222	521.66	4.6	2.35	49.47	8.33
Vulnerable	291	830.16	7.4	2.85	7.33	20.99
Depleted	1	2.49	0.0	2.49	-	0.07
Least Concern	283	1355.10	12.0	4.79	-	35.56
Not Applicable#	191	1514.32	13.4	7.93	43.20	35.06
Non-Vegetation	607	7040.84	62.5	11.60	N/A	N/A
	1595	11264.58	100.0		412.63	3811.10
	Percentage of study area				9.77	90.23
	Percentage of Bioregion				9.45	55.36

= Not Applicable refers to Unclassified Buffer and Core Habitat; * = See Appendix 5.1 for Category definitions. See Map 5.7. Shading denotes proportion in each category across Bioregions.

Table 5.8: EVC results – extant by Indigenous Vegetation Modification

EVC		Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Entirely (Urban/Industrial)	Primarily (Urban/Residential)	Primarily (Agricultural /Non-residential)	Significantly	Partially	Low
1	**Non-vegetation**	607	7040.84	62.50	11.60	51.0	18.8	30.2	-	-	-
2	**Buffer Habitat; Unclassified**	169	1433.46	12.73	8.48	20.1	45.3	33.5	1.2	-	-
3	**Core Habitat; Unclassified**	22	80.87	0.72	3.68	-	-	26.9	52.4	20.8	-
18	**Riparian Forest**	60	211.79	1.88	3.53	-	-	10.7	59.0	26.6	3.7
22	**Grassy Dry Forest**	188	1082.77	9.61	5.76	-	12.6	10.7	24.8	16.6	35.3
23	**Herb-rich Foothill Forest**	40	81.34	0.72	2.03	-	-	13.7	20.9	53.3	12.1
47	**Valley Grassy Forest**	286	809.36	7.19	2.83	-	6.5	18.7	27.5	35.5	11.8
55	**Plains Grassy Woodland**	10	9.39	0.08	0.94	-	-	77.1	22.9	-	-
56	**Floodplain Riparian Woodland**	27	65.05	0.58	2.41	-	-	17.6	69.8	12.6	-
68	**Creekline Grassy Woodland**	4	11.79	0.10	2.95	-	-	1.4	98.6	-	-
83	**Swampy Riparian Woodland**	1	2.49	0.02	2.49	-	-	-	100.0	-	-
126	**Swampy Riparian Complex**	11	13.42	0.12	1.22	-	-	30.6	69.4	-	-
127	**Valley Heathy Forest**	33	110.34	0.98	3.34	-	46.5	9.7	23.5	9.1	11.2
164	**Creekline Herb-rich Woodland**	116	252.36	2.24	2.18	-	3.8	14.3	51.7	14.5	15.7
172	**Floodplain Wetland Complex**	9	11.75	0.10	1.31	-	-	-	100.0	-	-
175	**Grassy Woodland**	0	0.00	0.00	0.00	-	-	-	-	-	-
641	**Riparian Woodland**	1	0.86	0.01	0.86	-	-	-	100.0	-	-
895	**Escarpment Shrubland**	9	45.93	0.41	5.10	-	-	-	27.2	72.8	-
937	**Swampy Woodland**	2	0.77	0.01	0.38	-	-	16.6	83.4	-	-
		1595	11264.58	100.00	7.06						

See Map 5.5. Shading denotes all combinations of EVCs and Indigenous Modification Index

Table 5.9: EVC results – extant by MCC Conservation Status and Biophysical (Habitat) Regions.

EVC		Pre 1750 Area (ha)	Extant Area (ha)	Extant (%)	MCC Status	*Ruffey/Koonung Low Hills	*Lower Yarra Low Hills	*Warrandyte Hills	*Middle Yarra Floodplains and Low Hills	*Lower Yarra Floodplain
						1	2	3	4	5
1	Non-vegetation	0	7040.8	NA	NA	-	-	-	-	-
2	Buffer-Unclassified	0	1433.5	NA	NA	-	-	-	-	-
3	Core-Unclassified	0	80.9	NA	NA	-	-	-	-	-
18	Riparian Forest	363.4	211.8	58.3	Vulnerable	85.8	-	54.3	-	36.4
22	Grassy Dry Forest	3360.7	1082.8	32.2	Least Concern	-	-	32.2	-	-
23	Herb-rich Foothill Forest	148.9	81.3	54.6	Vulnerable	-	-	53.3	-	-
47	Valley Grassy Forest	2430.4	809.4	33.3	Least Concern	3.9	-	37.0	1.6	-
55	Plains Grassy Woodland	871.9	9.4	1.1	Endangered	-	1.0	0.0	-	-
56	Floodplain Riparian Woodland	271.1	65	24	Vulnerable	-	-	5.7	-	21.4
68	Creekline Grassy Woodland	37.2	12.6	34	Endangered	-	31.7	-	-	-
83	Swampy Riparian Woodland	21.8	2.5	11.4	Endangered	-	-	-	11.4	-
126	Swampy Riparian Complex	199.4	13.4	6.7	Endangered	7.0	-	-	0.0	-
127	Valley Heathy Forest	2668.9	110.3	4.1	Endangered	3.5	-	75.4	-	-
164	Creekline Herb-rich Woodland	783.4	252.4	32.2	Vulnerable	-	-	31.9	0.0	-
172	Floodplain Wetland Complex	15.2	11.8	77.5	Endangered	-	-	-	-	77.2
175	Grassy Woodland	37.5	0	0	Extinct	0.0	-	-	-	-
641	Riparian Woodland	7.3	0.9	11.8	Endangered	-	10.1	-	-	-
895	Escarpment Shrubland	4.8	45.9	957.3	Least Concern	-	-	940.7	-	-
937	Swampy Woodland	22	0.8	3.5	Endangered	3.5	-	-	-	-
			11264.6							

Note: * = Indicative figures only. Shading denotes depletion levels for each EVC in each Biophysical (Habitat) Region.

Table 5.10: EVC results – extant Conservation Status by Bioregion within Port Phillip CMA.

EVC		Bioregion	EVC Bior. Cons Status	Pre1750 Area (ha) (a)	Total Cons. (c)	Total Extant Area (ha) (b)	Extant /Pre1750 (%) (b/a)	Con Res /Extant (%) (c/b)
18	**Riparian Forest***	GP	V	1,435	91	411	29%	22%
		HLSF	LC	15,989	4,799	9,900	62%	48%
22	**Grassy Dry Forest**	GP	LC	438	0	12	3%	0%
		HLSF	LC	24,008	1,785	12,221	51%	15%
23	**Herb-rich Foothill Forest***	GP	V	9,454	267	2,003	21%	13%
		HLSF	LC	24,553	5,088	15,982	65%	32%
47	**Valley Grassy Forest**	GP	V	3,011	0	88	3%	0%
		HLSF	V	31,739	647	5,260	17%	12%
55	**Plains Grassy Woodland**	GP	E	18,727	126	764	4%	17%
		HLSF	E	1,865	54	303	16%	18%
56	**Floodplain Riparian Woodland**	GP	E	1,436	0	172	12%	0%
		HLSF	E	1,841	10	296	16%	4%
68	**Creekline Grassy Woodland**	GP	E	730	0	3	0%	0%
		HLSF	E	16	0	0	0%	0%
83	**Swampy Riparian Woodland***	GP	E	13,286	259	1,522	11%	17%
		HLSF	D	2,150	188	1,762	82%	11%
126	**Swampy Riparian Complex**	GP	E	12,971	80	464	4%	17%
		HLSF	E	18,618	25	794	4%	3%
127	**Valley Heathy Forest**	GP	E	18,842	0	403	2%	0%
		HLSF	E	496	6	82	16%	7%
164	**Creekline Herb-rich Woodland**	GP	E	247	4	38	15%	10%
		HLSF	E	6,356	45	625	10%	7%
172	**Floodplain Wetland Complex**	GP	E	49	0	37	76%	0%
		HLSF	E	NA	0	2	NA	0%
175	**Grassy Woodland***	GP	E	55,245	207	2,637	5%	8%
		HLSF	D	2,954	1	114	4%	1%
641	**Riparian Woodland***	GP	E	89	0	3	3%	0%
		HLSF	NA	NA	NA	NA	NA	NA
895	**Escarpment Shrubland**	GP	E	40	0	16	39%	0%
		HLSF	E	236	13	209	89%	6%
937	**Swampy Woodland***	GP	E	5,993	34	946	16%	4%
		HLSF	V	162	13	247	NA	5%

*Note: Shading denotes those EVCs with a different Conservation Status within the two relevant Bioregions
Bioregion: GP = Gippsland Plains; HLSF = Highlands – Southern Fall
EVC Bior. Cons. Status: E = Endangered; V = Vulnerable; D = Depleted; LC = Least Concern; NA = Not Applicable.

Table 5.11: Indigenous Tree Health results

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)
Non-vegetation	607	7040.84	62.5	11.60
Poor	95	302.00	2.7	3.18
Fair	529	1731.51	15.4	3.27
Good	153	615.43	5.5	4.02
Unclassified	211	1574.80	14.0	7.46
	1595	11264.58	100.0	7.06

Note * = See Appendix 5.1 for Category definitions. See Map 5.8

Table 5.12: Human Occupation results.

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Non-vegetation (%Area)	Buffer (%Area)	Core (%Area)
Urban/Industrial	176	3542.41	31.4	20.13	50	3	0
Light urban	89	1778.94	15.8	19.99	14	46	5
Low density residency	124	875.98	7.8	7.06	5	17	10
Scattered residences	115	1152.88	10.2	10.03	9	18	8
Adjacent residences	604	1780.80	15.8	2.95	11	9	31
Unoccupied/Large	487	2133.57	18.9	4.38	11	8	45
	1595	11264.58	100.0	7.06	100	100	100

Note * = See Appendix 5.1 for Category definitions. Shading denotes the proportion of each category across habitat types. See Map 5.9

Table 5.13: Exotic Tree Cover results

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Non-vegetation (%Area)	Buffer (%Area)	Core (%Area)
No/Few Exotic Trees	702	5511.66	48.9	7.85	51	13	61
Exotic Shrubs	2	2.80	0.0	1.40	0	0	0
Exotic Grassland	162	1214.81	10.8	7.50	17	0	0
Sparce ETC &/or Grassland	465	3268.94	29.0	7.03	20	68	32
Moderate ETC	140	862.21	7.7	6.16	6	16	7
High ETC	98	370.21	3.3	3.78	5	2	0
Very High ETC	26	33.95	0.3	1.31	0	0	0
	1595	11264.58	100.0		100	100	100

Note * = See Appendix 5.1 for Category definitions. Shading denotes the proportion of each category across habitat types. See Map 5.10. ETC = Exotic Tree Cover.

Table 5.14: Habitat Type results

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)
Non-vegetation	607	7040.84	62.5	11.60
Buffer	169	1433.46	12.7	8.48
Core	819	2790.29	24.8	3.41
	1595	11264.58	100.0	7.06

Note * = See Appendix 5.1 for Category definitions. See Map 5.11

Table 5.15: Biosites results.

	BIOSITES Name	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	N/A	Least Concern	Depleted	Vulnerable	Endangered	Least Concern At Risk	Serious Risk	
0	Non-vegetation	607	7040.84	62.5	11.60	-	-	-	-	-	-	-	-
100	Buffer	169	1433.46	12.7	8.48	100	0	0	0	0	0	0	100
1	Mount Lofty	11	50.82	0.5	4.62	52	22	5	0	21	0	99	1
2	Clifford Park/Bend of Isles	33	158.47	1.4	4.80	7	44	0	31	18	78	15	7
3	Stane Brae/Blue Tongue Bend	86	442.27	3.9	5.14	5	61	0	22	12	77	13	9
4	Black Flat	30	72.41	0.6	2.41	3	56	0	29	12	68	10	22
5	Haslams Track	29	89.92	0.8	3.10	0	60	0	36	5	77	12	12
6	Anzac Road	16	45.87	0.4	2.87	0	34	0	59	7	33	38	29
7	Freyne Street	38	109.79	1.0	2.89	0	57	0	25	18	51	37	12
8	Gatters Road	26	49.24	0.4	1.89	0	22	0	58	19	28	43	29
9	Haven	24	91.70	0.8	3.82	0	43	0	50	7	55	19	26
10	Pound Bend	17	88.35	0.8	5.20	0	68	0	27	5	28	36	36
11	Fourth Hill	55	259.01	2.3	4.71	0	55	0	34	11	71	11	18
12	Grandview Road	34	132.39	1.2	3.89	0	60	0	32	9	28	65	6
13	Minter Court	37	134.16	1.2	3.63	4	44	0	27	25	54	36	10
14	One Hundred Acres	20	45.59	0.4	2.28	5	48	0	27	20	65	31	5
15	Naughton Avenue	7	42.21	0.4	6.03	0	49	0	42	10	67	5	28
16	Mullum Confluence	26	83.89	0.7	3.23	0	54	0	44	1	7	42	51
17	Currawong Reserve	31	99.47	0.9	3.21	2	46	0	43	8	31	47	22
18	Buck Reserve/Donvale Christian School	19	70.04	0.6	3.69	2	66	0	28	4	23	24	53
19	McIntrye Road	18	59.77	0.5	3.32	1	38	0	26	36	14	57	29
20	Rainbow Valley Road	36	123.28	1.1	3.42	1	63	0	24	11	2	76	22
21	Oban Road	28	89.31	0.8	3.19	0	55	0	24	20	1	66	34
22	Hillcrest Reserve/Chaim Court	20	91.55	0.8	4.58	0	0	0	26	74	26	29	44
23	Longridge Farm	6	22.60	0.2	3.77	6	56	0	39	0	0	21	79
24	Tindals Hill	2	9.98	0.1	4.99	0	100	0	0	0	76	24	0
25	Kenilworth Avenue	8	38.08	0.3	4.76	0	81	0	16	3	0	14	86
26	The Vines Hill	15	46.31	0.4	3.09	0	39	0	51	10	7	47	46
27	Andersons Creek/Colman Park	16	48.01	0.4	3.00	0	32	0	34	34	10	47	43
28	Candlebark	23	47.56	0.4	2.07	0	41	0	46	13	11	59	30
29	Westerfolds	18	36.71	0.3	2.04	0	0	0	12	88	0	73	27
30	Ruffey	11	7.35	0.1	0.67	0	0	0	43	57	0	25	75
31	Yarra	34	67.25	0.6	1.98	2	0	0	0	98	12	75	13
32	Koonung	11	8.65	0.1	0.79	0	0	0	0	100	11	61	28
33	Andersons Creek Road	7	6.85	0.1	0.98	0	52	0	48	0	44	56	0
34	Green Gulley	12	11.32	0.1	0.94	5	5	0	64	26	24	11	65
35	Urban Miscellaneous	15	10.13	0.1	0.68	0	0	0	3	97	0	29	71
		1595	11264.58	100.0									

Numbers in shaded columns are proportions of EVCs in categories of Bioregional Conservation Status (light) and Risk Assessment (dark). See Map 5.12

Table 5.16: Risk Assessment results

Category*	Polygon No.	Total Area (ha)	Total Area (%)	Average Polygon Area (ha)	Non-vegetation (%Area)	Buffer (%Area)	Core (%Area)
Non-vegetation	607	7040.84	62.5	11.60	100	0	0
Least Concern	264	1221.41	10.8	4.63	0	0	44
At Risk	351	965.26	8.6	2.75	0	1	34
Serious Risk	373	2037.07	18.1	5.46	0	99	22
	1595	11264.58	100.0		100	100	100

* = See Appendix 5.1 for Category definitions. Shading denotes the proportion of each category across habitat types. See Map 5.13

Table 5.17: Crude Landscape Index calculation

Categories*	Total Area (ha)	Core and Buffer Habitat (%)	Risk	Area (ha)	HaS (ave)	HaHa
Entirely (Urban/Industrial)	3875.10	7.42	N/A	287.53	0.00	0.00
Primarily (Urban/Residential)	2223.13	40.42	SR	898.59	0.10	89.86
Primarily (Agricultural/Non-residential)	3001.39	29.07	SR	872.51	0.10	87.25
Significantly	944.89	100.00	AR	944.89	0.50	472.45
Partially	672.14	100.00	LC	672.14	0.60	403.29
Low	547.92	100.00	LC	547.92	0.75	410.94
	11264.58			4223.58		1463.78

* = See Appendix 5.1 for Category definitions

Table 6.1: EVC sampling statistics calculation

EVC_No	EVC_Name	Q_No	TOT_Taxa	AVE_Taxa	AVE_Alt	ALT_Max	ALT_Min	Date_New	Date_Old
18	**Riparian Forest**	24	289	35.9	58	140	20	2000	1978
22	**Grassy Dry Forest**	73	505	48.5	94	130	40	2000	1978
23	**Herb-rich Foothill Forest**	7	168	45.9	99	115	50	1998	1991
47	**Valley Grassy Forest**	80	494	40.4	72	130	20	2000	1969
55	**Plains Grassy Woodland**	1	46	46.0	27	27	-	1987	-
56	**Floodplain Riparian Woodland**	2	56	34.0	15	20	14	1995	1987
68	**Creekline Grassy Woodland**	1	48	48.0	20	48	-	1987	-
83	**Swampy Riparian Woodland**	0	-	-	-	-	-	-	-
126	**Swampy Riparian Complex**	10	193	40.2	91	63	7	1999	1989
127	**Valley Heathy Forest**	27	344	59.6	97	130	60	1999	1978
164	**Creekline Herb-rich Woodland**	22	260	39.8	76	120	35	1998	1978
172	**Floodplain Wetland Complex**	3	62	26.0	16	20	14	1994	1990
175	**Grassy Woodland**	0	-	-	-	-	-	-	-
641	**Riparian Woodland**	0	-	-	-	-	-	-	-
895	**Escarpment Shrubland**	3	97	37.3	60	100	40	1991	1979
937	**Swampy Woodland**	0	-	-	-	-	-	-	-
		253							

Table 6.2: EVC typicality within Port Phillip and Westernport CMA.

EVC No	EVC Name	Typicality*
18	Riparian Forest	Yes
22	Grassy Dry Forest	Yes
23	Herb-rich Foothill Forest	Dry variant
47	Valley Grassy Forest	Dry variant
55	Plains Grassy Woodland	Too degraded
56	Floodplain Riparian Woodland	Yes
68	Creekline Grassy Woodland	Too degraded
83	Swampy Riparian Woodland	Yes
126	Swampy Riparian Complex	Not possible or too degraded
127	Valley Heathy Forest	Yes
164	Creekline Herb-rich Woodland	Yes
172	Floodplain Wetland Complex	Yes
175	Grassy Woodland	Extinct
641	Riparian Woodland	Too degraded
895	Escarpment Shrubland	Dry variant
937	Swampy Woodland	Too degraded

*Typicality refers to how closely the vegetation present within the study area accords with the general EVC descriptions in Oates and Taranto (2001). See Appendix 6.2; Sect. 6.

Table 6.3: Vascular plant richness by Division.

DIVISIONNAME	FAMILY No	Taxa No	Indigenous Taxa No	Exotic Taxa No	Naturalised Taxa No	Unclassified Taxa No	VROT	AROT
Monocotyledons	26	385	274	111	0	43	21	7
Gymnosperms	2	2	0	2	0	1	0	0
Ferns and fern allies	13	25	25	0	0	1	0	0
Dicotyledons	83	686	418	251	17	79	13	5
All Vascular Divisions	124	1098	717	364	17	124	34	12

See Appendix 6.1 for definitions.

Table 6.4: Vascular plant richness by Family.

DIVISIONNAME	FAMILYNAME	Taxa No	Indigenous Taxa No	Exotic Taxa No	Naturalised Taxa No	Unclassified Taxa No	VROT	AROT
Monocotyledons	Poaceae	139	70	69	0	16	1	1
Dicotyledons	Asteraceae	102	70	32	0	12	0	0
Monocotyledons	Orchidaceae	74	74	0	0	9	12	4
Dicotyledons	Fabaceae	64	32	31	1	7	1	0
Monocotyledons	Cyperaceae	43	38	5	0	3	5	0
Dicotyledons	Myrtaceae	41	34	3	4	3	1	0
Dicotyledons	Mimosaceae	37	25	5	7	1	2	4
Dicotyledons	Rosaceae	31	7	24	0	8	0	0
Monocotyledons	Juncaceae	27	22	5	0	2	0	0
Dicotyledons	Polygonaceae	22	11	11	0	3	0	0
Monocotyledons	Iridaceae	18	2	16	0	4	0	0
Dicotyledons	Scrophulariaceae	18	9	9	0	2	0	0
Dicotyledons	Apiaceae	17	12	5	0	1	0	0
Dicotyledons	Brassicaceae	16	6	10	0	4	3	1
Dicotyledons	Ranunculaceae	16	11	5	0	1	0	0
Monocotyledons	Phormiaceae	15	14	1	0	1	3	2
Dicotyledons	Geraniaceae	14	12	2	0	2	2	0
Dicotyledons	Rubiaceae	14	9	5	0	1	0	0
Dicotyledons	Lamiaceae	13	7	6	0	1	0	0
Dicotyledons	Campanulaceae	11	11	0	0	1	0	0
Dicotyledons	Haloragaceae	11	11	0	0	2	0	0
Dicotyledons	Oxalidaceae	11	6	5	0	1	0	0
Monocotyledons	Anthericaceae	10	10	0	0	2	0	0
Dicotyledons	Proteaceae	10	8	1	1	1	0	0
Monocotyledons	Xanthorrhoeaceae	10	10	0	0	0	0	0
Other (99 Families < 9 taxa)		99	314	196	114	4	36	4	0
Totals		124	1098	717	364	17	124	34	12

Note: AROT and VROT categories includes incidental (non-FIS) records, but excludes any MCC naturalised taxa or those considered locally extinct listed in Appendix 6.3. See Appendix 6.1 for definitions.

Table 7.1: Vertebrate fauna (Wildlife Atlas) richness by group

Group	MCC SP_No	VROT	OR	FFG	ESP (AROT)	TR	MCC Records	MCC+1km SP_No	MCC+1km Records
Bird	146	12	13	7	2	2	12028	154	23317
Bird, Water	52	15	1	6	0	5	1393	59	3837
Bird, Nesting (territorial)	18	5	0	3	0	0	411	18	823
Bird Total	216	32	14	16	2	7	13832	231	27977
Mammal	28	6	7	1	0	0	1006	31	1645
Reptile	29	7	0	0	0	0	293	30	511
Fish	21	6	7	5	2	0	444	25	852
Amphibian	16	2	0	1	1	0	377	17	592
Bat	15	5	0	1	1	0	128	15	360
Invertebrate (Atlas)	4	0	0	0	0	0	42	5	97
	329	58	28	24	6	7	16122	354	32034

See Appendix 7.2 for definitions.

Table 8.1: Sites selected for bryophyte survey organised by EVC and Indigenous Vegetation Modification

Category 6	**Category 5**	**Category 4**	**Category 3**	**Category 2**	**Indigenous Vegetation Modification**
Low	Partial	Substantial	Primarily (Agri)	Primarily (Res)	EVC
Stane Brae/Blue Tongue Bend (3)	Freyne Street (7)	100 Acres (14) Minter Court/Stintons Reserve (13) Freyne Street (7)	Black Flat (4)	Haven (9)	Creekline Herb-rich Woodland (EVC 164)
Pound Bend (10)	Pound Bend (10) Clifford Park/Bend of Isles (2) Naughton Avenue (15)	Mount Lofty (1) Pound Bend (10)	none available	none available	Escarpment Shrubland (EVC 895)
100 Acres (14) Minter Court/Stintons Reserve (13) Haven (9)	Haven (9) Minter Court/Stintons Reserve (13) Freyne Street (7)	Minter Court/Stintons Reserve (13) Freyne Street (7)	Kenilworth Avenue Hill (25)	Andersons Creek/Colman Park (27) Haven (9) Kenilworth Avenue Hill (25)	Grassy Dry Forest (EVC 22)
Black Flat (4) Freyne Street (7) Haven (9)	Freyne Street (7) Haven (9)	Mt Lofty (1) Haven (9)	Kenilworth Avenue Hill (25)	none available	Herb-rich Foothill Forest (EVC 23)
Freyne Street (7)	Haslams Track (5)	Pound Bend (10) Hillcrest Reserve/Chaim Court (22)	Pound Bend (10) Mullum Confluence (16)	none available	Riparian Forest (EVC 18)
none available	none available	Andersons Creek/Colman Park (27) Hillcrest Reserve/Chaim Court (22)	none available	none available	Swampy Riparian Complex (EVC 126)
none available	none available	Mt Lofty (1)	none available	none available	Swampy Riparian Woodland (EVC 83)
Minter Court/Stintons Reserve (13)	100 Acres (14) Freyne Street (7)	100 Acres (14)	Haven (9)	Andersons Creek/Colman Park (27)	Valley Grassy Forest (EVC 47)
Hillcrest Reserve/Chaim Court (22)	Hillcrest Reserve/Chaim Court (22)	Minter Court/Stintons Reserve (13) Hillcrest Reserve/Chaim Court (22)	Minter Court/Stintons Reserve (13)	Andersons Creek/Colman Park (27) Hillcrest Reserve/Chaim Court (22)	Valley Heathy Forest (EVC 127)

Numbers in Brackets represent Biosite Numbers. Note: Shading denotes sampling was undertaken.

Table 8.2: Summary of bryophyte species richness patterns by EVC and Indigenous Vegetation Modification

	EVC No	18	22	23	47	83	126	127	164	895
	EVC	RF	GDF	HFF	VGF	SRW	SRC	VHF	CHW	ES
	IVEG_MOD	6543	65432	6543	65432	4	4	65432	65432	654
Bryophyta (Mosses)										
Totals		43	26	3	30	2	3	21	22	14
Low (6)		23	22	3	9	-	-	18	14	14
Partial (5)		19	14	3	23	-	-	5	17	1
Substantial (4)		20	7	1	9	2	3	7	4	1
Primary (Ag) (3)		3	9	0	6	-	-	1	1	-
Primary (Res) (2)		-	5	-	2	-	-	0	0	-
Marchantiophyta (Liverworts)										
Totals		12	3	1	8	3	3	2	6	4
Low (6)		10	3	1	6	-	-	2	6	4
Partial (5)		3	0	1	6	-	-	2	2	0
Substantial (4)		4	0	0	3	3	3	1	1	0
Primary (Ag) (3)		1	0	0	2	-	-	0	1	-
Primary (Res) (2)		-	0	-	1	-	-	0	0	-
Bryophytes (combined)										
Totals		55	29	4	38	5	6	23	28	18
Low (6)		33	25	4	15	-	-	20	20	18
Partial (5)		22	14	4	29	-	-	7	19	1
Substantial (4)		24	7	1	12	5	6	8	5	1
Primary (Ag) (3)		4	9	0	8	-	-	1	2	-
Primary (Res) (2)		-	5	-	3	-	-	0	0	-

See Sect. 6 for EVC definitions and Sect. 8 for Bryophyte details

Table 8.3: Indigenous bryophytes expected for vegetation within the study area but not recorded

Bryophyta (Mosses)	**Marchantiophyta (Liverworts)**
Atrichum androgynum	*Bazzania adnexa*
Bartramia stricta	*Chaetophyllopsis whiteleggei*
Calyptopogon mnioides	*Cheilolejeunea mimosa*
Campylopus australis	*Chiloscyphus pallida*
Campylopus pyriformis	*Chiloscyphus villosus*
Catagonium nitens	*Heteroscyphus coalitus*
Distichophyllum crispulum	*Hyalolepidozia longiscypha*
Ditrichum cylindricarpum	*Lejeunea drummondii*
Fissidens linearis	*Lepidozia laevifolia*
Fissidens pallidus	*Lepidozia ulothrix*
Fallaciella gracilis	*Phaeoceros laevis*
Gigaspermum repens	*Megaceros gracilis*
Goniomitrium acuminatum	*Riccardia bipinnatifida*
Hedwigium integrifolium	*Siphonolejeunea nudipes*
Marchantia berteroana	*Riccardia crassa*
Mittenia plumula	*Symphyogyna podophylla*
Orthodontium lineare	*Telaranea centipes*
Philonotis tenuis	*Zoopsis argentea*
Plagiothecium denticulatum	
Pleuridium nervosum	
Pogonatum subulatum	
Tayloria octoblepharum	
Telaranea centipes	
Tortula muralis	
Tortula truncata	
25 species	**18 species**

See Sect. 8 for Bryophyte details

Table 9.1: Summary of macrofungi flora by major group including Conservation Status within study area.

	Group	Taxa	Genera	Families	Exotic	Described	Undescribed	Unclassified	Common	Uncommon	Rare	Endemic to Manningham?
1	**Cantherelloid fungi**	1	1	1	0	1	0	0	0	1	0	0
2	**Chamois-like fungi**	1	1	1	0	1	0	0	0	1	0	0
3	**Coral fungi**	19	6	2	0	17	0	2	4	12	4	0
4	**Cup fungi and relatives**	30	21	1	0	26	0	4	6	17	8	0
5	**Fleshy pore fungi**	16	10	3	0	11	0	5	1	10	6	0
6	**Fungi with gills**	284	62	15	3	152	22	110	52	179	63	9
7	**Jelly fungi**	12	7	4	0	8	0	4	3	8	2	0
8	**Leather/shelf fungi**	14	7	1	0	9	0	5	7	5	2	0
9	**Puff-balls**	9	5	2	0	5	0	4	8	3	0	0
10	**Slime Moulds**	2	1	1	0	2	0	0	0	2	0	0
11	**Spine fungi**	4	3	1	0	2	0	2	1	3	0	0
12	**Stinkhorns**	3	3	2	0	3	0	0	0	1	2	0
13	**Truffles**	1	1	1	0	0	0	1	0	1	0	0
14	**Woody pore fungi**	24	16	1	0	16	0	8	4	11	9	0
	Totals	420	144	36	3	253	22	145	86	254	96	9

Note: Underlined data incomplete. See Sect. 9.

Table 10.1: Ant functional Groups.

Ant functional group	Relevant features
Dominant Dolicherinae (DD)	Highly abundant, active and aggressive in hot and open habitats; able to monopolise resources and exert a strong competitive influence on other ants. Often absent from heavily shaded sites.
Associated subordinate Camponotinae (ASC)	Always co-occurring with Dominant Dolicherinae to which they are competitively subordinate, but can be competitively dominant in their absence. Despite their ubiquity and richness, their relative abundance in any community is generally low. Large body size, and often nocturnal foraging.
Hot climate specialists (HCS)	Arid-adapted species with behavioural and morphological specialisations which enable co-existence with *Iridomyrmex.*
Cold climate specialists (CCS)	Restricted to cool and wet regions where the abundance of Dominant Dolicherinae is generally not high.
Cryptic species (CS)	Foraging exclusively within soil and litter, and therefore probably have little interaction with other ants.
Opportunists (O)	Extremely unspecialised behaviour; poor competitors. Characteristic of sites where stress or disturbance severely limit ant productivity and diversity. Strongly influenced by competition from other ants.
Generalised myrmecines (GM)	Unspecialised behaviour, but successful competitors due to rapid recruitment and effective defences of clumped food resources. Three cosmopolitan genera, *Pheidole, Monomorium* and *Crematogaster*, are ubiquitous and often highly abundant.
Specialist predators (SP)	Unlikely to interact much with other ants because of large body size, low population densities and/or specialised diet.

See Sect. 9 for Invertebrate details

Table 10.2: Sampling matrix for invertebrate survey.

Indigenous Vegetation Modification	Category 5 and 6	Category 4	Category 3 and 2	Category 1
EVC	Low to Partial	Substantial	Primarily (Ag and Res)	
Grassy Dry Forest (EVC 22)	Stane Brae/Blue Tongue Bend (Biosite 3) (Field site 19)	Fourth Hill (Biosite 11) (Field site 7)	Oban Road (Biosite 21) (Field site 18) Candlebark (Biosite 28) (Field site 3)	-
Riparian Forest (EVC 18)	Black Flat (Biosite 4) (Field site 1)	Gatters Road (Biosite 8) (Field site 8)	Oban Road (Biosite 21) (Field site 10) Ruffey (Biosite 30) (Field site 15)	-
Creekline Herb-rich Woodland (EVC 164)	Stane Brae/Blue Tongue Bend (Biosite 3) (Field site 20)	Fourth Hill (Biosite 11) (Field site 6)	Oban Road (21) (Field site 17)	-
Valley Heathy Forest (EVC 127)	Hillcrest Reserve/Chaim Court (Biosite 22) (Field site 11)	Minter Court/Stintons Reserve (Biosite 13) (Field site 12)	Ruffey (Biosite 30) (Field site 16)	-
Valley Grassy Forest (EVC 47)	Black Flat (Biosite 4) (Field site 2)	100 Acres (14) (Field site 13) Candlebark (Biosite 28) (Field site 4)	Gatters Road (Biosite 8) (Field site 9)	-
Non-vegetation (Urban garden)	-	-	-	N/A Doncaster (Field site 5)
Non-vegetation (Exotic grassland)	-	-	N/A Ruffey Lake (Field site 14)	-
Non-vegetation (Grazed exotic grassland)	-	-	N/A Wonga Park (Field site 21)	-

See Sect. 9 for Invertebrate details

Table 10.3: Field sampling location details for invertebrate survey.

Biosite No	Field Site No		Location	Latitude-Longitude	EVC
4	1	A	Black Flat	37°44.952'S 145°17.129'E	RF
4	2	B	Black Flat	37°44.247'S 145°14.113'E	VGF
28	3	C	Candlebark	37°44.471'S 145°08.712'E	GDF
28	4	D	Candlebark	37°44.375'S 145°08.809'E	VGF
N/A	5	E	Doncaster urban garden	37°47.386'S 145°07.921'E	Non-veg
11	6	F	Fourth Hill	37°45.208'S 145°13.180'E	CHW
11	7	G	Fourth Hill (nr Tunnel St)	37°44.831'S 145°13.167'E	GDF
8	8	H	Gatters. 192-194 Brysons Rd	37°45.411'S 145°15.320'E	RF
8	9	I	Gatters. 192-194 Brysons Rd	37°45.420'S 145°15.210'E	VGF
22	10	J	Heads, 43A Heads Rd, Donvale	37°47.695'S 145°12.071'E	RF
22	11	K	Hillcrest	37°48.199'S 145°11.919'E	VHF
13	12	L	Minter Court, 101-107 Knees Rd	37°46.117'S 145°12.907'E	VHF
14	13	M	One Hundred Acres	37°46.609'S 145°13.646'E	VGF
N/A	14	N	Exotic grassland, Ruffey Lake	37°46.528'S 145°08.276'E	Non-veg
14	15	O	Ruffey	37°46.672'S 145°08.285'E	RF
14	16	P	Ruffey	37°46.554'S 145°08.266'E	VHF
21	17	Q	Smedley, 81 Smedley, Park Orchards (Oban)	37°47.473'S 145°12.880'E	CHW
21	18	R	Smedley, 92-94 Semedley, Park Orchards (Oban)	37°47.400'S 145°12.785'E	GDF
3	19	S	Stane Brae	37°43.439'S 145°15.079'E	GDF
3	20	T	Stane Brae	37°43.402'S 145°15.202'E	CHW
N/A	21	U	Rural grazed grassland, Wonga Park	37°44.924'S 145°17.141'E	Non-veg

See Sect. 9 for Invertebrate details

Table 10.4: Ordinal data from pitfall traps.

Taxa	All invertebrates		Relevant invertebrates	
	Total number individuals	Percentage Composition	Total number individuals	Percentage composition
Gastropoda	12	0.17	12	0.27
Scorpionida	13	0.18	13	0.29
Araneae	219	3.11	219	4.86
Opilionida	6	0.09	6	0.13
Acarina	607	8.63	-	-
Isopoda	587	8.35	587	13.02
Amphipoda	155	2.20	155	3.44
Chilopoda	4	0.06	4	0.09
Symphyla	1	0.01	1	0.02
Diplopoda	118	1.68	118	2.62
Collembola	1563	22.23	-	-
Blattodea	5	0.07	5	0.11
Dermaptera	164	2.33	164	3.64
Orthoptera	3	0.04	3	0.07
Psocoptera	7	0.10	7	0.16
Hemiptera	256	3.64	256	5.68
Thysanoptera	10	0.14	10	0.22
Coleoptera	383	5.45	383	8.49
Diptera	310	4.41	-	-
Lepidoptera	3	0.04	-	-
Hymenoptera: non ants	38	0.54	-	-
Hymenoptera: ants	2567	36.51	2567	56.92
TOTAL	**7031**		**4510**	

See Sect. 9 for Invertebrate details

Table 10.5: Ant species richness by EVC

RF		**CHW**		**VGF**		**GDF**		**VHF**		**Exotic**	
F S No	Sp No.	F S No	Sp No.	F S No	Sp No.	F S No	Sp No.	F S No	Sp No.	F S No	Sp No.
1	12	6	7	2	11	3	18	11	18	5	5
8	5	17	8	4	13	7	14	12	19	14	3
10	8	19	4	9	14	18	13	16	9	21	3
15	6			13	19	20	15				
	7.75 ±3.10		6.33 ±2.08		14.25 ±3.40		15.00 ±2.16		15.33 ±5.51		3.67 ±1.15

FS No = Field site number; Sp No. = Species number; ± = standard deviation (see Table 10.2; 10.3).
See Sect. 9 for Invertebrate details

Table 10.6: Ant functional groups and EVCs

	GDF	**RF**	**CHRW**	**VHF**	**VGF**	**Garden**	**Exotic**	**Grazed**
DD	14.81 %	21.05	10	10.71	12.12	20	33.33	33.33
ASC	7.41	15.79	10	10.71	6.06	0	0	0
HCS	18.52	5.26	5	14.29	15.15	0	0	0
CCS	18.52	21.05	25	21.43	21.21	20	0	0
CS	7.41	5.26	15	10.71	15.15	0	33.33	33.33
O	14.81	10.53	15	17.86	15.15	20	33.33	33.33
GM	14.81	21.05	20	14.29	12.12	40	0	0
SP	3.70	0	0	0	3.03	0	0	0
Sp No.	27	19	20	28	33	5	3	3
Means	**6.75**	**4.75**	**6.67**	**9.33**	**8.25**	**5.0**	**3.0**	**3.0**

See Sect. 9 for Invertebrate details

Table 10.7: Ant functional groups and Indigenous Vegetation Modification

	1	2/3	4	5/6
DD	33.33%	10.81	13.79	11.11
ASC	0	8.11	13.79	11.11
HCS	0	13.51	17.24	14.81
CCS	33.33	18.92	24.14	25.93
CS	0	13.51	17.24	7.41
O	33.33	16.22	13.79	14.81
GM	0	13.51	17.24	14.81
SP	0	5.41	3.45	0
Sp No.	3	37	29	27
Means	**3.00**	**4.11**	**4.83**	**5.4**

See Sect. 9 for Invertebrate details

Table 10.8: Butterfly census during 2003/2004

EVC	BIOSITES	Date	Species
CHW	Oban Road Biosite 21	6 Dec 2003	*Pieris rapae* *Heteronympha merope* *Vanessa kershawi*
CHW	Fourth Hill Biosite 11	28 Feb 2003	*Heteronympha merope*
GDF	Fourth Hill Biosite 11	6 Dec 2003	*Jalmenus evagoras* *Pieris rapae* *Heteronympha merope* *Vanessa kershawi*
GDF	Fourth Hill Biosite 11	13 Dec 2003	*Heteronympha merope* *Vanessa kershawi* *Jalmenus evagoras*
GDF	Fourth Hill Biosite 11	28 Feb 2003	*Jalmenus evagoras*
GDF	Oban Road Biosite 21	6 Dec 2003	*Heteronympha merope* *Vanessa kershawi* *Vanessa itea.*
RF	Black Flat Biosite 4	29 Nov 2003	*Heteronympha merope* *Vanessa kershawi* *Vanessa itea* *Toxidia doubledayi*
RF	Hillcrest Reserve/Chaim Court Biosite 22	13 Dec 2003	*Heteronympha merope* *Vanessa kershawi* *Zizina labradus*
RF	Ruffey Biosite 14	13 Dec 2003	*Pieris rapae* *Heteronympha merope* *Zizina labradus*
RF	Gatters Biosite 8	28 Feb 2004	*Heteronympha merope*
VGF	Black Flat Biosite 4	29 Nov 2003	*Pieris rapae* *Heteronympha merope* *Vanessa kershawi* *Toxidia doubledayi*
VGF	One Hundred Acres Biosite 14	6 Dec 2003	*Pieris rapae* *Heteronympha merope* *Vanessa kershawi*
VHF	Ruffey Biosite 14	13 Dec 2003	*Heteronympha merope* *Zizina labradus* *Pieris rapae* *Vanessa kershawi*
VHF	Minter Court/Stintons Reserve Biosite 13	13 Dec 2003	*Heteronympha merope*
VHF	Gatters Biosite 8	28 Feb 2004	*Heteronympha merope*
Mowed grassland	Ruffey Biosite 14	13 Dec 2003	None
Grazed grassland	Wonga Park N/A	13 Dec 2003	*Zizina labradus*

Table 11.1: Biosites classification summary

BIOSITES	No	Max cited Classification (Bot or Fauna)	Max under current Classification	Ecological integrity and viability (1)	Richness and diversity (2)	Rarity/Conservation status of assets (3)	Representativeness of type (4)	Scientific and educational value (5)
Mount Lofty	1	S	S	S	Nil	R	Nil	S
Clifford Park/Bend of Isles	2	S	N	S	R	S	Nil	N
Stan Brae/Blue Tongue Bend	3	S	N	S	S	S	Nil	N
Black Flat	4	R	S	R	S	S	Nil	R
Haslams Track	5	S	S	L	Nil	S	Nil	R
Anzac Road	6	S	S	L	Nil	S	Nil	Nil
Freyne Street	7	S	S	L	R	S	Nil	Nil
Gatters Road	8	S	S	L	Nil	S	Nil	Nil
Haven	9	S?	S	Nil	Nil	S	Nil	Nil
Pound Bend	10	S	N	R	Nil	S	Nil	N
Fourth Hill	11	S	N	L	Nil	S	Nil	N
Grandview Road	12	R	S	L	Nil	S	Nil	Nil
Minter Court/Stintons Reserve	13	R	S	L	Nil	S	Nil	Nil
One Hundred Acres	14	R	S	Nil	Nil	S	Nil	L
Naughton Avenue	15	S	S	R	Nil	S	Nil	Nil
Mullum Confluence	16	S	S	S	Nil	S	Nil	S
Currawong Reserve	17	R	S	L	Nil	S	Nil	S
Buck Reserve/Donvale Christian School	18	R	S	L	Nil	S	Nil	Nil
McIntyre Road	19	R	S	S	Nil	S	Nil	Nil
Rainbow Valley Road	20	R	S	L	Nil	S	Nil	Nil
Oban Road	21	R	S	L	Nil	S	Nil	S
Hillcrest Reserve/Chaim Court	22	R	S	S	Nil	S	Nil	S
Longridge Farm	23	S	S	S	Nil	R	Nil	Nil
Tindals Hill	24	R	S	Nil	Nil	S	Nil	L
Kenilworth Avenue Hill	25	-	R	L	Nil	R	Nil	Nil
The Vines Hill	26	S	S	Nil	Nil	S	Nil	Nil
Andersons Creek/Colman Park	27	R	S	L	Nil	S	Nil	L
Candlebark	28	S	N	S	Nil	S	Nil	N
Westerfolds	29	R	S	S	Nil	S	Nil	Nil
Ruffey	30	-	R	Nil	Nil	R	Nil	Nil
Yarra	31	S	N	S	Nil	S	Nil	N
Koonung	32	-	R	Nil	Nil	R	Nil	Nil
Andersons Creek Road	33	-	R	Nil	Nil	R	Nil	Nil
Green Gully	34	-	R	Nil	Nil	R	Nil	Nil
Urban miscellaneous	35	-	R	Nil	Nil	R	Nil	Nil

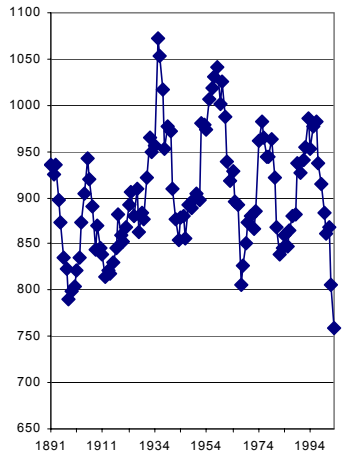
N = National Significance; S = State Significance; R = Regional Significance; L = Local Significance;
Nil = Not Significant; - = classification not undertaken. See Map 5.12; 11.2-11.7.

Figures/Graphs

Figure 2.1: Seven year average annual rainfall data from 6 selected long term, permanent weather stations in and around the study area

(a) Lilydale 1891-2003; (b) Eltham 1912-2003; (c) Warrandyte 1972-2003; (d) Mitcham 1942-2003; (e) Melbourne Regional Office (Lonsdale Street) 1861-2003; (f) Croydon (Council Depot) 1971-2003.

(a)



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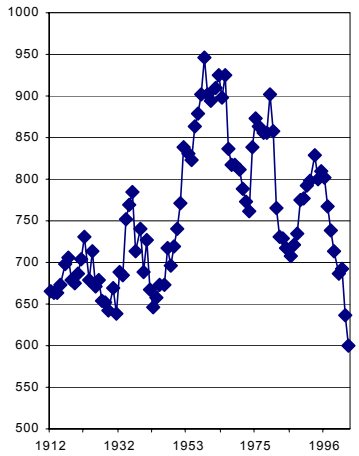
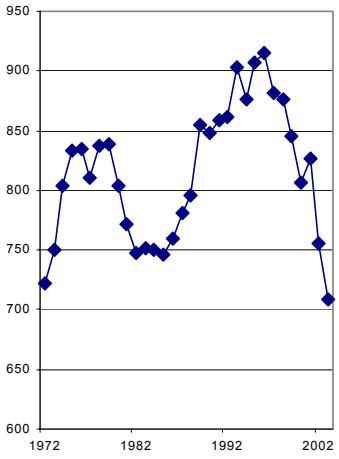
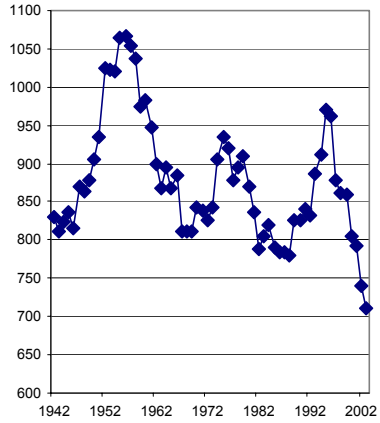


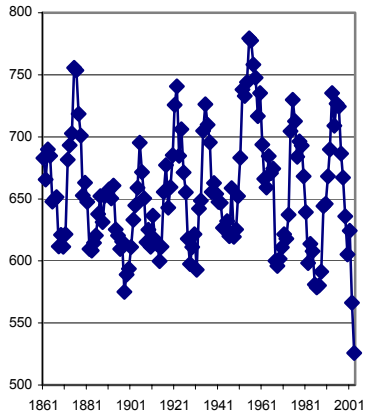
(c)



(d)



(e)



(f)

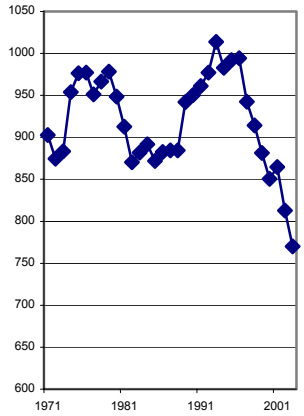


Figure 5.1: Histogram of vegetation polygon size-classes

Showing the relative distribution between Core (Yellow), Buffer (Burgundy) and Non-vegetation (Purple) areas.

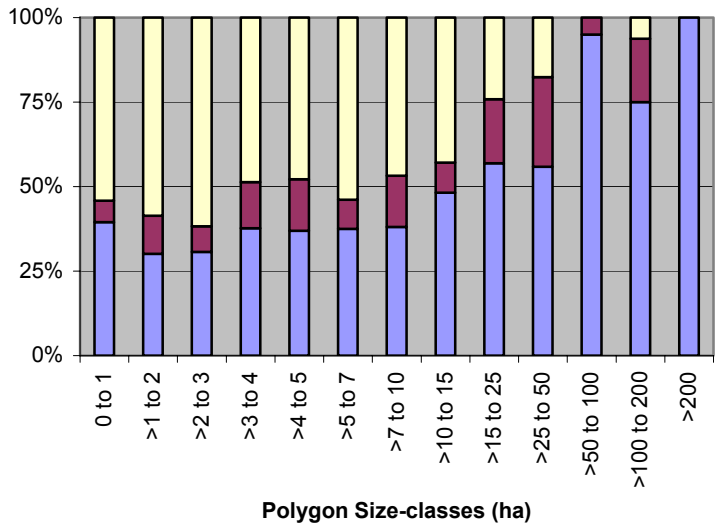


Figure 5.2: Pre-1750 (Blue) and Extant (Purple) EVC coverage

Area in hectares

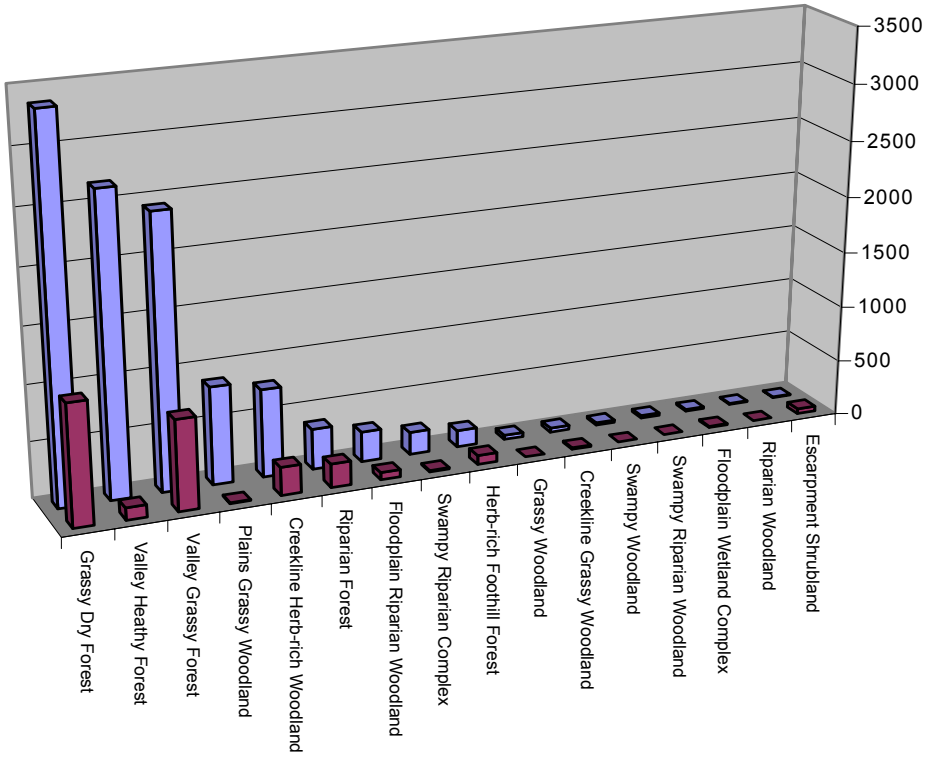


Figure 5.3: Dominant indigenous species frequencies (%) in polygons classified into EVCs

See Appendix 5.1 for species acronym definitions.

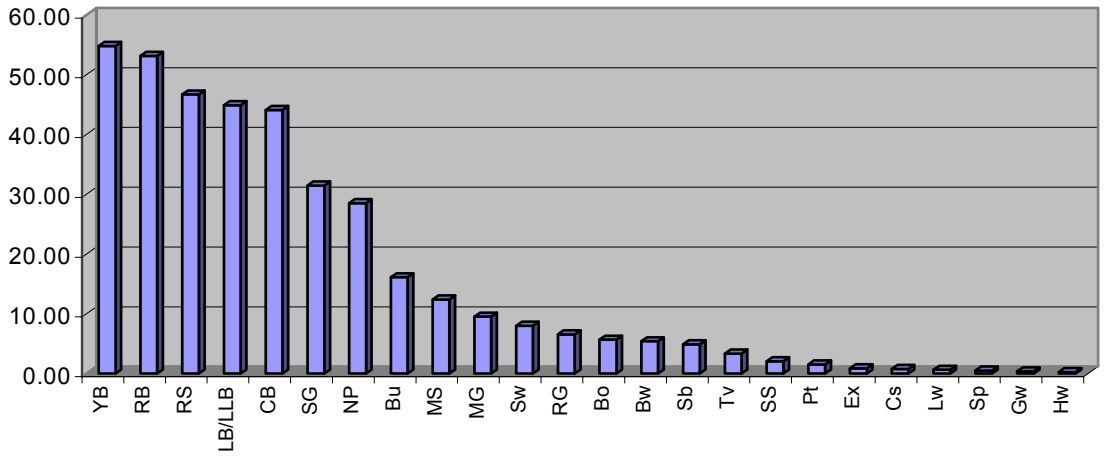


Figure 5.4: Relationship between Biosite area and proportion of habitat at risk or serious risk of immediate decline.

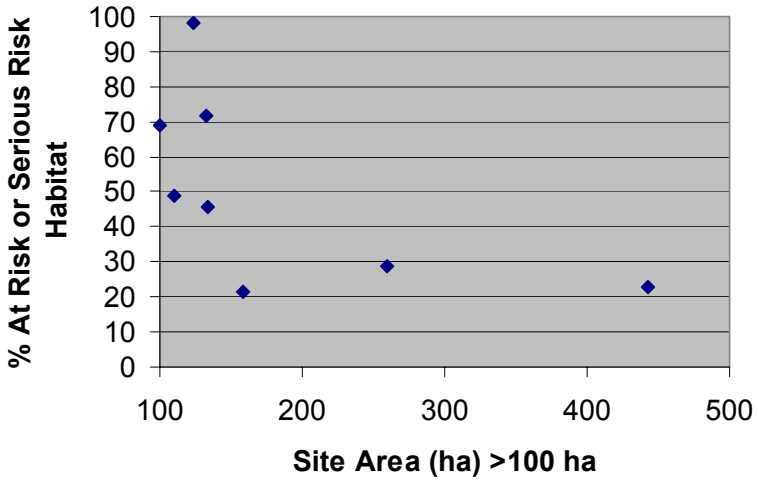


Figure 5.5: Relationship between Biosite area and proportion of habitat at risk or serious risk of immediate decline.

Green line = Net Gain projection; Red Line = Net Loss projection; Black Line = Status Quo projection; Grey line (solid) = Maximum Gain threshold; Grey line (broken) = Maximum Loss threshold

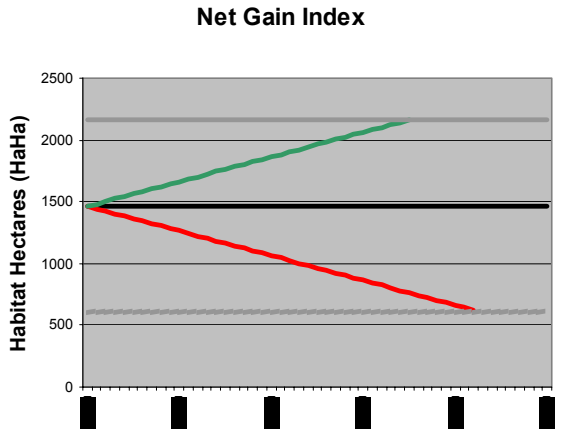


Figure 8.1: Pattern in Bryophyte Species Richness along a modification gradient for selected common EVCs within study area

Riparian Forest (18): diamonds and blue line; Valley Grassy Forest (47): triangles and black line; Creekline Herb-rich Woodland (164): stars and purple line; Grassy Dry Forest (22); squares and green line; Valley Heathy Forest (127): crosses and red line. See Sect. 5 for descriptions of Indigenous Vegetation Modification categories. See Table 8.2 for bryophyte species data.

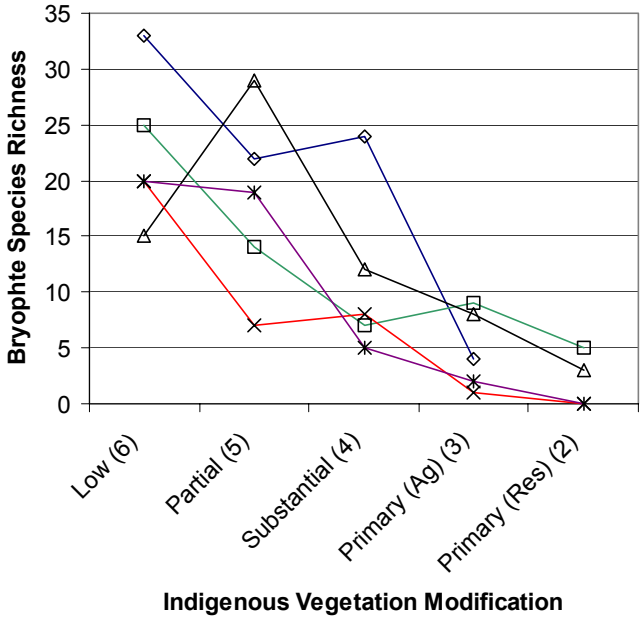


Figure 8.2: Pattern in Bryophyte Species Richness for all EVCs within study area

Liverwort species: squares and purple line; Moss species: diamonds and blue line; All bryophytes: triangles and green line. See Sect. 5 for descriptions of EVCs. See Table 8.2 for bryophyte species data.

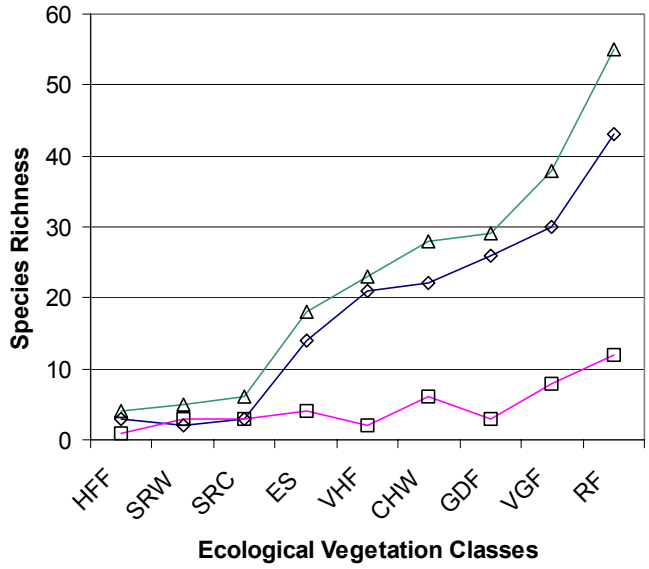


Figure 10.1: Ordination results of insect orders vs. EVC and Indigenous Vegetation index at all sites assessed.

See Table 10.3 for definition of the 21 field sites (A to U). Clusters represent same EVC or vegetation category

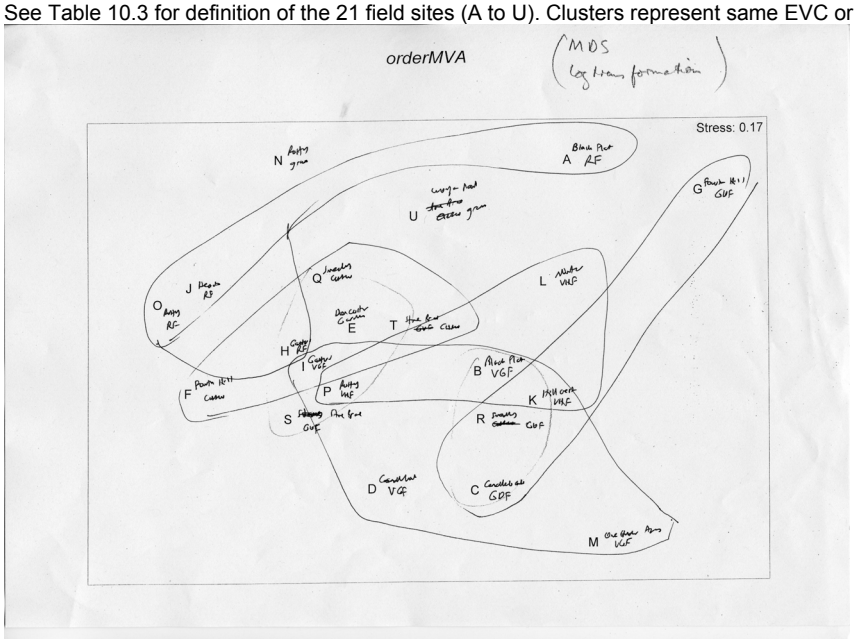


Figure 10.2: Ant species richness by EVC

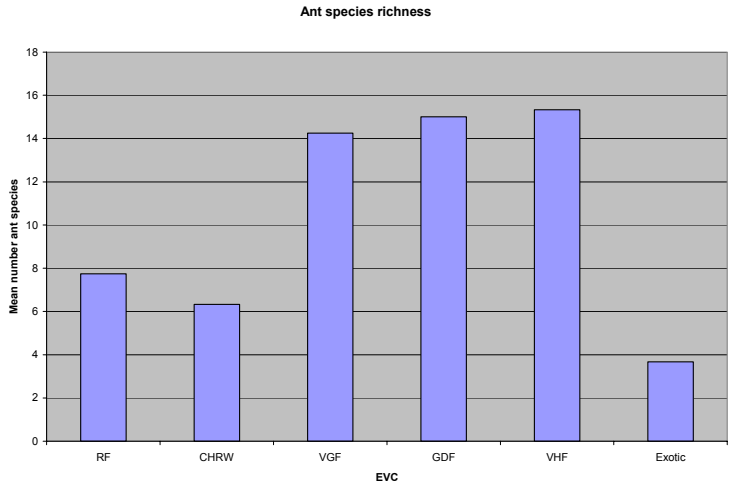


Figure 10.3: Distribution of ant species across the 21 field sites

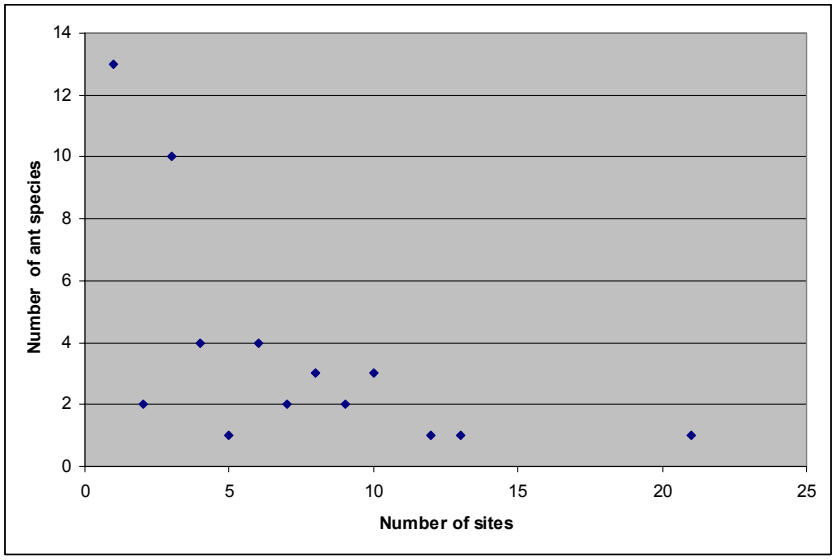


Figure 10.4: Ordination results - ants vs. EVC and Indigenous Vegetation index at all sites assessed.

See Table 10.3 for definition of the 21 field sites (A to U). Clusters represent same EVC or vegetation category

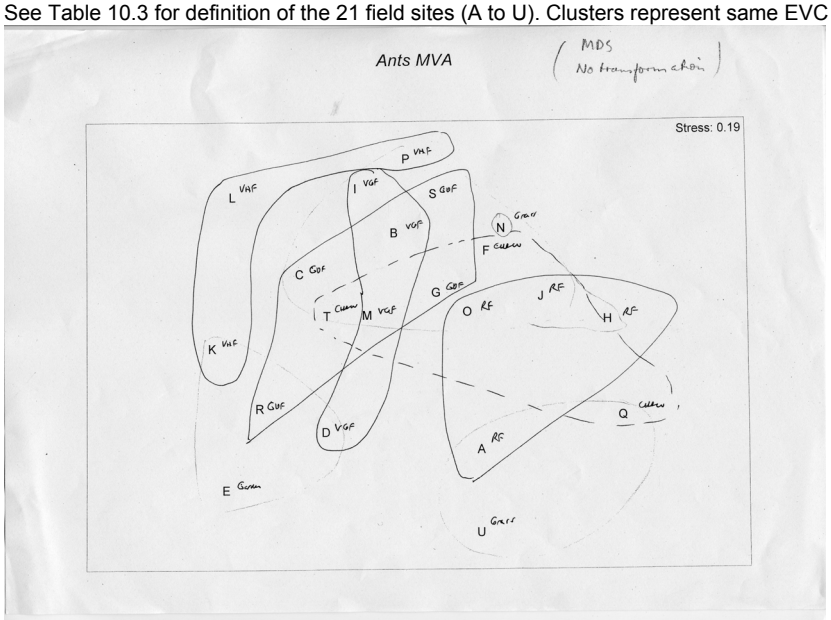


Figure 10.5: Ordination results - ants vs. EVC and Indigenous Vegetation index at all sites assessed (transformed).

See Table 10.3 for definition of the 21 field sites (A to U). Clusters represent same EVC or vegetation category

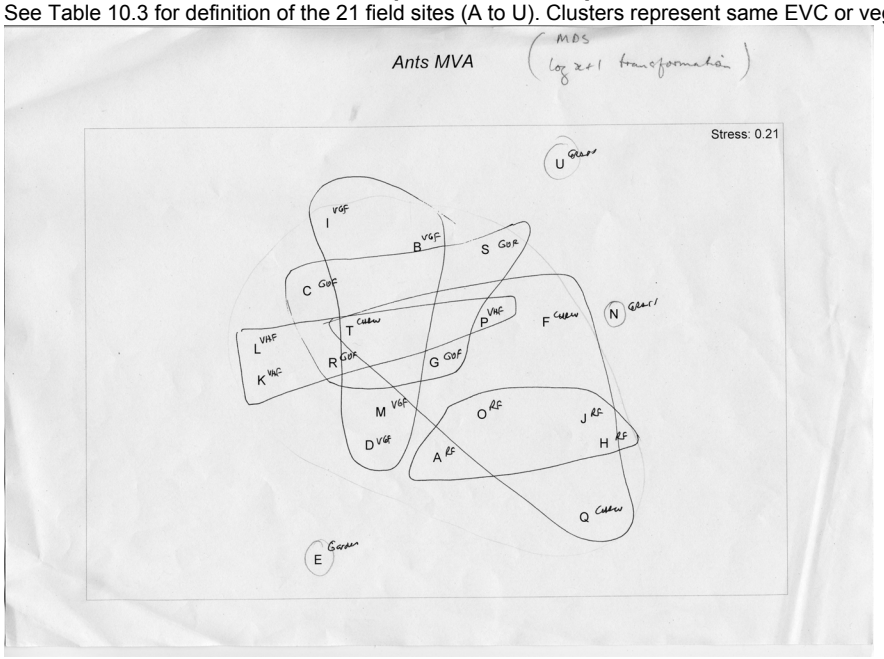
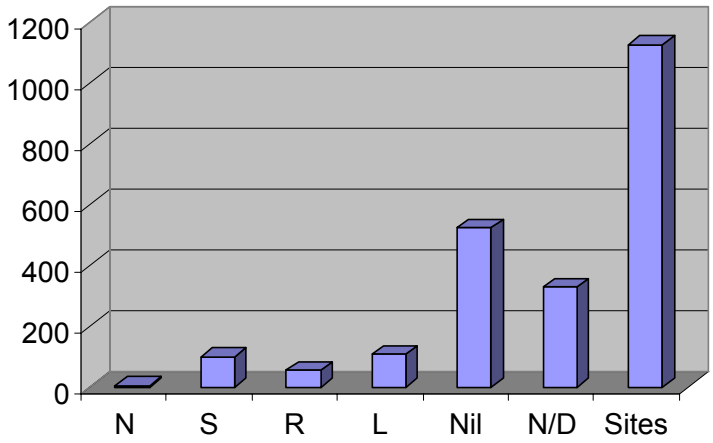


Figure 11.1: Biosites classifications for all sub-criteria and all sites

N = Nationally Significant; S = State Significant; R = Regionally Significant; L = Locally Significant; Nil = Not Significant; N/D = No data and not classified; Sites = number of sites by number of criteria.



Appendices

Appendix 5.1: Native Vegetation mapping variable category descriptions

Attached

Appendix 6.1: Vascular flora

Attached

Appendix 6.2: Ecological Vegetation Class descriptions

Attached

Appendix 6.3: VROT vascular flora

Attached

Appendix 7.1: VROT vertebrate fauna and distribution maps

Attached

Appendix 7.2: Vertebrate fauna

Attached

Appendix 8.1: Bryophyte flora

Attached

Appendix 9.1: Macrofungi

Attached

Appendix 10.1: Invertebrate fauna

Attached

Appendix 11.1: Biosites classification raw matrix

Attached

Appendix 11.2: Biosites classification

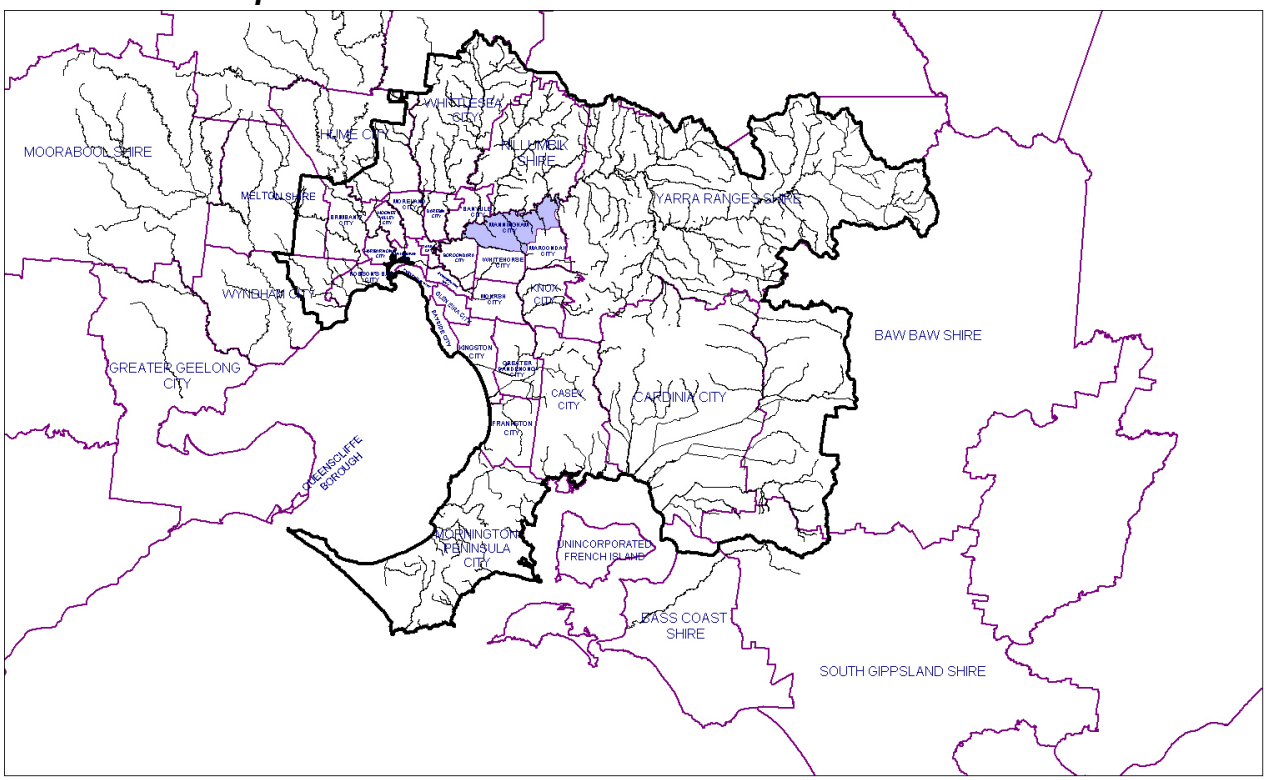
Attached

Appendix 11.3: Biosites criteria

Attached

Maps

Map 1.1: Manningham City Council Study area location and surrounding municipalities



Map 1.2: Manningham City Council Study area boundaries

Attached

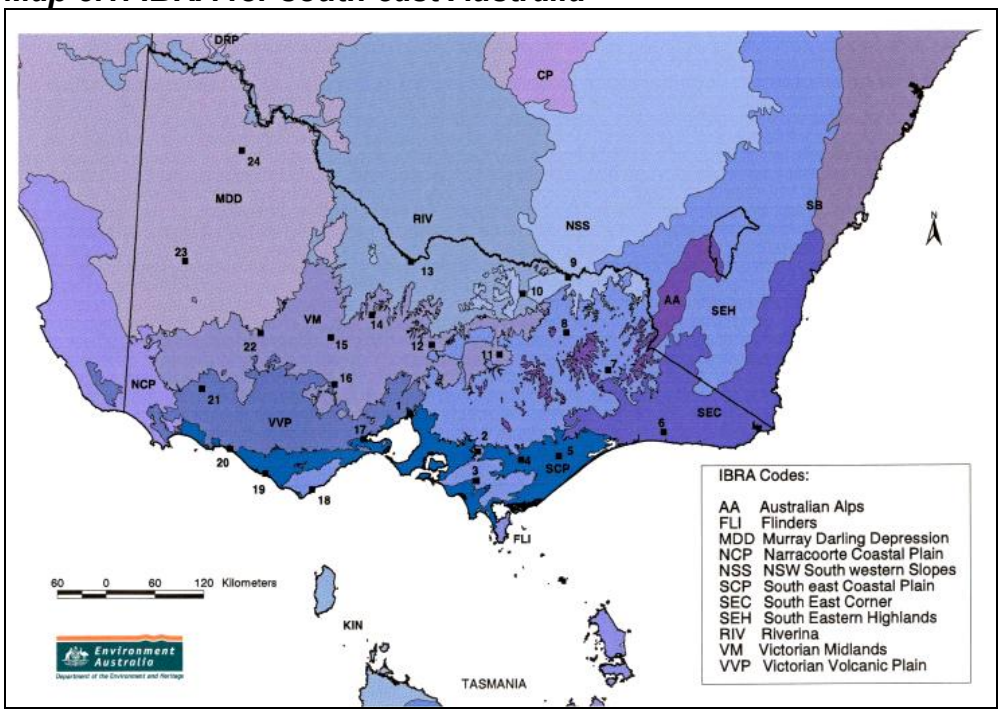
Map 2.1: Mean annual rainfall across study area

Attached

Map 2.2: Yarra River sub-catchments within study area

Attached

Map 3.1: IBRA for south east Australia



Map 3.2: Biophysical (Habitat) Regions and Bioregions

Attached

Map 5.1: Polygon data

Attached

Map 5.2: Landscape Units

Attached

Map 5.3: Indigenous Tree Crown Cover

Attached

Map 5.4: Indigenous Vegetation Modification

Attached

Map 5.5: Ecological Vegetation Classes – extant

Attached

Map 5.6: Ecological Vegetation Classes – pre 1750

Attached

Map 5.7: Ecological Vegetation Classes – Bioregional Conservation Status

Attached

Map 5.8: Indigenous Tree Health

Attached

Map 5.9: Human Occupation

Attached

Map 5.10: Exotic Tree/Shrub Cover

Attached

Map 5.11: Habitat Type (Core/Buffer)

Attached

Map 5.12: Biosites locations

Attached

Map 5.13: Risk Assessment

Attached

Map 11.1: Maximum Cited Significance

Attached

Map 11.2: Maximum Significance Classification in current Biosites Review

Attached

Map 11.3: Criterion 1: Ecological Integrity and viability

Attached

Map 11.4: Criterion 2: Richness and Diversity

Attached

Map 11.5: Criterion 3: Rarity/Conservation Status of Assets

Attached

Map 11.6: Criterion 4: Representativeness of Type

Attached

Map 11.7: Criterion 5: Scientific and Educational Value

Attached