THE HEALTH OF STREAMS IN THE WERRIBEE CATCHMENT

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Introduction

Careful management of our waterways and catchments is crucial to maintain and improve river health. Good decision making requires detailed information on the environmental condition of our rivers.

The Monitoring River Health Initiative (MRHI) – a biological monitoring program across Australia – was introduced as part of the National River Health Program funded by the Commonwealth. The main aim of the MRHI was to develop a standardised biological assessment scheme for evaluating river health. This was to be achieved by sampling reference sites and using the information collected to build models to predict which macroinvertebrate families would be expected to occur under specified environmental conditions. In Victoria the program was conducted by the Environment Protection Authority (EPA) and AWT Victoria (formerly Water EcoScience). In urban areas, this is also complemented by Melbourne Water's Healthy Waterways program.

Currently, an Australia-wide Assessment of River Health (AWARH) is being conducted under the National Rivercare Program to assess the health of Australia's rivers. EPA is sampling approximately 600 test sites in Victoria and evaluating these against the MRHI models.

Having undertaken biological monitoring in Victoria since 1983, EPA has a great deal of experience in the field. The results of previous studies will be combined with those of the current program, providing a solid background of data. This will be used to determine long term trends in the health of our rivers and will help the protection of water quality and the beneficial uses of our water courses.

Monitoring water quality

Traditional water quality monitoring involves measuring physical and chemical aspects of the water. Common measurements include pH, salinity, turbidity, nutrient levels, toxic substances and the amount of oxygen dissolved in the water. These measures provide a 'snapshot' of environmental conditions at the moment samples are taken. Water quality conditions are variable, so such monitoring can fail to detect occasional changes or intermittent pulses of pollution.

In contrast, the biological monitoring program involves sampling aquatic animals, which gives an indication of the health of the river as a whole. Because they live at the site for some time, animals reflect the build-up of impacts of environmental change on the river ecosystem – such as the influence of surrounding land use or the effects of pollution.

Biological monitoring techniques

Aquatic macroinvertebrates (such as insects, snails and worms) are very useful indicators in biological monitoring. They are visible to the naked eye and are commonly found in rivers and streams. They are an important source of food for fish and many are well known to anglers – such as yabbies, mudeyes, stoneflies and mayflies. They are widespread, easy to collect, relatively immobile and provide good information about the environment.

The presence or absence of specific species provides information about water quality. Some species are known to have particular tolerances to environmental factors such as temperature or levels of dissolved oxygen. Other information can be obtained from the number of species found at a site (biological diversity), the number of animals found at a site (abundance) and the relationship between all animals present (community structure).

Sites with a high level of species diversity generally have good water quality. Sites which have low diversity are less healthy – often due to the impacts of pollution. In polluted habitats, sensitive species are eliminated and less sensitive species show an increase in numbers.

Study site selection and assessment

Sites are selected to include a variety believed to be representative of the river basin's waterways – including sites that are relatively unimpacted (reference) and sites which are subject to the impact of pollution (test), although most of these are situated away from any obvious point source of pollution.

Sites are sampled twice a year (autumn and spring) using the rapid bioassessment technique. This involves collecting two types of biological samples where possible.

◆ ***Kick samples for riffle habitat***

To conduct kick samples, the stream bed is disturbed by the sampler's feet to dislodge animals which are swept into a net by the current. Samples are taken from shallow areas with stony or rocky substrates in medium to fast currents. This type of habitat is called a riffle and is usually associated with upland streams. In sandy streams, shallow fast flowing sandy areas are sampled.

◆ ***Sweep samples for edge habitat***

Sweep samples are collected by sweeping a net along banks and around snags in backwaters and pools which have slow currents or no flow. Aquatic plants (macrophytes) – which provide additional habitat for aquatic animals – are often found in these edge habitats and are included in the sweep sample. These habitats can be found in both the upland and lowland reaches of rivers.

Water quality measurements – including dissolved oxygen, pH, temperature and electrical conductivity – are made at each site and water samples are taken for laboratory analysis of nitrogen and phosphorus levels and turbidity. The vegetation along the river banks (the riparian zone) and the aquatic habitat are also assessed. The aquatic habitat is those parts of the river environment which animals use to make a home. It can be strongly affected by the streamside vegetation as well as the environment and land use of surrounding and upstream regions. The water quality and habitat measurements, taken at the same time as the biological samples, are also used in modelling and other data analyses.

For example, if fertiliser runoff is causing an excess of nutrient to enter the river, there may be excess growth of algae attached to rocks and snags in the river, affecting these important habitats. It can also result in blooms of toxic blue-green algae which are potentially hazardous to humans, animals and birds contacting or consuming the water. Thus different factors can influence many parts of the river environment. Biological monitoring can be a valuable tool to measure the overall effect of all these influences.

Invertebrate analysis techniques

Biological data can be analysed in a number of ways – from using simple biotic indices through to more complex statistical and modelling procedures.

A combination of analytical and interpretative measures gives far more reliable results than any measure on its own.

Number of families

The number of invertebrate families found in streams can give a reasonable representation of the health of a stream, though it is too great a simplification of data to be adequate on its own. Lack of suitable habitat or the presence of various pollutants can cause a reduction in the number of families present. This assessment method complements SIGNAL (see below) which tends to underestimate toxic effects.

SIGNAL

This biotic index uses families of aquatic invertebrates that have been awarded sensitivity scores according to their tolerance or intolerance to various pollutants. The index is calculated by totalling these scores and dividing by the number of families present. A single value between one and 10 is produced, reflecting the degree of water pollution – high quality sites have high SIGNAL scores (Chessman 1995) (table 1). While SIGNAL is particularly good for assessing water quality problems such as salinisation and organic pollution, its usefulness for toxic impacts and other types of disturbance is uncertain.

Table 1: Key to SIGNAL scores

SIGNAL score	*Water quality*
>7	Excellent
6-7	Clean water
5-6	Doubtful, mild pollution
4-5	Moderate pollution
<4	Severe pollution

AUSRIVAS

One of the main aims of the National River Health Program was the development of predictive models which could be used to assess river health. As a result, the Co-operative Research Centre for Freshwater Ecology has developed the Australian Rivers Assessment System (AUSRIVAS) which consists of several mathematical models. These models are being refined in 2000.

Each model uses reference data collected under the MRHI from a single aquatic habitat from either a single season (autumn or spring) or from the two seasons combined (Coysh *et al.* 2000).

AUSRIVAS predicts the macroinvertebrates which should be present in specific stream habitats under reference conditions. It does this by comparing a test site with a group of reference sites which are as free as possible of environmental impacts but have similar physical and chemical characteristics to those found at the test site.

One of the products of AUSRIVAS is a list of the aquatic macroinvertebrate families and the probability of each family being found at a test site if there were no environmental impacts. By comparing the totalled probabilities of predicted families and the number of families actually found, a ratio can be calculated for each test site. This ratio is expressed as the observed number of families/expected number of families (the O/E index).

The value of the O/E index can range from a minimum of zero (none of the expected families were found at the site) to around one (all of the families which were expected were found). It is also possible to derive a score of greater than one, if more families were found at the site than were predicted by the model. A site with a score greater than one might be an unexpectedly diverse location, or the score may indicate mild nutrient enrichment by organic pollution, allowing additional macroinvertebrates to colonise.

The O/E scores derived from the model can then be compared to bands representing different levels of biological condition, as recommended under the MRHI (table 2). This allows an assessment of the level of impact on the site to be made and characterisation of the general health of the part of the river that was sampled.

At this stage of its development, it appears that AUSRIVAS is more sensitive to changes in habitat than to changes in water quality.

Reporting results

With the end of the initial three-year biological monitoring program, a base of assessment has been completed for all the major river basins in Victoria. Currently, a wide range of test sites subject to the impact of pollution are being sampled and assessed against the MRHI models.

The River Health Bulletin series and River Health condition maps provide a summary of the health of streams in each basin as it becomes available. Direct access to the information collected under this program is expected to be available in September 2000 via the world-wide web.

Table 2: Example of AUSRIVAS O/E family score categories, for combined seasons edge data

Band label	O/E scores	Band name	Comments
X	>1.14	richer than reference	◆ more families found than expected ◆ potential biodiversity 'hot spot' ◆ possible mild organic enrichment
A	0.85–1.14	reference	◆ index value within range of the central 80% of reference sites
B	0.56–0.84	below reference	◆ fewer families than expected ◆ potential mild impact on water quality, habitat or both, resulting in loss of families
C	0.27–0.55	well below reference	◆ many fewer families than expected ◆ loss of families due to moderate to severe impact on water and/or habitat quality
D	<0.27	impoverished	◆ very few families collected ◆ highly degraded ◆ very poor water and/or habitat quality

THE HEALTH OF STREAMS IN THE WERRIBEE CATCHMENT

The Werribee catchment covers approximately 250,000 hectares to the north and west of Melbourne (figure 1). The catchment includes the Werribee and Lerderderg Rivers and smaller tributaries such as Goodman, Parwan, and Djerriwarrh Creeks. For the purposes of this bulletin, Little River, Kororoit Creek and Skeleton Creek are included in the Werribee catchment.

The source of the Werribee River is in the Wombat State Forest on the Great Dividing Range and from there the river flows south-east via the townships of Ballan, Bacchus Marsh and Werribee into Port Phillip Bay. The Lerderderg River also originates in the hills of the Wombat State Forest and flows in a south-easterly direction to discharge to the Werribee River downstream of Bacchus Marsh. The Lerderderg River is classified as a Victorian Heritage River from the junction of Crowley and Coppers Creeks in the Wombat State Forest to the Werribee Valley above Bacchus Marsh. This means that this portion of the river is set aside to protect natural heritage, cultural heritage and/or scenic values of outstanding significance.

Little River arises in the Brisbane Ranges National Park and flows south-east, via the township of Little River and the Western Treatment Plant into Port Phillip Bay. Kororoit Creek arises south of Gisborne in the north-east of the Werribee catchment and flows south-east, eventually flowing through the heavily urbanised western suburbs of Melbourne and discharging at Altona to Port Phillip Bay.

The climate within the Werribee catchment is generally temperate. Rainfall varies from approximately 1000 mm per year in the forested hills of the headwaters of the Werribee and Lerderderg Rivers to 450 mm per year in the southern plains near Melton and Werribee. These plains lie in the rain shadow of the Otway Ranges and form the driest area south of the Great Dividing Range in Victoria.

The majority of the Werribee catchment has been cleared for agricultural use since European settlement, the dominant landuse being dryland grazing. However, the catchment also includes urban settlements such as Werribee, Melton and Bacchus Marsh. Pressure for low-cost housing means that sizeable areas in the catchment have been set aside for residential growth and careful management will be needed to protect water quality and quantity in the region's waterways.

Rivers in the Werribee catchment are highly regulated to ensure water supply for domestic and agricultural (irrigation) use. However, the establishment of bulk water entitlements for the Werribee River system included provision of flows to maintain stream ecology. Major water storage basins within the catchment include Merrimu Reservoir on Pyrites Creek, Pykes Creek Reservoir and Melton Reservoir on the Werribee River.

Concern has been expressed about blooms of potentially toxic blue-green algae in waterways of the Werribee catchment (Cottingham *et al.* 1997). Consequently, the levels of nutrients, particularly nitrogen and phosphorus which promote the growth of blue-green algae, are also of concern.

Site selection

Forty-two sites in the catchment were selected for biological assessment – 30 were sampled by EPA and 12 by Melbourne Water. These sites included a range of catchment types. The locations of all 42 sites are shown in figure 1.

Physico-chemical water quality

Electrical conductivity (EC) values were relatively high across the catchment (table 3). The Australian and New Zealand Environment and Conservation Council (ANZECC 1992) recommends a maximum EC value for Australian freshwaters of 1500 µScm-1. This value was exceeded at 17 of the 42 sites tested. One of these sites, Kororoit Creek at Altona (MKC01), is subject to marine influence and would be expected to have a naturally elevated salinity level. Of more concern are the high salinity levels in Little River. For example, Little River at Ripley Road (LTR04) recorded an EC value more than three times the ANZECC maximum value.

Another area for concern is Parwan Creek. The two Parwan Creek sites sampled for this report, at Woolpack Road in Bacchus Marsh (PMN) and at Rowsley (PMC), recorded EC values of 6130 and 6159 μScm^{-1} respectively. These values are well above the ANZECC maximum value and also exceed the minimum requirements for agricultural use of water (5000 μScm^{-1}) as determined by SaltWatch in 1997.

When the EC values for sites in this survey were compared with catchment landuse, it was found that 10 of the 17 sites that exceeded the ANZECC maximum were in areas of intensive agriculture, either dryland grazing, irrigated grazing or horticulture. Six of the remaining 17 sites were in urban areas. Only one site that exceeded the ANZECC maximum occurred in an area with remnant forestry (Little River at You Yangs Road: LTR03).

Elevated nutrient levels in streams can result in excessive algal growth leading to hypoxia (low dissolved oxygen levels), increased turbidity and toxicity from blue-green algae.

EPA's *Preliminary Nutrient Guidelines* (EPA 1995) gives nutrient guideline maximums for Victorian inland streams. The Werribee catchment falls within the 'Southern Lowland and Urban River Region' which incorporates three stream classes: rural lowland rivers and their tributaries (eg. upper and middle reaches of the Werribee, Little and Lerderderg Rivers), large urban lowland rivers (eg. lower reaches of the Werribee River), and urban tributary streams (eg. Kororoit and Skeleton Creeks).

Thirty-two of the 42 sites in this survey exceeded the guideline maximum for total nitrogen (table 3). It is not surprising to find high total nitrogen values in a catchment dominated by agricultural and urban landuses. However, two of the sites located within relatively pristine catchments, Werribee River at Bunding Blakeville Road (PMF) and Little River at Little River Gorge (LTR07), also failed the nutrient guideline maximum. This suggests that total nitrogen values are naturally high in some parts of the Werribee catchment.

Eleven of the 42 sites sampled recorded total phosphorus levels above the relevant nutrient guideline maximum. Six of these sites were in urban catchments and included lower Kororoit and Skeleton Creek sites and also Toolern Creek at Melton Main Road (PNB). Two sites were in catchments with intensive agriculture, Dry Creek (PNF) and Little River at Ripley Road (LTR04). The three remaining sites that failed the total phosphorus guideline maximum were two sites on Djerriwarrh Creek (PNC and PND) and Werribee River at Cobble Dick Ford (PMA). Both Djerriwarrh Creek sites were stagnant pools at the time of sampling. Nutrient levels would be expected to be lower when the river is flowing. The reasons for elevated phosphorus levels in the Werribee River at Cobble Dick Ford are not clear.

Areas of greatest concern in the Werribee catchment are where both total phosphorus and nitrogen guideline maximums are exceeded. In the Werribee catchment this occurred at Skeleton Creek at Old Geelong Road (PNA), Toolern Creek at Melton Main Road (PNB), Djerriwarrh Creek at Diggers Rest-Coimadai Road and Hardys Road (PNC and PND), Dry Creek at Doherty's Road (PNF), Kororoit Creek at Altona, Sunshine and Melton East (MKC01, MKC02 and MKC03), Little River at Ripley Road (LTR04) and Werribee River at Cobble Dick Ford (PMA).

It is worth noting that the urban sites were assessed against 'interim' guideline maximums that are designed to prevent further deterioration of these waterways. An improvement in the ecological health of these streams will require much tougher nutrient guideline maximums to be met.

Number of families

For the purposes of this report, sites are divided into four landuse types: (1) urban/residential, (2) intensive agriculture/some residential, (3) some forestry/ agriculture eg. grazing and (4) native forest/native vegetation.

The mean number of families in each landuse type is shown in figure 2.

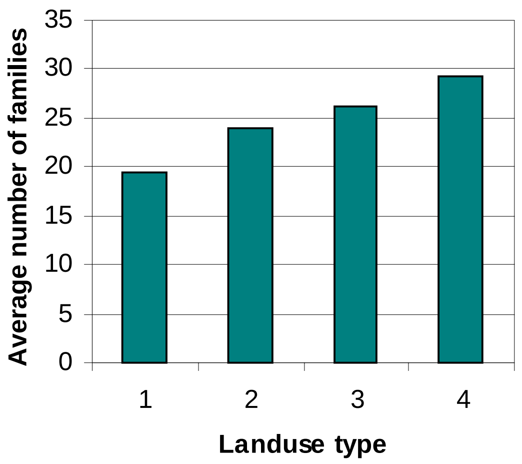

Figure 2: Average number of macroinvertebrate families per site according to landuse type

The total number of aquatic macroinvertebrate families found at Werribee catchment sites (based on combined seasons edge data) varied from nine to 35 with an average of 23 families per site. Figure 2 shows that more families were found in the sites with forest/native vegetation (category 4), while the least number of families were found in urbanised landuse sites (category 1).

AUSRIVAS and SIGNAL

Table 3 shows the AUSRIVAS O/E score (based on combined seasons edge habitat) and SIGNAL score for each site (colours indicate band membership).

Of the 42 sites sampled in this survey, 18 returned AUSRIVAS O/E scores of reference quality, 15 returned scores of below reference quality, five returned scores well below reference quality and one site was outside the experience of the model. This means that there were not enough reference sites with similar physical and chemical characteristics to compare with this site. A further three sites returned AUSRIVAS scores 'above reference quality'.

SIGNAL scores painted a slightly different picture. Only one site (Werribee River at Bunding-Blakeville Road, PMF) was designated the category of 'clean water' by SIGNAL. Thirty-four sites were designated the 'doubtful, mild pollution' category and the remaining seven sites were designated the 'moderate pollution' category. In general, SIGNAL is considered to be more sensitive to impacts of pollution while AUSRIVAS is relatively more sensitive to impacts on habitat.

The majority of the sites that were designated 'reference' quality by AUSRIVAS were in the upper to middle reaches of the catchment (figure 1). In particular, the upper reaches of the Werribee and Little Rivers were found to be in relatively good condition according to AUSRIVAS. This result reflects the fact that these sites are mostly situated in forested catchments and are largely protected from the impacts of human influence.

1. Urban/residential

The sites in urban/residential catchments were rated relatively poorly by AUSRIVAS. Only two of these sites were found to be of reference quality, eight were 'below reference' level, two were 'well below reference' level and one, Laverton Creek at Laverton (MLC01), was 'outside the experience of the model'.

The two sites in the 'well below reference level' group were the furthest downstream along Kororoit Creek. These sites recorded low numbers of macroinvertebrate families (13 families at Altona (MKC01) and nine at Sunshine (MKC02). Molluscs (snails), oligochaete worms, odonates (dragon- and damselflies), chironomids (midge larvae) and 'true

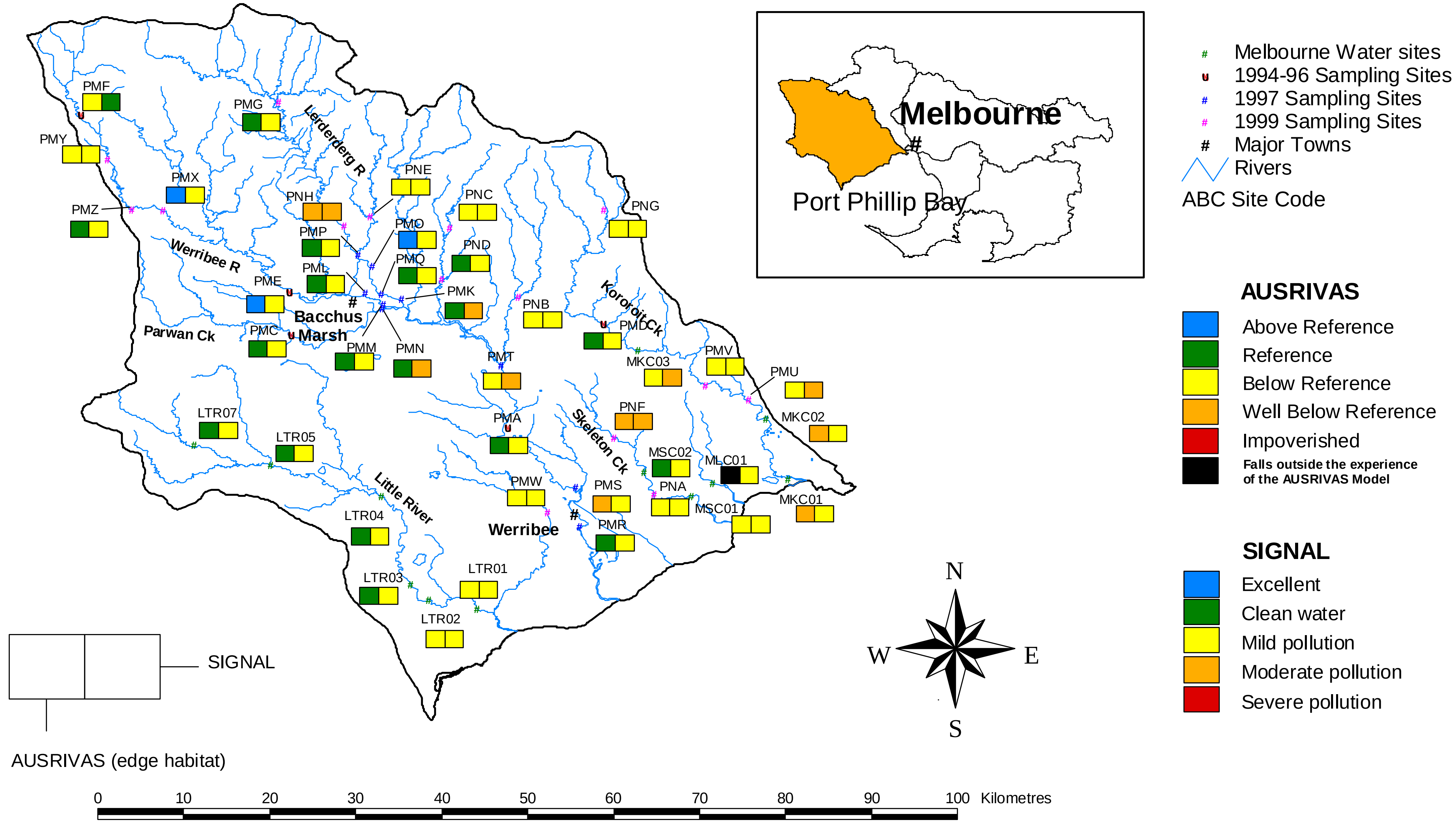

Figure 1: AUSRIVAS O/E and SIGNAL family bands (edge habitat, combined seasons) for the Werribee catchment.

Table 3: AUSRIVAS O/E and SIGNAL scores and physico-chemical results for sites in the Werribee Catchment (grouped by landuse type)

Site code	Site description	TP (mg 1⁻¹)	TN (mg 1⁻¹)	EC (µS cm⁻¹)µ	AUSRIVAS O/E	SIGNAL
1. Urban/residential						
PMR	Werribee R, downstream of Werribee	0.05	1.52	920	0.85	5.29
PMU	Kororoit Ck at Selwyn Park	0.04	1.93	1559	0.65	4.81
PMV	Kororoit Ck at Miles St	0.06	1.06	491	0.68	5.33
PMW	Lollypop Ck at Greens Rd	1.00	2.65	247	0.81	5.14
PMZ	Werribee R at Spencer Rd	0.03	1.21	234	1.12	5.75
PNA	Skeleton Ck at Old Geelong Road	0.12	1.19	4275	0.60	5.07
PNB	Toolern Ck at Melton Main Road	0.27	1.94	88	0.72	5.25
LTR02	Little River at McLeans Road	0.03	1.53	4360	0.73	5.07
MKC01	Kororoit Ck at Racecourse Rd, Altona	0.17	1.77	6640	0.49	5.38
MKC02	Kororoit Ck at Warmington Rd, Sunshine	0.19	2.00	2000	0.40	5.33
MKC03	Kororoit Ck at Keilor-Melton Rd, E Melton	0.08	0.97	635	0.74	4.81
MLC01	Laverton Ck at Laverton	NM	NM	409	**	5.14
MSC01	Skeleton Ck at Point Cook Rd, Laverton	0.11	0.79	4250	0.65	5.64
2. Intensive agriculture/ some residential						
PMC	Parwan Ck, Rowsley*	0.04	0.95	6159	1.14	5.50
PMD	Kororoit Ck at Beatys Road	0.32	1.06	8038	0.98	5.44
PMK	Lerderderg R, downstream of Sewage Treatment Plant	0.01	0.60	557	0.95	4.92
PML	Werribee R, Fisken Street	0.03	1.16	665	1.05	5.53
PMM	Werribee R, Woolpack Road	0.02	1.04	874	1.02	5.22
PMN	Parwan Ck, Woolpack Road	0.03	1.61	6130	0.93	4.76
PMO	Lerderderg R, Bacchus Marsh-Gisborne Rd	BLD	0.55	860	1.17	5.68
PMP	Lerderderg R, Robertsons Road	0.02	0.91	2339	1.01	4.95
PMQ	Lerderderg R, Bacchus Marsh Ave of Honour	0.01	0.39	905	0.88	5.63
PMS	Werribee R, upstream of Werribee	0.07	1.47	1724	0.40	5.50
PMX	Werribee R at Old Melbourne Road	0.02	0.96	1817	1.17	5.64

Site code	Site description	TP (mg l^{-1})	TN (mg l^{-1})	EC (µS cm^{-1})µ	AUSRIVAS O/E	SIGNAL
PMY	Werribee R at Stonehut Road	0.02	1.08	234	0.77	5.72
PNF	Dry Ck at Dohertys Road***	1.40	27.13	36	0.46	4.09
PNG	Kororoit Ck (East Branch) at Mt Aitken Rd***	0.04	0.73	2656	0.63	5.20
LTR01	Little River at ford upstream of Lake Borrie	0.03	1.39	2039	0.83	5.75
LTR04	Little River at end of Ripley Road	0.05	1.06	4720	0.85	5.17
MSC02	Skeleton Ck at Sayers Rd, Hoppers Crossing	0.07	1.41	2960	1.02	5.72
3. Some forestry/agriculture (eg. grazing)						
PMA	Werribee R at Cobble Dick Ford	0.13	0.71	1086	0.98	5.14
PME	Werribee R at Werribee Gorge*	0.02	0.52	422	1.16	5.55
PMG	Lerderderg R at O'Briens Crossing*	0.01	0.47	140	0.86	5.38
PMT	Werribee R, downstream of Melton Reservoir	0.02	1.05	1047	0.60	4.58
PNC	Djerriwarrh Ck at Diggers Res – Coimadai Rd	0.16	3.80	484	0.77	5.17
PND	Djerriwarrh Ck at Hardys Road	0.11	2.63	843	0.92	5.41
PNE	Goodman Ck at Seereys Road	0.02	0.74	376	0.76	5.23
PNH	Lerderderg R at Lerderderg R Road***	BLD	0.17	113	0.50	4.86
LTR03	Little River at You Yangs Road	0.05	1.74	2502	0.85	5.25
LTR05	Little River at Box Forest Road	0.11	2.62	491	0.93	5.41
4. Native forest/native vegetation						
PMF	Werribee R at Bunding-Blakeville Rd*	0.02	0.61	186	0.78	6.21
LTR07	Little River at Little River Gorge	0.04	1.469	1035	0.97	5.23

AUSRIVAS O/E

- Above reference
- Reference
- Below reference
- Well below reference
- Impoverished

SIGNAL

- Excellent
- Clean water
- Doubtful, mild pollution
- Moderate pollution
- Severe pollution

*	reference sites
**	outside experience of model
***	site sampled in spring only
BLD	below limit of detection
NM	not measured

Values that exceed the guideline nutrient maximums (EPA 1995) for total phosphorus (TP) or total nitrogen (TN) or the Australian and New Zealand Environment and Conservation Council recommended maximum for electrical conductivity (EC) are highlighted.

bugs' (Hemiptera) dominated the macroinvertebrate communities at these sites. These macroinvertebrate communities are typical of degraded urban sites.

2. Intensive agriculture/some residential

Of the 17 sites in areas of intensive agriculture (and/or some residential) landuse, 10 were of 'reference' quality according to AUSRIVAS. This may seem surprising given the nature of the dominant landuse. However, this result reflects the fact that reference sites need not be free of human influence but represent the 'best available' stream quality that can be expected in these areas. Three sites were designated as 'below reference' quality and two sites, Werribee River upstream of Werribee (PMS) and Dry Creek (PNF), were designated as 'well below reference' quality.

Werribee River upstream of Werribee (PMS) had very little habitat available for macroinvertebrates. The SIGNAL score for this site was not significantly lower than others in this group, which suggests poor habitat rather than poor water quality was responsible for the low AUSRIVAS score.

Dry Creek at Dohertys Road (PNF) scored poorly for both AUSRIVAS and SIGNAL. This site lies in a highly degraded urban/agricultural catchment and recorded very high total nitrogen (27 mg l^{-1}) and total phosphorus (1.4 mg l^{-1}) values.

Two sites in this group, Lerderderg River at Bacchus Marsh-Gisborne Road (PMO) and Werribee River at Old Melbourne Road (PMX), were designated as 'above reference' level. Such a score usually indicates mild organic enrichment or an unusually diverse macroinvertebrate community. SIGNAL scores of 5.68 and 5.72 suggest that these sites are in relatively good condition.

SIGNAL also rated Lerderderg River downstream of the sewage treatment plant (PMK) poorly. AUSRIVAS scored this site as 'reference' quality. This combination of scores suggests that a combination of moderate enrichment and relatively good habitat has maintained biological diversity at this site despite relatively poor water quality. Total nitrogen and phosphorus values for this site were not excessively high but may only provide a 'snapshot' of water quality at the particular times this site was sampled.

3. Some forestry/agriculture

Five of the 10 sites in this landuse category were designated as 'reference' quality by AUSRIVAS. Two of these sites are in the upper reaches of the Lerderderg and Little Rivers (PMG and LTR05 respectively). Djerriwarrh Creek at Hardys Road (PND) is situated in a steep valley with significant stands of native vegetation. Werribee River at Cobble Dick Ford (PMA) is in the lower reaches of the Werribee River but has relatively good riparian habitat.

Of the remaining sites in this category, three were designated as 'below reference' quality, one, Lerderderg River at Lerderderg River Road (PNH) as 'well below reference' and one, Werribee River at Werribee Gorge (PME), as 'above reference level'.

Sites that rated poorly for SIGNAL included Werribee River downstream of Melton Reservoir (PMT). This site yielded only 17 families, the majority of these were families that are relatively tolerant of pollution including true bugs (Hemiptera), Crustacea and freshwater snails (Mollusca). It is likely that the altered flow regime (high summer/low winter flows) downstream of the reservoir is responsible for this low SIGNAL score.

Lerderderg River at Lerderderg River Road scored poorly for SIGNAL and at 'well below reference' level for AUSRIVAS. This site was dry in autumn and not sampled at this time. The macroinvertebrate fauna of ephemeral streams, by their nature, are likely to be more tolerant forms. Therefore, it is not surprising to obtain low scores for such sites.

4. Native forest/native vegetation

Of the sites in native forest catchments, Little River at Little River Gorge (LTR07) was designated as 'reference' quality by AUSRIVAS while Werribee River at Bunding-Blakeville Road (PMF) was designated as 'below reference'. SIGNAL rated Little River at Little River Gorge (LTR07) as mildly polluted. Little River flows intermittently at this point and this relatively low score may reflect the fact that macroinvertebrates are periodically subject to low dissolved oxygen levels as a result.

The relatively low AUSRIVAS score for Werribee River at Bunding-Blakeville Road seems surprising since this site achieved the highest SIGNAL score of all the sites. This combination of scores suggests water quality is relatively good at this point but that there is a lack of edge habitat for macroinvertebrates.

Summary

Human impact on the Werribee catchment since European settlement has been marked. The clearing of large sections of the catchment and subsequent use of land for agriculture and urbanisation has resulted in widespread erosion, increases in nutrient levels and salinity and loss of habitat for aquatic life.

High total nitrogen levels in agricultural parts of the catchment are a concern, although there is some evidence that 'background' total nitrogen levels are also high. Total phosphorus levels are high in the urbanised areas of the catchment.

Despite these widespread problems, aquatic macroinvertebrate communities were not assessed as 'impoverished' by AUSRIVAS. In fact, over one third of the sites visited were assessed as equivalent to 'reference' quality. However, the majority of these were in the upper reaches of the catchment's rivers. SIGNAL scores were not so encouraging although no sites were assessed as 'severely polluted'. SIGNAL scores may have been relatively lower, at least partly because many of the high-scoring taxa in this index do not occur in relatively low-lying areas such as the Werribee catchment. EPA is developing regional SIGNAL objectives and application of these may see more sites assessed as having clean water.

Recommendations

Areas of concern highlighted by this report include high salinity values in Parwan Creek and the lower reaches of Little River, Kororoit and Skeleton Creeks. The values recorded in these waterways were above the ANZECC limit required to protect aquatic ecosystems and, in some cases, high enough to suggest that the water in these creeks was not suitable for agricultural use. A full discussion of the problems associated with dryland salinity is beyond the scope of this report. However, there is a clear need for replanting of native vegetation in the riparian zones of the rivers mentioned above. Although this is unlikely to reduce salinity values, at least in the medium term, the prevention of further rises in the groundwater table and reduction of streambank erosion should help to stem further deterioration. In addition, the replanting of riparian vegetation reduces the flow of nutrients into waterways. The replanting of some riparian zones along stretches of Kororoit and Skeleton Creeks was observed during the course of this study.

Urban sites in the catchment scored poorly in AUSRIVAS and SIGNAL. Many of these sites had elevated levels of nitrogen and phosphorus, results of high levels of urban runoff. The management of stormwater drains is a complex issue. However, the appropriate management of urban runoff at source and the installation, where practicable, of artificial wetlands will reduce the flow of nutrients and other pollutants into urban waterways (The Stormwater Committee 1998). These efforts will be vital in controlling nutrient inputs given the rapidly increasing urbanisation of this catchment.

The low SIGNAL score in the Werribee River downstream of Melton Reservoir (PMT) is considered to be associated with the altered flow regime downstream of the reservoir. Although bulk water entitlements for the Werribee basin include environmental flows, the flows allocated to the Werribee catchment represent a balance between the provision of water for environmental purposes and maintaining security of supply for existing users. It is unlikely that truly 'natural' flows can be restored without seriously impacting irrigators and other users who rely on this water source. Instead, the continued improvement of water quality in tributaries in heavily urbanised catchments such as Toolern Creek is likely to be more successful in achieving long term river health goals.

More detailed analysis of actions to improve the health of waterways in the Werribee catchment can be found in the Draft Water Quality Strategy for the Werribee River Basin (Cottingham *et al*. 1997).

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