ENVIRONMENT REPORT

ENVIRONMENTAL CONDITION OF RIVERS AND STREAMS IN THE OVENS CATCHMENT

ENVIRONMENT REPORT

ENVIRONMENTAL CONDITION OF RIVERS AND STREAMS IN THE OVENS CATCHMENT

Freshwater Sciences

EPA Victoria

Ernest Jones Drive

Macleod Victoria 3085

AUSTRALIA

Key contributors: Liza Miller and Nicole Barbee

Publication 909

ISBN 0 7306 7635 8

ABSTRACT

This report provides an assessment of the environmental condition of rivers and streams in the Ovens catchment prior to the bushfires in February 2003. As such, it provides a baseline condition for resource managers against which post-fire impacts and aquatic ecosystem recovery can be assessed.

Water quality in the Ovens catchment is considered to be important, not only at a regional scale, but also at the national level. The Ovens River contributes approximately 14 per cent of Murray-Darling Basin flows from a catchment area of less than 1 per cent of the total Murray-Darling Basin area. Hence, inputs are likely to have a direct effect on the health of the larger Murray-Darling system. Major blue-green algal blooms in recent years have focused attention on water quality and water resource management issues throughout the Murray-Darling Basin, with nutrient inputs, such as phosphorous and nitrogen, recognised as important factors influencing the occurrence of these blooms.

The Ovens River is considered to be one of the least modified catchments within the Murray-Darling Basin with more than 30 per cent of the river length remaining largely intact. As such, the Ovens River is considered to be a river of very high community value and is managed to protect a combination of conservation, cultural, economic and recreational values. The river itself provides natural conditions suitable for many significant native fish species, in particular, the endangered Murray Cod.

The environmental condition of the rivers and streams in the Ovens catchment was assessed against the State environment protection policy (Waters of Victoria) (SEPP WoV) biological objectives (EPA 2003a). Habitat condition assessments and water quality measures were used to help explain why sites might be degraded. Most of the upper catchments and highland areas were found to be in good to excellent condition, while in some of the mid to lowland areas biological scores were somewhat lower. Degraded riparian zones and poor water quality were identified as issues in the lower tributaries of the Ovens. On these streams, the loss of native streamside vegetation has resulted in destabilisation of banks, direct loss of habitat for biota and invasion by exotic vegetation. Irrigated run-off from intensive agriculture, sewage treatment plant discharges, industrial discharges, urbanisation and erosion were key contributors to poor water quality.

Initiatives are being implemented to restore the quality and quantity of streamside vegetation and in-stream habitat in these catchments. Also of high priority, is the reduction in total phosphorous concentrations and loads to reduce the risk of blue-green algal blooms within the catchment and further downstream. In particular, reduction of loads flowing into the Murray River is of major importance for its long-term ecological condition. Areas targeted for reduction in phosphorous loadings are primarily local sewage treatment plants and agricultural industries; as well as a number of activities to address diffuse phosphorous sources, such as stream bank and bed erosion.

LIST OF ACRONYMS

AUSRIVAS	Australian Rivers Assessment System
BMP	Best Management Practice
CMA	Catchment Management Authority
DSE	Department of Sustainability and Environment
EPA	Environment Protection Authority (Victoria)
EPT	Ephemeroptera, Plecoptera, Tricoptera
ISC	Index of Stream Condition
NECMA	North East Catchment Management Authority
NECMS	North East Catchment Management Strategy
NERCS	North East Regional Catchment Strategy
NPI	National Pollution Inventory
NRHP	National River Health Program
OBWQS	Ovens Basin Water Quality Strategy
RHA	Rapid Habitat Assessment
RIVPACS	River InVertebrate Prediction and Classification System
SEPP	State environment protection policy
SIGNAL	Stream Invertebrate Grade Number Average Level
STP	Sewage Treatment Plant
TN	Total Nitrogen
TP	Total Phosphorous
USEPA	United States Environmental Protection Agency
VWQMN	Victorian Water Quality Monitoring Network
WoV	Waters of Victoria

ACKNOWLEDGEMENTS

EPA acknowledges the financial support of the Murray Darling Basin Commission (Sustainable Rivers Audit Pilot) and the Commonwealth National River Health Program, for the collection of the biological information that provided the primary basis for this assessment of environmental condition.

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 The Ovens Catchment: Features and Land Use

The Ovens catchment forms part of the Murray-Darling Basin. It includes the Ovens and King rivers as well as the catchments of Black Dog and Indigo creeks (Figure 1). The Ovens catchment extends from the Great Dividing Range in the south to the Murray River in the north, with the Yarrawonga Weir forming the downstream boundary. It is considered to be one of the least modified catchments within the Murray-Darling Basin, with more than 30 per cent of the river length remaining largely unmodified. There are only two small impoundments in the Ovens catchment: Lake Buffalo on the Buffalo River, and Lake William Hovell on the King River. The Ovens River is recognised as a river of very high community value largely due to the high level of intactness of the Ovens River system, naturalness of flows and conservation value to native fish (Victorian River Health Strategy 2002). The Ovens River contributes about 14 per cent to the average flows of the Murray River in spite of its relatively small size (0.75 per cent of the total Murray-Darling Basin area) (North East Catchment Management Authority 2000). As such, inputs from the Ovens into the Murray-Darling system are likely to have a direct effect on the health of the larger scale system.

From Killawarra, downstream of Wangaratta, to the confluence with the Murray River, the Ovens River has been designated a Heritage River. Here the Ovens River is typically deep, slow flowing with high steep banks. Further toward the Murray River, the Ovens River is characterised by low-profile anabranches and billabongs forming a broad alluvial flood plain with internal benches (Cottingham *et al.* 2001). River Red Gum forests and woodlands dominate the Heritage area (Heritage Rivers and Natural Catchment Areas – Draft Management Plans, NRE 1997). The Heritage River corridor, with its continuous stretch of River Red Gum forests, provides a habitat corridor for numerous birds and mammals dependent on mature trees. The river itself provides natural conditions suitable for many significant native fish species, especially for the endangered Murray Cod (Heritage Rivers and Natural Catchment Areas – Draft Management Plans, NRE 1997). This part of the Ovens River is unusual in Victoria as it represents a large lowland river surrounded by substantial woodland forest.

The upper third of the Ovens catchment is forested and mountainous. The middle section comprises semi-cleared foothills and valleys, and the lower third extensively cleared riverine plains. Climate varies considerably with topography and elevation. Winter snowfalls are common at altitudes above 1000m. Mean annual rainfall varies from about 2000mm in parts of the upper alpine area to about 500mm on the plains in northwest Yarrawonga.

Most of the upland forested mountainous section is reserved as public land, either as National Parks or State Forest. Tourists regularly use the rivers and streams in this section for camping, fishing and general recreation. Presently, much of the foothills country is cleared for wine and tobacco growing or pine plantations, with approximately 63 per cent of State-owned pine plantations located in the Ovens catchment.

The Buckland, King, Buffalo and Ovens rivers merge into riverine plains and floodplains of the lower Ovens River. These plains formed on sediments laid down by ancestral rivers and are extensively cleared. Squatters settled the lower Ovens valley in the late 1830s and the population of the region increased rapidly following the discovery of gold in the Beechworth area in 1852. During this time, extensive dredge mining occurred in the Ovens River and its tributaries: Morses Creek, Buckland River, Happy Valley Creek, Barwidgee Creek, Buffalo River and Buffalo Creek. Dredging continued from the early 1860s to 1954. Its effects on floodplain hydrology include: randomisation of sediment distribution, movement of stream channels, change in soil texture and composition, change in stream profile and stream channel morphology (Shugg 1987). On the Ovens River, the natural channel above Porepunkah was destroyed by gold mining activities and the channel downstream filled with gravel and sludge (Beard 1979). Further, downstream of Myrtleford the Ovens River has changed from a tight meandering system to a broad, straight braided stream as a result of mining debris (Beard 1979).

Land use across the Ovens catchment is dominated by native vegetation on public land (48 per cent) and dryland cropping and grazing pasture (42 per cent). The remaining land is used for a mixture of pine plantations (4 per cent), irrigated horticulture, livestock grazing (1 per cent) and urban development (less than 1 per cent) (NECMA 2000). Irrigated horticulture occurs predominately along the river flats of the King, Buffalo and Ovens rivers. Crops, such as tobacco and hops, have been grown in the catchment for over a century, but are now being phased out of production. Wine grapes are replacing tobacco as a major irrigated-agriculture crop (NECMA 2000).

Agricultural run-off from tobacco, hop and grape crops, and dairying close to the rivers edge contribute to an increase in nutrients and sediments entering waterways and dams in the Ovens catchment (NECMA 2000). Nutrients are also released downstream of Myrtleford as secondary treated sewage which contributes to the total phosphorous load in the Ovens River. Nutrient enrichment has led to blue-green algal blooms in the summer months within the lower Ovens River, and has raised concerns regarding the health and sustainability of the Ovens River and its contribution to algal blooms farther downstream, particularly in regard to recent algal blooms in Lake Mulwala.

The population of the catchment is about 45,000 of which 35 per cent live in Wangaratta on the riverine plains. The urban areas of larger towns, such as Wangaratta, pose water quality problems due to industrial activities and stormwater run-off from impermeable surfaces. Stormwater from residential and industrial areas is carried into drains and deposited into the Ovens River. The tradewaste plant in Wangaratta receives and treats chemical waste from surrounding industries including textiles, spinning and chemical plants (NECMA 2000). This plant has been found to discharge treated waters with high levels of colour and salinity and high biochemical oxygen demand that depletes oxygen levels in Fifteen Mile Creek (McKenzie *et al.* 1994).

In 2000, these concerns led to the development of a comprehensive water quality strategy that outlined the major issues and management directions for the Ovens catchment (NECMA 2000).

1.2 Scope

This study provides an assessment of the environmental condition of rivers and streams in the Ovens catchment prior to the bushfires of 2003. Consequently, this report may assist management plans and monitoring programs in the catchment for both the regional catchment management strategy and bushfire recovery programs.

The assessment is based on a combination of biological, physical and habitat quality indicators, considered to be the best available indicators of overall condition. The impacts of broad scale catchment-wide issues are addressed but the effects of specific point source discharges and urban areas are not discussed in detail.

1.3 Data sources

The information presented in this report incorporates a number of data sources, but relies predominantly on biological monitoring undertaken by EPA between 1998 and 2002 for the National River Health Program (NRHP), EPA biological monitoring program and the Murray-Darling Basin Commission Sustainable Rivers Audit Pilot (www.mdbc.gov.au/about/governance/overview). Other main sources of information include the Index of Stream Condition assessment, water quality data collected for the Victorian Water Quality Monitoring Network (www.vicwaterdata.net) and where available for sites, EPA long term biological data.

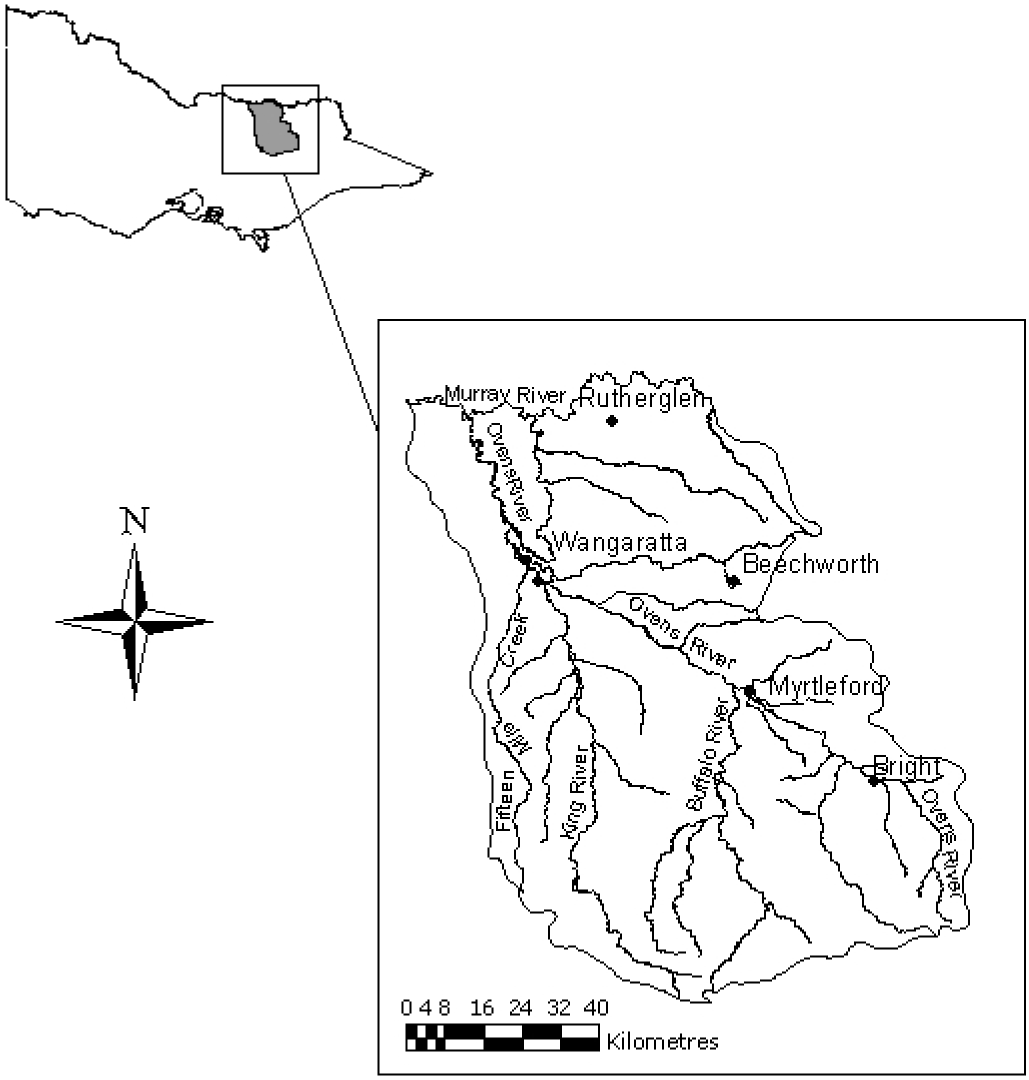

Figure 1: Location of the Ovens catchment in Victoria

2. ASSESSING ENVIRONMENTAL CONDITION

Monitoring and assessment of environmental condition provides essential information on the state of our river systems. This research enables managers to develop and refine management programs, and to direct resources and activities to where they are needed most.

Traditionally, assessment programs have relied upon physical and chemical indicators of water quality. In recent years, Victoria has moved towards a more wholistic approach to environmental assessment in rivers and streams, which incorporates biological indicators of ecosystem health.

When using physical and chemical indicators alone, the underlying assumption has been that if these are met, then the aquatic environment can be considered to be in good health, however the problems with using physical and chemical indicators alone include:

- Interactions between contaminants, which may affect biota, are not taken into account.
- The types of measurements, being spot measurements in time, do not reflect the full variability of water quality, and intermittent inputs and flood events are often missed.
- Appropriate parameters may not be measured.
- A reliance on physical and chemical data does not allow for assessment of other factors that affect distribution of biota, such as inadequate physical habitat, water volume, or introduced species.

The use of biological indicators largely overcomes these problems and provides a means for directly assessing the health of an ecosystem. Importantly, the impacts of factors other than water quality, such as habitat degradation and altered flows, can also be detected using biological indicators.

2.1 Environmental quality objectives

State environment protection policies (SEPPs) set a statutory framework for the protection of agreed beneficial uses and values of Victoria's water environments. One of the key beneficial uses is the protection of aquatic ecosystems; others include water supply for homes, industry and agriculture, and recreational use of surface waters.

Each beneficial use of water has its own quality requirements. SEPPs protect beneficial uses by establishing environmental quality objectives for key indicators. These objectives are based upon what is achievable in the context of natural background levels and constraints placed by human land uses and activities within a catchment. Objectives are set to maintain the quality of a healthy ecosystem or, in the case of degraded systems, are more usually set as targets to bring about a significant improvement in the condition of a water body over time.

In Victoria, all surface waters are covered by the SEPP Waters of Victoria (SEPP WoV) (EPA Victoria 2003a), which sets the strategic framework and environmental quality objectives for the protection of all surface waters within Victoria. Within the framework of the SEPP WoV, schedules are developed for specific water bodies and catchments in Victoria. For indicators of environmental condition not covered by specific schedules, the objectives in the principal policy SEPP WoV apply, which is the case for the Ovens catchment.

Table 1: Biological objectives for each biological region in the Ovens catchment

Biological Region	INDICATOR: Number of Families	SIGNAL index score	EPT index score	AUSRIVAS O/E score	AUSRIVAS Band	Key Families combined habitat score
Highlands						
• Riffle	22	5.8	10	N/A	N/A	18
• Edge	13	6.2	4	N/A	N/A	
Forests – A						
• Riffle	21	6.0	9	0.87 - 1.13	A	22
• Edge	22	5.7	7	0.86 - 1.15	A	
Forests – B						
• Riffle	23	6.0	10	0.87 - 1.13	A	26
• Edge	24	5.8	9	0.87 - 1.13	A	
Cleared Hills and coastal plains						
• Riffle	23	5.5	N/A	0.82 - 1.18	A	22
• Edge	26	5.5	N/A	0.85 – 1.15	A	
Murray and Western Plains						
• Edge	23	5.3	N/A	0.87 – 1.13	A	21

In order to meet the objectives, the test site value must be greater than or equal to the values given in the table, except for AUSRIVAS where the appropriate band must be obtained (N/A – no objective has been set) (EPA 2003b).

2.2 Biological Quality

During the last decade, EPA developed biological monitoring methods in recognition of the shortcomings of using only physical and chemical objectives for the protection of aquatic ecosystems. This has resulted in the development of indicators and SEPP objectives to supplement existing water quality objectives in environmental policies. Biological objectives are included in the SEPP WoV (Table 1) and apply to all surface water streams in the State that do not have specific catchment based objectives in place.

Given that it is not practical to develop indicators and objectives for all ecosystem components and processes, aquatic macroinvertebrates were selected as the most appropriate component for assessing the health of aquatic ecosystems (see Appendix 1.1). A fundamental feature of the objectives is that they are based on biological regions. This was needed due to the obvious differences between, for example, an alpine stream and a stream in the Wimmera, with distinctive biota in different regions requiring their own regionally based objectives. This approach is similar to that used to develop water quality objectives in catchment based policies in which segments are defined, usually based upon land use. In this case, the regions have been defined by the biota (Figure 2) and are further described in Chapter 3 and Appendix 1.2.

The biological objectives represent goals for the restoration of some streams and minimum maintenance standards for others. Some streams of very high quality will easily meet the objectives and, in these cases, maintenance of background condition is required.

Five biological indices of river condition are used to assess the environmental condition of the rivers and streams in the Ovens catchment. They are AUSRIVAS (Australian Rivers Assessment System), SIGNAL (Stream Invertebrate Grade Number Average Level), Key Families, Number of Families, and EPT (Ephemeroptera + Plecoptera + Tricoptera) Index. These indices specifically assess the status of the aquatic macroinvertebrate community.

In the SEPP (WoV), objectives for ecological health within each biological region are provided for up to five macroinvertebrate community indices. These indices can be broadly grouped into three categories: a measure of diversity (Number of Families), biotic indices (SIGNAL and EPT), and measures of community structure (AUSRIVAS and Key Families). Objectives are provided for both riffle and edge habitats as different invertebrate communities occur in each habitat and both habitats may not occur in all regions or at all sites. The exception is the Key Families indicator where macroinvertebrates from both habitats are combined to form a single site score.

In the Highlands, Forests A and Forests B segments, objectives have been set for all biological indicators (EPA 2003a,b). If a site does not meet two or more of the objectives, the site is triggered for further investigation. In the Cleared Hills and Coastal Plains and Murray and Western Plains segments, objectives have been set for biological indicators - Number of Families, SIGNAL, AUSRIVAS and Key Families. However, the latter is only applied where an AUSRIVAS objective or score is not available. If a site does not meet one or more of the objectives the site is triggered for further investigation (EPA 2003a,c). Objectives are generally provided for both riffle and edge habitats, and it is possible that one habitat will meet the objectives while the other habitat does not. When this discrepancy between habitats occurs, the overall site assessment should be based on the worst outcome; in other words, the precautionary principle should be followed and the site is triggered for further investigation.

In this report, unless otherwise noted, biological samples collected in two seasons (spring and autumn) are combined for assessment. Where multiple visits to a site occurred, only the most recent sampling data are used. If data from two seasons is not available for a site then results from a single season are presented, although interpretation of these results is treated cautiously.

Assessment against the biological objectives requires that:

- The Rapid Bioassessment Protocol (RBA) (EPA in press) has been used to collect the data;
- Edge and/or riffle habitat data are used;
- Samples are collected from two consecutive seasons (spring and autumn) within a 12-month period, and combined for assessment; and
- Presence or absence of all invertebrate families is recorded.

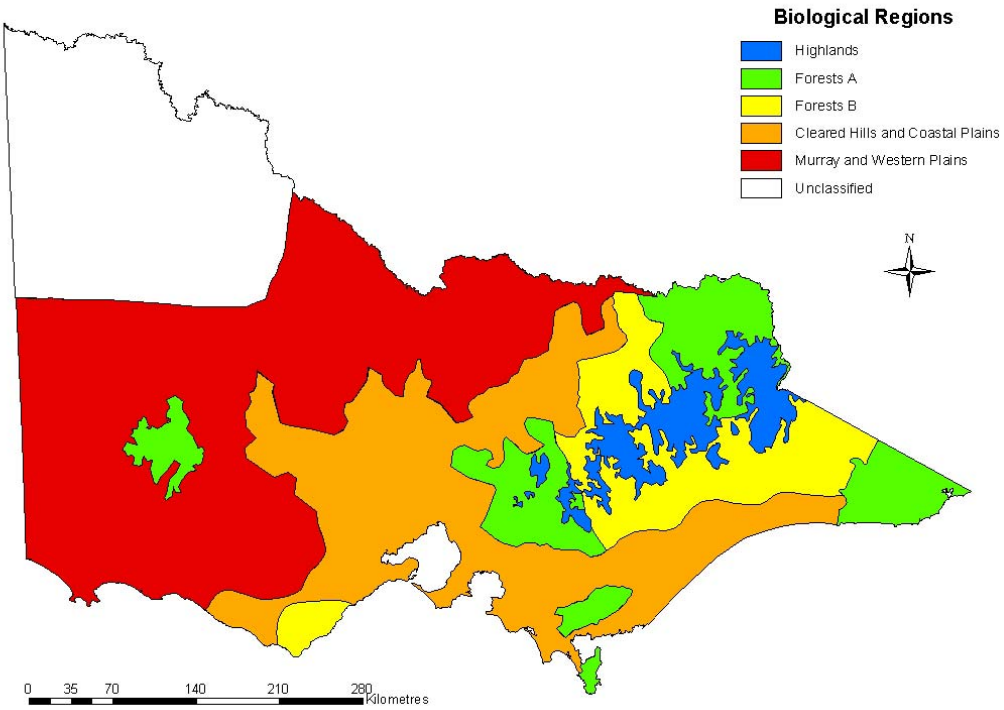

Figure 2: Biological Regions of Victoria

2.2.1 *AUSRIVAS*

AUSRIVAS is a classification and predictive modelling technique used to assess the condition of rivers and streams. The models predict the aquatic macroinvertebrate families expected to occur at a site in the absence of environmental stressors, such as water pollutants or habitat degradation. 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 ratio). The O/E scores are used to place a site into a band or category that summarises its ecological health. The derivation of AUSRIVAS scores and the banding categories are given in Appendix 1.3.

Regional AUSRIVAS models were developed for all biological regions except the Highlands Region. As a consequence, there is no AUSRIVAS objective for the Highlands Region. In this case, sites are assessed against the alternative Key Families objective.

2.2.2 *Key Families*

This index focuses mainly on the loss of taxa indicative of good habitat and water quality. The families selected are those that are typically found in the streams for that region. For example, families such as Coloburiscidae and Austroperlidae occur in cool, forested streams typical of the upland and mountain areas of the State. Other families, such as Calamoceratidae, Coenagrionidae and Hydrophilidae become more common in the warmer streams of the foothills and lowlands. Not all of the families can be expected to occur in every stream throughout each region, but the Key Families include taxa that are representative of all major habitats expected in each region and are commonly collected when present. The Key Families objective is applied when an AUSRIVAS objective or score is not available.

2.2.3 *SIGNAL*

The SIGNAL index (Stream Invertebrate Grade Number – Average Level) is an arithmetic average of pollution sensitivity values assigned at the family level for aquatic macroinvertebrate taxa (Chessman 1995). It was developed for south eastern Australian streams and is more sensitive to organic pollution than to habitat degradation. Sensitivity values range from one to 10 with lower values representing pollution tolerant families. A high SIGNAL score is indicative of good ecological condition, while a low SIGNAL score generally indicates site degradation.

2.2.4 *Number of Families*

The number of families of aquatic macroinvertebrates collected using a rapid biological assessment method provides a general indication of the health of a site. Generally, a healthy site will support a large number of families, whereas the presence of stressors will eliminate some families. However, it is recognised that the number of families of invertebrates found at a site may vary over time and across a catchment. This is a simple index of health and is best used in conjunction with other biotic indices.

2.2.5 EPT Index

Species from the insect orders of the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddis flies) are considered to be some of the most sensitive to pollution and disturbance. High numbers of families from these orders at a site are considered to indicate a healthy stream.

2.3 Water Quality

Water quality measurements were used to aid in the interpretation of results for the biological indices. The key physical and chemical indicators considered were nutrients (total phosphorus and total nitrogen), turbidity and salinity, with the SEPP WoV water quality objectives used as the basis for the assessment (Table 2).

Water quality assessments are based on data from a number of sources. Firstly, EPA site data from water samples collected and physical/chemical parameters measured at the time of biological sampling. There are limitations in the use of this data in that it only represents the average of two points in time (autumn and spring) and trends cannot be described, nor can it be clearly stated whether water quality meets established objectives (EPA 2003a,d and e). These data can only be used to give an indication of the conditions in which the aquatic biota were living at the time of collection and to help explain differences in community composition. As such, the site based water quality data are effectively only snapshots of the water quality in the Ovens catchment at the time of sampling.

In addition to the EPA snapshot water quality data, a number of reports and databases exist which assess or provide long-term water quality data throughout the Ovens catchment. The major sources used are annual reporting from the Victorian Water Quality Monitoring Network (VWQMN) and trend analysis based on sites with a minimum of 10 years data (Smith and Nathan 1999). The information from these sources is used in conjunction with the water quality data collected during the biological sampling to complement and strengthen our understanding of the environmental quality in the rivers and streams throughout the Ovens catchment.

Table 2: State environment protection policy (Waters of Victoria) in-stream water key quality indicators and objectives as they apply to the Ovens catchment

Biological Region		TP (µg/L) 75th percentile	TN (µg/L) 75th percentile	Turbidity (NTU) 75th percentile	EC (µS/cm) 75th percentile
Highlands	Alpine sites in the Ovens catchment	≤20	≤150	≤5	≤100
Forests A	Upland sites to mid-slope sites in the Ovens catchment	≤25	≤350	≤5	≤100
Forests B	Upland to mid-slope sites in the Ovens catchment	≤25	≤350	≤5	≤100
Cleared Hills and Coastal Plains	Mid-slope to lowland sites in the Ovens catchment	≤25	≤600	≤10	≤500
Murray and Western Plains	Lowland sites in the Ovens catchment	≤45	≤900	≤30	≤500

2.4 Habitat Condition

Maintenance of stream habitat features is a key component of river health. Even with good water quality and flows, a healthy aquatic ecosystem cannot be supported if suitable habitat is not present. In recognition of the importance of the surrounding habitat to the health of the biological community of rivers and streams, the physical degradation of waterways and the loss of in-stream habitat and riparian vegetation have recently received increased attention.

While quantitative environmental quality objectives for habitat have yet to be developed, the importance of habitat is emphasised in the SEPP WoV management objectives, which feature strongly in the policy's attainment measures. In this report, two general qualitative or semi-quantitative assessments of habitat condition have been used. These are the Rapid Habitat Assessment (RHA), originally developed by the US Environmental Protection Agency (USEPA), and the Index of Stream Condition (ISC), developed by the Department of Sustainability and the Environment (DSE, formerly Department of Natural Resources and the Environment), Victoria. Both indices are used to aid in the interpretation of results obtained from the biological indices.

2.4.1 Rapid Habitat Assessment – RHA

The Rapid Habitat Assessment is based on a method developed and used by the USEPA, which classifies stream habitat condition based on the variety and quality of substrate, channel morphology, bank structure and riparian vegetation (Barbour *et al.* 1999). Ten habitat parameters are evaluated visually at each site and rated on a numerical scale of zero to 20. Scores for the 10 parameters are then summed together, resulting in a total score ranging from zero to 200. To obtain a rating for each site, totalled scores are compared to a region-specific Reference Habitat Score (Table 3). These region-specific scores represent the 50th percentile (for Highlands, Forests A and Forests B biological regions) or 75th percentile (for the Cleared Hills and Coastal Plains, and Murray and Western Plains biological regions) of the RHA scores for all available reference sites within each region.

Table 3: Regional reference habitat scores for each biological region

	Highlands	Forests A	Forests B	Cleared Hills and Coastal Plains	Murray and Western Plains
Regional Reference Habitat Score	176	164	163	133	146

Source: 1998-2002 reference data.

The ratio of a test site RHA score to the Regional Reference Habitat Score provides a percent comparability measure for each site (Plafkin *et al.* 1989, Barbour and Stribling 1991). The percent comparability of the site relative to reference condition is then used to classify the habitat condition at that site on a qualitative scale (Table 4). Sites with a high percent comparability are considered to be in excellent condition, while sites with low comparability are considered poor.

The use of a ratio of test site score to regional reference score scales the assessment of habitat condition at a test site to the best available conditions within a given region. This also allows for differences in stream size, morphology, substrate and riparian structure, which may vary naturally among the biological regions in much the same way that the biological communities do.

2.4.2 Index of Stream Condition – ISC

The ISC is a general indicator of environmental condition of rivers and streams that integrates information from five sub-indices:

1. Hydrology - flow volume and seasonality of flow.
2. Physical Form - stream bank and bed condition, presence of and access to physical habitat.
3. Streamside Zone - quality and quantity of streamside vegetation.
4. Water Quality - nutrient concentration (total phosphorous), turbidity, electrical conductivity and pH.
5. Aquatic Life - diversity of macroinvertebrates.

The final ISC score is a weighted mean of the five sub-indices and ranges from zero to 50 with higher scores (greater than 35) indicating good stream condition (Table 4).

The data for the hydrology, water quality and aquatic life sub-indices were collated by the Department of Sustainability and Environment (DSE) from the Victorian Hydrographic Network, the Victorian Water Quality Monitoring Network (VWQMN) and the National River Health Program (NRHP), respectively. In some cases, data for the water quality and aquatic life sub-indices were not available and were estimated by EPA. Data on physical form and streamside zone data were collected in 1999 when the ISC was first implemented.

Table 4: Habitat condition categories for the ISC and RHA scores

	Excellent	Good	Marginal	Poor	Very Poor
RHA Percent Comparability* rank	≥90%	89-75%	74-60%	<60%	-
ISC score	42-50	35-41	26-34	20-25	0-19

* Percent comparability is calculated as the ratio of the test site RHA score to the regional reference habitat score.

3. BIOLOGICAL REGIONS IN THE OVENS CATCHMENT

3.1 Highlands (Region 1)

As the name suggests, the Highlands Region is restricted to the high country of Victoria, with streams often on steep slopes, generally above 1000m and subject to high rainfall. The vegetation tends to be native forest, woodland and grassland. Riparian shading varies from moderate to low cover, depending on the flow of streams through forested or grassland areas, respectively. The streams tend to be small (compared to other biological regions). They also have the lowest water temperatures, and very low alkalinity, turbidity and salinity. The stream habitat is generally characterised by the presence of riffles and limited edge habitat, with coarse substrate, and low macrophyte cover and diversity. An example of a site in this region is Crystal Brook at Mount Buffalo (CCB) (Figure 3).

Figure 3: Crystal Brook at Mount Buffalo (CCB)

3.2 Forests A (Region 2)

Five separate areas form the Forests A Region, including the Grampians and Strzelecki Ranges, the upper catchments of the Yarra and Murray Rivers, Wilson's Promontory and the far east of the State. Although discontinuous, they share similar environmental and biological characteristics. The streams are generally located on moderately steep slopes at much lower altitudes than the Highlands Region, but at moderately high altitudes relative to the remaining regions. Rainfall is moderate to high. Tall forests and woodlands are the typical vegetation cover. Streams generally have considerable shading from the riparian zone, and tend to be larger than streams in the Highlands Region. Cool waters with very low alkalinity, turbidity and salinity characterise the region. Streams typically have both riffle and edge habitat with moderately coarse substrate, and very low macrophyte cover and diversity. Only a very small portion of the Ovens catchment corresponds to this biological region, and none of the sites assessed in this report fell within this region.

3.3 Forests B (Region 3)

The Forests B Region incorporates the Otway Ranges, Alpine National Park and the foothills of the Great Dividing Range to form a discontinuous region supporting tall open forests. The region generally covers areas lower in altitude than the Highlands Region. Stream slopes are less steep and rainfall is moderate to high. Forestry and agriculture dominates this region. Streams are generally large, with more than double the catchment area of streams in the Highlands Region. Alkalinity of the cool waters typical of this region is slightly elevated relative to the Highlands Region, but still remains low along with turbidity and salinity. Stream habitat is characterised by the presence of riffles and edges, with very coarse substrate and high macrophyte diversity and cover. Figure 4 shows an example of this type of river in the Ovens catchment.

Figure 4: Dandongadale River at Pine Plantation Track (CDV)

3.4 Cleared Hills and Coastal Plains (Region 4)

The Cleared Hills and Coastal Plains region covers a wide area in Victoria ranging from coastal plains in the south, to inland plains and low foothills in the north and east. Streams usually flow through an undulating landscape of low altitude with little gradient and relatively low rainfall. In the Ovens catchment, this region is substantially cleared for intensive agriculture including dryland and irrigated pastures, resulting in poor riparian shading. Warm stream waters with high alkalinity, and low to moderate turbidity and salinity characterise the region. The edge habitat is more developed and extensive runs and riffles are less common. The substrate tends to be composed of moderate to fine particles, and a somewhat low diversity and moderate cover of macrophytes. The Ovens River near Everton (CDP) (Figure 5) is an example of a river in this region from the Ovens catchment.

Figure 5: Ovens River near Everton (CDP)

3.5 Murray and Western Plains (Region 5)

The Murray and Western Plains region includes lowland rivers and streams in the Ovens catchment in areas below 200m in altitude with very little topographical relief and low rainfall. The region is generally cleared for dryland and irrigated pasture, and broad-acre cropping. The waters are warm and slow flowing, can be seasonally intermittent, tending toward pond-like waterways with high alkalinity and moderate to high turbidity (Figure 6). The finer stream substrate means that the principal habitat is along edges, with macrophytes and woody debris being the dominant habitat for macroinvertebrates. Ovens River at Talbot Bend (CDI) (Figure 6) is an example of a river in this region from the Ovens catchment.

Figure 6: Ovens River at Talbot Bend (CDI)

4. WATER QUALITY CHARACTERISATION

There are nine active Victorian Water Quality Monitoring Network sites in the Ovens catchment (Figure 7). To provide an overall picture of the water quality throughout the Ovens catchment during the time period covered by the biological data, water quality results for total nitrogen (TN), total phosphorus (TP), turbidity, and salinity (measured as electrical conductivity at 25°C) are presented for these nine sites (Table 5). These data represent the 75th percentile values for each water quality parameter based on monthly sampling throughout 2002. They are assessed against the SEPP objectives for nutrients and water quality given in Table 2.

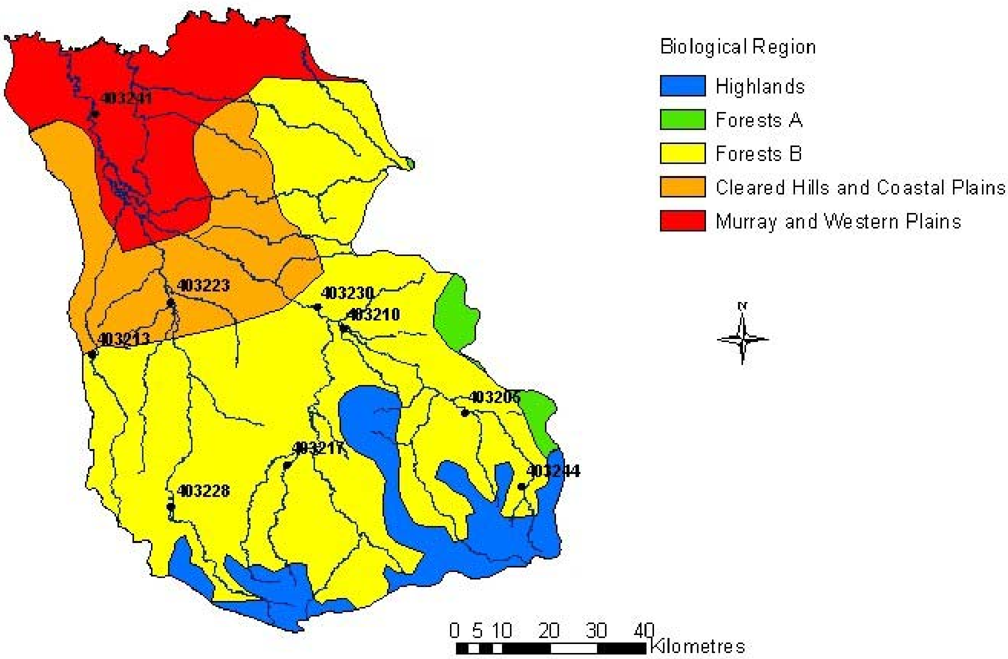

Figure 7: Location of VWQMN sites and biological regions in the Ovens catchment

Generally speaking, the water quality of the Ovens catchment, as represented by these key sites, is good to excellent (Table 5). Total nitrogen and salinity levels were below SEPP objectives at all the monitoring sites. Turbidity levels were also low at all sites with the exception of Fifteen Mile Creek at Greta South, where turbidity levels exceeded the turbidity objective. Of some concern, however, are the elevated levels of total phosphorous, which did not meet the SEPP phosphorous objectives at six of the sites for which data was available. Only Fifteen Mile Creek at Greta South and Ovens River at Bright exhibited phosphorous levels substantially above the SEPP objectives.

Table 5: The 75th percentile values for key water quality parameters based on monthly sampling throughout 2002

Site	Site Number	TP (µg/L)	TN (µg/L)	Turbidity (NTU)	EC (µS/cm)
Fifteen Mile Creek at Greta South	403213	34	303	7.3	95
King River at Lake William Hovell	403228	NM	NM	1.5	35
King River at Docker Road Bridge	403223	27	277	6.1	52
Rose River at Metong North	403217	27	338	1.9	48
Ovens River at Harrietville	403244	27	161	0.8	41
Ovens River at Bright	403205	35	263	2.0	43
Ovens River at Myrtleford	403210	24	235	3.3	43
Ovens River at Rocky Point	403230	27	332	2.3	49
Ovens River at Peechelba	403241	45	375	9.4	89

Values that exceed the SEPP objectives are highlighted in red.
NM - not measured

Trends in water quality at the VWQMN sites in the Ovens catchment are presented in Table 6. These results summarise trends in the key water quality parameters (total nitrogen and phosphorous, salinity and turbidity) from 1975 to 1999 (Smith and Nathan 1999). Only those sites with a minimum of 10 years of data were included in the analysis. These results provide a longer temporal view of water quality conditions in the Ovens catchment.

The analysis did not find a significant increase in total nitrogen or total phosphorus levels at any of the sites for which sufficient data was available. In fact, there was a trend of decreasing total nitrogen levels at Ovens River at Rocky Point (403230) and Ovens River at Bright (403205). There was no trend towards an increase or decrease in salinity or turbidity at any sites, with the notable exception of the Ovens River at Peechelba (403241). At this site there has been a significant increase in turbidity over the 24 years to 1999.

Table 6: Trends in water quality in the Ovens catchment from 1975 to 1999

Site	Site Number		TP (µg/L)	TN (µg/L)	Turbidity (NTU)	EC (µS/cm)
Fifteen Mile Creek at Greta South	403213	Change (units per year)	no data	no data	0	0
		Significance			0.05	0.05
Rose River at Metong North	403217	Change (units per year)	no data	no data	0	0
		Significance			0.05	0.05
Ovens River at Bright	403205	Change (units per year)	0	-0.011	0	0
		Significance	NS	0.05	0.05	NS
Ovens River at Myrtleford	403210	Change (units per year)	no data	no data	0	0
		Significance			0.05	NS
Ovens River at Rocky Point	403230	Change (units per year)	0	-0.008	0	0
		Significance		0.05	0.05	NS
Ovens River at Peechelba	403241	Change (units per year)	N/A	N/A	0.46	0
		Significance			0.05	0.05

NS – not significant
N/A – reliable results could not be determined
Source: Smith and Nathan 1999

In addition to the long-term data from the VWQMN sites, snapshot water quality results taken at each of the sites where biological samples were collected are presented (Table 7). These results provide an indication of the water quality conditions experienced by the biological communities at each site at the time of sampling. As such, they may assist in the interpretation of biological results and also provide an indication of any potential problems in meeting water quality objectives. These results are discussed in more detail in section 5 (Biological Assessment).

Table 7: Water quality results for biological sites in the Ovens catchment

Site	Site Code	TP (µg/L)	TN (µg/L)	Turbidity (NTU)	EC (µS/cm)
Highlands					
Running Jump Ck Tributary, u/s Tatra	CBY	11	123	1.2	10
Crystal Brook at Mt Buffalo	CCB	10	77	0.5	10
Forests B					
Buffalo R at Merriang Rd	CAA	13	229	1.0	40
Ovens R, u/s Myrtleford	CAB	12	144	0.7	38
Ovens R, d/s fish farm	CAD	18	77	1.0	37
Ovens R, d/s Smoko	CAE	16	70	1.1	35
Ovens R at McMahons Ln	CAF	31	83	1.9	36
Ovens R at Old Harrietville Rd	CAG	14	46	1.2	38
Buffalo Ck at Buffalo Ck Rd	CAH	9	115	0.8	16
Ovens R, d/s Buffalo Ck at Myrtleford	CBA	7	122	1.9	36
Ovens R at Bright	CBC	13	79	1.4	41
Fifteen Mile Ck at Greta Sth	CBF	18	178	5.2	55
Rose R at Metong North	CBG	9	104	1.8	33
Ovens R at Whorouly Sth - Gapsted Rd bridge	CBJ	17	216	1.1	43
Ovens R at Harrietville	CBK	12	66	0.7	49
King R, u/s Lake William Hovell	CBL	12	71	0.4	27
King R at Edge of Forest, Cheshunt Sth	CBU	9	117	2.6	26
Barwidgee Ck at Myrtleford Rd	CCD	29	481	2.9	138
Reedy Ck at Wooragee	CCE	33	1020	9.4	132
Ovens R, u/s fish farm	CCH	14	80	0.9	37
King R at Edi Cutting	CCL	11	135	0.9	31
Barwidgee Ck at Myrtleford	CCN	19	232	2.6	108
Happy Valley Ck at Mudgeegonga Rd	CCO	92	634	9.6	110
Ovens R at Braithwaite Pumping Station	CCP	7	114	1.4	39
Buckland R at Mt Buffalo Rd	CCQ	5	247	1.5	34
Roberts Ck at Roberts Creek Rd	CCR	25	176	3.8	44
Morses Ck at Hawthorne Ck	CCS	6	117	1.7	46
German Ck, Nth of Germantown	CCT	12	134	1.8	39
Ovens R at Mills View	CCU	12	100	1.0	37
Indigo Ck at Pooleys Rd	CCZ	26	800	5.8	375
Spring Ck at Beechworth	CDB	28	380	4.4	56
Fifteen Mile Ck at Fairfield Park	CDD	29	204	3.6	57
King R at Gentle Annie Ln	CDG	17	195	1.1	30
Buffalo R, u/s Durling Track	CDJ	13	114	0.9	38
Buffalo R at Camp Creek Track	CDK	13	120	1.2	35
Buffalo R at Blades Picnic Ground	CDL	14	115	1.0	42
Buffalo R, u/s Catherine R	CDM	13	130	1.1	40
Buffalo R off Buffalo Rd	CDN	19	145	1.3	47
King R at King Hut Track	CDQ	14	67	0.9	16

Site	Site Code	TP (µg/L)	TN (µg/L)	Turbidity (NTU)	EC (µS/cm)
King R at Pineapple Flat	CDR	20	65	1.0	30
Dandongadale R at Cobbler's Lake Rd	CDU	11	79	0.9	22
Dandongadale R at Pine Plantation Track	CDV	13	114	0.8	42
Rose R at Rose River Road	CDW	26	261	1.7	63
Rose R at Bennies	CDX	12	108	0.7	26
Black Range Ck at Carboor Rd	CDY	50	312	4.7	78
Black Range Ck at Pigram's Farm	CDZ	24	179	4.3	87
Yarrabula Ck off Yarrabula Rd	CEB	7	78	0.7	27
Cleared Hills and Coastal Plains					
Burgoigee Ck at Ovens Valley Hwy	CAI	50	1275	6.6	1102
Hodgsons Ck at Farmers Rd	CAJ	12	328	3.4	309
King R at Docker	CBH	15	220	2.6	37
King R at Oxley	CCJ	16	204	6.5	62
Boggy Ck at Top Plain Rd	CCK	30	435	10.9	163
Croppers Ck at Tetley Ln	CCW	75	1400	13.0	272
Hodgsons Ck at Kays Road bridge	CCX	15	510	6.7	234
Fifteen Mile Ck at Glenrowan - Milawa Rd	CDC	63	886	36.4	248
Ovens R at Oxley Flats	CDO	14	169	1.5	54
Ovens R near Everton	CDP	21	200	1.1	45
Ovens R at River Road Reserve	CDS	19	172	1.5	43
Murray and Western Plains					
Ovens R at Peechelba East	CBB	35	259	5.9	35
Fifteen Mile Ck at Cruse St	CBR	1125	2860	13.5	930
Ovens R at Robinson Rd	CBV	37	312	4.3	81
Indigo Ck at Murray Valley Hwy	CBW	162	1520	20.0	655
Black Dog Ck at Rutherglen - Springhurst Rd	CCF	101	1705	17.5	418
Black Dog Ck at Dugays Bridge Rd	CCG	96	1215	21.5	198
Ovens R at Ovens Track	CCI	30	321	5.3	119
Reedy Ck at Carraragarmungee Estate Rd	CCY	14	342	2.8	102
Fifteen Mile Ck at Ussher's Dr	CDA	545	1730	17.0	465
Ovens R at Boland Rd	CDE	38	276	4.4	66
Ovens R at Cinnamonds	CDF	37	281	7.4	67
Ovens R at Wallis' property	CDH	38	304	7.5	73
Ovens R at Talbot Bend	CDI	59	517	8.0	71
Ovens R at Carmody Rd	CEC	36	272	4.8	72
Ovens R at Warby Range Rd	CED	34	242	4.3	66

Source: Snapshot water quality measurements averaged for 2 samples taken at the time of biological sampling.

5. BIOLOGICAL ASSESSMENT

The five biological indices described in section 2.2 were used to make an assessment of the environmental condition of the health of the rivers and streams of the Ovens catchment. The SEPP biological objectives for each biological region are given in Table 1, and the results of this assessment are presented in Table 8.

For the convenience of discussion, sites in the Ovens catchment have been assigned to the biological regions in which they occur. The distribution of sites among biological regions is shown in Figure 8 and is as follows:

1. Highlands (2 sites)
2. Forests B upland to mid-slope reaches of the Ovens River and tributaries (45 sites)
3. Cleared Hills and Coastal Plains (11 sites)
4. Murray and Western Plains (15 sites)

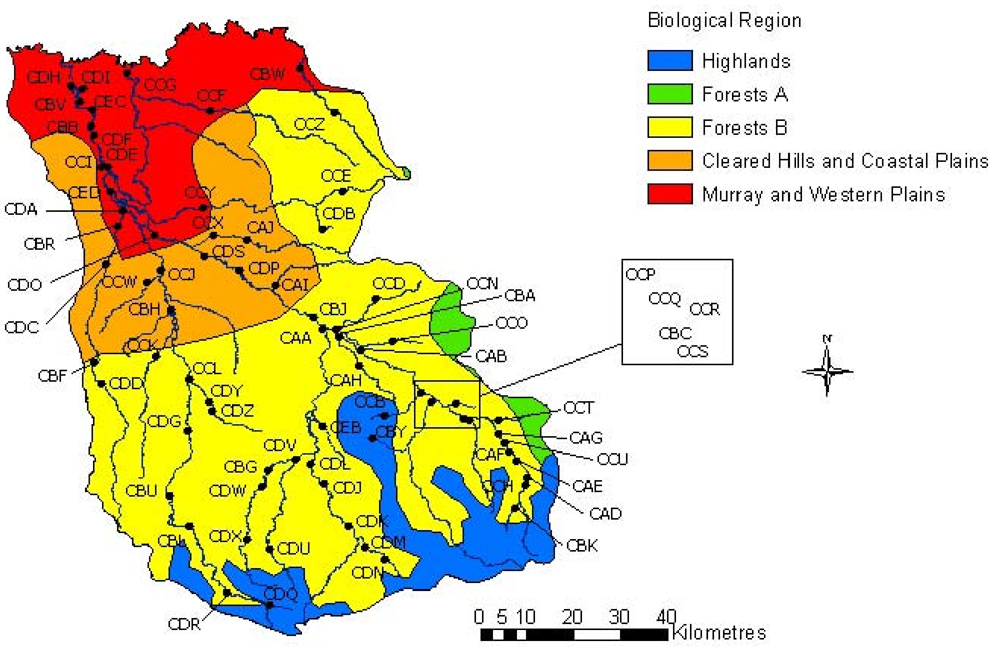

Figure 8: Location of sampling sites and biological regions in the Ovens catchment

The rivers and streams in the Ovens catchment that are considered to be in good ecological condition occur predominantly in the upper catchment. Areas of reduced habitat and water quality occur sporadically in the mid to lower sites of the Ovens catchment. This is evident in Figure 9, which shows the AUSRIVAS and SIGNAL results for each site. These results are discussed in sections 5.1 to 5.4 in relation to the SEPP WoV objectives and the land uses within the catchment (Figure 10).

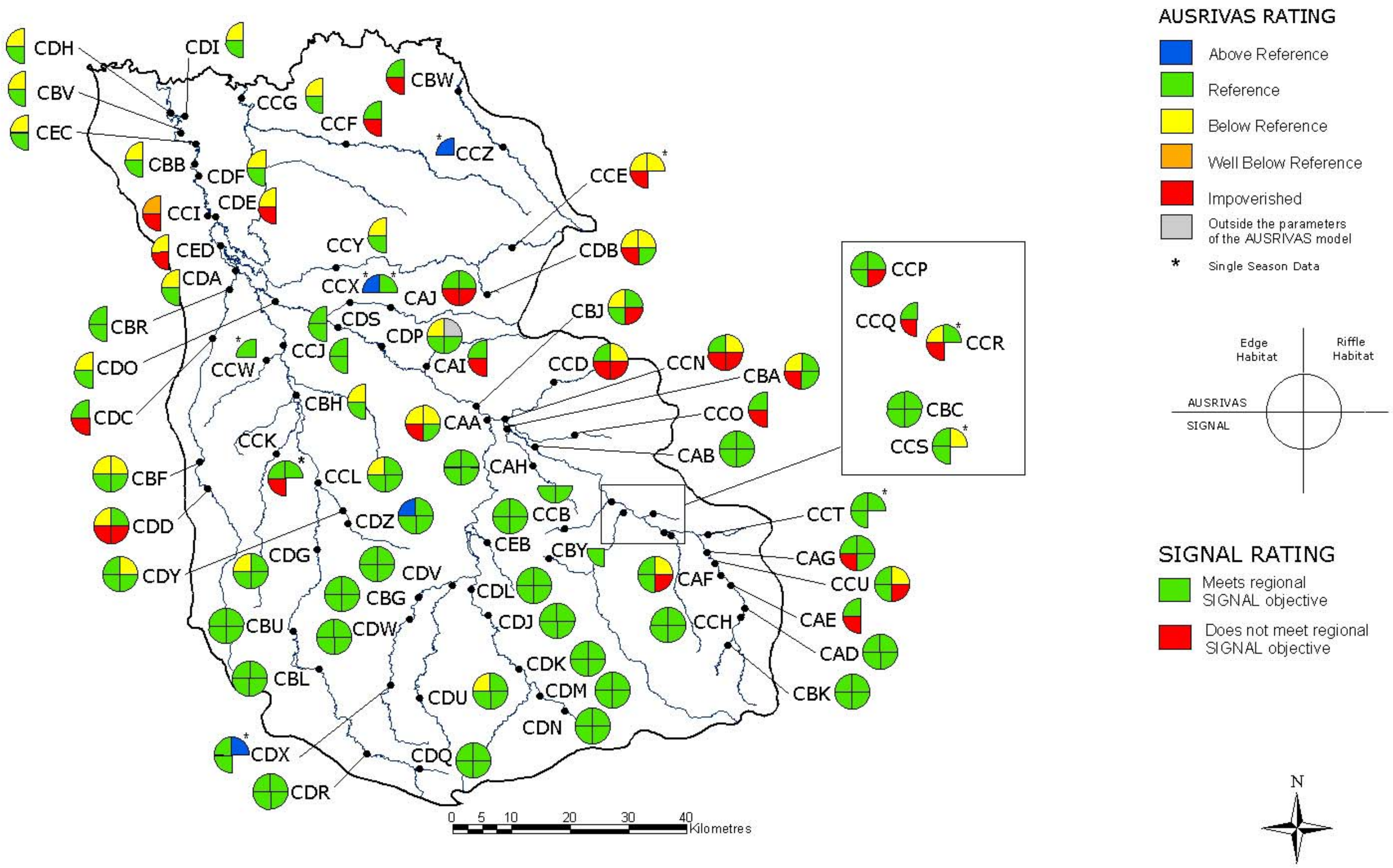

Figure 9: AUSRIVAS and SIGNAL ratings for sites in the Ovens catchment

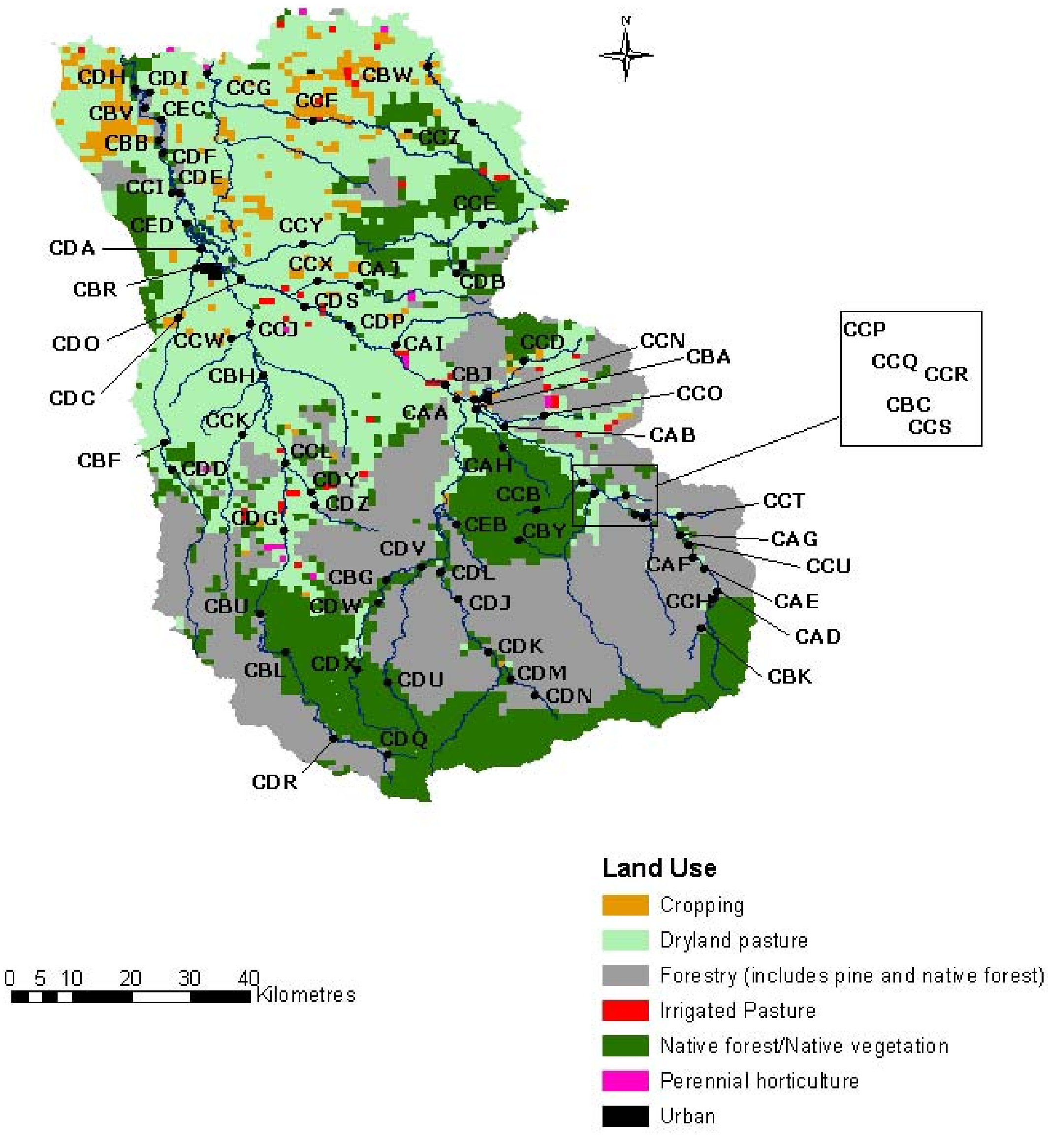

Figure 10: Sampling sites and land use categories for the Ovens catchment

(Data Source: NPI 2003)

Table 8: Results for the biological objectives, ISC and RHA for sites in the Ovens catchment

Site	Site Code	AUSRIVAS O/E score (Band)		Key Families Combined Habitats	SIGNAL		Number of Families		EPT Taxa		ISC Reach	ISC Score	RHA Score
		Edge	Riffle		Edge	Riffle	Edge	Riffle	Edge	Riffle			
Highlands													
Running Jump Ck Tributary, u/s Tatra	CBY	No AUSRIVAS Model		17[2]	6.3	6.5[2]	23	17[2]	7	6[2]	N/E	N/E	165
Crystal Brook at Mt Buffalo	CCB	No AUSRIVAS Model		21	6.9	6.9	21	24	8	10	N/E	N/E	164
Forests B													
Buffalo R at Merriang Rd	CAA	0.84 (B)	0.80 (B)	N/R	5.7	6.0	32	25	10	11	33	32*	148
Ovens R, u/s Myrtleford	CAB	0.93 (A)	0.89 (A)	N/R	6.2	6.7	34	28	12	14	5	33	125
Ovens R, d/s fish farm	CAD	1.04 (A)	0.97 (A)	N/R	6.2	6.5	32	32	14	15	6	37	148
Ovens R, d/s Smoko	CAE	0.93 (A)	N/A	N/R	5.6	N/A	37	N/A	11	N/A	6	37	128
Ovens R at McMahons Lane	CAF	1.08 (A)	0.78 (B)	N/R	6.0	5.9	35	25	15	11	6	37	99
Ovens R at Old Harrietville Rd	CAG	0.95 (A)	0.98 (A)	N/R	5.7	6.2	30	32	10	14	6	37	133
Buffalo Ck at Buffalo Ck Rd	CAH	1.01 (A)	1.03 (A)	N/R	6.1	6.7	33	37	12	17	42	35*	140
Ovens R, d/s Buffalo Ck at Myrtleford	CBA	0.84 (B)	0.96 (A)	N/R	5.6	6.4	30	26	11	12	5	33	102
Ovens R at Bright	CBC	0.93 (A)	1.04 (A)	N/R	6.2	6.1	31	35	12	15	6	37	134
Fifteen Mile Ck at Greta Sth	CBF	0.82 (B)	0.75 (B)	N/R	5.8	6.0	31	31	8	11	9	27*	99
Rose R at Metong North	CBG	0.93 (A)	0.93 (A)	N/R	6.0	6.9	34	32	12	16	37	36*	157
Ovens R at Whorouly Sth - Gapsted Rd bridge	CBJ	0.83 (B)	0.97 (A)	N/R	5.8	5.8	25	30	9	11	4	27*	128
Ovens R at Harrietville	CBK	0.99 (A)	0.98 (A)	N/R	6.6	6.7	33	36	16	17	N/E	N/E	151
King R, u/s Lake William Hovell	CBL	0.99 (A)	1.04 (A)	N/R	6.3	6.6	29	36	12	16	25	41*	178
King R at Edge of Forest, Cheshunt Sth	CBU	0.95 (A)	0.97 (A)	N/R	5.9	6.3	34	30	11	13	24	43	181
Barwidgee Ck at Myrtleford Rd	CCD	1.07 (A)	0.80 (B)	N/R	5.6	5.5	37	33	9	10	40	29*	126
Reedy Ck at Wooragee	CCE	0.84 (B)	0.55 (B)[2]	N/R	5.6	5.8[2]	36	13[2]	7	5[2]	20	37*	94
Ovens R, u/s fish farm	CCH	0.95 (A)	0.99 (A)	N/R	6.4	6.4	25	34	10	16	6	37	156
King R at Edi Cutting	CCL	0.86 (B)	0.97 (A)	N/R	6.0	6.1	31	27	12	13	23	33*	131
Barwidgee Ck at Myrtleford	CCN	0.95 (A)	0.74 (B)	N/R	5.5	5.3	31	27	8	8	39	29*	103
Happy Valley Ck at Mudgeegonga Rd	CCO	0.88 (A)	N/A	N/R	5.2	N/A	36	N/A	9	N/A	41	24*	108
Ovens R at Braithwaite Pumping Station	CCP	0.93 (A)	1.04 (A)	N/R	6.0	5.8	31	33	12	12	5	33	93
Buckland R at Mt Buffalo Rd	CCQ	0.99 (A)	N/A	N/R	5.7	N/A	31	N/A	8	N/A	43	30*	110
Roberts Ck at Roberts Creek Rd	CCR	0.67 (B)	0.95 (A)[2]	N/R	5.5	6.3[2]	22	25[2]	4	9[2]	N/E	N/E	113
Morses Ck at Hawthorne Ck	CCS	0.93 (A)	0.82 (B)[2]	N/R	5.8	6.1[2]	34	17[2]	10	5[2]	45	31*	92
German Ck, Nth of Germantown	CCT	0.93 (A)	0.83 (A)[2]	N/R	6.0	6.4[2]	37	17[2]	13	9[2]	N/E	N/E	128
Ovens R at Mills View	CCU	0.95 (A)	0.81 (B)	N/R	6.1	5.9	37	22	12	10	6	37	149
Indigo Ck at Pooleys Rd	CCZ	1.22 (X)[2]	N/A	N/R	5.3[2]	N/A	26[2]	N/A	7[2]	N/A	47	34*	140
Spring Ck at Beechworth	CDB	0.80 (B)	0.68 (B)	N/R	5.7	6.0	29	26	6	9	N/E	N/E	101
Fifteen Mile Ck at Fairfield Park	CDD	0.75 (B)	0.97 (A)	N/R	5.7	5.8	29	36	7	13	10	30*	108
King R at Gentle Annie Ln	CDG	0.81 (B)	0.95 (A)	N/R	5.8	6.2	26	28	11	12	23	33*	148
Buffalo R, u/s Durling Track	CDJ	0.97 (A)	0.94 (A)	N/R	6.3	6.3	33	30	10	13	35	36*	191
Buffalo R at Camp Creek Track	CDK	0.97 (A)	1.05 (A)	N/R	6.7	6.6	29	41	14	19	35	36*	195
Buffalo R at Blades Picnic Ground	CDL	1.12 (A)	1.00 (A)	N/R	6.5	6.4	33	33	13	14	35	36*	178

Site	Site Code	AUSRIVAS O/E score (Band)		Key Families Combined Habitats	SIGNAL		Number of Families		EPT Taxa		ISC Reach	ISC Score	RHA Score
		Edge	Riffle		Edge	Riffle	Edge	Riffle	Edge	Riffle			
Buffalo R, u/s Catherine R	CDM	1.10 (A)	1.12 (A)	N/R	6.6	6.7	40	42	16	18	35	36*	180
Buffalo R off Buffalo Rd	CDN	1.06 (A)	1.06 (A)	N/R	7.1	6.9	37	36	16	18	35	36*	183
King R at King Hut Track	CDQ	0.97 (A)	1.02 (A)	N/R	6.8	7.2	29	42	14	21	25	41*	188
King R at Pineapple Flat	CDR	1.10 (A)	0.98 (A)	N/R	6.6	7.1	36	38	14	19	25	41*	191
Dandongadale R at Cobbler's Lake Rd	CDU	0.78 (B)	0.94 (A)	N/R	6.5	7.0	26	35	11	17	N/E	N/E	174
Dandongadale R at Pine Plantation Track	CDV	0.93 (A)	0.92 (A)	N/R	6.3	6.3	32	31	11	13	N/E	N/E	173
Rose R at Rose River Road	CDW	1.00 (A)	1.00 (A)	N/R	6.2	6.5	33	36	11	15	37	36*	146
Rose R at Bennies	CDX	0.93 (A)	1.22 (X)[2]	N/R	6.2	6.9[2]	35	29[2]	12	12[2]	37	36*	174
Black Range Ck at Carboor Rd	CDY	0.91 (A)	0.82 (B)	N/R	5.8	6.1	31	25	11	11	29	34*	113
Black Range Ck at Pigram's Farm	CDZ	1.13 (X)	0.97 (A)	N/R	6.0	6.2	43	34	11	14	29	34*	141
Yarrabula Ck off Yarrabula Rd	CEB	1.01 (A)	1.04 (A)	N/R	6.5	6.7	30	33	13	15	N/E	N/E	166
Cleared Hills and Coastal Plains													
Burgoigee Ck at Ovens Valley Hwy	CAI	0.94 (A)	N/A	N/R	5.3	N/A	33	N/A	5[3]	N/A	32	36*	91
Hodgsons Ck at Farmers Rd	CAJ	1.11 (A)	1.01 (A)	N/R	5.3	5.2	35	30	8[3]	8[3]	31	36*	99
King R at Docker	CBH	0.66 (B)	N/A	N/R	6.1	N/A	20	N/A	8[3]	N/A	22	37	99
King R at Oxley	CCJ	0.90 (A)	N/A	N/R	5.7	N/A	27	N/A	7[3]	N/A	21	35*	114
Boggy Ck at Top Plain Rd	CCK	0.86 (A)	0.89 (A)[2]	N/R	5.3	5.9[2]	27	20[2]	6[3]	9[2,3]	27	28*	79
Croppers Ck at Tetley Ln	CCW	1.09 (A)[2]	N/A	N/R	5.2[2]	N/A	22[2]	N/A	3[2,3]	N/A	N/E	N/E	113
Hodgsons Ck at Kays Road bridge	CCX	1.19 (X)[2]	0.85 (A)[2]	N/R	5.4[2]	6.1[2]	25[2]	19[2]	4[2,3]	6[2,3]	30	28*	84
Fifteen Mile Ck at Glenrowan - Milawa Rd	CDC	0.89 (A)	N/A	N/R	5.4	N/A	25	N/A	5[3]	N/A	8	35*	82
Ovens R at Oxley Flats	CDO	0.81 (B)	N/A	N/R	6.2	N/A	24	N/A	7[3]	N/A	3	25*	140
Ovens R near Everton	CDP	0.73 (B)	O/S	N/R	6.2	5.8	23	26	8[3]	10[3]	4	27*	119
Ovens R at River Road Reserve	CDS	1.08 (A)	N/A	N/R	5.8	N/A	31	N/A	9[3]	N/A	4	27*	137
Murray and Western Plains													
Ovens R at Peechelba East	CBB	0.68 (B)	0.78 (B)[1,3]	N/R	5.5	5.4[1,3]	21	14[1,3]	3[3]	7[1,3]	1	30	150
Fifteen Mile Ck at Cruse St	CBR	0.90 (A)	0.61 (B)[2,3]	N/R	5.7	5.4[2,3]	21	11[2,3]	4[3]	2[2,3]	8	35*	125
Ovens R at Robinson Rd	CBV	0.82 (B)	N/A	N/R	5.6	N/A	20	N/A	4[3]	N/A	1	30	142
Indigo Ck at Murray Valley Hwy	CBW	0.89 (A)	N/A	N/R	5.1	N/A	25	N/A	3[3]	N/A	46	34*	110
Black Dog Ck at Rutherglen - Springhurst Rd	CCF	0.87 (A)	N/A	N/R	5.2	N/A	26	N/A	3[3]	N/A	13	37*	86
Black Dog Ck at Dugays Bridge Rd	CCG	0.78 (B)	N/A	N/R	5.3	N/A	27	N/A	3[3]	N/A	N/E	N/E	105
Ovens R at Ovens Track	CCI	0.55 (C)	N/A	N/R	5.2	N/A	19	N/A	3[3]	N/A	2	27*	111
Reedy Ck at Carraragarmungee Estate Rd	CCY	0.85 (B)	0.71 (B)[3]	N/R	5.4	5.7[3]	29	19[3]	7[3]	7[3]	17	35*	69
Fifteen Mile Ck at Ussher's Dr	CDA	0.60 (B)	N/A	N/R	5.4	N/A	15	N/A	2[3]	N/A	8	35*	134
Ovens R at Boland Rd	CDE	0.78 (B)	0.67 (B)[3]	N/R	5.1	5.6[3]	21	17[3]	4[3]	8[3]	2	27*	130
Ovens R at Cinnamonds	CDF	0.78 (B)	0.58 (B)[1,3]	N/R	5.5	5.1[1,3]	24	13[1,3]	6[3]	5[1,3]	1	30	145
Ovens R at Wallis' property	CDH	0.62 (B)	N/A	N/R	5.7	N/A	19	N/A	3[3]	N/A	1	30	155
Ovens R at Talbot Bend	CDI	0.82 (B)	N/A	N/R	5.4	N/A	21	N/A	5[3]	N/A	1	30	151
Ovens R at Carmody Rd	CEC	0.72 (B)	N/A	N/R	6.1	N/A	21	N/A	3[3]	N/A	1	30	149
Ovens R at Warby Range Rd	CED	0.63 (B)	N/A	N/R	5.1	N/A	18	N/A	5[3]	N/A	2	27*	139

Key for Biological Indicators	
Meets SEPP biological objective	[1] single season, autumn
Does not meet SEPP biological objective	[2] single season, spring
O/S = outside the experience of the model	[3] no SEPP objective
N/R = not required when AUSRIVAS results available	N/A = habitat not available

Key for ISC and RHA ratings	
Excellent	N/E = site not evaluated for ISC
Good	* Some subindices estimated
Marginal	
Poor	
Very Poor	

5.1 Highlands

The Alpine National Park and Mount Buffalo National Park fall within the Highlands Biological Region in the southern part of the Ovens catchment (Figure 8). Two sites were sampled in this region: Crystal Brook at Mount Buffalo (CCB) and Running Jump Creek upstream of Tatra (CBY). These sites are typical of the Highlands Region. The streams are small with average depths of 10 to 20cm, mean channel width is 1.5 to 4.0m, and the stream substrate is characterised by a high proportion of gravel. The excellent habitat scores are indicative of the largely natural state of these sites. Both sites are long-term reference sites and in excellent condition, meeting all the SEPP objectives for their respective edge habitats. The riffle habitat for CCB also met the SEPP objectives.

The riffle habitat for CBY was only sampled in a single season and therefore was not assessed against the SEPP objectives, however a preliminary assessment indicates that this site is very healthy. Although CBY is located downstream of a sewage treatment plant the available data suggests that the plant does not have a large impact on this creek.

5.2 Forests B

The Forests B Biological Region covers the largest section of the Ovens catchment. This region includes parts of the Alpine National Park and the foothills of the Great Dividing Range, extending from tall open forests to areas of lower altitude where forestry and agriculture dominate. The two regional towns, Bright and Myrtleford, are located in the lower foothills. Waterways within this region include the upper and middle sections of the Ovens, Buffalo, and King rivers as well as the upper reaches of Fifteen Mile Creek. Streams in this region are in a relatively natural state. There are two small impoundments at Lake Buffalo on the Buffalo River and Lake William Hovel on the King River, and while additional water is extracted from some streams for domestic and irrigation use, the flows are otherwise unregulated. Stream condition in this region generally varies according to local catchment area activity.

5.2.1 Fifteen Mile Creek

Two sites were assessed on Fifteen Mile Creek: Fifteen Mile Creek at Fairfield Park (CDD) and at Greta South (CBF). The riffle habitat for CDD met the SEPP objectives for AUSRIVAS and EPT, and both habitats met the objectives for Number of Families. The objectives for SIGNAL were not met for either habitat and the edge habitat did not meet the SEPP objectives for AUSRIVAS and EPT. The ISC and RHA ratings were marginal for this site and these results indicate that the stream condition and local catchment area are under environmental stress. Fifteen Mile Creek at Greta South (CBF) met the SEPP objectives for SIGNAL and Number of Families but did not meet AUSRIVAS objectives for either habitat. The edge habitat did not meet the EPT objectives and this site scored marginally for the ISC and RHA.

Poor riparian zones, with bank erosion where cattle appear to access at CBF, and the presence of few macrophytes at both sites may be contributing to the loss of macroinvertebrate families, especially the environmentally sensitive EPT taxa. Elevated phosphorous levels at CDD at the time of sampling, and phosphorous results from the VWQMN 2002 data for CBF (Table 5) suggest that nutrients may be a problem at these sites.

5.2.2 King River and Black Range Creek

Six sites were assessed on the King River and two on Black Range Creek, which flows into the King River. The sites on the King River were: King River at King Hut Track (CDQ); at Pineapple Flat (CDR); upstream of Lake William Hovell (CBL); at edge of forest at Cheshunt South (CBU); at Gentle Annie Lane (CDG); and at Edi Cutting (CCL). The two sites on Black Range Creek were Black Range Creek at Pigram's Farm (CDZ) and Black Range Creek at Carboor Road (CDY).

All the sites upstream of Myrrhee on the King River (CDQ, CDR, CBL and CBU) met the SEPP objectives for all the macroinvertebrate indices and received high ratings for habitat condition. These sites are in good health because they flow through undisturbed native forest. Indeed, the long-term results for CBL indicate that this site has been in consistently good condition since 1990 (Table 9).

Table 9: Long term biological results for King River upstream of Lake William Hovell (CBL)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	B	6.6	27	12	A	6.6	33	17
1991	A	6.6	36	17	A	6.6	33	16
1997	A	6.7	34	19	X	6.5	36	16
2000	A	6.6	36	16	A	6.8	35	16
2002	A	6.6	36	16	A	6.3	29	12

Downstream of Myrrhee, CDG and CCL achieved the SEPP objectives for most of the macroinvertebrate indices, with the exception of AUSRIVAS for the edge habitat. Both sites rated well for the RHA but marginally for the ISC. In this reach, horticulture and irrigated and dryland pastures become more prevalent. Total phosphorous loads increase from Lake William Hovell to Moyhu, indicating that some nutrient enrichment is creating problems in the waterways (NECMA 2000).

Black Range Creek at Carboor Road (CDY) achieves the SEPP objectives for all the macroinvertebrate indices, except AUSRIVAS for the edge habitat. Black Range Creek at Pigram's Farm (CDZ) met the SEPP objectives for all the macroinvertebrate indices. This site received an 'above reference' AUSRIVAS score for the edge habitat which could be indicative of nutrient enrichment. While snapshot water quality data did not show evidence of elevated nutrient levels at CDZ, high phosphorous levels at CDY suggest that water quality may be an issue in Black Range Creek. Extensive clearing for grazing and cropping in the area surrounding these sites may be contributing to the reduced biological health (NPI 2003), despite the presence of good local habitat at both sites.

5.2.3 Rose River and Dandongadale River

The Rose and Dandongadale rivers flow into the Buffalo River, which joins the Ovens River just downstream of Myrtleford. Three sites were surveyed on Rose River: Rose River at Bennies (CDX); at Rose River Road (CDW); and at Metong North (CBG). Above SEPP objective results and excellent habitat scores at all three sites indicate that the Rose River is in a natural state. The riffle data for CDX was not assessed against the SEPP objectives as it was only single season data, however, a preliminary assessment supports the conclusion that this site is in its natural state. VWQMN data collected over the past 12 years (Site 403217; Table 5 and 6), as well as long-term biological results (Table 10), indicate that the Rose River has generally been in consistently good condition. A substantial part of the Rose River, including the surveyed sites, flows through undisturbed native forest that probably buffers the reach against any perturbations in the catchment (Figure 10).

Table 10: Long term biological results for Rose River at Metong North (CBG)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	A	6.4	37	17	A	6.5	32	13
1991	A	6.4	36	19	A	6.5	40	15
2000	A	6.9	32	16	A	6.0	34	12

Two sites were surveyed on the Dandongadale River: Dandongadale River at Cobbler's Lake Road (CDU) and Dandongadale River at Pine Plantation Track (CDV). Both sites received 'excellent' ratings for the RHA and met the SEPP objectives for the macroinvertebrate indices, with the exception of the AUSRIVAS score for the edge habitat at CDU. Like the Rose River, a substantial part of the Dandongadale River flows through native forest, which allows for a healthy macroinvertebrate community.

The AUSRIVAS score for the edge habitat at CDU is atypical of these forested headwater reaches. It was particularly unusual given the diverse and abundant edge habitat and the presence of key macroinvertebrate families expected to occur in cool mountain streams. Additional sampling of this site is required to determine whether this result is anomalous or whether these results are actually indicative of impairment.

5.2.4 Buffalo River and Yarrabula Creek

Six sites were surveyed on Buffalo River and one site on Yarrabula Creek, off Yarrabula Road (CEB). The sites on the Buffalo River were: Buffalo River off Buffalo Road (CDN); upstream of Catherine River (CDM); at Camp Creek Track (CDK); upstream of Durling Track (CDJ); at Blades Picnic Ground (CDL); and at Merriang Road (CAA). All the sites upstream of Lake Buffalo (CDN, CDM, CDK, CDJ, CDL, and CEB) met the SEPP objectives for all the macroinvertebrate indices. All sites received an 'excellent' rating for the RHA and 'good' ISC rating. This indicates that local habitat around each site is in good health and the catchment area of each site includes areas of native forest.

Below Lake Buffalo and downstream of Myrtleford, CAA presents a very different picture, failing to met SEPP objectives for SIGNAL at the edge habitat and AUSRIVAS at the riffle habitat. It is likely that urbanisation around Myrtleford may be adversely affecting the health of this site through increased run-off from impermeable surfaces, cropping, septic tanks and stormwater. Input flows from relatively healthy catchments, such as the Rose, Dandongadale and upper Buffalo rivers, appear insufficient to overcome the effects of local urban development. Additionally, the artificial water holding at Lake Buffalo may be exacerbating the effects of urbanisation and agriculture thus indirectly contributing to the relatively poor health of this site.

5.2.5 Buffalo Creek

One site was surveyed on Buffalo Creek at Buffalo Creek Road (CAH). Buffalo Creek flows through native forest and joins the Ovens River upstream of Myrtleford. This site met the SEPP objectives for all macroinvertebrate indices and rated well for both water and habitat quality. A substantial portion of Buffalo Creek receives flows from areas of undisturbed native forest that probably enhances water quality and may counteract any disturbances arising from nearby pine forest and dryland pastures (Figure 10).

5.2.6 Buckland River

One site was surveyed on the Buckland River at Mount Buffalo Road (CCQ), near its confluence with the Ovens River. This site only had data for the edge habitat. It did not meet the SEPP objectives for SIGNAL or EPT, but did attain the objectives for AUSRIVAS and Number of Families. CCQ received 'marginal' ratings for the RHA and ISC scores. Local agricultural activity around the site may be contributing to a degraded macroinvertebrate community.

5.2.7 Ovens River

Twelve sites were assessed on the Ovens River within the Forests B Biological Region. The sites were Ovens River: at Harrietville (CBK); upstream of fish farm (CCH); downstream of fish farm (CAD); downstream of Smoko (CAE); at McMahons Lane (CAF); at Mills View (CCU); at Old Harrietville Road (CAG); at Bright (CBC); at Braithwaite Pumping Station (CCP); upstream of Myrtleford (CAB); downstream of Buffalo Creek at Myrtleford (CBA); and at Whorouly South-Gapsted Road (CBJ).

The Ovens River at Harrietville (CBK), upstream of fish farm (CCH) and downstream of fish farm (CAD) met the SEPP objectives for all the macroinvertebrate indices. These sites received 'excellent' and 'good' ratings for the RHA and ISC scores, respectively, and water quality was very good at the time of sampling (Table 7). A common feature of these sites was that the riparian zones and edge habitats had a substantial coverage of native vegetation. Stream banks are fenced off to prevent nearby cattle accessing the sites, bank stability is excellent and the riffles are well developed. However, biological monitoring at CBK over the past 12 years shows that this site does occasionally fail to meet the AUSRIVAS objectives for the edge habitat (Table 11) and annual water quality results (VWQMN 2002) also suggest a potential for phosphorous enrichment (Table 5).

Table 11: Long term biological results for the Ovens River at Harrietville (CBK)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	A	7.0	35	20	B	6.9	36	18
1991	A	6.7	39	22	A	7.0	31	16
2000	A	6.6	36	17	B	6.4	27	13
2002	A	6.7	36	17	A	6.6	33	16

The Ovens River sites downstream of Smoko (CAE); at McMahons Lane (CAF); at Mills View (CCU); and at Old Harrietville Road (CAG) are all upstream of Bright township. CAE, CAF and CAG scored just below the SIGNAL objective for one of the two habitats. CCU and CAF did not meet the riffle AUSRIVAS objective, and CCU did not attain the SEPP objective for Number of Families by one family. This suggests that the riffle habitat at these sites may not be well developed. At CCU evidence of environmental disturbance in the riffle habitat is quite obvious as it is just below a ford. Consequently, the stream substrate probably undergoes frequent disturbance making it unlikely that the riffle can support a diverse macroinvertebrate community. It is puzzling as to why the edge habitat of CAG scores below the SEPP objectives for SIGNAL as it represents excellent habitat for macroinvertebrates. Overhanging native vegetation from the riparian zone, submergent macrophytes and undercut banks are all present. A possible reason may be diffuse pollution sources from surrounding apple orchards and dairy farms, although water quality was generally good at the time of sampling. All the sites received 'good' ISC scores and CAE, CAG and CCU rated well for the RHA, while CAF was marginal.

Ovens River at Bright (CBC) and upstream of Myrtleford (CAB) met all the SEPP objectives for the macroinvertebrate indices. Ovens River at Braithwaite Pumping Station (CCP) met all the SEPP objectives except SIGNAL in the riffle habitat, indicating mild pollution. It is interesting that neither CBC nor CAB exhibit a decline in macroinvertebrate diversity that is often associated with urbanisation, despite being downstream of Bright and surrounded by increasing agricultural activity. CCP shows a slight decline in the presence of the more pollution sensitive taxa. Run-off from an adjacent pine plantation at CCP and extensive erosion of one bank due to the removal of native vegetation may be contributing to the low SIGNAL score. Good RHA scores at CAB and CBC and a poor local habitat score at CCP underscore the importance of good riparian and in-stream habitat to the health of a river. Inputs from headwater streams that flow through alpine areas may also help to dilute pollutants and alleviate potential environmental perturbations at some of these sites.

Results from long term monitoring indicate that the biological health (Table 12) and water quality (Table 6) of the Ovens River at Bright (403205) are consistently good. However, annual water quality results (VWQMN 2002; Table 5) show phosphorous levels above the SEPP objective. Future monitoring will help keep track of potential signs of degradation at this site.

Table 12: Long term biological results for Ovens River at Bright (CBC)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	B	6.7	24	13	A	7.1	29	17
1991	A	6.4	32	15	A	6.1	34	14
2000	A	6.1	35	15	A	6.2	31	12

The biological data for the Ovens River downstream of Buffalo Creek at Myrtleford (CBA) and at Whorouly South-Gapsted Road Bridge (CBJ) indicate environmental impairment. The edge habitat of CBA indicates mild pollution as it just fails to meet the SEPP objectives for SIGNAL and AUSRIVAS. This site received 'marginal' scores for ISC and RHA. One reason the CBA edge habitat did not meet the SEPP objectives is that it has few areas of still water, and some of the sampled areas are under willows where it is likely that a low diversity of macroinvertebrates is present. Earlier biological sampling at this site also indicates that the edge habitat would not have previously met SEPP objectives (Table 13). Interestingly, the 2002 annual water quality data (site 403210; Table 5) does not indicate water quality as a source of impacts despite the proximity of CBA to Myrtleford. Monitoring should be continued at this site to assess whether environmental condition is continuing to degrade.

Table 13: Long term biological results for Ovens River downstream of Buffalo Creek at Myrtleford (CBA)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	A	6.5	25	15	B	6.3	28	14
1991	A	6.1	26	14	A	5.9	32	12
2000	A	6.4	26	12	B	5.6	30	11

The riffle habitat at CBJ narrowly falls short of meeting the SIGNAL objective for the riffle habitat. It is likely that the presence of large amounts of bedrock in the riffle may be limiting the availability of habitat for macroinvertebrates. CBJ does not meet the SEPP objective for the edge habitat for AUSRIVAS but otherwise met all the other SEPP biological objectives. The AUSRIVAS rating for CBJ edge habitat indicates biological impairment. However, earlier biological sampling at this site shows that the edge habitat consistently received a 'reference' score for AUSRIVAS (Table 14), suggesting that this site was in reasonably good condition. A 'good' score for the RHA, and very good water quality conditions at the time of sampling (Table 7) support this.

Table 14: Long term biological results for Ovens River at Whorouly South – Gapsted Road (CBJ)

Year	RIFFLE				EDGE			
	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa	AUSRIVAS Band	SIGNAL	Number of Families	EPT Taxa
1990	A	6.1	26	12	A	6.0	36	14
1991	A	6.1	31	16	A	5.7	33	12
2000	N/D	N/D	N/D	N/D	A	5.8	37	9
2002	A	5.8	30	11	B	5.8	25	9

N/D – no data

Interestingly, the VWQMN 2002 data for a nearby site, Ovens River at Rocky Point (Table 5) exceeded the SEPP objective for total phosphorous concentration, suggesting that mild pollution may be eliminating some of the more sensitive taxa and contributing to below objective scores. Likely contributions to elevated phosphorous levels are run-off from tobacco cropping, wineries and septic tanks in the surrounding region.

Seven sites were assessed on smaller creeks that flow directly into the Ovens River. There were two sites on the Barwidgee Creek (CCD and CCN) and one each on the Buffalo (CAH), German (CCT), Morses (CCS), Roberts (CCR) and Happy Valley creeks (CCO).

5.2.8 Buffalo Creek and German Creek

The results for the sites on German Creek and Buffalo Creek are discussed together as the habitats are very similar. German Creek north of Germantown (CCT) and Buffalo Creek at Buffalo Creek Road (CAH) met the SEPP objectives for all the macroinvertebrate indicators, demonstrated good water quality at the time of sampling and received excellent habitat ratings. Only a single season of riffle data for CCT was available and the results must be interpreted with caution. Nonetheless, a preliminary assessment of the riffle habitat supports the good results obtained for the edge habitat. Both creeks flow through native forests and therefore are largely undisturbed.

5.2.9 Morses and Roberts Creek

Morses Creek at Hawthorne Creek (CCS) and Roberts Creek at Roberts Creek Road (CCR) are both situated near Bright. These sites have only single season data for the riffle habitat due to low flows over the autumn 1998 sampling period. CCS achieved the SEPP objectives for all the macroinvertebrate indices for the edge habitat. By contrast, CCR did not meet the SEPP objectives for any of the macroinvertebrate indices. Both in-stream and surrounding habitats were marginal at both sites.

The poor health of CCR could be due to a combination of catchment and site level impacts. Upstream of the site are pine plantations, an apple orchard and a dairy. It is possible that direct effects, such as water extractions, and indirect effects including fertiliser run-off, may be impacting this site. Certainly the low incidence of pollution sensitive macroinvertebrates could be attributable to any one of these disturbances. Furthermore, as Roberts Creek is a narrow, shallow creek with a small catchment area, it is particularly vulnerable to environmental impacts and recovery from any disturbance is likely to be prolonged.

5.2.10 Happy Valley Creek

Happy Valley Creek at Mudgeegonga Road (CCO) is surrounded by cattle grazing and pine forest. Only the edge habitat was assessed due to the absence of adequate riffle habitat. The SIGNAL objective was not met indicating mild pollution and the site received 'poor' and 'marginal' ratings for the ISC and RHA, respectively. In addition, all the water quality parameters were elevated at the time of sampling. The chief source of environmental degradation appears to be cattle access at the site, together with the presence of extensive grazing and forestry throughout the catchment (NPI 2003). Indeed bank erosion, as evidenced by a slumped left bank, may be increasing sedimentation and reducing available in-stream habitat thus adversely affecting the macroinvertebrate community.

5.2.11 Barwidgee Creek

Two sites were sampled on Barwidgee Creek: at Myrtleford Road (CCD) and at Myrtleford (CCN). Both sites indicate signs of environmental stress. CCD failed to meet the SEPP objectives for AUSRIVAS for the riffle habitat and SIGNAL for both habitats. CCN, which is closer to Myrtleford, only met the SEPP objectives for Number of Families for both habitats and AUSRIVAS for the edge habitat. Both sites received ‘marginal’ habitat index scores, with the exception of the RHA score for CCD, which achieved a ‘good’ rating.

High salinity, phosphorous and nitrogen levels at CCD at the time of sampling and generally low habitat scores are indicative of poor condition in Barwidgee Creek. Extensive cattle grazing (NPI 2003) and cropping within 20m of the stream bank are potential sources of salinity and nutrient inputs into Barwidgee Creek. The loss of riparian vegetation has also contributed to poor bank stability at both sites as they are devoid of native trees. The few trees present are willows, shrubs are scarce and exotic grasses grow abundantly in the stream. Bank stabilisation works are in place as evidenced by retaining rock walls. The inherent characteristics of Barwidgee Creek also predispose this tributary to environmental sensitivity. These characteristics include small catchment area, sandy alluvial streambed and high level of sedimentation. This means that the Barwidgee Creek has a low buffering capacity and is prone to bank instability.

5.2.12 Spring Creek

Spring Creek at Beechworth (CDB) did not meet the SEPP objectives for AUSRIVAS and EPT for either habitat or SIGNAL for the edge habitat. Both riffle and edge habitats are poor and each had a high incidence of exotic grasses in the substrate, which impedes the establishment of a healthy macroinvertebrate community. A marginal RHA score reflects the fact that CDB is surrounded by parkland and housing with little vegetation along the waters edge. Phosphorous and nitrogen levels were elevated at the time of sampling, most likely arising from urban development in Beechworth and subsequent run-off from impermeable surfaces, fertiliser run-off from local parks and gardens, septic tank seepages and stormwater input. Additionally, Lake Sambell, which is an artificial water holding in Beechworth about 250m away from CDB, may be reducing flows to Spring Creek as it falls within CDB’s catchment area. Intensive gold mining activity over the last century in Spring Creek is also likely to have significantly degraded its condition, which has been further exacerbated by subsequent urbanisation in Beechworth. Investigation of the environmental condition of Lake Sambell may be useful to evaluate whether increased flows from Lake Sambell to Spring Creek could be used to overcome the effects of local urban development at this site.

5.2.13 Reedy Creek

Reedy Creek at Wooragee (CCE) did not meet any of the edge biological SEPP objectives except Number of Families. The riffle sample at this site had single season data only and was not assessed against the SEPP objectives. While the ISC habitat score was 'good', the RHA was rated as 'poor'. This site is unusual compared to other sites on small creeks in the Forests B Biological Region, as the substrate is mostly bedrock. It is likely that any environmental disturbance is likely to leave at least the riffle habitat vulnerable to degradation, as the possibility of a diverse array of macroinvertebrates finding suitable niches in the riffle is low. Exotic trees, such as poplars and willows, surround the site and evidence of cattle grazing is widespread within the catchment. Frequent habitat disturbance is highly likely through cattle access to the site and the subsequent nutrient fluctuations from faecal matter and fertiliser inputs. Various native macrophytes are present in the edge habitat at the site and this is usually indicative of a healthy invertebrate community. However, elevated nutrient levels at the time of sampling, as well as high turbidity and salinity suggest that poor water quality is contributing to reduced biological condition. Reedy Creek probably also experiences periods of low flows due to a small impoundment about 250m upstream of the site. This is supported by the observed edge habitat macroinvertebrate community that is typical of biota found in ephemeral ponds; with Dytiscidae, Culicidae and Acarina being most abundant.

5.2.14 Indigo Creek

Indigo Creek at Pooleys Road (CCZ) had single season edge data only, which limits the assessment that can be made for this site. An 'above reference' score for AUSRIVAS and elevated snapshot water quality measures indicate that the macroinvertebrate community may be subject to mild organic enrichment from surrounding pastures. Further investigation is needed to clarify the ecological condition of Indigo Creek.

5.3 Cleared Hills and Coastal Plains

The Cleared Hills and Coastal Plains Biological Region covers the low foothills and the riverine plains of the Ovens catchment. Streams in this region flow through an undulating landscape of low altitude with little gradient and relatively low rainfall. This part of the Ovens Valley is substantially cleared for intensive agriculture, including dryland and irrigated pastures, resulting in poor riparian shading. Warm stream waters with high alkalinity, and low to moderate turbidity and salinity characterise the region. Although the edge habitat is well developed, extensive runs and riffles are less common. The substrate tends to be composed of moderate to fine particles, and a very high diversity and moderate cover of macrophytes.

5.3.1 Fifteen Mile Creek

At Fifteen Mile Creek at Glenrowan-Milawa Road (CDC) only edge habitat was sampled. AUSRIVAS met the SEPP objectives but SIGNAL and Number of Families did not. Although the ISC score received a 'good' rating, a marginal RHA score indicates that local habitat conditions are impacted. High nutrient and turbidity levels from the snapshot water quality data suggest that poor water quality may be a cause of the degraded biological conditions.

Dryland pasture is the largest potential source of nutrient enrichment in Fifteen Mile Creek (NPI 2003). As with the other upstream sites on Fifteen Mile Creek, extensive stock access and probable water extractions are likely factors also contributing to the impaired environmental quality of this site.

5.3.2 King River, Croppers Creek and Boggy Creek

Two sites were assessed on the King River and one each on Croppers and Boggy creeks, both of which flow into the King River. For King River at Docker (CBH) and Oxley (CCJ), and Croppers Creek at Tetley Lane (CCW) only the edge habitats were assessed, as riffle habitats were not present. CCW had only single season data for the edge habitat, however a preliminary assessment shows that this site may be degraded. Both the riffle and edge were sampled at Boggy Creek at Top Plain Road (CCK), but only the edge habitat had two seasons of data. A low SIGNAL score for the edge habitat at Boggy Creek (CCK) is suggestive of some biological impact. Severe bank erosion and high turbidity levels at the time of sampling (Table 7), may be reducing the availability of in-stream habitat, and eliminating many of the less tolerant taxa.

The King River at Docker (CBH) only met the SEPP objective for SIGNAL. The 'marginal' RHA score is reflected in the absence of riparian vegetation and moderately unstable banks, as well as a predominately sandy stream substrate; all factors contributing to the low diversity of macroinvertebrates. It is likely that run-off from cropping, dryland pastures and forestry in the catchment may also be adversely affecting the health of this site (NPI 2003). Additionally, artificial water holding at Lake William Hovell may be exacerbating the effects of dryland pasture and indirectly contributing to the relative poor health of this site. Long term biological monitoring shows that CBH has regularly failed to meet the AUSRIVAS and Number of Families objectives (Table 15).

Table 15: Long term biological results for King River at Docker (CBH)

Year	AUSRIVAS Band	SIGNAL	Number of Families
1990	A	5.8	30
1991	B	6.0	24
2000	B	5.5	24
2002	B	6.1	20

Downstream of Docker, King River at Oxley (CCJ) displayed a healthy in-stream habitat, an intact riparian zone, and a diverse macroinvertebrate community meeting all the SEPP objectives. These contrasting results underline the importance of local habitat conditions to the biological health of a river.

5.3.3 Ovens River

Three Ovens River sites within the region were assessed: Ovens River near Everton (CDP), at Oxley Flats (CDO), and at River Road Reserve (CDS). CDS met the objectives for all the biological indicators, while CDP and CDO failed to meet the edge habitat objectives for AUSRIVAS and Number of Families. The RHA scores at all three sites were 'good' to 'excellent', whereas the ISC scores were 'marginal' to 'poor'. The low macroinvertebrate scores for CDP and CDO indicates that extensive clearing for grazing and cropping in the surrounding catchment are likely to be impacting upon the health of the reach.

These impacts were not detected at CDS and the site was found to be in excellent biological health. A diverse array of macrophytes in the edge habitat at CDS ensures that a healthy macroinvertebrate community can be sustained. Furthermore, the riparian zone is relatively complex with native trees, shrubs and grasses over a 30m wide area. The banks are stable and any evidence of cattle grazing is at least 50m away from the river's edge. These results underscore the finding that local habitat conditions directly affect the macroinvertebrate communities of a reach.

5.3.4 Burgoigee Creek and Hodgsons Creek

Burgoigee Creek at Ovens Valley Highway (CAI), and Hodgsons Creek at Kays Road Bridge (CCX) and at Farmers Road (CAJ) are discussed together as the results are very similar and the sites appear to be subject to similar environmental stresses. Both CAI and CAJ met the SEPP objectives for AUSRIVAS and Number of Families, but did not meet the SEPP objectives for SIGNAL. High phosphorous and salinity in the snapshot water quality data at CAI may be indicative of mild pollution from fertiliser run-off from surrounding agricultural activity. A deeply incised and eroding bank as well as the absence of macrophytes at CAJ may explain the loss of some of the more sensitive macroinvertebrate taxa. Hodgsons Creek at Kays Road Bridge (CCX) was sampled in spring only and was not assessed against the SEPP objectives. An 'above reference' AUSRIVAS score suggests that nutrient enrichment may be an issue at this site. Additionally, it is likely that flows from the Beechworth area and surrounding pastures may be adversely affecting the reaches of the Burgoigee and Hodgsons Creeks, especially as sites in and close to Beechworth (CDB and CCE) display evidence of environmental impacts.

5.4 Murray and Western Plains

The Murray and Western Plains Biological Region covers the lowland rivers and streams of the Ovens catchment. Given the general lack of riffles in waterways of this region, SEPP objectives have only been set for the edge habitat. Streams flow through an undulating landscape of low altitude with little gradient and relatively low rainfall. The region is largely cleared for dryland and irrigated pasture and broad-acre cropping. Fifteen Mile Creek, King River, Ovens River and Reedy Creek all converge just outside Wangaratta, forming a large, slow flowing waterway with multiple anabranches downstream of the township. At most sites, riffle habitats were absent and therefore not sampled. Many of the sites in this region are located in the Heritage River section of the Ovens River. In addition, two sites were sampled on Fifteen Mile Creek and three sites were sampled on smaller creeks: Indigo Creek, Black Dog Creek and Reedy Creek.

5.4.1 *Fifteen Mile Creek*

Fifteen Mile Creek at Cruse Street (CBR) borders the Wangaratta racecourse and contains a large number of macrophytes, particularly reeds, within the surveyed site. The edge habitat met the SEPP objectives for AUSRIVAS and SIGNAL, but did not meet the objectives for Number of Families. ISC and RHA each received a 'good' habitat rating. The edge habitat has a high incidence of macrophytes and the macroinvertebrate community is fairly healthy but very high nutrients and salinity at the time of sampling (Table 7) suggest that poor water quality may be an issue at this site. Chironomidae, Simuliidae and Corixidae were most abundant at the site. These taxa are often the least affected by environmental stressors, such as increased turbidity and sedimentation. A potential source of water pollution is the Trade Waste Plant which takes wastewater from Bruck Textiles Pty Ltd, Nuplex Industries Australia Pty Ltd and Australian Country Spinners. Treated water is then discharged into Fifteen Mile Creek. Another potential source of water pollution in Fifteen Mile Creek is storm water which flows straight into the creek.

Fifteen Mile Creek at Ussher's Drive (CDA) did not meet the SEPP objectives for AUSRIVAS and Number of Families but did attain the objectives for SIGNAL. Despite receiving good to excellent habitat scores, CDA has few macrophytes, which may help to explain why this site is only able to support a limited macroinvertebrate community. As with Cruse Street, the snapshot water quality data showed very high nutrient levels (Table 7), which is indicative of upstream discharges most likely from any one of the large industries on Fifteen Mile Creek.

5.4.2 *Reedy Creek*

For Reedy Creek at Carraragarmungee Estate Road (CCY), SIGNAL and Number of Families scores met the SEPP objectives, however, the AUSRIVAS score did not. The ISC received a 'good' rating but the RHA rating was 'poor'. Poor bank stability and heavy catchment erosion are likely to be contributing to high sedimentation and a loss of adequate in-stream habitat. Additionally, it is likely that flows from Beechworth and surrounding pastures may be adversely affecting this site, particularly as sites upstream of CCY, such as Reedy Creek at Wooragee (CCE) and Spring Creek at Beechworth (CDB), are clearly suffering from environmental impacts.

5.4.3 *Black Dog Creek and Indigo Creek*

The biological condition of Black Dog and Indigo creeks shows signs of mild impairment. Black Dog Creek at Rutherglen – Springhurst Road (CCF), Black Dog Creek at Dugays Bridge Road (CCG) and Indigo Creek at the Murray Valley Highway (CBW) all scored below the SEPP objectives for either SIGNAL or AUSRIVAS. Extensive cattle grazing in both of these catchments is undoubtedly contributing to the diffuse impacts on these waterways (NPI 2003). A reinforced bank at CBW suggests erosion has been a recurrent problem at this site. On Black Dog Creek, poor to marginal habitat quality ratings at both sites suggest that low macroinvertebrate diversity has resulted from degraded habitat conditions in this creek. Also of concern are the very high nutrient levels detected in the snapshot water quality measurements at all three sites.

5.4.4 *Ovens River downstream of Wangaratta*

The most impacted segment of the Ovens River is just downstream of Wangaratta. These sites are Ovens River at Warby Range Road (CED), Ovens River at Ovens Track (CCI), and Ovens River at Boland Road (CDE). All three sites did not meet any of the SEPP objectives for SIGNAL, AUSRIVAS and Number of Families. It seems likely that increased run-off and associated contaminants from impermeable surfaces from Wangaratta, discharges from the Wangaratta sewage treatment plant (via Reedy Creek), trade waste effluents, the spread of exotic vegetation, water extractions, and heavy livestock grazing on the outskirts of Wangaratta are all contributing to reduced macroinvertebrate diversity and a shift toward pollution tolerant groups. Interestingly the biological indicator results are not corroborated by the habitat assessments and snapshot water quality measurements. No water quality issues were identified during sampling and the habitat assessments indicate very good habitat condition. Further investigation is needed to clarify the cause of biotic community degradation in this part of the Ovens River.

5.4.5 *Heritage Area of the Ovens River*

The Heritage Area of the Ovens River is significant because it is one of the few remaining riverine plains with a relatively low degree of human disturbance. Six sites were surveyed within the Heritage River corridor and only edge habitat data was sampled at all sites. The sites include the Ovens River: at Cinnamonds (CDF); at Peechelba (CBB); at Carmody Road (CEC); at Robinson Road (CBV); at Talbot Bend (CDI); and at Wallis' property (CDH). Despite excellent habitat conditions in this area and generally reasonable water quality, these sites all scored below the SEPP objective for AUSRIVAS, and all but CDF failed to meet the Number of Families objective. Biological monitoring at Peechelba (CBB) during the past 12 years shows that these results are typical for this site (Table 16). In addition, the water quality results for 2002 (Table 5) at Peechelba (403241) indicate that phosphorous concentrations are somewhat high. Continued monitoring of this site is recommended to ascertain whether phosphorous concentrations are rising or falling at this site.

Table 16: Long term biological results for Ovens River at Peechelba (CBB)

Year	AUSRIVAS Band	SIGNAL	Number of Families
1990	B	6.4	28
1998	B	5.6	22
1999	B	5.3	19
2000	B	5.2	22
2002	B	5.5	21

The lower sections of the Ovens River are characterised by a deeply incised channel with few macrophytes, sandy to gravel substrate, steep banks typified by some bank instability and a wide floodplain (Government of Victoria 1997). In contrast to many of the lowland rivers in the western plains of Victoria, edge habitats that typically support a diverse macroinvertebrate community, such as shallow backwaters, macrophytes, trailing bank vegetation and undercut banks, are absent in this section of the Ovens River. The lower than expected biological ratings for these sites in the otherwise apparently healthy Heritage section of the Ovens River may be more indicative of the uniqueness of these habitats than poor ecosystem health. These results suggest that a refinement of the lowland model (Murray and Western Plains) is needed to develop a more accurate picture of the environmental condition of the Murray lowland rivers.

6. OVENS CATCHMENT SUMMMARY AND DIRECTIONS IN MANAGEMENT

6.1 Ovens Catchment Summary

Environmental condition in the upland tributaries of the Ovens catchment was generally good and this was reflected in the biological and habitat assessments. A general decline in water quality from the headwaters was closely correlated with human activity that is typical of many catchments, particularly as urban settlements, agriculture and industry are often located in lowland areas. There was some evidence of environmental degradation, possibly from nearby agricultural activity, in the upper Ovens catchment as reflected in the slightly lower AUSRIVAS and SIGNAL scores.

Sites in the lower Ovens catchment were clearly more impacted, as would be expected since the majority of human settlement and agriculture occurs here. This was particularly evident for water quality and instream habitat measures in rivers and streams around the townships of Wangaratta and Myrtleford. Only two sites in the lower catchment, Ovens River at River Road Reserve and King River at Oxley met all the SEPP biological objectives. Water quality was generally poorer in this region. While water quality in the Ovens River itself was reasonably good, a number of smaller streams such as Reedy Creek, Barwidgee Creek, Spring Creek and Happy Valley Creek had elevated salinities, turbidity and/or nutrient-enriched waters. Increasing acidity and turbidity has been identified as a significant trend in some reaches of the Ovens catchment although it was difficult to interpret a longitudinal trend (Water EcoScience 1997). Nutrients and salinity were also an issue for some sites but there was no apparent trend (Hedger and O'Shanassy 1995).

Sites with small catchment areas appear to be more sensitive to environmental disturbances. It is likely that these sites are more sensitive to land use changes because they do not have the same capacity to 'buffer' potential impacts as larger catchments. Farming practises around small creeks and tributaries in the catchment need to be undertaken recognising that these waterways reveal a high degree of environmental sensitivity, principally to habitat disturbance and increasing nutrient and sediment inputs. This is particularly relevant in the small streams of the Beechworth area and tributaries in the middle and upper reaches of the Ovens River where urbanisation and agricultural activity have localised impacts. Poor scores for habitat measures were usually observed for the small creeks in these regions and, in many of these waterways, the riparian zone has been removed or is dominated by weeds, such as willow and blackberry. Many of the smaller creeks are also badly eroded and provide poor habitat for aquatic fauna. Improving bank stabilisation and reducing erosion is of particular importance in these sub-catchments. In some sections, cattle have direct access to the streambed. Trampling of the banks and channel causes increased turbidity and bank and bed erosion, as well as preventing natural regeneration of the riparian zone. In addition, the lack of adequate riparian vegetation has led to reductions in shading, and loss of leaf litter and woody debris that provides essential sources of food and habitat for aquatic macroinvertebrates. This is particularly apparent in Fifteen Mile Creek as a result of widespread cattle access. Restriction or prevention of stock access to streamside zones and waterways would improve water quality and in-stream habitat condition, especially in small sub-catchments.

Generally, environmental flows in the Ovens catchment are good as there are relatively few storages and the Ovens River is largely unregulated. In those reaches where biological condition was degraded, two main contributing factors were identified: habitat and water quality degradation. However, low flows resulting from water extraction and ongoing drought conditions also appear to be affecting riverine condition, particularly in the smaller sub-catchments.

The results for the Heritage Area of the Ovens River revealed a need to further develop the AUSRIVAS models. Of concern were the lower than expected AUSRIVAS scores for an otherwise apparently healthy Heritage listed section of the Ovens River. Floodplain rivers in the Western Plains are not usually as turbid, and support substantial macrophyte growth, compared to the tributaries in the Murray River region (EPA 2003d). These results suggest that a refinement of the current lowland model (Murray and Western Plains) is needed to develop a more accurate picture of the environmental condition of the Murray lowland rivers.

6.2 Catchment and Waterways Management

The Ovens Basin Water Quality Working Group identified a number of key areas for improving the water quality in the Ovens Catchment (NECMA 2000). Of high priority is a reduction in the total phosphorous concentrations to reduce the risk of blue-green algal blooms within the catchment and further downstream. It is also recognised that total nitrogen, turbidity, and suspended solids are important indicators of water quality and are likely to be closely linked to total phosphorous concentrations and loads (NECMA 2000). Reducing concentrations of total phosphorous (particularly during the summer-autumn period) is important in reducing the risk of algal blooms both locally and downstream, while reducing the total phosphorous loads flowing into the Murray River is of major importance for the long-term ecological condition of this river. Areas targeted for reduction in total phosphorous outputs are primarily local sewage treatment plants (STPs) and agricultural industries.

6.2.1 Sewage Treatment Plants

North East Water has developed reclaimed water reuse schemes across the region in line with the requirements of the State Environment Protection Policy (SEPP) Waters of Victoria. Of the seven sewage treatment plants in the Ovens catchment, Yackandandah, Chiltern, Rutherglen and Yarrawonga currently reuse 100 per cent reclaimed water, and Beechworth and Wangaratta reuse up to 50 per cent of their reclaimed water. This water is used over the summer months for irrigation by local farmers, as well as maintaining golf courses and other sports fields. Using reclaimed water is considered to be a practical strategy for lowering TN and TP in the Ovens River and endeavouring to prevent blue-green algal blooms in the summer months.

The Ovens Basin Water Quality Working Group (NECMA 2000) found that tertiary treatment of sewage effluent provides a cost-effective means of reducing TP and TN loads disposed to streams, although reuse is preferred. Of the seven STPs only Wangaratta and Beechworth release tertiary treated sewage effluent, into Reedy and Spring Creeks, respectively. Wangaratta has only recently upgraded its STP to a tertiary facility. An expansion of the available irrigation area for land disposal over the summer months is proposed. These works are expected to reduce TP loads by 12.1 tonne per year and improve water quality within the lower Reedy Creek and lower Ovens River. Works to improve the quality of treatment and reduce discharges from the Myrtleford STP would also achieve major nutrient load reductions and significant improvements in local water quality, with the development of tertiary treatment facilities is estimated to reduce TP loads by 5 tonne per year (NECMA 2000).

6.2.2 Agricultural Industries

Agricultural industries in the Ovens catchment include trout farms, dryland grazing, broadacre cropping, irrigated grazing, horticulture and forestry. Implementation of best management practice (BMP) is generally recommended to improve water quality practices within agriculture, reducing nutrient losses, while maintaining or improving farm and/or industry productivity and economic viability. The focus of BMPs varies according to the industry depending on sources of environmental stress. Good practice implementation can include contour cultivation, stream stabilisation works, buffer strips along drainage lines, and no cultivation within drainage lines, floodways, adjacent to streambanks (within 30m), or within regularly flooded zones.

Two further benefits of implementing BMP are the Land Protection Incentive Scheme and Landholder Partnership Agreements. The Land Protection Incentive Scheme contributes funding to landholders who intend to fence out waterways and revegetate these areas on their properties, provide off-stream watering for stock and reduce nutrient and sediments entering the waterway. Landholder Partnership Agreements are made between the landholder and the Catchment Management Authority. These agreements can involve anything from river works, bank stabilisation, willow removal and erosion control works with responsibilities allocated to both the landholder and the CMA.

6.2.3 Erosion

Stream bank erosion is a major contributor to nutrient loads in waterways of the Ovens catchment. About 40 per cent of the Ovens River TP load is derived from in-stream sources, particularly bank erosion during flood events (NECMA 2000). Although erosion is part of the natural process of stream and floodplain development, poor in-stream and frontage condition often causes severe and unnatural erosion rates.

The North East Catchment Management Authority is taking a whole-of-catchment approach to river management through the stabilisation of the major rivers in the Ovens catchment. Priority waterways include: Ovens River - Myrtleford to Wangaratta, Bright to Myrtleford and Harrietville to Bright; Barwidgee Creek System, Happy Valley Creek, Fifteen Mile Creek, Black Range Creek, Boggy Creek, Black Dog Creek system and Indigo Creek.

Stream management activities are concentrating on stabilising erosion in tributaries and gullies. The construction of retaining rock walls, revegetation programs, stock exclusion fencing, as well as establishing buffer strips along minor drainage lines have been carried out. Additionally, willow removal programs aim to help return streams to their natural drainage capacity, re-establish native vegetation, improve stream habitat and water quality, and improve streambed and bank stability. River stabilisation works have already been carried out in various reaches, such as the Barwidgee Creek and parts of the Ovens River. Such works have the effect of reducing sediment, and therefore nutrient loads, to these reaches and ultimately the Murray River.

Existing rehabilitation and restoration programs involve a considerable investment of resources and the effectiveness of these programs needs to be demonstrated through monitoring and assessment programs.

6.2.4 Urban Stormwater

Stormwater drainage from urban areas in the Ovens catchment contributes about 13 tonnes per year of total phosphorous and 54 tonnes per year of total nitrogen to the Murray River (NECMA 2000). This represents about 8 per cent of the TP load and 3.5 per cent of the TN load from the catchment. Works such as drain screens, outfall structures and wetlands are recognised as a cost-effective means of nutrient load reduction and works are currently underway (NECMA 2000). Priority towns for works are Wangaratta, Myrtleford and Beechworth.

Continued implementation of the Water Quality Strategy, and timely review of data as they become available, will further aid in the targeting of management action to improve the environmental condition of the rivers and streams in the Ovens catchment.

6.3 Natural Disasters

This assessment relates observed environmental quality to likely causes and catchment issues. While not the focus of this study, natural disasters were highlighted as relevant to consider in current and future management and monitoring programs.

6.3.1 Drought

Drought is part of the natural climatic cycle in the Australian environment. Natural low-flow and dry periods for rivers and streams are as important as natural high flows and floods for maintaining in-stream biodiversity and health. Many native populations survive and recover from drought through adaptive behavioural and physiological mechanisms. But when ecosystems are already degraded, the capacity for survival may be lessened and the speed of recovery prolonged.

The effective management of land and water during and after a drought is critically important to overall ecosystem condition. Agricultural activity covers a large area of the Ovens catchment and is shown to directly and indirectly affect the environmental condition of rivers and streams. Coupled with an ongoing drought, its effects can lead to overgrazing of pasture, importation of weed-contaminated feed and a decline in farm productivity. When rain does come it can further exacerbate existing problems through increased run-off to streams, including nutrients and sediments. A different approach to farm management should be considered which integrates climate risk and careful stock, crop, water and soil management with long-range financial and ecological planning (NECMS 1997).

Over the 2002 sampling period, the Ovens catchment experienced reduced flows due to ongoing drought conditions. It is unclear what the immediate and long-term effects of drought conditions, as a single stressor, are on the biological health of aquatic ecosystems. It is generally considered, however, that systems that are already impacted will take longer to recover from a drought. While a better understanding of the specific effects of drought is clearly needed, improvements to habitat and water quality, and a reduction in water extractions will go a long way to help ensure the long-term health of rivers and streams in the Ovens catchment. The Streamflows Management Plan being developed for the upper Ovens River, for example, is one measure aimed to ensure a better balance between water extractions and environmental flow requirements throughout the catchment.

6.3.2 Fire

The Ovens catchment is one of the most fire prone areas in Victoria. The high fire risk is due to a combination of dry weather during summer, highly flammable vegetation and high incidence of thunderstorms. Multiple wildfires following thunderstorm activity occurs frequently with lightning accounting for a high proportion of fires on public land. Campfire escapes and burning off are other causes (NECMS 1997).

Bushfires in the summer of 2003 burnt a large portion of the forests in the headwaters of the Ovens catchment. Ash and sediment laden run-off from burnt areas in the Buckland Valley, following a large rain event in February 2003, led to the movement of a massive sediment slug through the Ovens River and subsequent fish kills. While the data in this report was collected prior to the fires, State monitoring efforts are attempting to assess post-fire impacts on aquatic habitats and track their recovery. Together with post-fire monitoring, it will lead to a better understanding of the impacts of fire on aquatic ecosystems and how to manage these impacts in the future.

7. REFERENCES AND FURTHER READING

Australian Water Technologies 1999. *Victorian Water Quality Monitoring Annual Report: 1998*. Report prepared for Department of Natural Resources and Environment by Australian Water Technologies, Glen Waverly Victoria.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and Stribling, J.B. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Barbour, M.T., and J.B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. *In* George Gibson, ed. *Biological criteria: Research and regulation, proceedings of a symposium, 12-13 December 1990, Arlington, Virginia.* Office of Water, U.S. Environmental Protection Agency, Washington, D.C. EPA-440-5-91-005.

Barmuta, L. A., Chessman, B. C., and Hart, B. T. H. 1997. Interpretation of the Outputs from AUSRIVAS. Land and Water Resources Research and Development Corporation.

Beard D (1979). Bucket dredging in the upper Ovens valley. Honours Thesis, Department of Geography, University of Melbourne.

Boulton, A.J., and Brock, M.A. 1999. *Australian Freshwater Ecology: Process and Management.* Gleneales Publishing, Glen Osmond, SA, Australia.

Bunn, S.E., Davies, P. M. and Mosisch, T. D. 1999. Ecosystem measures of river health and their response to riparian and catchment degradation. *Freshwater Biology* 41: 333-345.

Chessman, B.C. 1995. Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology* 20: 122-129.

Cottingham, P., Hannan, G., Hillman, T., Koehn, J., Metzeling, L., Roberts, J. and Rutherfurd, I. 2001. *Report of the Ovens Scientific Panel on the Environmental Condition and Flows of the Ovens River.* Technical Report 9/2001. Cooperative Research Centre for Freshwater Ecology.

Davies, P.E. 1994. River Bioassessment Manual. National River Processes and Management Program. Monitoring River Health Initiative.

EPA 2003a. *State Environment Protection Policy (Waters of Victoria)*. EPA Victoria, Publication S107

EPA 2003b. *Biological Objectives for Rivers and Streams – Ecosystem Protection.* EPA Victoria, Publication 793.1

EPA 2003c. *Risk Assessment Approach – Ecosystem Protection.* EPA Victoria, Publication 790.1

EPA 2003d. *Nutrient Objectives for Rivers and Streams – Ecosystem Protection.* EPA Victoria, Publication 792.1

EPA 2003e. *Water Quality Objectives for Victorian Streams- Ecosystem Protection.* EPA Victoria, Publication 791.1

EPA in press. *Rapid Bioassessment Protocol for Rivers and Streams* EPA Victoria.

Furse, M. T., Moss, D., Wright, J. F. and Armitage, P. D. 1984. The influence of seasonal and taxonomic factors on the ordination and classification of running-water sites in Great Britain (UK) and on the prediction of their macro-invertebrate communities. *Freshwater Biology* 14: 257-280.

Government of Victoria 1988. *State Environment Protection Policy, Waters of Victoria.* Victoria Government Gazette, No.S13, Friday 26 February 1988.

Government of Victoria 1997. Heritage rivers and natural catchment areas daft management plans. Volume 2 – North East. Department of Natural Resources and Environment. Victoria.

Government of Victorian 1995. *Nutrient Management Strategy for Victorian Inland Waters-Strategy*. State Government of Victoria.

Hedger, M. and O'Shanassy, K. 1995. *Nutrients and Water Quality in the Ovens Catchment.* Report prepared for Goulburn-Murray Water. Water EcoScience Report No. 30/95, October 1995.

Hellawell, J.M. 1978. *Biological surveillance of rivers.* National Environment Research Council and Water Research Centre, Water Research Centre, Stevenage, England.

Heritage Rivers and Natural Catchment Areas – Draft Management Plans, State of Victoria, Department of Natural Resources and Environment 1997

Hewlett, R. 2000. *Classification of Victorian streams: Implications of taxonomic resolution, sample habitat and sample season.* Thesis (M.Sc.), La Trobe University. Submitted to the School of Environmental Management and Ecology, Faculty of Science, Technology and Engineering.

Marchant, R. 1990. Robustness of classification and ordination techniques applied to macroinvertebrate communities from the Latrobe River, Victoria, Australia. *Australian Journal of Marine and Freshwater Research.* 41: 493-504

Marchant, R., Barmuta, L. A., and Chessman, B. C. 1995. Influence of sample quantification and taxonomic resolution on the ordination of macroinvertebrate communities from running waters in Victoria, Australia. *Marine and Freshwater Research* 46: 501-506.

McKenzie, F., Tiller, D., and Allen, D. 1994. Organochlorine pesticide residues in water and sediments from the Ovens and King rivers, north-east Victoria, Australia. *Archives of Environmental Contamination and Toxicology*. 26: 483-490.

Metzeling, L., Doeg, T., and O'Connor, W. 1995. The impact of salinisation and sedimentation on aquatic biota. In: *Conserving Biodiversity: Threats and Solutions*. Bradstock, R.A., Auld, T.D., Keith, D.A., Kingsford, R.T., Lunney, D., and Sivertsen, D.P. (eds). Pp 126-136. Surrey Beatty and Sons, Sydney.

National Pollution Inventory 2003. http://www.npi.gov.au/

Newall, P. and Wells, F. 2000. Potential for delineating indicator-defined regions for streams in Victoria, Australia. *Journal of the North American Benthological Society*, 19, 557-571.

Norris, R.H. and Norris, K.R. 1995. The needs for biological assessment of water quality: Australian perspective. *Australian Journal of Ecology*, 20: 1-6.

North East Catchment Management Authority, Ovens Basin Water Quality Working Group. *Ovens Basin Water Quality Strategy: An Action Plan within the North East Regional Catchment Strategy*. May 2000. Department of Natural Resources and Environment, Wangaratta Victoria. Prominent Press, Shepparton Victoria.

North East Regional Catchment and Land Protection Board. *North East Regional Catchment Strategy*. June 1997. Department of Natural Resources and Environment, Wangaratta Victoria. Prominent Press, Shepparton Victoria.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K. and Hughes, R.M. 1989. *Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish*, Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K. and Hughes, R.M., U.S. Environmental Protection Agency (EPA/444/4-89-001).

Read, M.G. and Barmuta, L.A. 1999. Comparisons of benthic communities adjacent to riparian native eucalypt and introduced willow vegetation. *Freshwater Biology* 42: 359-374

Reynoldson, T.B., Norris, R.H., Resh, V.H., Day, K.E. and Rosenberg, D.M. 1997. The reference condition: a comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macroinvertebrates. *Journal of the North American Benthological Society* 16: 833-852.

Rutherfurd, I.D., Jerie K.E. and Marsh, N. 1999. A Rehabilitation Manual for Australian Streams Volumes 1 and 2. LWRRDC and CRC for Catchment Hydrology [Canberra, Australia] June 1999. Available from Internet: http://www.rivers.gov.au

Shugg, A. 1987. *Hydrogeology of the Upper Ovens Valley*. Unpublished report for the Department of Industry, Technology and Research. Victoria.

Smith, W and Nathan R. 1999. *Victorian Water Quality Monitoring Network Trends Analysis – North East Catchment Management Authority Area*. Report to Department of Natural Resources and Environment by Sinclair Knight Merz.

Victorian Water Quality Monitoring Network http://www.vicwaterdata.net

Victorian River Health Strategy: Healthy Rivers, Healthy Communities and Regional Growth. The State of Victoria, Department of Natural Resources and Environment, 2002.

Water EcoScience 1997. *Long Term Water Quality Trends in the Ovens River Basin*. Report for the Department of Natural Resources and Environment, March 1997.

Wells, F., Metzeling, L., and Newall, P. 2002. Macroinvertebrate regionalisation for use in the management of aquatic ecosystems in Victoria, Australia. *Environmental Monitoring and Assessment*. 74: 271-294

Wright, J.F., Furse, M.T. and Armitage, P.D. 1994. Use of macroinvertebrate communities to detect environmental stress in running waters. In: *Water quality and stress indicators in marine and freshwater systems: linking levels of organisation*. Eds. Sutcliff, D. W., Freshwater Biological Association, London.

Wright, J. F. 1995. Development and use of a system for predicting the macroinvertebrate fauna in flowing waters. *Australian Journal of Ecology* 20: 181-197.

APPENDIX 1: BIOLOGICAL INDICATORS AND REGIONS

1.1 Using Macroinvertebrates as Biological Indicators

Ecosystems are generally complex with many component organisms and processes. There are many components of aquatic ecosystems that could potentially be used for the assessment of environmental condition, such as phytoplankton, benthic diatoms, fish, bacteria, and invertebrates (Hellawell 1978). Some community process measures have also been proposed, such as stream metabolism (Bunn *et al.* 1999). The aquatic invertebrate community, however, offers many advantages over other components of the biota, and is the most commonly used component in assessments of environmental health, both in Australia and overseas (Hellawell 1978, Norris and Norris 1995).

Aquatic invertebrates are small animals, generally less than 1cm long, and include mayfly and dragonfly nymphs, beetles, snails, worms, shrimp, and the like. They are very abundant in streams, occurring in all aquatic habitats. They can be found burrowed in mud, in or on woody debris (snags), on the surface of stones in fast flowing riffles and among macrophyte (aquatic plant) beds. As well as being important in their own right, invertebrates are critical to stream ecosystem functioning, both in the processing of energy, and as a food supply to yabbies and other invertebrates, fish, platypus and some birds.

There are now considerable data available on the response of invertebrates to various forms of pollution, to changes in catchment use (agriculture, forestry, and urbanisation, for example), and of their general habitat preferences and ecology. Some types are known to be sensitive to changes in environmental factors such as temperature, dissolved oxygen or nutrient status.

Being of limited mobility, the presence or absence of invertebrate species or families reflects conditions at a site over time, allowing an assessment of intermittent stresses that are often missed in chemical monitoring programs. The presence or absence of specific types of invertebrates is just one way in which information can be obtained about environmental quality. Other information can be obtained from how many different types of animals are found in a stream (biological diversity), the number of animals found in a stream (abundance), and the relationship between all animals present (community structure). Generally, streams with a high level of diversity are in good health. Streams that have low diversity are typically less healthy, often due to the impacts of pollution or loss of suitable habitat. In polluted streams, sensitive species are eliminated and less sensitive species show an increase in numbers.

Most monitoring programs around the world have chosen to use invertebrates, identified to family level, and simple presence / absence (or binary data) (Plafkin *et al.* 1989, Wright et al. 1984). Studies both in Australia (Marchant *et al.* 1995, Hewlett 2000) and elsewhere (Furse *et al.* 1984, Plafkin *et al.* 1989) have shown sufficiently high similarity between family and species level patterns and their interpretations, and between quantitative and binary data, particularly when used in broad scale assessments (Marchant 1990).

1.2 Developing the Biological Regions

Around 900 stream sites in Victoria were sampled for macroinvertebrates under the National River Health Program (NRHP), using the Rapid Bioassessment Protocol (RBA) (EPA in press). Of these, about 200 were designated as 'reference' sites for the purpose of building predictive models (Davies 1994). A reference site does not necessarily mean that the site is pristine, but rather is a minimally impacted or best available site (Reynoldson *et al.* 1997). This is in recognition that most streams in foothill and lowland areas in particular have been greatly modified by human activities and few, if any, unaltered or pristine examples of such streams exist. In developing the biological objectives for the SEPP WoV, all available invertebrate reference site data from edge and riffle habitats (including stream habitat assessments and water quality data) were used.

Stream invertebrate species respond to small-scale influences within a stream as well as large-scale influences. The most obvious large-scale factor is the longitudinal or upstream-downstream dimension as a river runs from its headwaters to the sea. As you move downstream from the headwaters a number of physical features change. There tends to be a decrease in gradient, mean particle size, dissolved oxygen, amount of coarse particulate organic matter, and the degree of channel shading by streamside vegetation. Mean flow and discharge increase the further downstream you travel, the channel becomes more sinuous, the floodplain starts to develop, and turbidity, salinity and temperature tend to increase as well (Boulton and Brock 1999). All of these features are variables with which aquatic biota interact and the mix will influence their distribution and abundances.

As well as these longitudinal changes there are, over an area as large as Victoria, factors that operate on a regional scale to influence invertebrate distribution. Regional scale factors include climate, geology and topography. In developing biological objectives for rivers and streams in Victoria it was necessary to take account of these longitudinal and regional scale influences. This was achieved by dividing the State into regions with like combinations of longitudinal and regional scale factors. These are termed biological regions.

The regionalisation process involved the classification of reference sites using a combination of statistical (clustering, ordination and multi-linear regression analyses) and qualitative (expert judgement) methods. Regions were delineated primarily on the patterns of invertebrate community assemblage across Victoria. Environmental factors were also used to assist with boundary positioning and the general descriptions of the regions. More detailed description of the regionalisation process and the regions themselves can be found in Newall and Wells (2000) and Wells *et al.* (2002).

1.3 AUSRIVAS

AUSRIVAS is a classification and predictive modelling technique based upon the River InVertebrate Prediction and Classification System (RIVPACS), originally developed in Britain (Wright 1995). AUSRIVAS was developed under the Federal Government's National River Health Program as a means to assess the condition of rivers and streams across Australia. The models predict the aquatic macroinvertebrate families expected to occur at a site in the absence of environmental stressors, such as water pollutants or habitat degradation. 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 expected by the model. That is, the model predicted a site with a score greater than one, if more families were found at the site. A site with a score greater than one may simply be the result of variation in the capture efficiency of sampling methods, or it may indicate an unexpectedly diverse location, or mild nutrient stimulating primary and secondary production. The O/E scores derived from the model are assigned to bands (Table 17), which are considered to represent different levels of biological condition (as recommended under the NRHP, Barmuta *et al.* 1997). The width of the band varies between models but is constant within each model. The band labels for the equivalent classifications remain constant across all models, that is, Band A always corresponds as equal to reference site quality.

Table 17: Example AUSRIVAS O/E family score categories

Band Label	O/E score	Band Name	Comments
X	>1.15	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	0.55-0.84	Below reference	• fewer families than expected • potential mild to severe impact on water quality, habitat or both, resulting in loss of families
C	0.25-0.54	Well below reference	• many fewer families than expected • loss of families due to severe to extreme impact on water and/or habitat quality
D	<0.25	Impoverished	• very few families collected • highly degraded • very poor water and/or habitat quality