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THE HEALTH OF STREAMS IN THE OVENS CATCHMENT

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Introduction

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

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

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

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

Monitoring water quality

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

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

Biological monitoring techniques

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

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

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

Study site selection and assessment

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

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

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

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

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

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

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

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

Invertebrate analysis techniques

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

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

Number of families

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

SIGNAL

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

Table 1: Key to SIGNAL scores

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

AUSRIVAS

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

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

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

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

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

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

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

Reporting results

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

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

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

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

THE HEALTH OF STREAMS IN THE OVENS CATCHMENT

The Ovens Catchment covers an area of approximately 7,800 km^2 and includes the Ovens and King River systems as well as Black Dog and Indigo Creeks. The economic wealth of the Ovens catchment is dependant on primary production and its associated processing (DOWQS 1998). The population of the catchment is approximately 45,000, of which 35 per cent live in Wangaratta on the riverine plains.

One third of the catchment is forested but the streams also pass through residential areas, farmland used for crops or grazing and softwood plantations. The upper third of the Ovens catchment consists of mountainous areas reserved as public land either in national parks or state forests, including the Alpine National Park. The rest of the area is privately owned land in the valleys and on the floodplains. The middle section consists largely of semi-cleared foothills and valleys planted with pines or developed for the wine and tobacco industries. The major land uses in the extensively cleared riverine plains are dryland grazing of beef cattle and sheep, and broadacre cropping.

The climate and rainfall varies dramatically across the catchment due to the broad range in elevation. Generally it has a cool, temperate climate. The hottest months are January and February, while snow falls above 1,500 m occur in the colder months of July to September.

The Ovens River system is one of the least regulated rivers in the Murray-Darling Basin. There are only two small impoundments constructed for water storage on the Buffalo River (Lake Buffalo) and the King River (Lake William Hovell). The lower section of the Ovens River from Wangaratta to the Murray River has been designated a Heritage river because of its importance as a habitat for endangered fish such as the Murray Cod.

Increases in nutrients in streams usually occur due to sediment erosion, agricultural runoff and treated sewage inputs. Agricultural runoff from tobacco, hop and grape crops, and dairying close to the rivers edge transports nutrients into streams. Increased phosphorus and nitrogen in waterways and dams are the major factors influencing the development of blue-green algal blooms in the summer months (DOWQS 1998). These blooms can be toxic to humans and stock. Relatively few blue-green algal blooms have been recorded in the Ovens catchment; however they have become common occurrences in Lake Mulwala and the Murray River downstream, to which the Ovens is a major contributor of flows and nutrients (DOWQS 1998). Nutrients are also released downstream of Myrtleford and Wangaratta in the form of secondary treated sewage, contributing about 12 per cent of the total phosphorus load in the Ovens River (DOWQS 1998).

Turbidity is also an important element of water quality as most organisms need clear water for their survival and will be affected by increased turbidity (DOWQS 1998). High turbidity can inhibit plant growth by decreasing light levels and lowering water temperature. Suspended sediments in the water column can eventually settle and smother macroinvertebrate habitat on the riverbed. This can limit habitat for many macroinvertebrates causing decreased species diversity in streams. Erosion from land and effluent from sewage treatment plants increases sediment loads in waterways (Metzeling *et al.*1995). Removal of streamside vegetation for crops or grazing land also increases sedimentation as streamside vegetation can act as a trap for nutrients and soil before it is washed into rivers and streams. In general, the Ovens catchment has moderate levels of turbidity but this increases after heavy rain and worsens downstream of Wangaratta (DOWQS 1998).

Gold mining in the first half of the 1900s caused problems with sedimentation in the Ovens catchment. Dredging of the upper Ovens River and Reedy Creek, and sludge from these gold mining activities has had a considerable effect of the morphology and stability of the rivers (Anon 1994). Many deep waterholes along the Ovens River have filled with sand and gravel over the past fifty years and it is believed that gold mining has contributed significantly to this change in geomorphology (Binnie and Partners 1984).

Sediments carried into streams can have other effects on water quality as they can carry pesticides and mercury residues from past cropping and mining activities respectively. Significant levels of organochlorine pesticide residues were still present in the soils of tobacco farms along the Ovens and King Rivers long after the use of DDT and dieldrin was banned (McKenzie-Smith *et al.* 1994). Soils in the area can become mobilised during storm events and, in the early 90s, these chemicals were detected in sediments and aquatic organisms along the Ovens River (McKenzie-Smith *et al.* 1994). Mercury was used to recover gold from ore in the early part of the 1900s. Mine tailings containing mercury were deposited into the river in some areas, while elsewhere, water from the tailings leached into the river. Mercury was still detectable in the water column and sediments in 1986 (Tiller 1990). It is a very persistent environmental pollutant and is likely to remain in the Ovens system for decades to come.

Alteration to natural riparian vegetation is another problem affecting streams in the Ovens catchment. Some of the results of changes to riparian vegetation are erosion of streambanks, introduction of weeds, changes to shading and organic debris in the stream. This problem is compounded by the fact that most of the upper catchment area is typically steep. Severe gullying and sedimentation downstream of the smaller tributaries has lead to channel instability on the larger rivers (DOWQS 1998).

Salinisation is caused by the raising of the water table due to clearing of vegetation and irrigation of crops (Macumber 1991). Salinity levels are generally low in the Ovens catchment although it increases further downstream towards the Murray River. The salt load from the Ovens and King Rivers to the Murray is significant (DOWQS 1998). Irrigation of crops is the major cause of increased salinity in the Ovens catchment but as yet is not a major concern.

The urban areas of larger towns like Wangaratta pose further water quality problems due to industrial activities and stormwater runoff from the increased amount of 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 (DOWQS 1998). The tradewaste plant has been found in the past to discharge wastewater with high levels of colour and salinity and high biochemical oxygen demand which depletes oxygen levels in Fifteen Mile Creek (Tiller 1991).

Biological Assessment of Catchment Health

Forty sites in the Ovens catchment were assessed using water quality and macroinvertebrate data collected in 1997 and 1998. Streams were sampled in the alpine areas of the Mt Buffalo National Park, the surrounding forests, throughout the agricultural areas and downstream or within towns. Sites were sampled on two occasions, in autumn and spring of each year. Edge habitats were sampled at all sites but riffles were absent from many. To enable catchment-wide comparisons, edge habitat data from the combined autumn and spring sampling is used for all analyses and interpretation. Riffle habitat data are not used in this report but are available upon request.

The levels of phosphorus and nitrogen measured in this study were compared with the *Preliminary Nutrient Guidelines for Victorian Inland Streams* (EPA 1995). These guidelines vary in different geographical areas, with lower acceptable concentrations in the mountain areas compared to the foothills and higher allowable concentrations in the lowland areas. In Australian waters, phosphorus is usually considered to be the most important nutrient contributing to algal growth as it is a limiting nutrient and can be taken up and recycled very efficiently through the food chain (Ovens Water Quality Strategy 1998).

Analysis from the edge habitat biological data using classification and ordination techniques showed three main groupings of streams in the Ovens catchment – high altitude streams, intermediate or foothill streams, and lowland streams. The high altitude group consists of streams on the Mt Buffalo plateau and two sites on the upper King River. The intermediate group consists of streams in the foothills and higher valleys of the Ovens and King Rivers. These streams vary from smaller tributaries with rocky substrate and moderate flow, to broad sections of the Ovens and King Rivers. The lowland sites are characteristically large, slower flowing rivers but do include smaller streams. Most sites in this group are on the Ovens River downstream of Wangaratta or on the adjacent floodplains.

High Altitude group

The streams on Mt Buffalo are small, clear, fast-flowing streams with predominantly bedrock and boulder substrate. They flow through alpine heathland where cover is sparse and nutrient and salinity levels are low compared to lowland streams (Tiller 1993). The upper King River is a wider, fast-flowing stream, with cobble substrate, cool, clear water, frequent riffle habitats and shading from forest riparian vegetation. The dominant or commonly occurring taxa are the mayflies from the families Leptophlebiidae and Baetidae, the stoneflies Notonemouridae, Gripopterygidae and Austroperlidae, and the caddisflies Leptoceridae, Conoesucidae, Ecnomidae and Odontoceridae.

Sites in this group were generally in excellent condition. Two of the Buffalo Plateau sites near the Tatra ski resort (CBX and CBY) were outside the experience of the AUSRIVAS model. The upper King River downstream of Lake William Hovell (CBT) was below reference condition, probably because of the seasonal regulation of flows from Lake William Hovell. SIGNAL scores indicated that water quality was fair to good at these sites.

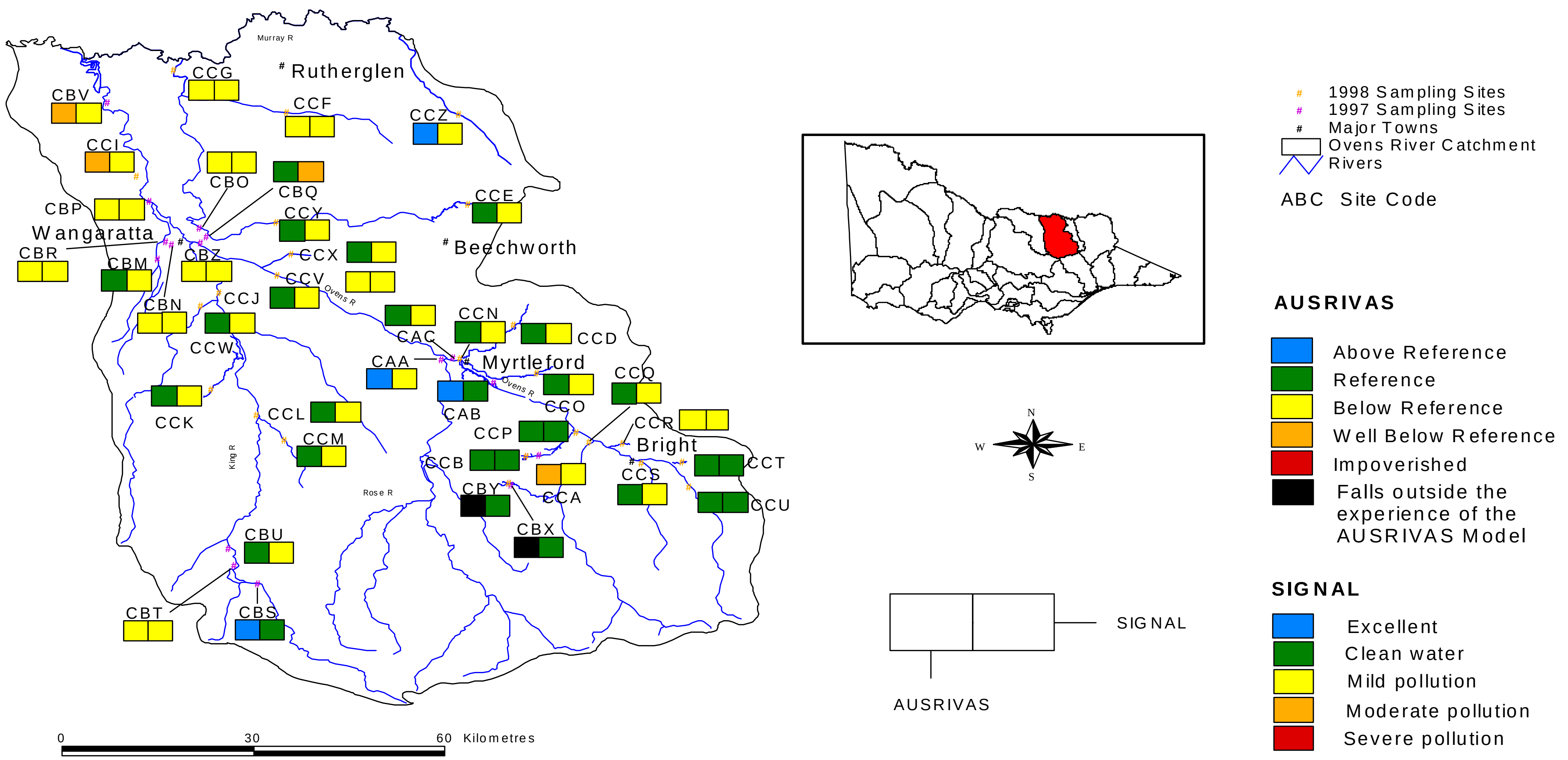
Chalet Creek downstream of Mt Buffalo Chalet (CCA) and Running Jump Creek downstream of the Tatra ski resort (CBX) exceeded the nutrient guidelines for both nitrogen and phosphorus (table 3). Chalet Creek is very small, flows intermittently and is situated downstream of the sewage treatment plant for the Mt Buffalo Chalet, which accounts for the very high levels of nitrogen and phosphorus present.

This site also rated well below reference for AUSRIVAS and the SIGNAL score indicted mild pollution. Running Jump Creek is a permanent stream which would have received run-off from the ski resort and treated effluent from the Tatra sewage treatment plant via seepage through the alpine bogs and meadows. Faunal richness in both Chalet Creek and Running Jump Creek was very low (table 3) particularly in comparison with the other alpine sites. Several families in faunal groups known to be intolerant to nutrient enrichment (stoneflies, mayflies and caddisflies) as well as families from other groups such as dragonfly and damselfly nymphs, were missing from these sites.

Intermediate group

The streams in this group are mostly in the Ovens and King valleys and pass through forests, agricultural land, pine plantations and some small towns. They vary considerably in substrate, current, shading, frequency of riffles and water temperature. The dominant macroinvertebrates in this group consists of mayflies and caddisflies, with beetles (Coleoptera), water bugs (Hemiptera) and dragonfly larvae (Odonata) becoming more common. In comparison with the higher altitude groups, these sites had higher turbidity, more sand/silt on the river bed and were generally larger, slower-flowing streams. The majority of sites had largely intact streamside vegetation and fairly diverse macroinvertebrate assemblages.

AUSRIVAS rated most of these sites as being in good condition (equal to reference sites) or above reference (usually indicative of mild nutrient enrichment). Reedy Creek downstream of the Wangaratta sewage treatment plant (CBQ), failed both the nitrogen and phosphorus guidelines, rated poor in SIGNAL yet was equal to reference sites in AUSRIVAS. This indicates that the habitat is probably in relatively good condition allowing the existence of a fairly diverse macroinvertebrate community (table 3) tolerant of poor water quality.



Murray R
Rutherglen
Wangaratta
Beechworth
Myrtleford
Bright
Ovens R
King R
Rose R
CCG
CBV
CCF
CCZ
CCI
CBO
CBQ
CCE
CBP
CCY
CBR
CBM
CBZ
CCX
CCV
CBN
CCJ
CCN
CAC
CCD
CCW
CAA
CCQ
CCK
CAB
CCO
CCL
CCR
CCM
CCP
CCT
CCB
CCS
CBY
CCA
CCU
CBX
CBU
CBT
CBS
0
30
60 Kilometres
N
W
E
S
SIGNAL
AUSRIVAS
1998 Sampling Sites
1997 Sampling Sites
Major Towns
Ovens River Catchment
Rivers
ABC Site Code
AUSRIVAS
Above Reference
Reference
Below Reference
Well Below Reference
Impoverished
Falls outside the experience of the AUSRIVAS Model
SIGNAL
Excellent
Clean water
Mild pollution
Moderate pollution
Severe pollution

Three sites, although geographically in the lowland area, grouped with the intermediate sites. Two sites on Black Dog Creek (CCF and CCG) were below reference condition probably due to a poor quality habitat. Nutrient levels were also high at these sites with both exceeding the guideline values for nitrogen and phosphorus. The third site, Indigo Creek (CCZ), was above reference condition. Despite the fact that Indigo Creek is in a lowland area this site had reasonable water quality, some native riparian vegetation and abundant macrophytes. Nitrogen levels for this site were slightly above EPA's recommended guidelines and this mild nutrient enrichment is likely to have contributed to the increased diversity of invertebrates and the high AUSRIVAS rating. SIGNAL scores indicated that all sites experienced mild pollution.

Another four sites in this group exceeded both phosphorus and nitrogen guidelines and an additional seven sites exceeded the nitrogen guidelines. Of particular concern were Fifteen Mile Creek at the Racecourse (CBR), downstream of the tradewaste plant, One Mile Creek in urban Wangaratta (CBN) and Reedy Creek at Wooragee (CCE). These sites were all surrounded by either irrigated agriculture (broadacre cropping or pasture), dryland grazing or urban areas, activities which are known to increase nutrient and sediment levels in nearby watercourses (DOWQS 1998).

Lowland group

These rivers are surrounded by dryland grazing, viticulture, broadacre cropping and some irrigated horticulture. Remnant native riparian vegetation exists along some stretches of the Ovens and King Rivers but generally riparian vegetation is of poor quality. The rivers are typically slow-flowing streams with predominantly sand or clay bottoms, highly turbid and mostly unshaded. Riffles are rarely found. The dominant macroinvertebrates in this group consist of water bugs, beetles, midge larvae (Chironomidae), dragonfly larvae and some mayflies.

Sites in this group were in the vicinity of and downstream of Wangaratta. Turbidity, salinity, nutrient levels and water temperature were all higher at these sites than at sites higher in the catchment. The health of the streams within this group was the poorest in the Ovens catchment. AUSRIVAS scores showed all but one of the sites to be below or well below reference condition. Few families were present (table 3) suggesting that habitat was in poor condition, while the SIGNAL scores indicated mild pollution.

Three of the six sites exceeded EPA nutrient guidelines for both nitrogen and phosphorus. These were Reedy Creek, Hume Hwy (CBO) downstream of the sewage treatment plant, Fifteen Mile Creek, 30 m upstream of Ovens River (CBP), which receives urban runoff and discharges from the tradewaste plant, and Croppers Creek, Tetley's Lane (CCW).

Summary

The health of streams in the Ovens catchment declines from the upland forested sites to lowland riverine areas, but overall the health of streams in the catchment is reasonably good compared to many other catchments in Victoria. Generally, river health decreases with increasing distance downstream, reflecting the accumulation of impacts, higher populations and more intensive land use at lower altitudes.

There are some impacts on water quality in the upper catchment from ski resorts on Mt Buffalo (and presumably the other resorts) and their associated roads and services. The majority of significant impacts however, occur in the foothills and plains where land clearing, erosion, cropping and grazing have affected river condition in a number of ways.

Biological monitoring results divide the catchment into high altitude, intermediate (mainly foothill) and lowland groups based both on natural features which vary geographically and as a result of environmental impacts which change along the length of the streams. There are poor quality sites in all three groups due to localised point source pollution, in particular sewage treatment plants.

SIGNAL scores suggest that water quality was often good in the high altitude group and generally indicative of mild pollution in the intermediate group and lowland areas particularly near Wangaratta. AUSRIVAS results suggest that habitat is in reasonable condition across much of the upper and middle catchment. Lowland sites were in the worst condition with poor habitat, high nutrient concentrations and turbidity.

Nutrient guideline levels for both total phosphorus and total nitrogen were exceeded at 12 of 40 sites in the Ovens catchment (30%). Another seven sites failed just the nitrogen guideline. While it is important to realise that these guideline maxima are based on limited information, and are under review, there is evidence from these results that nutrient levels in waterways in the Ovens catchment are a cause for concern.

Recommendations

The major problems associated with reduced river health in the Ovens catchment can be attributed to increased nutrient concentrations, changes in streamside and instream habitat, increased turbidity and suspended particulate matter (SPM), and flow modifications in some streams.

Remedial measures which should be undertaken to reduce inputs of contaminants to streams include:

- revegetation of riparian zones and land surfaces which are subject to storm runoff, thereby reducing soil erosion and transport of associated nutrients and suspended particulate matter.
- restriction of stock access to waterways, thus minimising bank erosion and preventing livestock excretory products from entering the stream.
- reduction of nutrient export from urban areas, which can be achieved by reuse of effluent from sewage treatment plants, the upgrade of treatment facilities from secondary to tertiary, and by the passing of stormwater runoff through artificial wetlands to remove nutrients.
- improving the effluent quality from the sewage and tradewaste treatment plants.

The Government's water reform initiative aims to ensure that municipal sewage management is upgraded. All water authorities are currently planning or implementing either major upgrades to their sewage treatment plants to reduce nutrient loads or are implementing new effluent reuse schemes. When completed, these measures should result in an improved level of river health in areas currently affected by nutrient rich discharges. The water authorities are currently in the planning process and are aiming at meeting the Government deadline of all sewage treatment plants being upgraded by December 2001.

Remedial action to overcome the environmental impacts of flow modifications should be possible through the development of Streamflow Management Plans or Bulk Water Entitlements. Environmental flows are not seen as a big issue in the catchment with the Ovens River itself being essentially unregulated. Nonetheless, it is important that water audits are undertaken with a view to increasing river flows and establishing more natural flow regimes downstream of reservoirs on tributary streams.

The development of a water quality management strategy (DOWQS 1998) for the Ovens catchment represents a very positive step for protection of the environment. This needs to be coupled with better catchment management and associated implementation programs which address improving the condition of riparian and instream habitat. It is essential, however, that the success of programs be evaluated. Monitoring of river macroinvertebrate communities is recommended as a measure of future environmental changes.

Table 3 AUSRIVAS and SIGNAL scores for combined season edge samples from sites in the Ovens catchment

Within each group sites are arranged alphabetically. Family numbers fewer than 25 are highlighted, as are values of total Phosphorus and total Nitrogen which exceed nutrient guideline maxima. Sites for which only spring data were available are marked with a #. * = outside the experience of the AUSRIVAS model

site code	Site name and location	AUSRIVAS	SIGNAL	No. of Families	total N (m/g/L)	total P (mg/L)
High altitude sites						
CBT	Upper King River, Small Weir	0.8	5.56	27	0.095	0.005
CBU	Upper King R, Edge of Forest	0.9	5.59	31	0.09	0.005
CBX	Running Jump Ck, d/s Tatra	*	6.40	18	0.2385	565
CBY	Tributory of Running Jump Ck, u/s Tatra	*	6.67	29	0.1335	0.005
CCA	Chalet Ck, d/s Mt Buffalo Chalet STP	0.52	5.67	16	18.35	3.05
CCB	Crystal Brook, Mt Buffalo	1.1	6.64	28	0.087	0.005
Intermediate altitude sites						
CAA	Buffalo R, Merriang Rd near Myrtleford	1.24	5.81	39	0.245	0.009
CAB	Ovens R, u/s Myrtleford	1.22	6.16	32	0.1345	0.005
CAC	Ovens R, d/s Myrtleford	1.15	6.00	35	0.105	0.0055
CBM	Fifteen Mile Ck, Gravel Pit Rd @ Hume Hwy	1.02	5.72	29	0.278	0.02
CBN	One Mile Ck, Phillipson St Wangaratta	0.64	5.12	18	1.09	0.2
CBQ	Reedy Ck, d/s STP	0.96	4.96	26	8.025	3.7
CBR	Fifteen Mile Ck, Racecourse	0.83	5.10	23	6.25	1.35
CBS	Upper King, Top Crossing Track	1.22	6.68	35	0.074	0.005
CBZ	Yellow Ck, Ovens Hwy	0.7	5.45	23	0.143	0.0125
CCD	Barwidgee Ck	1.14	5.76	36	0.4805	0.029
CCE	Reedy Ck @ Woorragee	1	5.59	36	1.0195	0.033
CCF	Black Dog Ck @ Rutherglen-Springhurst Rd	0.81	5.24	27	1.705	0.101
CCG	Black Dog Ck @ Dugays Bridge Rd	0.82	5.46	26	1.215	0.096
CCJ	King R @ Oxley	0.88	5.73	27	0.204	0.0155
CCK	Boggy Ck @ Top Plain Rd	0.9	5.48	26	0.435	0.0295
CCL	King R @ Edi Cutting	0.94	5.53	31	0.2585	0.0085
CCM	Black Range Ck @ Pettifer Rd	0.96	5.66	33	0.285	0.0115
CCN	Barwidgee Ck @ Myrtleford	0.88	5.66	30	0.232	0.019
CCO	Happy Valley Ck @ Mudgeegonga Rd	1.04	5.33	34	0.6335	0.092
CCP	Ovens R @ Braithwaite Pumping Station	1.03	6.18	29	0.114	0.007
CCQ	Buckland R @ Mt Buffalo Rd	1.08	5.86	31	0.2465	0.005
CCR	Roberts Ck @ Roberts Ck Rd	0.66	5.68	20	0.1755	0.025
CCS	Morses Ck @ Hawthorne Ck	0.95	5.91	33	0.117	0.0055
CCT	German Ck	0.99	6.14	36	0.1335	0.0115
CCU	Ovens R @ Mills View	1.12	6.23	36	0.0995	0.012
CCV	Ovens R @ Tarrawingee Bridge	0.81	5.68	23	0.157	0.0085
#CCY	Reedy Ck, Carraragarmungee Estate Rd	0.92	5.36	26	0.361	0.018
#CCZ	Indigo Creek, Pooley's Rd	1.18	5.28	26	0.8	0.026
Lowland sites						
CBO	Reedy or Yellow Ck, Hume Hwy	0.77	5.42	26	1.875	0.865
CBP	Fifteen Mile Ck, 30 M U/S Ovens R	0.78	5.35	20	1.066	0.145
CBV	Ovens R, Robinson Rd	0.49	5.44	17	0.2645	0.0295
CCI	Ovens R @ Ovens Tk	0.49	5.24	19	0.321	0.03
#CCW	Croppers Ck, Tetley's Lane	0.85	5.19	22	1.4	0.075
#CCX	Hodgsons Ck, Kay's Road Bridge	0.97	5.52	25	0.51	0.015

SIGNAL	AUSRIVAS O/E
Excellent	Above reference
Clean water	Reference
Mild pollution	Below reference
Moderate pollution	Well below reference
Severe pollution	Impoverished

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