



DEPARTMENT *of*
PRIMARY INDUSTRIES,
WATER *and* ENVIRONMENT

Tasmania

**Index of River Condition
for the
Pipers River Catchment**

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Executive Summary

This report provides a broad picture of stream condition in the Pipers River based upon a rapid ground survey of sites from within the catchment. The method used is known as the Index of River Condition (IRC) and is based upon similar habitat survey approaches being used in Victoria and Queensland. The IRC includes a number of rating factors which have yet to be fully tested in Tasmania. This project forms part of investigations into the suitability of these ratings in this State.

The IRC provides an index of change from what is regarded as a natural state. The index is composed of a number of sub-indices relating to hydrology, water quality, physical stream form, streamside habitat and ecological health. The results presented in this report provide a summary of the current catchment condition and can be used as a benchmark for future comparison.

Field data collection for IRC parameters occurred at 34 representative sites within the Pipers River catchment; 14 on the main-stream Pipers River and 20 on tributary streams. An examination of the overall condition ratings for both tributary and main-stream lengths reveals no section with a high or major modification to condition. But conversely only one site came out as essentially natural (site 13) and this also was borderline. The data shows that 45% of the main-stream has some modification to condition while 46% is near natural and 9% is essentially natural (one reach only) with 5 of the near natural sites at the top of the catchment and the rest scattered through the remainder of the catchment. For the tributary streams, 35% fall into the category of some modification to condition, while the majority (64%) show near to natural conditions. In general, it was estimated that 40% of all the catchment streams have some modification from natural conditions and the remaining 60% are near natural.

Analysis of sub-indices indicates major degradation of streamside zones with excellent condition of hydrology, good condition of water quality and physical form although there is significant degradation of physical stream form in a number of areas. Aquatic fauna (freshwater invertebrates) also rated as in good condition overall. Major disturbance to the streamside habitat zone has been detected in approximately 60% of the catchment sites. Issues which arise from this data include the extensive growth of riparian weed species, unvegetated or poorly vegetated riparian zones, and uncontrolled stock access to river banks.

It is clear that riparian (streamside) zone management is a significant issue in the Pipers River catchment and should be a focus of catchment management activities to avoid further degradation. The maps included in this report provide information to allow a strategic approach to the implementation of programs to address this situation.

The IRC assessment suggests that the majority of sites in within the catchment rate as being near natural, although conditions are bordering on some modification. Sub-indices provide additional information with regard to specific features of each measuring location and suggest a range of management issues for the future.

1. INTRODUCTION

This study was developed as an adjunct to the requirements of the Land and Water Management Branch, DPIWE, to produce State of Rivers reports for catchments around Tasmania. The study consisted of a ground survey method that utilised a one off snap-shot approach for sites within the Pipers River catchment. The information collected from representative reaches was intended to provide a rapid Index of River Condition (IRC) for the river. The methodology is designed to provide a broad picture of stream condition.

The whole concept was developed with a view to providing a simple descriptive format that could provide a rapid qualitative assessment of river condition of specific sites and representative reaches. The report is far from comprehensive but the basic presumption is that it provides suitable data to illustrate the overall health of reaches throughout the Pipers River catchment. The data has been collected to provide a benchmark study that can be re-run, or expanded, at a later date to observe changes over time.

For the purposes of this report 'stream condition' is defined as the physical condition of the river as it directly relates to a 'natural condition'. The basis of the whole process is to analyse data against a benchmark of what is regarded as an unimpacted example. Each parameter is also viewed in terms of its importance for maintaining adequate conditions to support the ecological integrity of the system.

This report is a continuation of a program being developed by Land and Water Management Branch staff that is designed to provide rapid analysis of environmental conditions of Tasmanian streams. The basic methodology is a modification of methods that have been successfully trialed and are now operational in several mainland states.

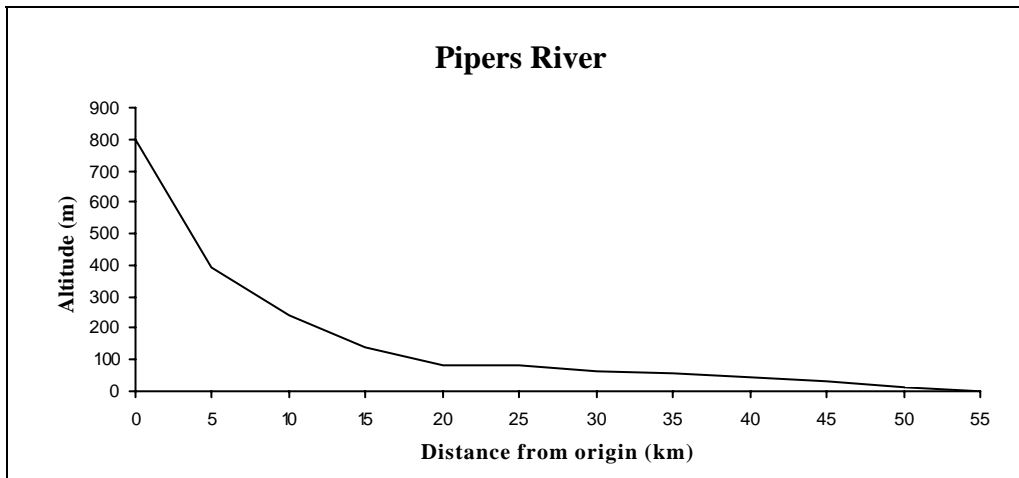
2. STUDY AREA

The study catchment was that containing the Pipers River system. The Pipers River itself is situated in the north-east of the state and flows north into Bass Strait. It is an unregulated stream but it has tributary streams that are heavily impacted by on-stream storage's. There are few irrigation rights in the catchment with most water extracted for stock and domestic purposes. The mid to lower catchment has been cleared for a mixture of cropping and pasture. Stream substrate grades are predominantly boulder/cobble and gravel. Instream habitat is dominated by pools and runs with pools providing the largest size categories. The catchment geology is largely composed of Jurassic dolerite in its upper reaches and a mixture of Triassic sedimentary sequences including Devonian mudstone and alluvial sands and gravel in the lower reaches. The total river length is 48 km originating at an altitude of approximately 960m (**Figure 1**) and the catchment area is 380 km². The median summer and annual flows from the catchment are 0.145 and 0.79 cumecs (12.53 and 68.26 Ml/day) respectively.

Land use within the catchment varies considerably with plantation forestry and clearfelling activities occurring on some tributaries and within the headwaters. Within the mid to lower reach land use is composed predominantly of cleared pasture for stock grazing with some small scale intensive cropping.

Field data collection for IRC occurred at 34 sites within the catchment. 14 were on the mainstream Pipers River, and 20 on tributary streams (Figure 2).

Figure 1. Pipers R. altitudinal profile.



3. METHODOLOGY DESCRIPTION

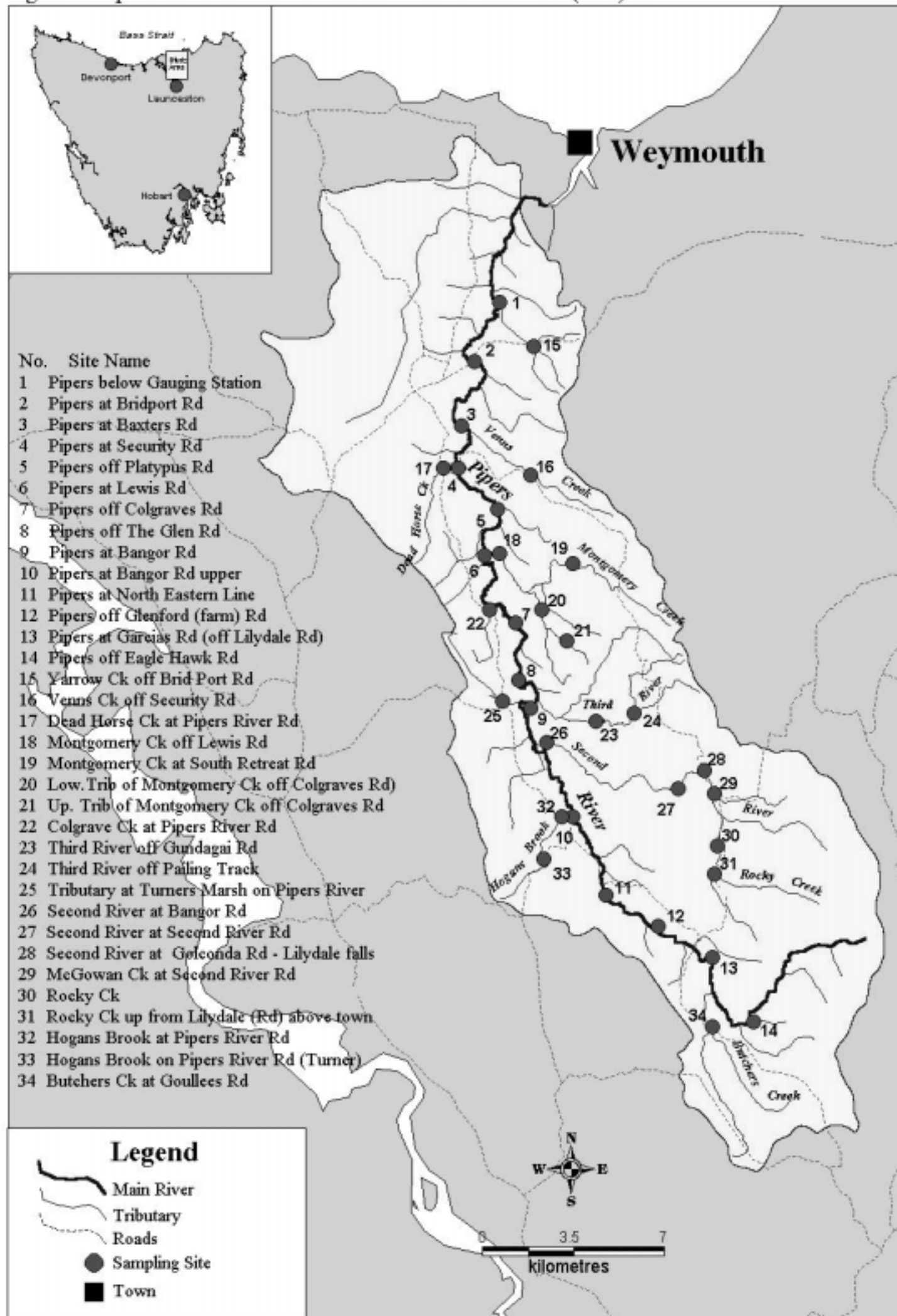
This technique is a modification of the methods adopted by the Queensland Department of Primary Industries 'State of the Rivers' studies and the 'Index of Stream Condition' developed by the Victorian Department of Conservation and Natural Resources. It involves the use of a 'snap-shot' approach, that is, a one off survey of river condition at a number of representative sites along the length of target streams within the catchment. Most of the recorded parameters have been adopted from the Victorian method. For a precise understanding of the parameters recorded in accordance with the Victorian model, readers are referred to CEAH (1997) Index of Stream Condition User's, Reference and Trial Application manuals.

The aim is to achieve an understanding of current physical conditions within a system which can be used as a bench-mark for future comparative work. This is achieved through gathering information on physical and ecological conditions of the stream system that will detect impacted reaches within the catchment and provide a baseline against which future assessments of river condition can be compared. The overall format, therefore, is designed not only to provide rapid assessment of river condition, but also as a long term tool for monitoring change within the catchment.

This procedure requires the assessment of data gathered from field and office sources. The assessments are based on a range of inputs that are placed into rating categories. A number of indicators may be recorded and these values will be combined under one group category to provide a sub-index value. Sub-index values are weighted on a scale of between 0 and 10. These scores are then combined to supply an overall environmental condition rating for each site. The final assessment of site and catchment condition is subjective in nature and findings must be viewed with this in mind.

Field sampling was conducted by teams of two. One team member sampled and picked the macroinvertebrate fauna, the other member assessed habitat variables. To standardise the sampling techniques each individual retained their role for the entire sampling period. If several teams were used they worked areas together and the close proximity of most sites enabled six to eight samples to be completed per day. This approach also ensured good communication between the teams, helping to standardise techniques and minimise potential problems.

Figure 2: Pipers River Catchment. Index of River Condition (IRC) Sites



The methodology is based on the following sub-indices:

- 1) Physical form;
- 2) Streamside zone;
- 3) Water quality;
- 4) Aquatic life;
- 5) Hydrology.

Each sub-index represents a composite of one or more parameter measurements, and the sub-indices are combined to provide a single rating of site condition.

Objectives

- a) to create an index of condition for all observed parameters (i.e. quality rating).
- b) to develop a system to determine overall site condition and incorporate this into a factor of river condition.
- c) to base site condition on physical parameters which detect departure from a condition of an estimated 'norm' or 'natural' condition.
- d) to produce a standardised, easily replicated format that is transferable to other systems.

Full descriptions of all physical aspects of each site are necessary to observe changes (improvements/degradation) in sites if subsequent studies are undertaken at a later date, and as optional input into the analysis of stream condition. Therefore, more information than is directly used in final analysis is normally collected as back-up information to observe potential anomalies or discrepancies in the data sets and as full descriptors of sites if follow-up studies are to be undertaken.

Parameter ratings

Parameter scoring is based on a 5 point rating scale wherever possible. Ratings are based on the difference between the current value of the indicator and what it would be under unimpacted conditions. Victorian authorities justify the use of a 5 point scale by stating that higher ratings would be unrealistic given the current state of knowledge. With less than 5 points there are problems as the category size becomes too large.

Table 1. Example of a 5 point scale for indicator measurements.

Category	Numerical value (Rating)
Essentially natural	4
Near natural	3
Some modification	2
Major modification	1
Highly modified	0

Training

All team members participating in field sampling were required to undergo a days field training. Initial training is essential to maintain consistency in faunal sampling techniques and habitat assessment protocols. Training also corrects deficiencies in descriptive formats that can lead to confusion during field operations.

3.1 Sub-index headings

Through field measurements, a number of indicators may be recorded (Table 2) and these values are then combined under 1 group category to provide a sub-index value. Sub-index values are weighted in a scale of between 0 and 10. Descriptions of sub-index parameters are detailed below.

Table 2. The sub-index parameters and their associated indicator categorise.

Sub-index	Indicator
Physical form	Overall disturbance
Streamside zone	Width of streamside zone Density of native species Tree height Vegetation type
Water quality	Turbidity Conductivity pH
Aquatic life	SIGNAL
Hydrology	Upstream CWR's

3.1.1 Physical form

Bank condition

Bank condition or stability is an assessment of the amount of erosion occurring at set points within the study site. Potential indicators of current bank instabilities include:

- a lack of vegetative cover or exposed soil.
- irregularities and sharp bends in the stream course.
- undermining of the toe of the banks and exposed roots.
- water discoloration along the toe of the bank, and
- evidence of recent soil slips.

Bed condition

Bed condition is a measure of overall aggradation and degradation of the stream bed at each transect location. Potential indicators of current bank instabilities include:

- erosion heads.
- there are bank instabilities on both sides of the bank (this indicates bed degradation).
- the type of soil present in the area (i.e. generally sand, mostly clays, etc.) is different to the soil in the bed;
- any accumulations of sediment around obstructions (typically coarse woody debris), and
- the general width to depth ratio is low for degradation and high for aggradation.

Density and origin of coarse woody debris (snags)

Instream woody debris can represent a very important habitat for aquatic animals. It provides a refuge for many animals, food source for many macroinvertebrates, and is important for spawning for some fish species (e.g. Blackfish). The rating scale is based on the proportion of available (maximum to minimum) snags. The rating assumes that the greater the proportion of snags available, the more habitat there is for instream fauna.

Influence of artificial barriers

The presence of artificial barriers indicates a clear change from natural conditions. Barriers include weirs, dams, culverts, etc. Barriers largely affect fish movement but may heavily impact available downstream water quantity which can have an effect on all ecosystem functions. The rating for artificial barriers is based on a function of fish migration.

Overall site disturbance

This parameter was singularly categorised as an overall rating for a total site reach. Six disturbance categories were available (extreme, very high, high, moderate, low and very low) one of which was selected for each site. All categories were present in this assessment. The categories are largely based on physical aspects of streamside vegetation.

3.1.2 Streamside zone

Riparian vegetation plays an important role in the maintenance of stream condition. For example, streamside vegetation exhibits the following attributes (taken from Skills and Pen, 1995).

- increased bank roughness reducing erosion potential,
- roots bind and reinforce soil (bank stabilisation),
- roots also loosen soil allowing greater infiltration of rainwater,
- sediment and nutrient filters,
- promotes sediment deposition,
- ecological corridors,
- habitat availability for animals and plants.

Factors such as these aid in maintaining the quality and integrity of a waterway.

Width of streamside zone

This was regarded as the average distance from waters edge at base flow to any cleared or developed land. The streamside zone is the interface between the aquatic and terrestrial environment. This parameter is largely designed to determine how much vegetation is present from the river bank to when some form of disturbance, such as clearing, occurs. Of course the streamside zone may be extensive therefore anything over 40 m should be recorded as such. The size of the streamside zone is important to determine how much of a buffering effect it is having from adjacent developed land and to indicate the continuous presence of vegetation which is important as faunal corridors and habitat.

Structural intactness

Structural intactness is an indicator of disturbance relating to the original size distribution of streamside vegetation.

The following definitions for the three structural layers are based on the Victorian model.

- overstorey: woody plants greater than 5 m tall.
- understorey: woody plants less than 5 m tall.
- ground cover: other plants without woody stems.

The ratings for structural intactness are based on a scale of continuous, patchy and sparse. This rating is applied for each structural layer.

Proportion of cover which is indigenous

This category is reasonably self explanatory. It refers to the proportion of non-exotic or introduced species that are present. The amount of native species present provides a rating of how near to natural the site may be. The presence of exotic species may also be undesirable depending on the quantity and/or the particular species. Ratings are according to the percentage cover that is available and also applies to each structural layer.

Presence of regeneration of indigenous species

Regeneration of indigenous species is an important descriptor of current condition.

But, due to the difficulty in assessing the regeneration of ground cover species, it has been applied to overstorey and understorey species only.

Condition of wetlands and ponds

This factor has been directly adopted from the Victorian model but is of limited application for the Tasmanian environment. Nevertheless, there are examples of significant wetlands that exist so the category has been retained.

In general, this category has been developed to assess whether more than 50% of a wetland in a reach is in reasonable condition. This indicator only applies to floodplain reaches.

Longitudinal continuity

This parameter proved to be the most difficult for field staff to adopt yet it is one of the more affective measures. In essence, longitudinal continuity is simply a measure of how continuous streamside vegetation is. Any gap that exists in vegetation corridors has the potential to act as a barrier to faunal movement. The parameter specifications adopted here are the result of expert panel discussions. The two factors applied are:

- proportion of bank length with vegetation greater than 5 m wide, and
- the number of significant discontinuities per unit length.

A significant discontinuity is a gap in the streamside vegetation 10 m long or greater that is less than 5 m wide.

Overstorey streamside vegetation regeneration

This parameter is regarded as a rough indicator of disturbance. Taller trees indicate long term stability potentially from fire, logging or general clearing.

Vegetative regrowth categories

This rating is based on the assumption that natural succession in vegetation occurs whereby the final position is that of pure rainforest (highest rating).

Streamside cover

The indicators for this section are categorised as follows:

- canopy cover
- vegetation overhang
- root overhang
- bank overhang
- man-made overhang

The data collected for this section provides an assessment of available habitat in the form of shelter and shading for aquatic life. Overhanging trees may also provide a direct food source in the form of leaf and insect fall into the stream.

3.1.3 Water quality

Water quality parameters were collected by two separate methods within this study. At each habitat analysis sampling date for each site a single set of water quality parameters were collected. In association with this a temporal pattern of catchment water quality is reviewed

in a separate section of the State of Rivers report. This involved monthly spot samples of representative sites throughout the catchment over a 12 month period. This information, although collected separately to the IRC process, was made available so that a more rounded assessment of catchment water quality could be determined from a broader data set. All results are presented in accordance to the guidelines listed below.

Turbidity Guidelines For Tasmanian Rivers

Turbidity in water is caused by;

- suspended matter such as clay, silt, fine organic and inorganic matter.
- soluble coloured compounds.
- and microscopic organisms.

Turbidity is an expression of the optical property of the water that causes light to be scattered rather than transmitted in a straight line through the sample. It is a useful measure of the amount of sediment being transported in the river and high turbidity readings often indicate active erosion or stream disturbance.

Turbidity is often related to flow and can vary dramatically with time, so classification of a river using turbidity should be based on the average of many readings taken over a wide range of flows. This was achieved for a number of representative sites throughout the catchment but restricted to low flow period only. Table 3 illustrates the rating scale for turbidity levels subject to reach location.

Table 3. Turbidity values for Tasmanian streams.

Mountain	Valley	Plain	Rating
< 5	< 10	< 15	4
< 7.5	< 12.5	< 17.5	3
< 10	< 15	< 20	2
< 12.5	< 22.5	< 30	1
> 12.5	> 22.5	> 30	0

* Values are in Nephelometric Turbidity Units (NTU's).

Conductivity Guidelines For Tasmanian Rivers

The Electrical Conductivity measured in water provides an indication of the amount of dissolved salts and hence salinity. The following table is an approximate guide to what constitutes a high or low conductivity value with respect to dissolved salts. In Tasmania, most of our lowland rivers will generally fall within the range of 100 - 500 μ S. In the upper catchment most readings will be between 20 - 100 μ S.

Table 4. Conductivity values for Tasmanian streams.

Mountain	Valley	Plain	Rating
< 20	<50	< 100	4
20 - 60	50 - 100	100 - 250	3
60 - 90	100 - 300	250 - 450	2
100 - 150	300 - 500	450 - 750	1
>150	>500	>750	0

* All expressed in μ S cm^{-1} (microSiemens per cm).

pH Guidelines For Tasmanian Rivers

Ratings for pH are presented in Table 5. Available pH data for Tasmanian rivers is limited at this stage, therefore, the rating scale adopted by Victorian authorities has been used for this survey.

Table 5. Criteria for assessing pH.

pH range	Rating
6.5 - 7.5	4
6.0 - 6.4 or 7.6 - 8.0	3
5.5 - 5.9 or 8.1 - 8.5	2
4.5 - 5.4 or 8.6 - 9.4	1
> 9.5 or < 4.5	0

A full evaluation for water quality for the whole catchment is detailed in the SOR water quality section of this report.

3.1.4 Aquatic Life

Macroinvertebrate Sampling

Invertebrates are animals without backbones. Macroinvertebrates are those invertebrates that can be easily seen with the naked eye. As a group they have become widely used as biological indicators of stream and river health. They are one of the most easily studied biological components of streams. They can be simply collected in large quantities with inexpensive equipment and readily preserved and identified. They occupy a central role in the food chain and include herbivores which eat algae and other material, detritivores which eat dead animal and plant material and carnivores that eat other invertebrates. They themselves provide a valuable food source for freshwater vertebrates such as fish, platypus and birds.

A large number of species, or groups of species, are highly sensitive to even a mild stress. Impacts from agricultural and industrial activities, forestry operations and mining, and physical modification of streams such as damming and channelisation have all been known to effect the abundance and or composition of the macroinvertebrate community (Oldmeadow; In: Bobbi *et al.* 1996). Macroinvertebrates, therefore, are important indicators of instream quality and are a useful tool for monitoring purposes.

Macroinvertebrates were sampled from one riffle habitat. Edgewater habitats were sampled only if the level of flow was so low that riffle habitats were not available. Samples were taken using a standard 250um mesh dip net (dimensions 25 x 35 x 70 cm, height x width x depth). The substratum from a ten metre section from each habitat was disturbed by kicking over and rubbing the surface of stones while the net was held downstream. This action dislodged organisms which were then swept into the net.

The contents of the dip net were emptied into a sorting tray and the sample picked for a total of 30 minutes using forceps. The picked material was identified to the taxonomic level of family and numbers were counted in the laboratory.

Aquatic invertebrates are good indicators of river health. Invertebrate data was collected for 25 of 27 sites during the field sampling program. From the available invertebrate data a scoring system based on a sensitivity grade for Family level information can be determined to

ascertain the health of a particular site. The conversion factors and comments for the appropriate grades are listed below (Table 6).

Table 6. SIGNAL values for faunal data based on Chessman (1995).

SIGNAL value	Rating	Comment
>7	4	Excellent
6-7	3	Clean water
5-6	2	Doubtful, mild pollution
4-5	1	Moderate pollution
<4	0	Severe pollution

The SIGNAL (Stream Invertebrate Grade Number Average Level) value is a simple biotic index based on a sensitivity grade for families of common invertebrate fauna to pollution in rivers. The index is calculated by summing the grades for all the families present at a site, the total is then divided by the number of families at the site which gives an average grade per family. Analysis of specific Tasmanian data has led to Tasmanian River Health Officers recommending the use of the original scale (Chessman, 1995) rather than the new national scale (Chessman, *et al.* 1997).

3.1.5 Hydrology

Tasmanian rivers suffer from a number of impacts that effect water quantity. Many rivers are subject to hydro-electric regulation, many others are impacted by agricultural, industrial and domestic extraction requirements. The Pipers River catchment has some small scale water extraction for power generation purposes and does come under irrigation extraction pressures particularly during the summer months.

The hydrology index encompasses the deviation between estimated unimpacted and current impacted flow regimes. The data used to calculate this index is the median monthly flow during the summer period (January to March) with the addition of the estimated Commission Water Right (CWR) outake used to calculate what flow should be in the river. The deviation between the estimated natural flow and current flow is used to calculate a rating scale for this parameter. The median flow over the past 10 years of record was chosen as the best representation of the normal amount of water in the river for each month.

4. RESULTS

The IRC for the Pipers River system were assessed from a total of 34 catchment sites (Figure 2). Final analysis is reported in the following section. If no results were reported for a site then no data was available for evaluation. The results are presented for the main-stream Pipers River, and its tributaries. The final environmental rating for each site was determined by combining all the sub-index values from the sources indicated above. Table 7 illustrates the condition categories associated with the appropriate rating scores for the range of values that may be obtained for each individual site. This data can then be used to produce an overall environmental value for a site. This is a generalised category that supplies a descriptive condition for a site. A full list of site sub-index ratings are presented in Appendix 1.

Table 7. IRC rating categories for individual sites.

Condition	<u>Very poor</u> Highly modified	<u>Poor</u> Major modification	<u>Moderate</u> Some modification	<u>Good</u> Near natural	<u>Excellent</u> Essentially natural
Total score	0 - 10	11 - 20	21 - 30	31 - 40	41 - 50
Environmental rating	0	1	2	3	4

All field data was collected in February 1998.

Each site was selected as representative of a reach (length of river). Photographs of each site were also taken.

A graphical illustration of all the parameter ratings as estimated for each stream reach is presented in Appendix 3 to 7. The parameters are for physical form, streamside zone, water quality, aquatic life and hydrology sub-index ratings.

4.1 Summary results for main-stream Pipers River sites

The IRC results for the main-stream Pipers River are provided in Figure 3. A total of 14 reaches were sampled on the main-stream (Table 8). Parameters that suggest major or extreme modification from a natural or ideal condition are highlighted in Table 9 along with data gaps. Descriptive maps for each sub-index and how they rate throughout the catchment in association with stream length are provided in Appendices 3 to 7.

Comments on the results illustrated in Figure 3 and Table 9 are highlighted as follows:

- The IRC scores illustrate a gradual increase in quality up the catchment. There is a slight drop in condition within the middle catchment (sites 5 to 9), but from sites 10 to 14 all improve to a level of near natural or good condition. The average condition of the entire catchment rates out as in good condition overall. In summary, 4 sites (2, 5, 6 & 9) rate as showing some modification and the remainder rate as in good condition (near natural) except site 13 at the top of the catchment which rated within the essentially natural band (excellent condition).
- The hydrology sub-index rated well for the mainstream with 5 out of 14 sites in excellent condition (upper catchment), 8 sites (1 to 8, mid to lower catchment) in good condition (near natural) and the remaining site (9) in moderate condition (some modification). The greatest level of water extraction occurs in the tributary streams in the middle of the catchment (largely Second R. and its tributaries) and therefore all the mainstream sites above the confluence (sites 10 to 14) were unimpacted.
- Physical form sub-index rated as in good condition (near natural) throughout much of the catchment with site conditions ranging between moderate (1, 6 & 10), good condition (2 - 5, 7 - 9, 11 & 12) and excellent condition for the top 2 sites (13 & 14).
- The streamside zone sub-index scores rated poorly on average throughout the catchment with some sites exhibiting scores of less than 2 indicating highly modified or very poor conditions (sites 2, 6 & 10). Of the remaining 14 sites 3 were in poor (major modification) condition, 5 were in moderate (some modification) condition and 3 were in good (near natural) condition. No sites rated as in essentially natural condition. Overall the condition of the mainstream streamside zone was variable throughout the catchment with only one site in the lower catchment (4) and the top 2 sites (13 & 14) standing out as in good condition. This sub-index also clearly stood out as the most modified as illustrated in Table 12.
- Water quality at all sites rated consistently as in good condition (near natural). All sites ranked the same and no site stood out as impacted to any great degree. Overall pH was essentially neutral, conductivity ranged between 150 to 180 $\mu\text{S}/\text{cm}$ and turbidity was low (4 to 6 NTU's). Final analysis was derived from a limited data set and this may explain the consistency of the scores.
- IRC results suggest that aquatic life within the main-stream is in reasonable condition with 9 of the 14 sites exhibiting good (near natural) conditions, 3 sites (5, 8 & 9) in moderate (some modification) condition and 1 site (10) in excellent (essentially natural) condition. No data was collected from site 14 due to lack of flow.

- The only data gap present was for site 14 where no water quality or aquatic life could be sampled due to dry conditions during the sampling period. Follow up water quality information from the Water Quality study (refer to attached report) allowed subsequent creation of an index for this parameter.

Table 8. Site locations and physical attributes within the mainstream Pipers R.

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
1	Pipers below Gauging Station	509600	5453600	15	303.3
2	Pipers at Bridport Rd	508600	5451300	28	284.4
3	Pipers at Baxters Rd.	508100	5448800	40	274.6
4	Pipers at Security Rd	508000	5447200	45	249.5
5	Pipers off Platypus Rd.	509500	5445600	55	245.3
6	Pipers at Lewis Rd	509000	5443800	55	211.4
7	Pipers off Colgraves Rd.	510200	5441200	65	202.9
8	Pipers off The Glen Rd.	510300	5439000	68	201
9	Pipers at Bangor Rd.	510800	5437900	75	175.9
10	Pipers at Bangor Rd - upper	512400	5433700	95	77.2
11	Pipers at North Eastern line	513700	5430700	138	68.4
12	Pipers off Glenford (Farm) Rd.	515700	5429500	208	61.5
13	Pipers at Garcias Rd (off Lilydale Rd.)	517800	5428300	250	52.7
14	Pipers off Eagle Hawk Rd.	519400	5425800	388	16.1

Figure 3. IRC results for the Pipers River main-stream sites.

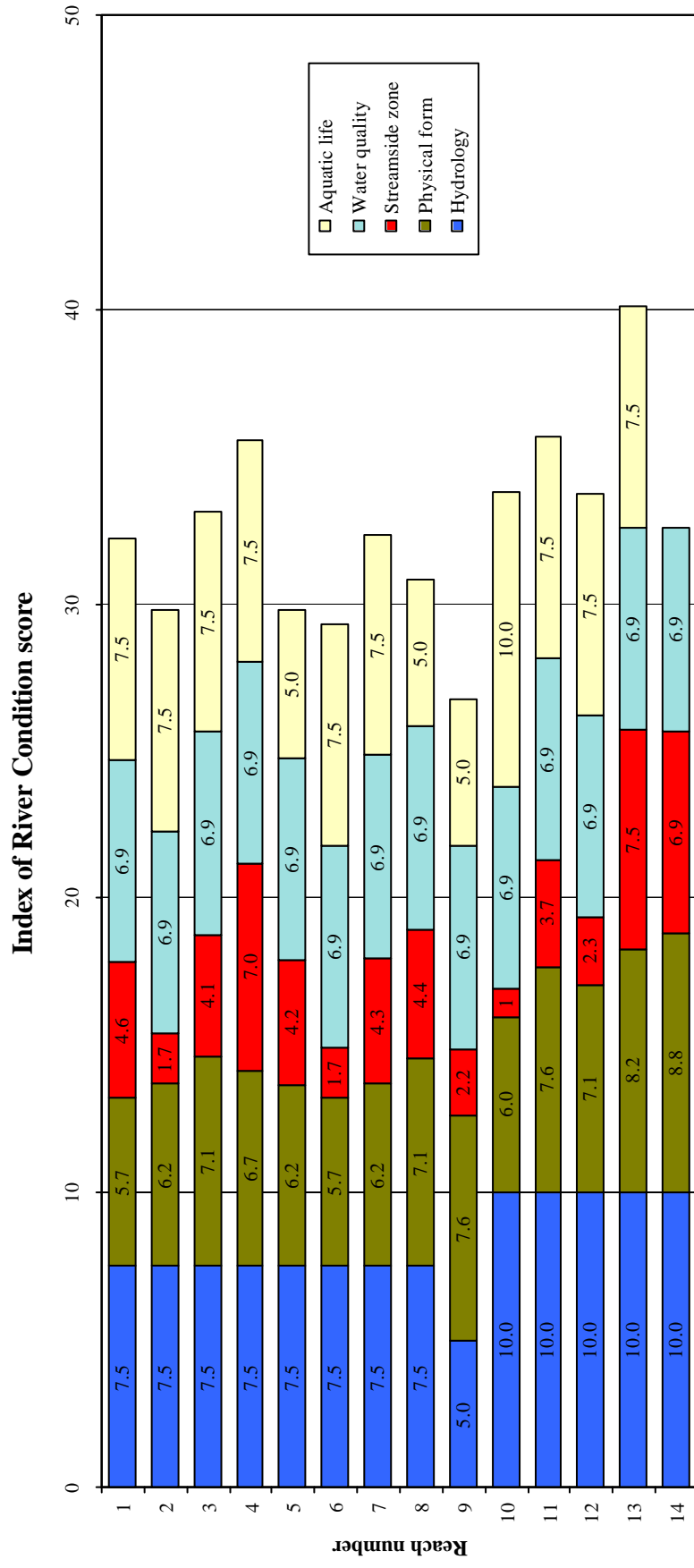


Table 9. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Pipers R. main-stream sites.

Reach	M, V or F.	Hydrology (#)					Physical form (#)					Streamside zone (#)					Water quality (#)			Aquatic life (#)	
		Dams or diversions	Hydro-electric	CWR extract.	Bank	Bed	Barrier	CWD	OSD	Riparian width	Struct. int.	% indig.	Regen.	LC	Overst. regen.	SC	Turb.	Cond	PH		
1	F	No	No																		
2	F	No	No																		
3	F	No	No																		
4	F	No	No																		
5	V	No	No																		
6	F	No	No																		
7	F	No	No																		
8	V	No	No																		
9	V	No	No																		
10	F	No	No																		
11	V	No	No																		
12	V	No	No																		
13	V	No	No																		
14	V	No	No																		

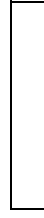
Key to table



Indicator suggests major or extreme difference from natural or ideal conditions.



Inadequate data to evaluate sub-index.



Adequate data to evaluate indicator and ratings suggest changes have not been extreme or major.

= refer to Section 3 (Methodology Description) for details of all parameters.

M = Mountain.

V = Valley.

F = Floodplain.

CWR = Commissioned water rights.

CWD = Coarse woody debris (snags).

OSD = Overall site disturbance.

LC = Longitudinal continuity.

SC = Streamside cover.

Regen = presence of regeneration of indigenous species.

4.2 Summary results for tributary streams of the Pipers River.

The IRC results for the tributary streams of the Pipers River are provided in Figure 4. A total of 20 sites were sampled on 13 tributaries (Table 10). Parameters that suggest major or extreme modification from a natural condition are highlighted in Table 11 along with data gaps. Descriptive maps for each sub-index value and how they rate throughout the catchment in association with stream length are provided in Appendices 3 to 7.

Comments on the results in Figure 4 and Table 11 are highlighted as follows:

- The average condition of the tributary streams rated as in good condition (near natural) but all final scores were borderline between some modification and good condition (refer to Table 12). Of the 20 sites assessed, 11 rated as in moderate condition and 9 rated as in good condition (near natural). There was no clear pattern of improving condition in the tributary streams throughout the main catchment. Individual tributaries exhibited improved conditions in their upper catchments. For example, Montgomery Ck (sites 18 & 19), Second River (sites 23 & 24) and Rocky Ck (sites 30 & 31) all showed improved conditions at upper sites, while Third River (sites 23 & 24) and Hogans Ck (sites 32 & 33) did not.
- The hydrology sub-index rated well for the tributary streams with 15 out of 20 sites showing little hydrological modification (essentially natural). Four sites (26 - 28, 30) showed some modification and the remaining site (31) was highly modified.
- In general, physical form sub-index rated as in good condition (near natural) throughout the catchment with site conditions ranging between moderate condition (15, 22 - 25, 27, 29, 33 & 34), good condition (16 - 19, 26, 30 & 32) and excellent condition (20, 21, 28 & 31).
- The streamside zone sub-index varied considerably amongst the tributary streams but did not rate highly overall (overall average of moderate condition, Table 12). The most impacted site (22) was Colgrave Ck at Pipers River Rd, which had an extremely low rating of 0.4 (highly modified, very poor condition). 7 other sites also fell within this rating of very poor condition (sites 15, 23, 24, 25, 27, 32 & 33). 4 sites (18, 26, 29 & 30) rated as in poor condition 4 as in good condition (17, 20, 28 & 34) with the remaining 4 sites (16, 19, 21 & 31) rating as essentially natural. Both sites on Hogans River (32 & 33) rated as in very poor condition. Rocky Ck (30 & 31) was in poor condition in its lower catchment but essentially natural in the upper reaches. This pattern was also evident for the Second River (26, 27 & 28) and Montgomery Ck (18 & 19) sites. In all highly impacted sites, riparian width and regeneration of indigenous species was minimal to non-existent, while structural intactness, proportion of indigenous cover, longitudinal continuity and streamside cover were all highly modified.
- The Water quality sub-index rated reasonably well within the tributary sites. The average condition was moderate (some modification). 4 sites (22, 24, 25 & 33) out of the 20 assessed, rated as in poor condition (major modification), 2 sites (16 & 23) were in moderate condition, while the remaining 11 sites (15, 18-20, 26-32 & 34) rated as in good condition. All the water ways were slightly acidic (<7) and the majority had slightly elevated conductivity readings (i.e. over 100 $\mu\text{S}/\text{cm}$). Site 25,

on a small tributary of the mainstream, had a very high conductivity reading (423 $\mu\text{S}/\text{cm}$), site 24 had a very high turbidity reading of 68.8 NTU and site 31 had a very low turbidity reading of only 1.56 NTU.

- The Aquatic life sub-index rated as in moderate condition (some modification) overall. Sites 27 and 30 rated as in excellent condition (essentially natural), while sites 23 and 24 were assessed as reflecting major modification. Of the remaining sites, 4 were in moderate condition (16, 19, 25 & 33) and 7 rated as in good condition (18, 22, 26, 28, 29, 31 & 34).
- Data gaps present for the tributary stream sites were minimal with information missing from sites 15, 17, 20, 21 and 32. Sites 17 and 21 had water quality and instream faunal parameters missing due to dry conditions. Water quality information for sites 15, 20 and 32 came from the Water Quality study of the State of Rivers report but no flow at the time of sampling inhibited the collection of faunal data.

Table 10. Site locations and physical attributes within the tributary streams of the Pipers R.

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
15	Yarrow Ck off Brid Port Rd.	510900	5451900	40	5.8
16	Venns Ck. off Security Rd. (control site for pine plantation)	509900	5447400	65	7.4
17	Dead Horse Ck. at Pipers River Rd.	507400	5447200	50	8.3
18	Montgomery Ck off (at) Lewis Rd	509600	5443900	58	26
19	Montgomery Ck. at South Retreat Rd.	512400	5443400	108	10.9
20	Trib. of Montgomery Ck off Colgraves Rd (no.10 on sheet)	511200	5441700	85	4.3
21	Trib of Montgomery Ck off Colgraves Rd.	512200	5440500	128	1
22	Colgrave Crk. at Pipers River Rd.	509200	5441700	70	2.8
23	Third River off Gundagai Rd.	513300	5437400	98	11.8
24	Third River off Pailing Track	514800	5437700	180	10.2
25	Tributary at Turners Marsh on Pipers River	509700	5438200	88	6
26	Second River at Bangor Rd.	511400	5436600	78	62.7
27	Second River at Second River Rd.	516500	5434800	135	48.4
28	Second River Golconda Rd - Lilydale falls	517500	5435500	168	11.6
29	McGowan Ck. at Second River Rd.	517900	5434600	150	13.4
30	Rocky Ck. no.23	518000	5432600	170	12.3
31	Rocky Ck. up from Lilydale (Rd.) above Town	517900	5431500	200	4.8
32	Hogans Brook at Pipers R. Rd	512000	5433700	95	13.6
33	Hogans Brook on Pipers River Rd. (Turner)	511300	5432100	115	9.3
34	Butchers Ck. at Goullees Rd.	517800	5425600	340	9.7

Figure 4. IRC results for the Pipers River tributaries.

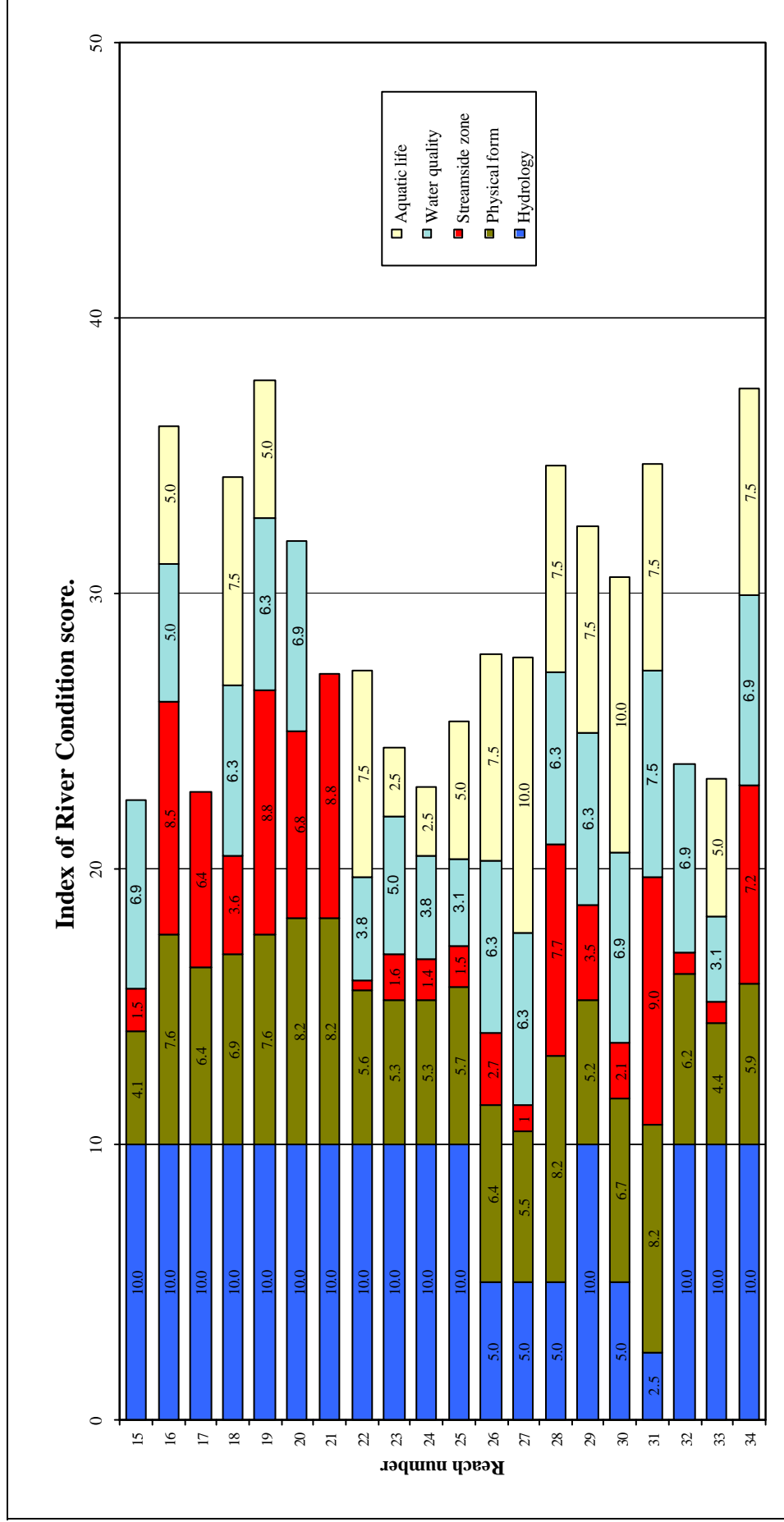


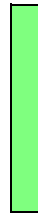
Table 11. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Pipers R. tributary sites.

Reach	M, V or F.	Hydrology (#)				Physical form (#)				Streamside zone (#)						Water quality (#)			Aquatic life (#)	
		Dams or diversions	Hydro-electric	CWR extract	Bank	Bed	Barrier	CWD	OSD	Riparian width	Struct. int.	% indig.	Regen.	LC	Overst. regen.	SC	Turb.	Cond.		pH
15	V	Yes	No																	
16	V	No	No																	
17	F	No	No																	
18	F	No	No																	
19	V	No	No																	
20	V	No	No																	
21	V	No	No																	
22	V	No	No																	
23	V	Yes	No																	
24	V	Yes	No																	
25	F	Yes	No																	
26	F	Yes	No																	
27	F	Yes	No																	
28	V	Yes	No																	
29	F	No	No																	
30	F	No	No																	
31	V	No	No																	
32	F	Yes	No																	
33	V	Yes	No																	
34	V	Yes	No																	

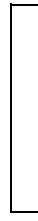
Key to table



Indicator suggests major or extreme difference from natural or ideal conditions.



Inadequate data to evaluate sub-index.



Adequate data to evaluate indicator and ratings suggest changes have not been extreme or major.

M = Mountain.

V = Valley.

F = Floodplain.

CWR = Commissioned water rights.

CWD = Coarse woody debris (snags).

OSD = Overall site disturbance.

LC = Longitudinal continuity.

SC = Streamside cover.

Regen = presence of regeneration of indigenous species.

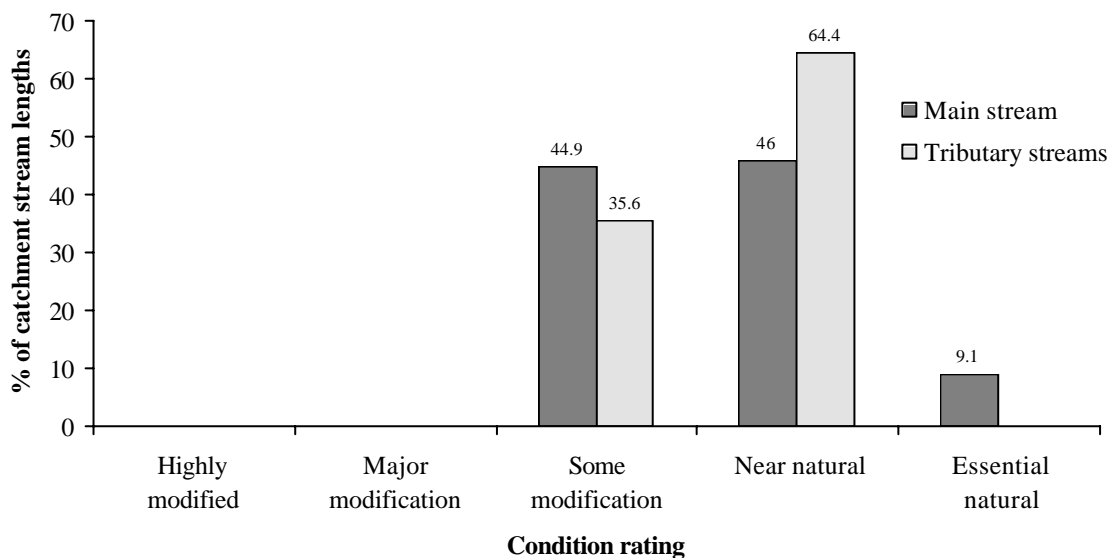
= refer to Section 3 (Methodology Description) for details of all parameters.

4.3 Rating of stream length

An examination of the overall condition ratings for both tributary and main-stream lengths reveals no section with a high or major modification to condition. But conversely only one site came out as essentially natural (site 13) and this also was borderline. Figure 5 details the rating structure of the proportion of stream lengths within the catchment. The data in that chart shows that 45% of the main-stream has some modification to condition while 46% is near natural and 9% is essentially natural (one reach only) with 5 of the near natural sites at the top of the catchment and the rest scattered through the remainder (refer to Fig. 2 and 3). For the tributary streams, 35% fall into the category of some modification to condition, while the majority (64%) show near to natural conditions. In general, it was estimated that 40% of all the catchment streams have some modification from natural conditions and the remaining 60% are near natural. But, as detailed above, sub-index parameters within each final rating structure may vary considerably from site to site indicating the potential problems that lie within each reach.

The information is limited by the location of each study site and stream length condition is an extrapolation of information from sites that were chosen as reasonably representative of that particular reach. Only major tributaries and the main-stream river were targeted.

Figure 5. Overall river condition.



Catchment conditions are frequently characterised by impacted condition in the lower catchment and improved conditions higher in the catchment. This clearly occurs in the Pipers River catchment, with the top 5 sites rating as near natural, although actual scores within the near natural rating do not rank highly (Fig. 3). Site 13 is the only site within the entire catchment that ranks as essentially natural. In general the rating scores vary around the near natural/some modification boundary through the length of the mainstream in particular (Fig. 3). The majority of the tributary streams rated as near natural but once again scores varied considerably throughout the catchment. Second River sites (26, 27 and 28) improved in condition up the catchment. Two thirds of the Pipers River catchment is modified by agricultural activities. The very top of the catchment is well forested as are some sections in the middle of the catchment.

Figure 6 graphically illustrates the distribution of overall condition ratings for stream length within the catchment. The information is limited by the location of study sites and stream length condition is an extrapolation of site information. Only major tributaries and the main-stream river were targeted. The information available indicates that the overall condition of the catchment is one of moderately impacted environment with the lowest score of moderate or some change from natural or ideal conditions. As detailed above, sub-index parameters within each final rating structure may vary considerably from site to site.

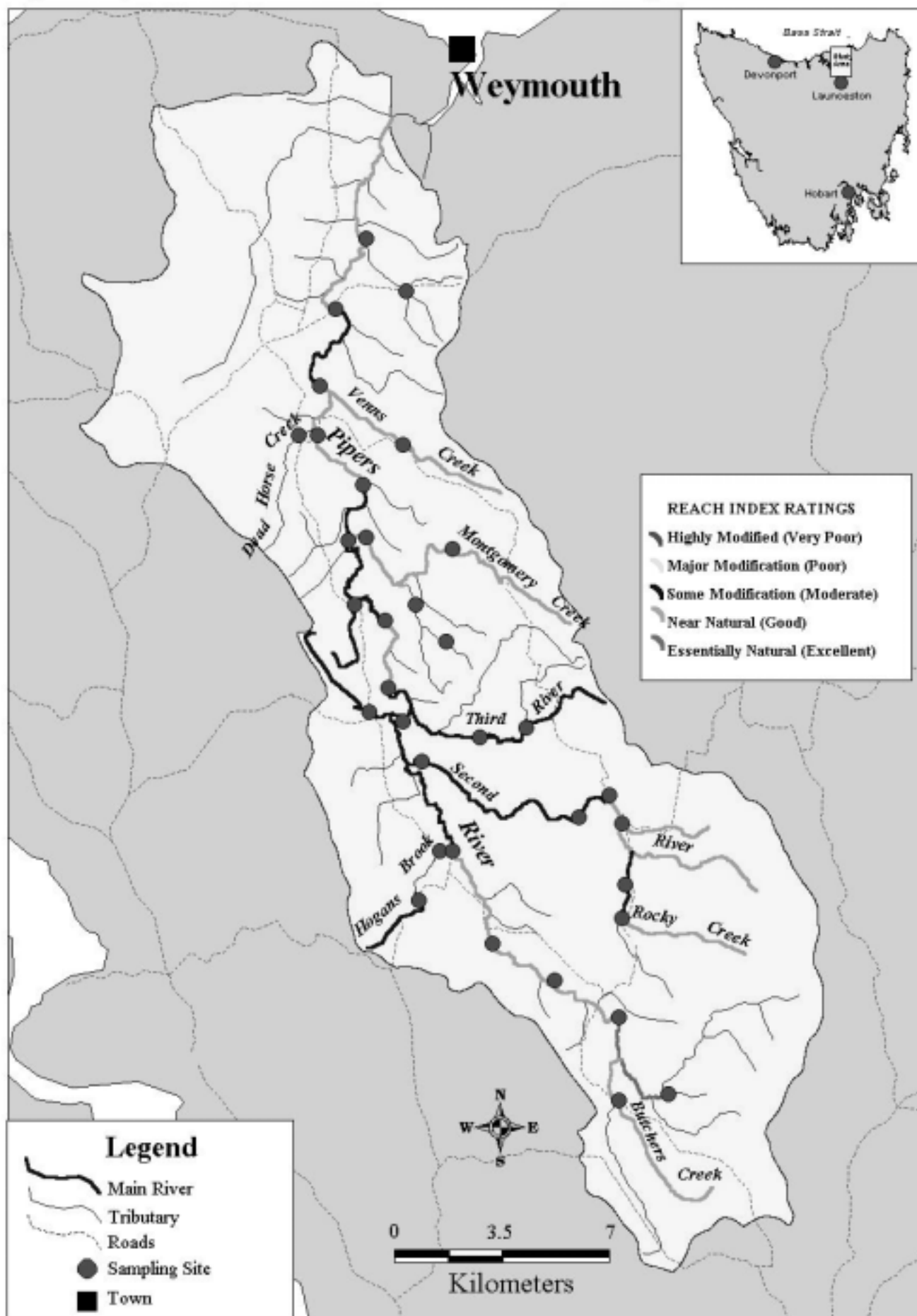
The data in Table 12 illustrates the average value score for each independent sub-index and overall IRC value for the combined sites within the catchment and further supports the findings illustrated above. These values are highly dependant on site selection and the result may be skewed towards higher or lower values dependant on site information. The available data illustrates that, on average, the overall catchment condition is one that closely borders between moderate and good condition. It should be noted that this is an average figure and may be drawn up or down respectively by very low or high scores. Of all the values hydrology rates highest, indicating that there appears to be minimal impact from water extraction. Aquatic fauna also rates well (good condition) (refer to the ‘Aquatic Ecology’ report for full details), followed by physical form and then water quality. The remaining rating, streamside zone, is poor for both the main river and tributary streams, indicating major modification from a natural condition. This data varies from that presented in Figure 5, which is a calculation based on proportion of stream length and is a total of all sub-index scores, whereas Table 12 illustrates data that is calculated directly from total numbers. The results in Table 12 are highly generalised and are influenced by poor or good scores within the sub-index categories and do not illustrate specific site impacts.

Table 12. Environmental rating for all streams and combination of streams in the entire catchment (corresponds to an average value). Overall IRC ratings correspond to values illustrated in Table 7.

Category	Numerical value (Rating)		
	Main-stream Pipers R. Sites	Pipers R. Tributaries	Average for all catchment sites
Hydrology	8.2	8.6	8.5
Physical form	6.9	6.4	6.6
Streamside zone	4.0	4.2	4.1
Water quality	6.9	5.7	6.2
Aquatic life	7.1	6.5	6.8
Overall IRC values	32.5 (3)	30.5 (3)	31.4 (3)

NB: bracketed 2 = moderate condition (some modification).

Figure 6: Pipers River Catchment. Overall Reach Condition Ratings



5. DISCUSSION

The Index of River Condition assessment protocol has effectively illustrated the state of specific sites and representative reaches within the Pipers River catchment. A broad range of sites were chosen to provide a suitable description of catchment condition and to cover the range of conditions that are present. Resource limitations will always restrict the number of sites that can be assessed therefore only major tributaries and the main-stream river were covered.

Catchment conditions are frequently characterised by zones of reduced condition within the lower catchment and an improvement in condition higher in the catchment. The diverse nature of land use in the Pipers River catchment is highlighted by the variable nature of the final scores although a distinct increase in quality occurs in the upper 5 sites on the mainstream. Intensive agriculture occurs in over three quarters of the catchment and problems have been highlighted that include very poor condition of streamside zones (refer to Fig. 3). The main tributaries seem to follow the scenario of improved condition in the upper catchment, with overall quality increasing up the Montgomery Creek, Second River and Rocky Creek catchments, although Hogans Brook and Third River do not follow this trend. Potential management issues arising from this information are referred to in Appendix 2B. Obvious factors that came out as influencing site condition include the presence of non-native species in the stream-side zone (such as Crack Willow, blackberries, hawthorn and thistles), which were shown to be well established in certain sections of Pipers River and many of the tributaries. Blackberries appear as a streamside weed at 27 of the 34 sites. The excessive growth of blackberries is inhibitory to the growth of native species and may encroach on pasture. Willows occur at 19 of the 34 sites including most sites on the mainstream. The effects of willows, if they become too well established, include:

- altered runoff patterns due to a lack of understorey;
- altered instream habitat;
- inhibition of primary production through reduced light penetration;
- increased sedimentation and organic load - nutrient increases;
- reduced low flows - decreased dissolved oxygen levels; and
- reduced drainage - decreased land capability / productivity.

Of all the sub-indices the streamside zone sub-index indicated that this zone was where most of the critical problems occurred. Unrestricted stock access to stream banks was clearly a widespread problem. This frequently creates excessive bank erosion, which was evident at some sites within this survey, and may lead to increased sediment load into a watercourse. Lack of riparian vegetation at sites throughout the catchment was also noted. The streamside zone is the interface between the aquatic and terrestrial environment. This zone is an important buffer to any activities that may occur in the adjacent land zone. This zone also provides the following purposes:

- it provides protection from sediment runoff from forestry, farming or roading activities.
- it may act as a filter to chemical spray from intensive agriculture or forestry.
- it provides bankside stability and inhibits erosion.
- it forms an important relationship with aquatic systems by providing instream and bankside habitat for fauna.
- it is the source of nutrient inputs through snags and leaf fall.
- it reduces water temperature through shading effects, and continuous vegetation is also important as faunal corridors and in maintaining suitable habitat.

The presence of pasture grass and other weeds does not provide the deep soil-root matrix required to support the river embankment, particularly from the effects of erosion.

In general, it has been shown that there are a range of factors that strongly influence site condition, including land use and riparian management practices, water quality and water quantity (flow). It is clear from the information collected that most sites within the catchment vary away from a natural state to a moderate degree (15 of 34 sites) with the remainder rating as near natural (good condition). This is largely due to a good rating of water quality (particularly for the mainstream) and limited impacts of hydrological change. There are limited recorded Commission Water Right (CWR) allocations within the catchment. Using only this information there is limited authorised impacts on the hydrological regime.

Main-stream Pipers River

The information which has been collected indicates that the sites on the main-stream Pipers River are bordering on moderate to good condition overall. It is likely that impacts have occurred due to intensive agricultural land practices. Site conditions are also influenced by the presence of non-native species in the stream-side zone, including Crack Willow and blackberries.

The aquatic ecology index indicates that there may be few impacts on the aquatic community (however for a more in depth assessment see the “Aquatic Ecology” report). Water quality is only fair (refer to the “Water Quality” report for comprehensive details). The hydrological deviation was greatest for the main-stream but this is heavily reliant on the fact that data used to calculate the index is based on estimated outakes only. Physical form rated as in good condition overall, while the condition of the streamside zone was clearly the most impacted, particularly in the middle of the catchment.

Management issues that may be considered include the presence of Crack Willow at 11 of the 14 sites (effectively throughout the catchment), the presence of understorey weed species such as blackberries and thistles, limited riparian zones at most sites and stock access and bankside erosion at a number of sites.

In summary, the available data indicates that most of the critical problems for the main-stream occurs in the stream side zone where ratings are low.

Tributaries of the Pipers River

As with the main-stream of the Pipers River, the tributary sites are apparently impacted by land practices such as farming and in certain areas forestry. Hydrology rates as in excellent condition overall while physical form and aquatic life rate as in good condition. Streamside zone and water quality rate as the most impacted, both being in moderate condition. However, these smaller streams are also heavily influenced by riparian practices. Issues and impacts include the following:

- stream bank erosion due to the lack of streamside zones;
- uncontrolled stock access to stream banks;
- presence of exotic plant species;
- limited indigenous plant regeneration;
- farming practices that limit riparian zones.

The available data indicates that, as with the mainstream sites, most of the critical problems for tributary streams occurs in the stream side zone. There are few instream faunal problems and water quality is in moderate condition. The most common issues encountered for the tributary streams were excessive quantities of exotic weed species and limited to no streamside zones.

Yarrow Creek. (Site 15)

Yarrow Creek is a system that rates as moderately impacted. The site had no flowing water so no instream fauna ratings could be determined. Nevertheless, the remaining ratings scored variably and the overall site condition would probably not have gone beyond moderate condition. In general, riparian structure is very poor, water quality rated as in good condition (despite lack of flow) and physical form was in moderate condition. The hydrology sub-index was unaffected (essentially natural). Physical problems included virtually no riparian zone, presence of exotic weeds and unrestricted stock access to the stream banks.

Venns Creek.(Site 16)

This site was in good, near natural condition. No management issues or physical degradation was encountered. Aquatic life and water quality ratings were down (moderate condition) this being most likely due to very low water levels at the time of sampling.

Dead Horse Creek (Site 17)

Only one site was surveyed in this small tributary creek. At the time of sampling the available water consisted of a series of stagnant pools and therefore water quality and aquatic life could not be recorded. Of the remaining sub-index parameters hydrology was unaffected and both streamside zone and physical form rated as in good condition, although there was a limited riparian zone recorded for one bank. Weed species reported as being evident included blackberries, ragwort and thistles. The banks were also reported to be moderately eroded.

Montgomery Creek (Site 18 & 19)

Both sites within this tributary were reported to be in good condition with the upper site rating slightly higher overall. Some management problems could be addressed for the lower site including the presence of blackberries, some evident stock access to stream banks and moderate erosion of the stream banks. No management issues were recorded for the upper site. Aquatic life rated as being in moderate condition for the upper site, this may have been a result of the low flows evident at the time of sampling.

Tributary of Montgomery Creek.(Site 20 & 21)

This tributary had limited to no flow at the time of sampling and due to this no water quality or aquatic fauna could be recorded. Subsequent collection of water quality data through the “Water Quality” study allowed for estimation of this parameter for site 20. Nevertheless, analysis of the remaining sub-index parameters allows for a limited estimation of conditions within this tributary. Overall hydrology was unimpacted for both sites, physical form rated as in excellent condition for both sites and streamside zone rated as good condition for the lower site (20) and excellent for the upper site (21). No management issues other than the presence of blackberries at the lower site were recorded. Subsequent water quality analysis for site 20 indicated that this parameter was in good condition.

Colgrave Creek (Site 22)

This tributary site varied considerably in condition. Hydrology was largely unimpacted but streamside zone rated as in very poor (highly modified) condition with virtually no overstorey and understorey structure present. The sub-index physical form was also recorded to be in moderate (some modification) condition and water quality in poor (major modification) condition. Aquatic life was

recorded as being in good condition. Management issues included the presence of blackberries which were recorded as being extensive, unrestricted stock access to stream banks was evident and moderate erosion to the stream banks was also recorded.

Third River (Site 23 & 24)

Both these sites rated as being in moderate condition overall. Both sites had very poor (highly modified streamside zones with limited to no overstorey and understorey structure. Aquatic life also rated as in poor (major modification) condition although water quality for the lower site (23) was in better condition (moderate) than the upper site (24) which was in poor (major modification) condition. Both sites physical form rated as moderate condition and hydrology was largely unimpacted. Management issues included moderate erosion of stream banks (both sites), the presence of blackberries and thistles at both sites including willows at the lower site, no indigenous plant regeneration and unrestricted stock access to the stream banks.

Unnamed Tributary Creek. (Site 25)

This tributary creek rated as in moderate condition overall. The condition of the streamside zone was very poor with limited structure and regeneration of indigenous plant species. Aquatic life was in moderate condition and water quality poor condition. Hydrology was unimpacted and physical form in moderate condition. Management issues included the presence of excessive willow growth, blackberries and thistles and unrestricted stock access to the stream banks. Overall site disturbance rated as extreme therefore adding to the issue that significant problems exist within this section.

Second River (Sites 26, 27 & 28)

Second River lives up to its name in being the second biggest stream within the Pipers River catchment. This system is also highly influenced by agricultural practices. For this reason 3 sites were chosen to cover the range in variation within the system. The variation that can exist between upper and lower sections of a catchment is clearly illustrated here. The 2 lower sites (26 & 27) rate as in moderate condition while the upper site (28) clearly stands out as in good (near natural) condition. All 3 sites have a hydrological rating that indicates moderate condition, an aquatic life ratings that are good to excellent and water quality that is uniformly in good condition. The physical ratings are where differences occur. Both the lower sites have streamside zone ratings that are very poor and poor as compared to good condition of the upper site. The physical form rating varies from good (site 26), moderate (site 27) and excellent (site 28). Management issues include the presence of weed species such as blackberries (all sites), gorse (site 26), willows (site 26 & 27) and hawthorn (site 27). There is also limited to no riparian zone and limited to no indigenous plant regeneration at the 2 lower sites. Stock access to the river banks was reported for all 3 sites. It is clear that intensive agricultural activities have affected the lower sites.

McGowan Creek (Site 29)

This site rated as in good condition overall. The hydrology rating was unimpacted, aquatic life and water quality in good condition, streamside zone was in poor condition and physical form in moderate condition. Willows, blackberries, hawthorn and thistles were present. The riparian zone was severely limited and consisted largely of introduced species and stock access to the stream banks was evident.

Rocky Creek (Sites 30 & 31)

Both these sites rated as in good condition except the lower site was borderline between good and moderate condition (Figure 4). The hydrological index was higher for the lower site (moderate condition) than the upper site (poor condition). Physical form and streamside zone rated strongly for the upper site (excellent condition) although streamside zone rated as poor for the lower site. Water quality was similar for both sites (good condition) but in real terms scored slightly lower for the bottom site. Aquatic life rated as excellent for the bottom site and good for the top site. The bottom site had extensive weed issues with blackberries, willows, hawthorn and thistles evident, while for the top site blackberries were recorded as present but limited.

Hogans Brook (Sites 32 & 33)

Both sites on this tributary rated similarly (moderate condition) but obvious differences within the sub-index parameters were evident. Water quality was higher for the lower site but this would be a result of information used from the “Water Quality” study as opposed to data obtained for the top site through a snapshot survey. The streamside zone for both sites rated as in very poor condition. Physical form was higher for the lower site (moderate condition) as compared to the upper site (poor condition). The hydrology sub-index was unimpacted for both sites. Aquatic life was recorded as in moderate condition for the upper site but no data was collected for the lower site due to inadequate flows. Both sites had similar management problems in that weed species such as willows, blackberries and hawthorn were present, there was limited to no riparian zone, no regeneration of indigenous plant species and unrestricted stock access to the stream banks..

Butchers Creek (Site 34)

Butchers Creek was the highest catchment tributary stream sampled. The site overall was in good condition with excellent indigenous plant cover, limited erosion, and extensive riparian structure. Aquatic life, water quality and streamside zone rated as in good (near natural) condition, physical form was in moderate condition and hydrology was unimpacted. No management issues were evident other than a reported artificial damming of the watercourse.

As with the main-stream of the Pipers River, the tributary sites are apparently impacted by land practices such as farming and to a lesser extent forestry. There is some indication of impacts through modified flow regimes from water extraction. However, these smaller streams are heavily influenced by riparian practices. Issues and impacts include the following:

- erosion due to destruction of streamside zones;
- uncontrolled stock access to streambanks;
- presence of exotic plant species;
- lack of streamside vegetation;
- forestry practices including extensive plantations with no natural streamside zones and limited understorey;
- limited indigenous plant regeneration.

The available data indicates that most of the critical problems for tributary streams occur in the stream side zone. There are few instream faunal problems, water quality is reasonable but not good and there appears to be only slight modification of hydrology. No single stream stood out as badly impacted (poor or very poor condition) but some individual sites scored very low within the moderate condition band (Fig 4), the obvious trend was for tributary streams to be in moderate condition or

some modification from a natural condition. The most common problems encountered for the tributary streams were the presence of exotic weed species, unrestricted stock access to streamside zones and limited streamside vegetation at many sites.

6. CONCLUSION

Final assessment of data sets for the Index of River Condition has clearly shown that it is a useful tool in assessing river condition. It has proven a practical means of illustrating the deviation of a site away from its predicted natural state and has illustrated the overall condition of the catchment and its associated waterways.

The technique also highlights potential problems that may exist within a catchment which are, or have the potential to reduce riverine quality. Using the data available from this study it becomes possible for managers to target potential problem areas. Nevertheless, it would be unreasonable to assume that sites should be returned to as near a natural state as possible for this does not necessarily mean the health of a site would be improved. Management options to improve the overall condition would be more appropriate. These may include:

- better streamside zone management to allow the reestablishment of an appropriate buffer strip of native species;
- weed reduction and control programs;
- stream bank protection by limiting stock access; and
- control of stream bank erosion.

This project set out to illustrate the condition of reaches within the Pipers River catchment and this has been achieved. Data collection for this study provides a baseline of information that can be used for comparative purposes to observe changes within the catchment over time. With a management infrastructure in place for the catchment, it would be possible to re-run this program in 5 years using the same sites to determine if the overall condition of the catchment has improved or declined.

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The author would also like to acknowledge the support received from landowners within the Pipers River catchment.

APPENDIX 1 Sub-index and overall IRC ratings and associated values for all mainstream Pipers River catchment sites (refer to Fig. 2 for site locations).

Reach	Hydrology sub-index	Physical form sub-index	Streamside zone sub-index	Water quality sub-index	Aquatic life sub-index	Total IRC for site out of 50	Grid reference Easting - Northing
1	7.5	5.7	4.6	6.9	7.5	32.2	509600 5453600
2	7.5	6.2	1.7	6.9	7.5	29.8	508600 5451300
3	7.5	7.1	4.1	6.9	7.5	33.2	508100 5448800
4	7.5	6.7	7.0	6.9	7.5	35.65	508000 5447200
5	7.5	6.2	4.2	6.9	5.0	29.8	509500 5445600
6	7.5	5.7	1.7	6.9	7.5	29.3	509000 5443800
7	7.5	6.2	4.3	6.9	7.5	32.4	510200 5441200
8	7.5	7.1	4.4	6.9	5.0	30.8	510300 5439000
9	5.0	7.6	2.2	6.9	5.0	26.8	510800 5437900
10	10.0	6.0	1.0	6.9	10.0	33.8	512400 5433700
11	10.0	7.6	3.7	6.9	7.5	35.7	513700 5430700
12	10.0	7.1	2.3	6.9	7.5	33.7	515700 5429500
13	10.0	8.2	7.5	6.9	7.5	40.1	517800 5428300
14	10.0	8.8	6.9	6.9	##	##	519400 5425800

APPENDIX 1 (Cont.) Sub-index and overall IRC ratings and associated values for all Pipers River tributary stream catchment sites (refer to Fig. 2 for site locations).

15	10.0	4.1	1.5	6.9	##	##	510900 5451900
16	10.0	7.6	8.5	5.0	5.0	36.1	510800 5446900
17	10.0	6.4	6.4	##	##	##	507400 5447200
18	10.0	6.9	3.6	6.3	7.5	34.2	509600 5443900
19	10.0	7.6	8.8	6.3	5.0	37.7	512400 5443500
20	10.0	8.2	6.8	6.9	##	##	511200 5441700
21	10.0	8.2	8.8	##	##	##	512200 5440500
22	10.0	5.6	0.4	3.8	7.5	27.2	509200 5441700
23	10.0	5.3	1.6	5.0	2.5	24.4	513300 5437400
24	10.0	5.3	1.4	3.8	2.5	23.0	514800 5437700
25	10.0	5.7	1.5	3.1	5.0	25.4	509700 5438200
26	5.0	6.4	2.7	6.3	7.5	27.8	511400 5436600
27	5.0	5.5	1.0	6.3	10.0	27.7	516500 5434800
28	5.0	8.2	7.7	6.3	7.5	34.7	517500 5435500
29	10.0	5.2	3.5	6.3	7.5	32.4	517900 5434600
30	5.0	6.7	2.1	6.9	10.0	30.6	518000 5432600
31	2.5	8.2	9.0	7.5	7.5	34.7	517900 5431500
32	10.0	6.2	0.8	6.9	##	##	512000 5433700
33	10.0	4.4	0.8	3.1	5.0	23.3	511300 5432100
34	10.0	5.9	7.2	6.9	7.5	37.4	517800 5425600

Actual average	10	10	10	10	10	10	10
Observ. average	8.5	6.6	4.1	6.2	6.8	6.8	31.4
Condition	Moderate Some modificat.	Moderate Some modification	Poor Major modification	Moderate Some modification	Good Near natural	Moderate Some modification	Moderate Some modification

= no data available.

APPENDIX 2A. Pipers River site list with grid references for each study location.

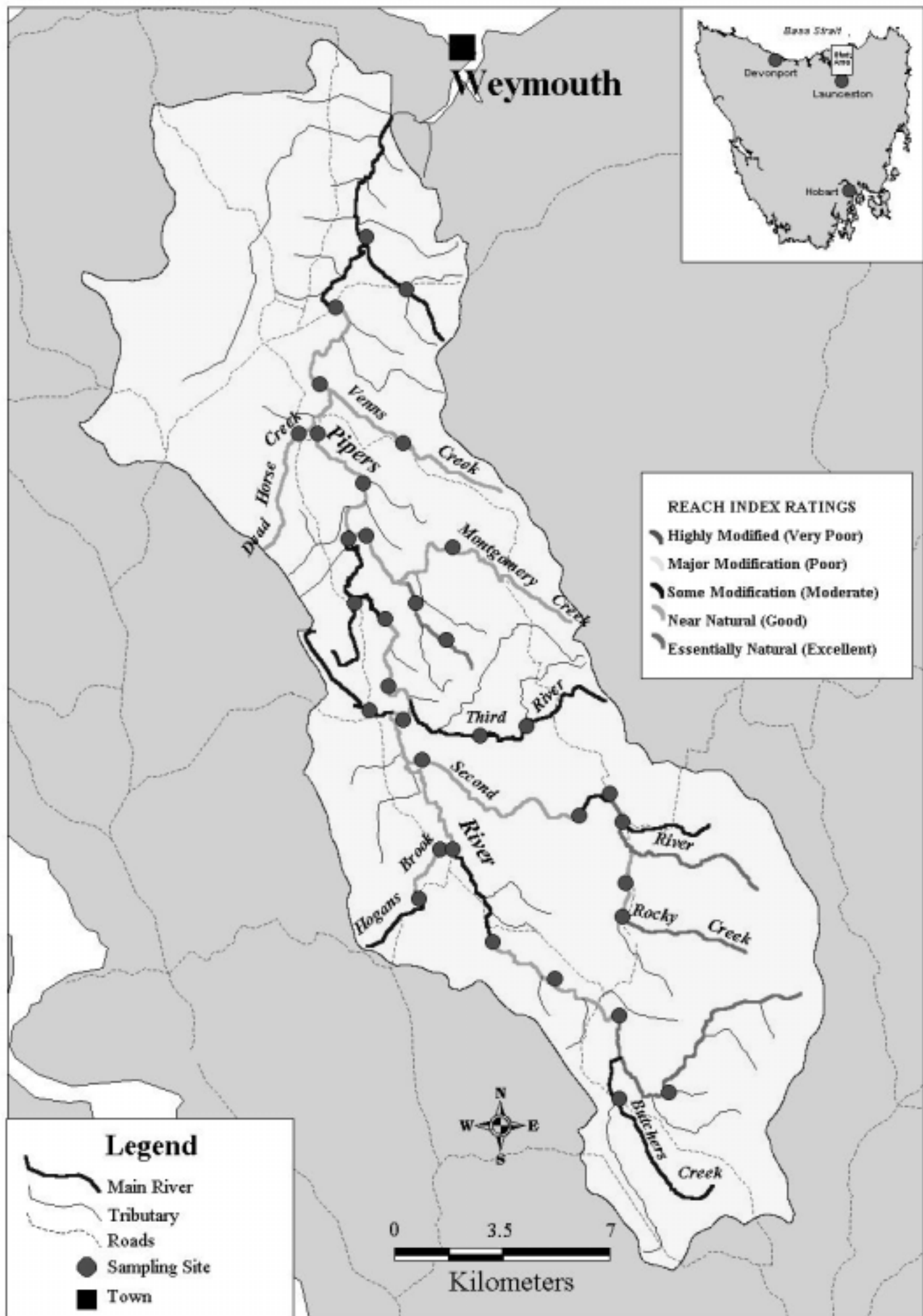
Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
1	Pipers below Gauging Station	509600	5453600	15	303.3
2	Pipers at Bridport Rd	508600	5451300	28	284.4
3	Pipers at Baxters Rd.	508100	5448800	40	274.6
4	Pipers at Security Rd	508000	5447200	45	249.5
5	Pipers off Platypus Rd.	509500	5445600	55	245.3
6	Pipers at Lewis Rd	509000	5443800	55	211.4
7	Pipers off Colgraves Rd.	510200	5441200	65	202.9
8	Pipers off The Glen Rd.	510300	5439000	68	201
9	Pipers at Bangor Rd.	510800	5437900	75	175.9
10	Pipers at Bangor Rd - upper	512400	5433700	95	77.2
11	Pipers at North Eastern line	513700	5430700	138	68.4
12	Pipers off Glenford (Farm) Rd.	515700	5429500	208	61.5
13	Pipers at Garcias Rd (off Lilydale Rd.)	517800	5428300	250	52.7
14	Pipers off Eagle Hawk Rd.	519400	5425800	388	16.1
15	Yarrow Ck off Brid Port Rd.	510900	5451900	40	5.8
16	Venns Ck. off Security Rd. (control site for pine plantation)	509900	5447400	65	7.4
17	Dead Horse Ck. at Pipers River Rd.	507400	5447200	50	8.3
18	Montgomery Ck off (at) Lewis Rd	509600	5443900	58	26
19	Montgomery Ck. at South Retreat Rd.	512400	5443400	108	10.9
20	Trib. of Montgomery Ck off Colgraves Rd (no.10 on sheet)	511200	5441700	85	4.3
21	Trib of Montgomery Ck off Colgraves Rd.	512200	5440500	128	1
22	Colgrave Crk. at Pipers River Rd.	509200	5441700	70	2.8
23	Third River off Gundagai Rd.	513300	5437400	98	11.8
24	Third River off Pailing Track	514800	5437700	180	10.2
25	Tributary at Turners Marsh on Pipers River	509700	5438200	88	6
26	Second River at Bangor Rd.	511400	5436600	78	62.7
27	Second River at Second River Rd.	516500	5434800	135	48.4
28	Second River Golconda Rd - Lilydale falls	517500	5435500	168	11.6
29	McGowan Ck. at Second River Rd.	517900	5434600	150	13.4
30	Rocky Ck. no.23	518000	5432600	170	12.3
31	Rocky Ck. up from Lilydale (Rd.) above Town	517900	5431500	200	4.8
32	Hogans Brook at Pipers R. Rd	512000	5433700	95	13.6
33	Hogans Brook on Pipers River Rd. (Turner)	511300	5432100	115	9.3
34	Butchers Ck. at Goullees Rd.	517800	5425600	340	9.7

APPENDIX 2B. Management issues identified for the Pipers River sites.

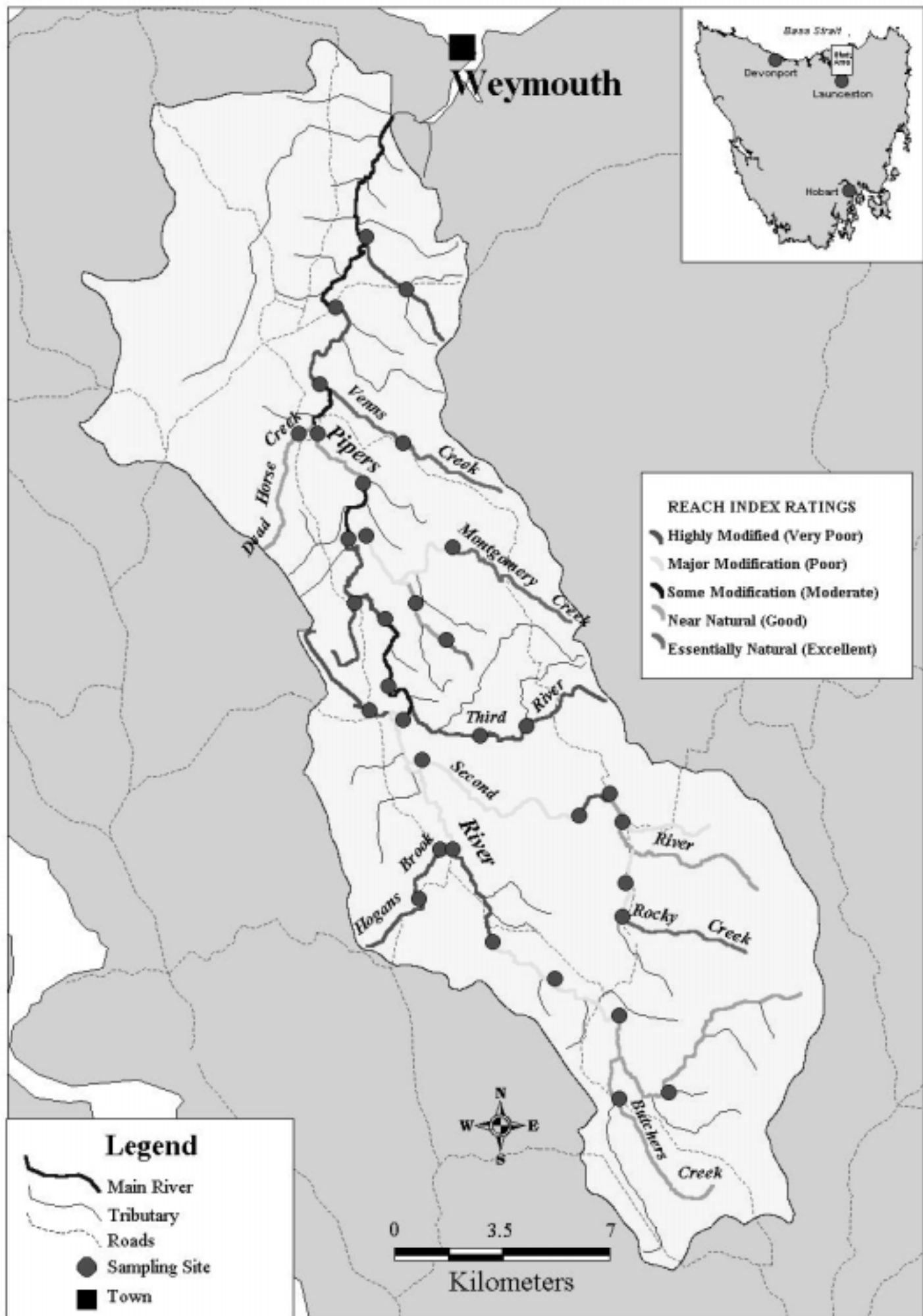
Reach	Management issues
1	Weeds - gorse, willows, blackberries, ragwort. Limited riparian zone on one bank. Unrestricted stock access to river banks.
2	Weeds - hawthorn, willows, blackberries, ragwort. Limited riparian zone. Stock access to river banks. Limited indigenous plant regeneration.
3	Weeds - blackberries, willows, hawthorn. Excessive silt build-up instream.
4	Weeds - hawthorn, willows, blackberries, ragwort. Limited stock access to river banks.
5	Limited riparian zone on one bank, some stock access. Limited indigenous plant regeneration on one bank.
6	Weeds - hawthorn, willows, blackberries, ragwort. Limited to no riparian zone. Limited indigenous plant regeneration. Excessive bank erosion evident from unrestricted stock access.
7	Weeds - ragwort, blackberries, thistle. Stock access to river banks. No riparian zone on one bank. Stock access to river banks. Severe bank erosion evident.
8	Weeds - willows, thistle. Limited riparian zone on one bank. Limited indigenous plant regeneration on one bank. Stock access to river banks.
9	Weeds - blackberries, willows, bulrushes. Limited riparian zone on one bank. No indigenous plant regeneration. Stock access to river banks.
10	Weeds - hawthorn, willows, blackberries, ragwort, thistles. Limited riparian zone. No indigenous plant regeneration. Stock access to river banks.
11	Weeds - willows, blackberries, ragwort. Limited to no riparian zone. Limited indigenous plant regeneration. Some bank erosion evident.
12	Weeds - willows, blackberries, ragwort. Limited riparian zone. Limited indigenous plant regeneration. Stock access to river banks.
13	Weeds - blackberries, willows.
14	None.
15	Weeds - blackberries, hawthorn. Limited to no riparian zone. No indigenous plant regeneration. Unrestricted stock access to river banks.
16	None.
17	Weeds - blackberries, ragwort, thistles. Limited riparian zone on one bank. Stock access to river banks.
18	Weeds - blackberries, thistle. Limited to no riparian zone on one bank. No indigenous plant regeneration on one bank. Stock access to river banks.
19	None.
20	Blackberries present. No other issues.
21	None.
22	Weeds - blackberries, ragwort, thistles. Limited to no riparian zone. No indigenous plant regeneration. Stock access to river banks.
23	Weeds - willows, blackberries, ragwort, thistles. Limited to no riparian zone. No indigenous plant regeneration. Stock access to river banks.
24	Weeds - blackberry, thistles. Limited to no riparian zone. Limited to no indigenous plant regeneration. Stock access to river banks.
25	Weeds - willows, blackberries, thistles. Limited to no riparian zone. Limited to no indigenous plant regeneration. Unrestricted stock access to river banks.
26	Weeds - blackberry, gorse, ragwort, willows. Limited to no riparian zone. Limited to no indigenous plant regeneration. Limited stock access to river banks.
27	Weeds - blackberry, thistles, willow, hawthorn. Limited to no riparian zone. No indigenous plant regeneration. Stock access to river banks.
28	Weeds - blackberries, thistles. Some stock access to river banks.
29	Weeds - blackberry, thistles, willow, hawthorn. Limited riparian zone. Limited to no indigenous plant regeneration. Stock access to river banks.
30	Weeds - blackberry, willow, hawthorn, thistles. Limited to no riparian zone. Limited to no indigenous plant regeneration.
31	Blackberries present. No other issues.
32	Weeds - blackberry, willow, hawthorn. Limited to no riparian zone. No indigenous plant regeneration. Stock access to river banks.

33	Weeds - blackberry, willow, thistle. No riparian zone. No indigenous plant regeneration. Unrestricted stock access to river banks.
34	Artificial damming of watercourse evident.

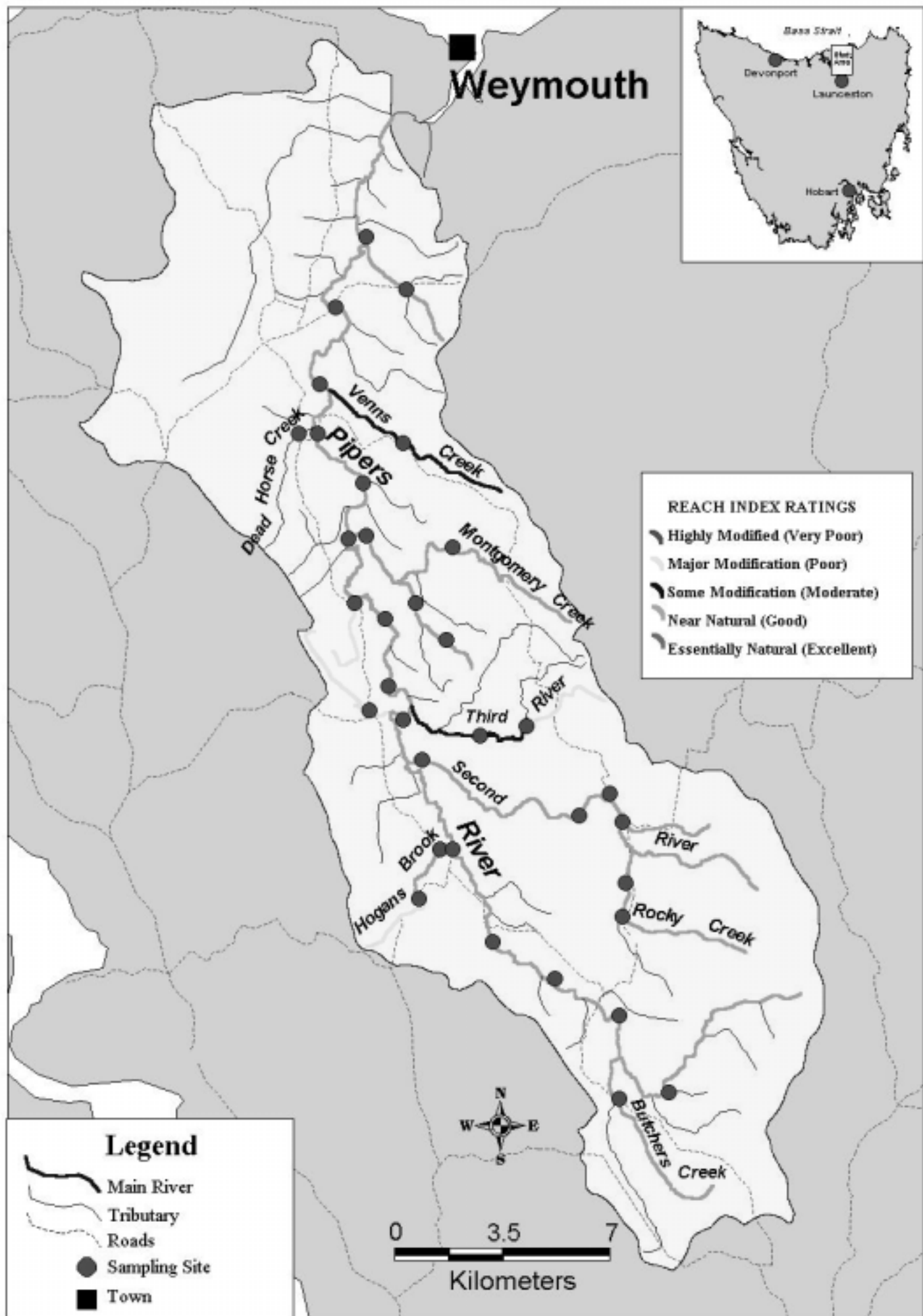
Appendix 3: Pipers River Catchment. Physical Form sub-index ratings



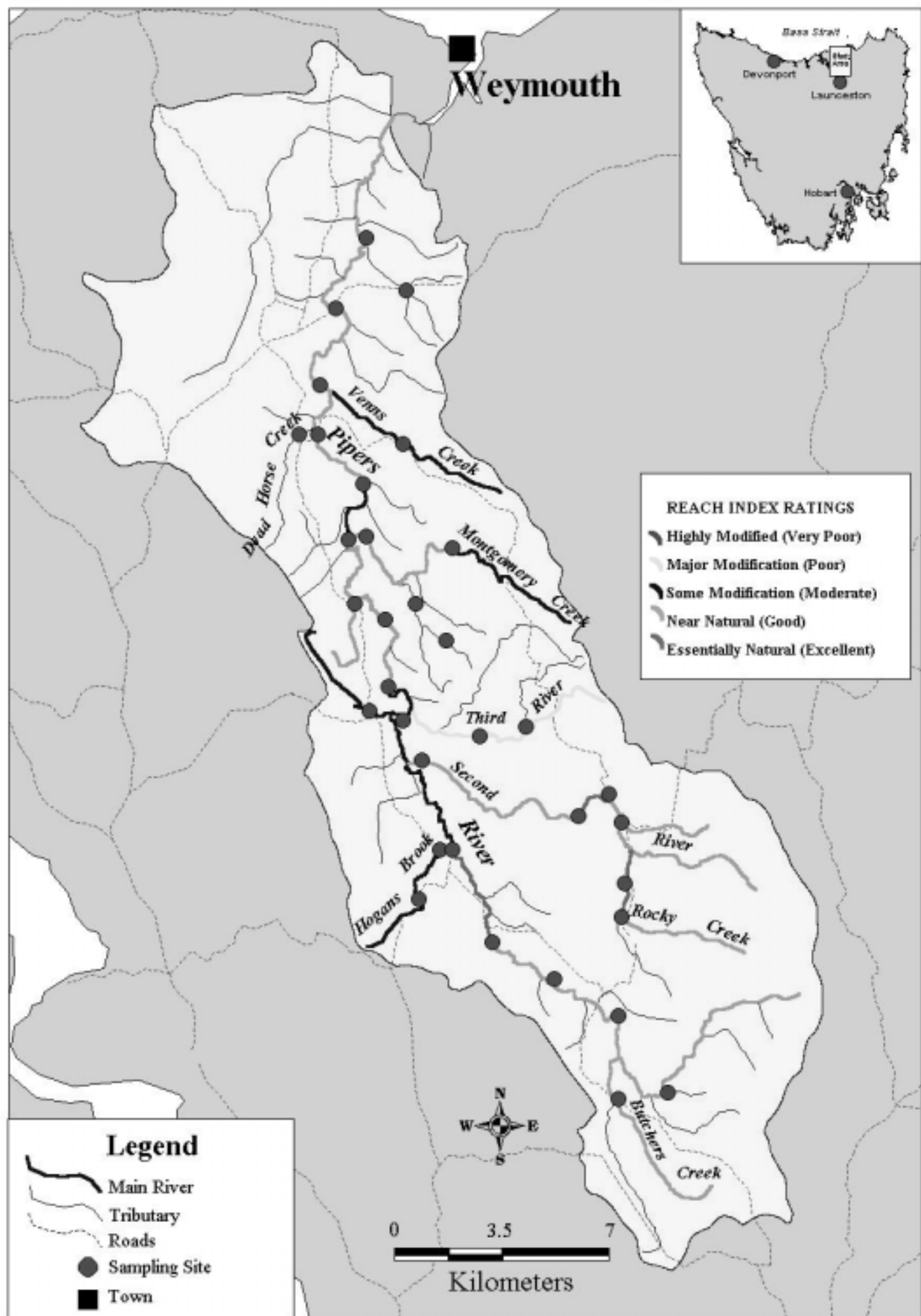
Appendix 4: Pipers River Catchment. Streamside sub-index ratings



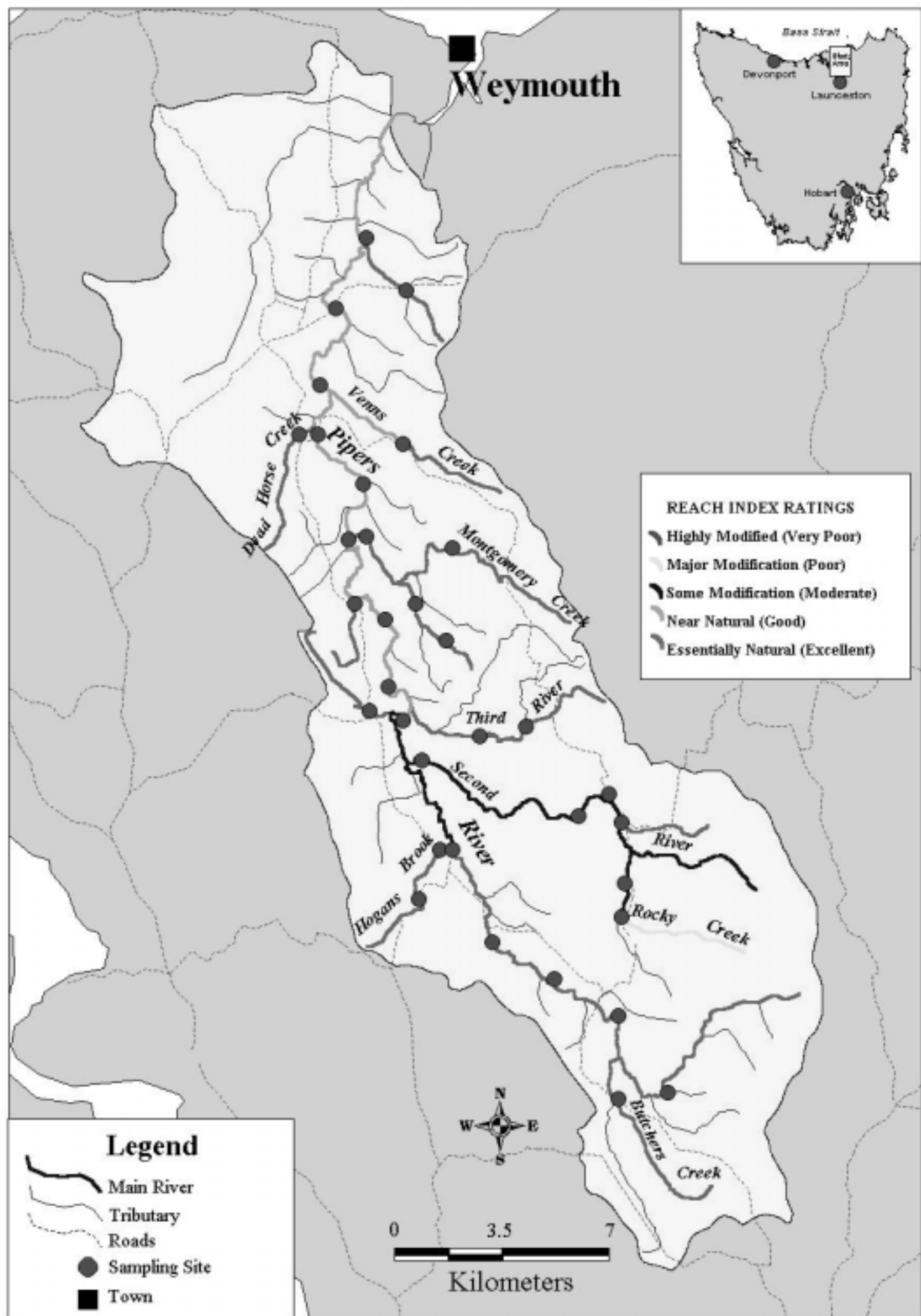
Appendix 5: Pipers River Catchment. Water Quality sub-index ratings



Appendix 6: Pipers River Catchment. Aquatic Life Sub-index ratings



Appendix 7: Pipers River Catchment. Hydrological sub-index ratings



33	Weeds - blackberry, willow, thistle. No riparian zone. No indigenous plant regeneration. Unrestricted stock access to river banks.
34	Artificial damming of watercourse evident.