



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

Tasmania

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

Mark Nelson,
Aquatic Ecologist
Land and Water Management Branch
Resource Management and Conservation Division
DPIWE.

Report Series WRA 99/18
December, 1999.

Executive Summary

This report provides a broad picture of stream condition in the Brid 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. Future comparisons should be run at intervals of no less than about five years.

Field data collection for IRC parameters occurred at 27 representative sites within the Brid River catchment; 14 on the main-stream Brid River and 13 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 there are no sections of river in the catchment that rate as essentially natural. Over 44% of the main-stream has some modification to condition while 55% is near natural and all of these latter sites are located in the lower section of the river. The very top site on the mainstream was assessed as near to natural. For the tributary streams 23% fall into the category of near natural condition, while the majority (77%) show some modification to condition. In general, it was estimated that 58.2% of the catchment streams have some modification while the remaining 41.7% are near natural.

Analysis of sub-indices indicates major degradation of streamside zones and physical form with moderate condition for hydrology and water quality. Aquatic fauna (freshwater invertebrates) rated as in good condition overall. Some modification to the hydrology of the catchment indicates that summer extraction is significant at a number of locations. Significant degradation of physical stream form is evident in a number of areas. Major disturbance to the catchment is evident in the riparian zones where significant habitat disturbance has been detected in about 70% of the catchment sites. Management issues include the existence of extensive 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 Brid River catchment and should be a focus of catchment management activities to avoid further degradation. The maps enclosed in the appendix to this report provide information to allow a strategic approach to the implementation of programs to address this situation.

The IRC suggests that the majority of sites within the catchment vary away from a natural state to a moderate degree although some stretches are bordering on major 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.

TABLE OF CONTENTS

Executive Summary	ii
1. INTRODUCTION	2
2. STUDY AREA	2
3. METHODOLOGY DESCRIPTION	3
3.1 Sub-index headings	5
3.1.1 Physical form	6
3.1.2 Streamside zone	7
3.1.3 Water quality	9
3.1.4 Aquatic life	10
3.1.5 Hydrology	11
4. RESULTS	12
4.1 Summary results for main-stream Brid River sites	13
4.2 Summary results for tributary streams of the Brid River	17
4.3 Rating of stream length	21
5. DISCUSSION	24
6. CONCLUSION	28
7. REFERENCES	29
Acknowledgements	29
APPENDICES	30

1. INTRODUCTION

This study was developed as an adjunct to the requirements of the Land and Water Management Branch, DPIWE, to develop State of Rivers reports for specific catchments within Tasmania. The study consisted of a ground survey method that utilised a one off snapshot approach for selected sites within a given catchment. The information collected was intended to provide a rapid Index of River Condition (IRC) for representative reaches of a surveyed 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 a number of representative reaches throughout each 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 directly related 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.

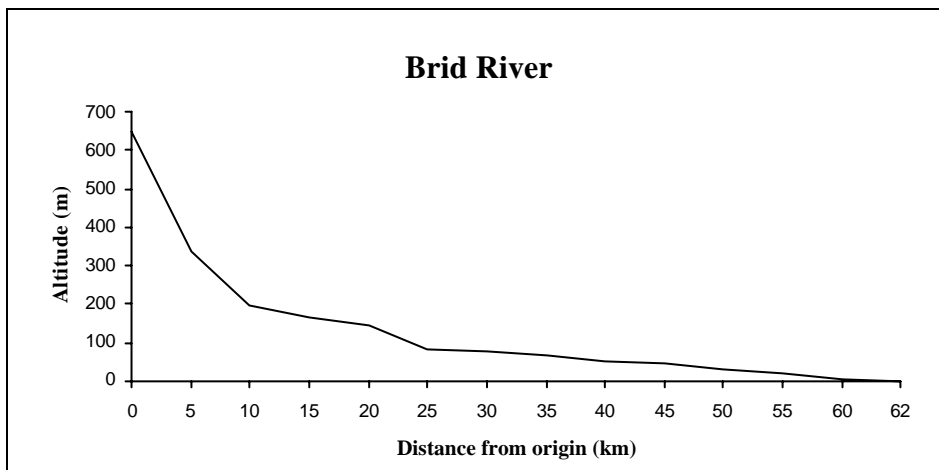
2. STUDY AREA

The study catchment was that containing the main Brid River system. The Brid River itself is situated in the north-east of the state. It is a class 4 unregulated stream but it has tributary streams that are heavily impacted by on-stream storage's. The upper catchment has been cleared for a mixture of cropping and pasture. The middle catchment is heavily forested and the lower catchment is largely cleared for pasture. Stream substrate grades from boulder and sand to cobble, gravel and dominant sand in the lower reaches. Geologically the river originates in granodiorite and passes through a turbidite and alluvial sequence. The river originates at an altitude of 660 m (**Figure 1**) and is approximately 60 km in length.

The annual median flow at the catchment outlet is 0.918 cumecs and summer median flow is 0.35 cumecs. The average annual rainfall range for the catchment is 700-900 mm. There is an average (last 10 years) summer (December to March) outtake of water for irrigation purposes of approximately 500 megalitres.

Field data collection for IRC parameters occurred at 27 sites within the catchment. 14 were on the mainstream Brid River, and 13 on tributary streams (**Figure 2**).

Figure 1. Brid R. altitudinal profile.



3. METHODOLOGY DESCRIPTION

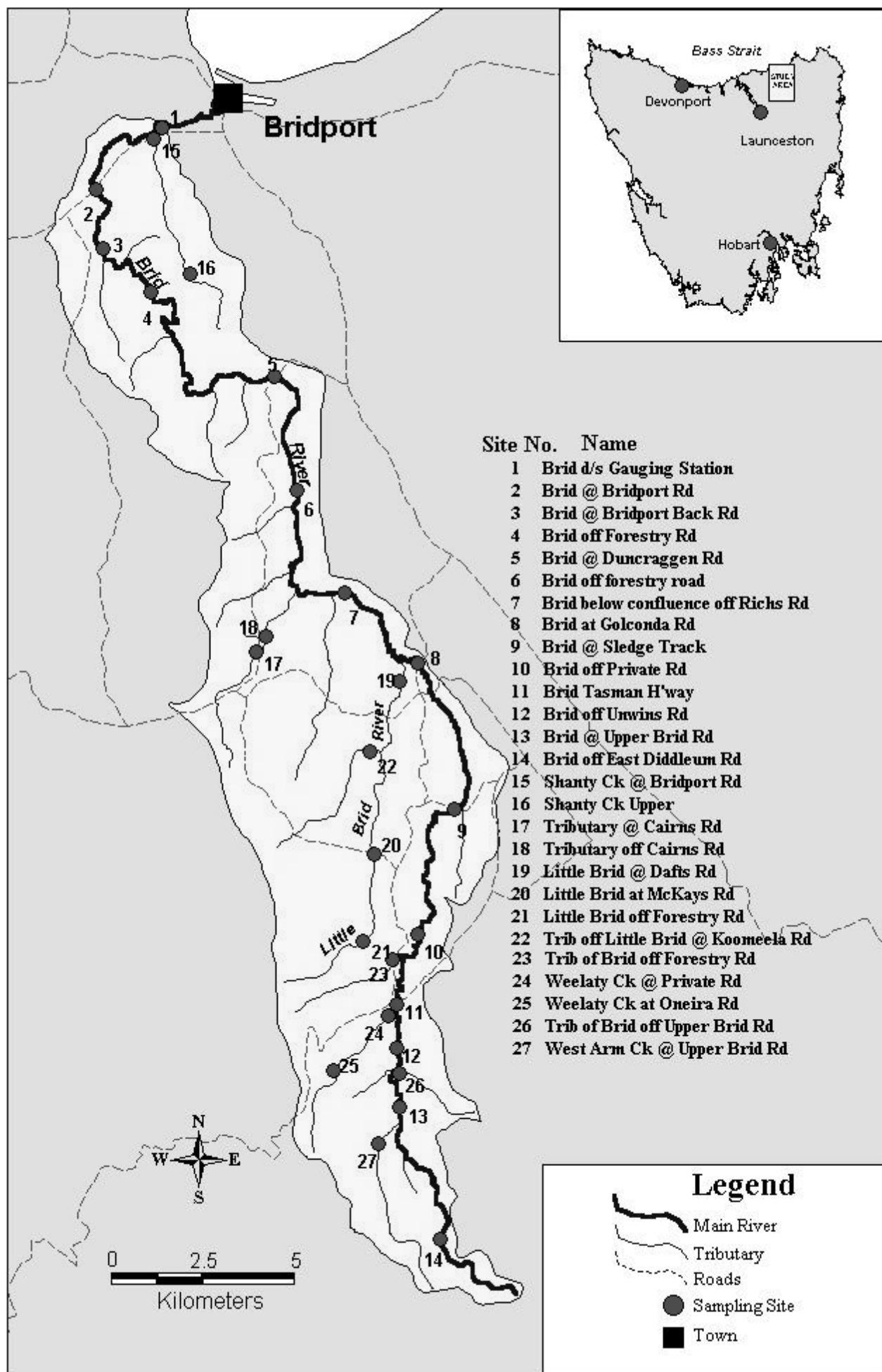
This technique is a modification of the methods adopted by the Queensland Department of Primary Industries 'State of the Rivers' studies and the 'Index of Stream Condition' developed by the Victorian Department of Conservation and Natural Resources. It involves the use of a 'snap-shot' approach, that 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. These 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: Brid 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 $\mu\text{S cm}^{-1}$ (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 lead 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 Brid River catchment has no hydro influence but 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 results for the Brid River system were assessed from a total of 27 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 Brid 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 Brid River sites

The IRC results for the main-stream Brid River are provided in Figure 3. 14 sites (reaches 1-14) were sampled in 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 value 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 indicate that the overall conditions within the mainstream of the catchment are reasonably uniform. The only clear trend is that the overall condition of the lower mainstream catchment sites was better than the upper section. The bottom 7 sites all recorded a condition rating of good or near natural whilst all the upper catchment sites (8 to 13) were all in moderate (some modification) condition. Site 14 at the top of the catchment rated in near natural condition, this site being above the influence of agricultural activities.
- The hydrology sub-index scores largely indicated some modification (moderate) to condition. Overall 11 of the 14 sites were moderately impacted, 1 was (site 6) highly modified and the remaining 2 (sites 13 and 14) were near natural and essentially natural. This indicates that extraction rates during the summer period are high and may be strongly influencing instream processes.
- Physical form sub-index rated poorly throughout the catchment with conditions ranging from major modification to near natural. Of the mainstream sites, 4 in the upper catchment (8, 10, 12 & 13), rated poorly (major modification). Eight other sites in the mainstream rated moderately (some modification) and 2 sites (4 & 6) rated near natural (good condition). Both of the near natural sites were in the mid to lower portion of the river which is surrounded by State forest.
- The streamside zone sub-index scores rated poorly along most of the river, with some sites exhibiting scores of less than 1 indicating highly modified or very poor conditions (sites 12 & 13). Of the 14 sites examined, 6 were in very poor (highly modified) condition, 3 were in poor condition (major modification), 1 was in moderate condition (some modification), 3 were in good condition (near natural) and only 1 was in excellent (essentially natural condition). In essence the condition of the mainstream streamside zone was better in the lower half of the catchment (Fig. 3). As is illustrated in Table 9, this sub-index clearly stands out as the area where most impact has occurred.
- Water quality at all sites was moderate to good. Only one lower and one upper site (4 & 14) rated poorly. Once again the middle catchment sites rated strongly (sites 5 to 8).
- IRC results suggests that aquatic life within the main-stream is in a healthy state with 10 of the 14 sites exhibiting excellent (essentially natural) conditions. One site (9) rated poorly and the 3 remaining sites (10, 11 & 14) rated as in good (near natural) condition.
- No data gaps were present for the main-stream sites.

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

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
1	Brid d/s Gauging Station	532000	5459100	15	146.8
2	Brid @ Bridport Rd	530200	5457400	19	135.9
3	Brid @ Bridport Back Rd	530400	5455800	25	131
4	Brid off Forestry Rd	531700	5454600	28	125
5	Brid @ Duncraggen Rd	535100	5452300	45	110.8
6	Brid off forestry road	535700	5449200	57	104.1
7	Brid below confluence off Richs Rd	537000	5446400	65	74.1
8	Brid at Golconda Rd	539000	5444500	75	45.7
9	Brid @ Sledge Track	540000	5440500	128	37.9
10	Brid off Private Rd	539000	5437100	168	32.2
11	Brid Tasman Highway	538400	5435200	175	24.2
12	Brid off Unwins Rd	538400	5434000	195	17.8
13	Brid @ Upper Brid Rd	538500	5432400	228	11.8
14	Brid off East Diddleum Rd	539600	5428800	530	2.1

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

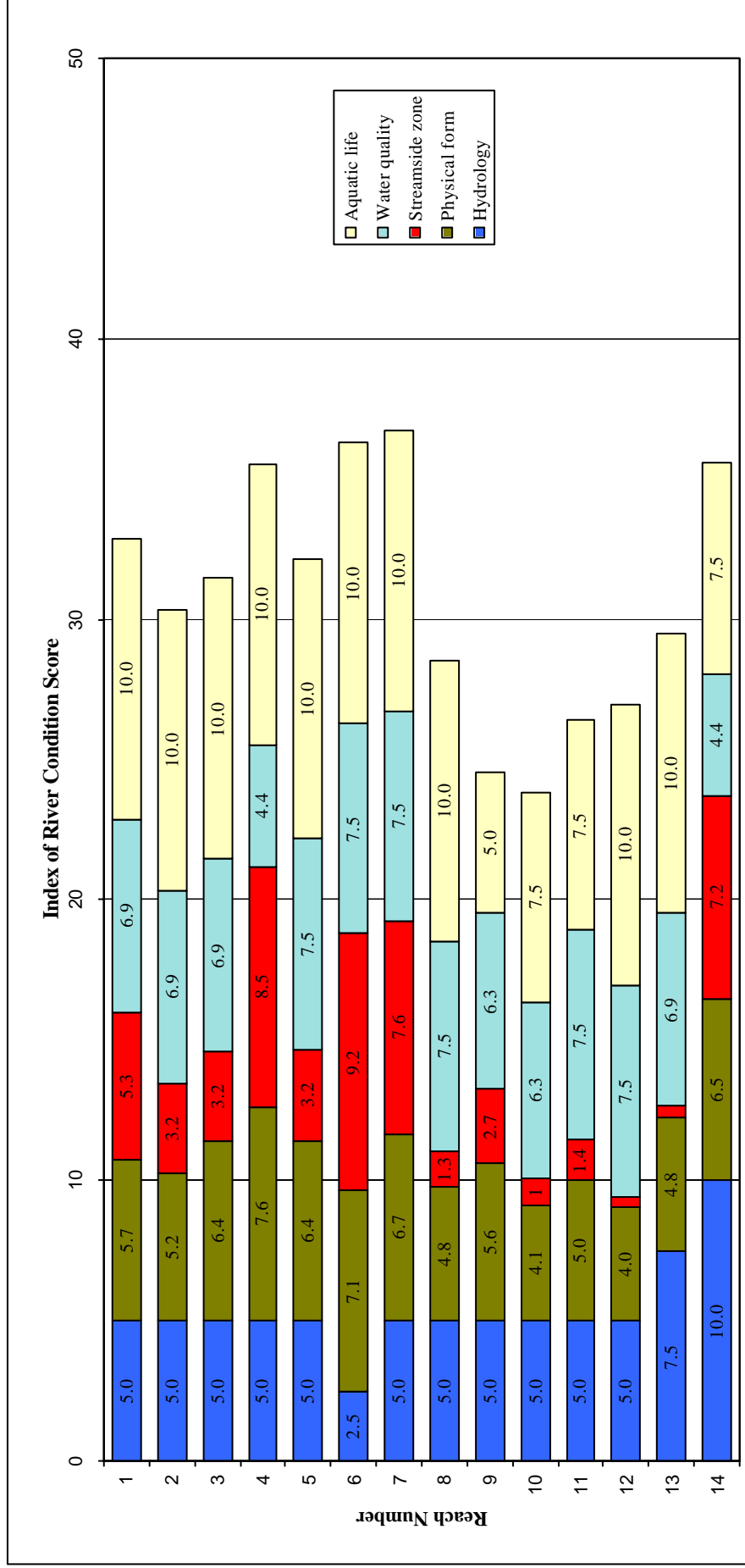


Table 9. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Brid R. main-stream sites.

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		SIGNAL
1	F	No	No																		
2	F	No	No																		
3	F	No	No																		
4	V	No	No																		
5	F	No	No																		
6	F	No	No																		
7	F	No	No																		
8	F	No	No																		
9	F	No	No																		
10	F	No	No																		
11	F	No	No																		
12	F	No	No																		
13	F	No	No																		
14	F	No	No																		

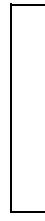
Key to table



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 Brid River.

The IRC results for the tributary streams of the Brid River are provided in Figure 4. A total of 13 sites were sampled on 9 tributaries (Table 10). Parameters that suggest major or extreme modification from a natural or ideal 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 illustrated in Figure 4 and Table 11 are highlighted as follows:

- The average condition of tributary streams rated as moderate condition (some modification). Of the 13 sites, 8 rated as in moderate condition and 3 (sites 18, 21 & 27) rated as in good condition (near natural). There was no clear pattern of improving condition in the tributary streams along their length, except for the Little Brid River which did improve in quality up its length. Site 21 (upper Little Brid R.) was clearly in the best condition, while site 22 (a small tributary of the Little Brid R.) had the lowest rating.
- The hydrology sub-index varies considerably amongst the tributaries with 2 out of 13 sites in very poor condition (highly modified), 5 sites in moderate condition and the remaining 6 in excellent condition.
- The streamside zone sub-index varies considerably amongst the tributary streams but does not rate highly overall. The most impacted reach (site 23) was on the unnamed tributary off the Sledge Track road which had an extremely low rating of 0.4 (highly modified, very poor condition). Six other sites also fell within this rating of very poor condition (sites 15, 17, 19, 20, 22, & 26). The Little Brid R. tributary was clearly highly impacted in its lower reaches (sites 19 & 20) but rated as essentially natural in its upper reach (site 21). Site 18 was the only other to rate as essentially natural. Both sites on Weelaty Ck rated as poor (major modification) as did the site on West Arm Ck. Site 17 was the only site to rate in good (near natural condition). In all the highly impacted sites riparian width, structural intactness, proportion of indigenous cover, longitudinal continuity and streamside cover were all highly modified.
- The Water quality sub-index did not rate well within the tributary sites. Site 15 (Shanty Ck) was in very poor condition and Weelaty Ck (site 25) showed major modification. The remaining 9 sites all rated as in moderate condition. All the waterways were slightly acidic (<7) and sites 15 & 17 - 20 all had high turbidity and conductivity. Site 15 (lower Shanty Ck) recorded a conductivity reading of 4100 ($\mu\text{S}/\text{cm}$).
- The Aquatic life sub-index rated highly (good condition) for all sites except site 21 (Little Brid R. upper catchment) which was in moderate condition.
- Data gaps present for the tributary stream sites were minimal with information missing from sites 16 and 26 in the form of water quality parameters and aquatic life. This was due to lack of available water at the time of sampling.

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

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
15	Shanty Ck @ Bridport Rd	531800	5458800	17	6
16	Shanty Ck Upper	532800	5455100	85	1.4
17	Tributary @ Cairns Rd	534600	5444800	85	7.8
18	Small Trib u/s Brid	534600	5445200	83	1.1
19	Little Brid @ Dafts Rd	538500	5444000	78	24.6
20	Little Brid at McKays Rd	537800	5439300	175	7.4
21	Little Brid off Forestry Rd	537500	5436900	202	2.6
22	Trib off Little Brid @ Koomeela Rd	537700	5442100	98	6
23	Trib of Brid off Forestry Rd	538300	5436400	168	3.3
24	Weelaty Ck @ Private Rd	538200	5434900	170	4.7
25	Weelaty Ck at Oneira Rd	536700	5433400	290	1.6
26	Trib of Brid off Upper Brid Rd	538500	5433300	209	1.5
27	West Arm Ck @ Upper Brid Rd	537900	5431400	278	4.9

Figure 4. IRC results for the Brid River tributaries.

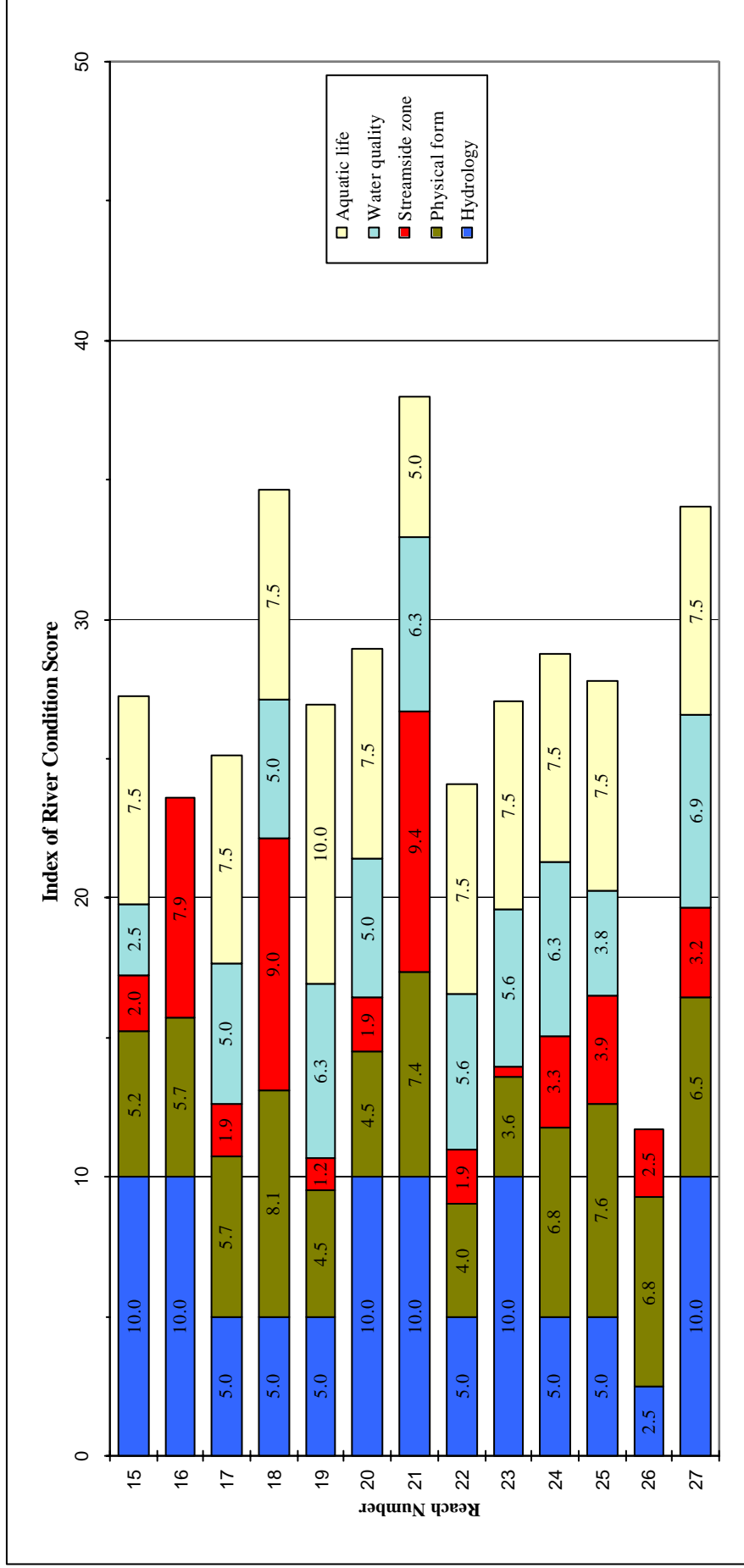


Table 11. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Brid R. tributary sites.

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	F	No	No																	
16	F	No	No																	
17	V	No	No																	
18	V	No	No																	
19	V	No	No																	
20	F	No	No																	
21	V	No	No																	
22	F	No	No																	
23	V	Yes	No																	
24	F	No	No																	
25	V	No	No																	
26	V	No	No																	
27	F	No	No																	

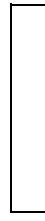
Key to table



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.

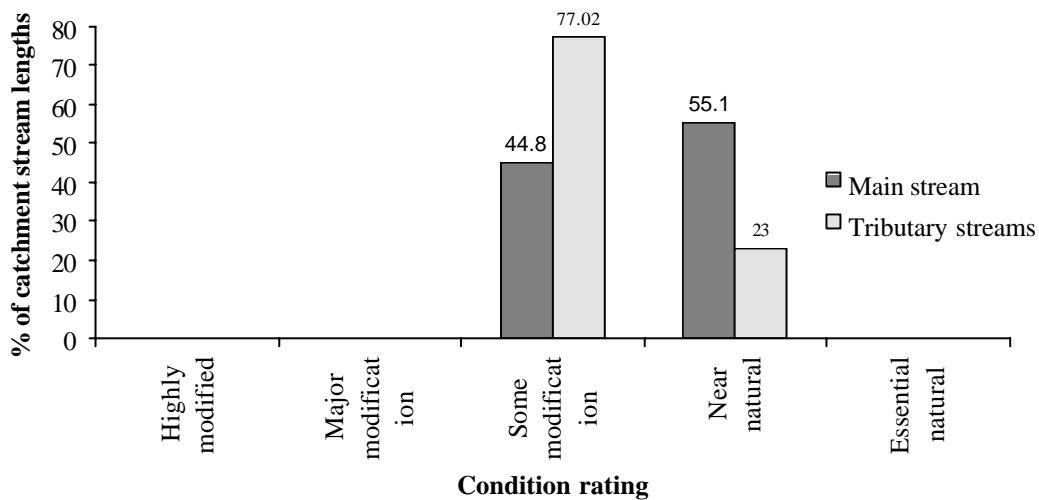
Regen = presence of regeneration of indigenous species.

4.3 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 there are no sections of river in the catchment that rate as essentially natural. Figure 5 details the rating structure of the proportion of stream lengths within the catchment. The data illustrated in the chart shows that over 44% of the main-stream has some modification to condition while 55% is near natural and all of these latter sites are located in the lower section of the river (refer to Fig. 3 and 2). Only the very top site (site 14) in the upper section on the mainstream comes out as near to natural. For the tributary streams 23% fall into the category of near natural condition, while the majority (77%) show some modification to condition. In general, it was estimated that 58.2% of the catchment streams have some modification from natural conditions and the remaining 41.7% 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 site information 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 zones of reduced condition within the lower catchment and an increase in condition higher in the catchment. The diverse nature of land use in the Brid River catchment is highlighted by the reduced condition of some of the upper catchment reaches. All the mainstream sites in the upper catchment (other than the top site (14) rated lower than the lower catchment sites, where State forest surrounds large sections of the river. The majority of the tributary streams rated as slightly modified. Little Brid River (sites 19, 20 and 21) improved in condition up the catchment. The very lowest stretches of the Brid River are modified by agricultural activities as is a small section in the middle reaches and much of the upper reaches. This is interspersed with near natural conditions in heavily forested regions that occur in a number of locations but particularly through the lower middle section.

Figure 6 graphically illustrates the distribution of overall condition ratings for stream length within the catchment. The information is limited by the location of each study site and the map is an extrapolation of information from sites that were chosen as reasonably representative. Only major tributaries and the main-stream river were targeted. The information available indicates that the overall condition of the catchment is one of a moderately impacted environment with good conditions in the middle lower half. As detailed above, sub-index parameters within each final rating may vary considerably from site to site.

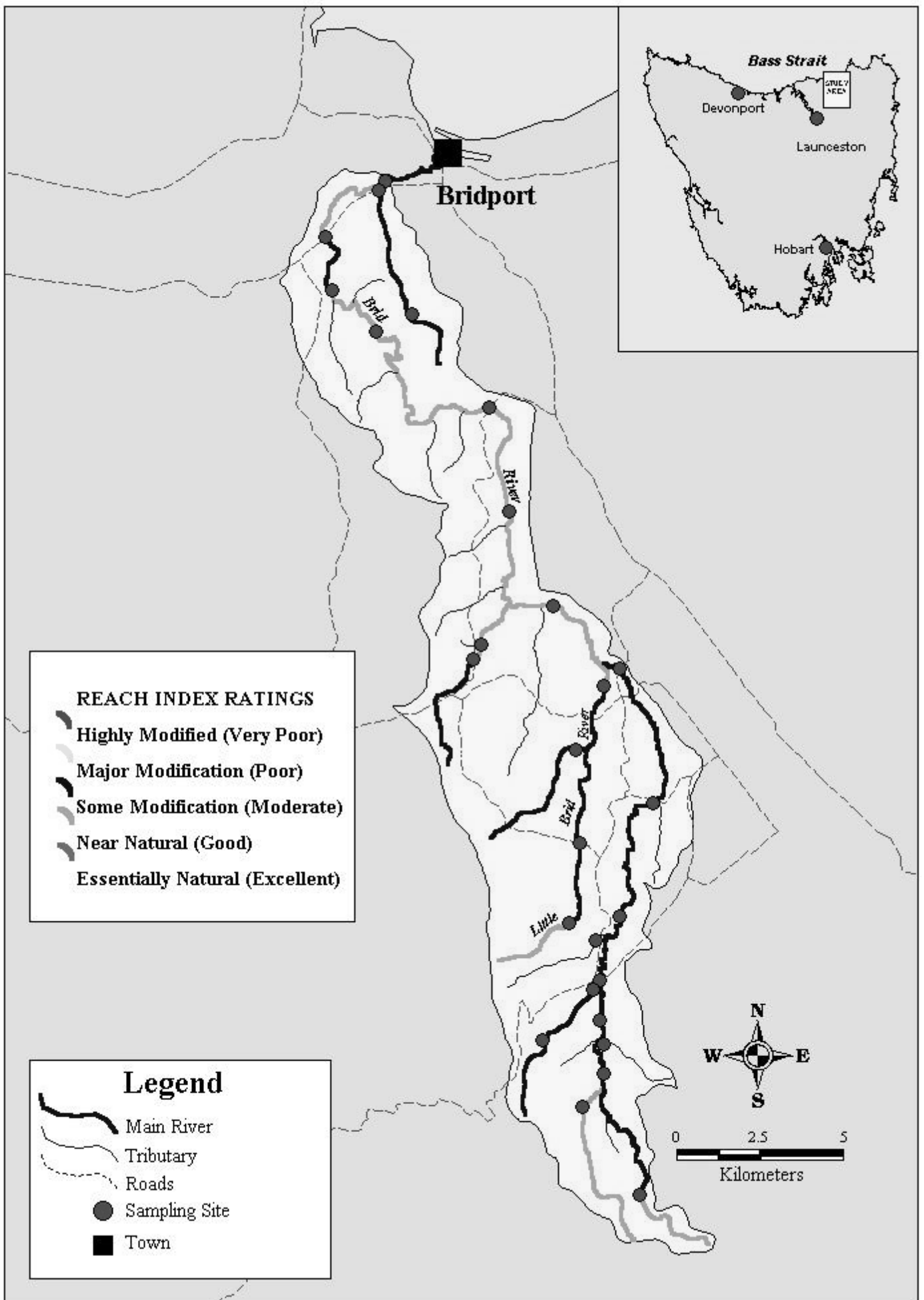
The data in Table 12 illustrates the average value score for each independent sub-index and overall IRC value for the combined sites within the catchment and further supports the findings illustrated above. These values are highly dependant on site selection and the result may be skewed towards higher or lower values dependant on site information. The available data illustrates that, on average, the overall catchment condition is one that 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. But, when the data is reduced further it is clear that more sites fall within the condition of some modification (Fig. 5). Of all the sub-indices, aquatic fauna scores best, indicating macroinvertebrate fauna is in reasonable condition (refer to the 'Aquatic Ecology' report for full details). This is followed by water quality and hydrology. The greatest proportion of outakes occur on the main-stream Brid River and this has dragged the hydrology index rating down accordingly. The rating for streamside zone is very poor for both the mainstream and tributary streams indicating major modification from a natural condition. This data is different from that in Figure 5 which is a calculation based on proportion of stream length, whereas Table 12 illustrates data that is calculated directly from total numbers. The results illustrated here 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 Brid R. Sites	Brid R. Tributaries	Average for all catchment sites
Hydrology	5.36	6.9	6.1
Physical form	5.7	5.8	5.8
Streamside zone	3.9	3.7	3.8
Water quality	6.7	5.3	6.1
Aquatic life	9.1	7.5	8.4
Overall IRC values	30.76 (2)	29.1 (2)	30.2 (2)

NB: bracketed 2 = moderate condition (some modification)

Figure 6: Brid River catchment. Overall reach condition ratings sub-index ratings.



5. DISCUSSION

The Index of River Condition assessment protocol has effectively illustrated the condition of specific sites and representative reaches within the Brid River catchment. A broad range of sites were chosen to provide a suitable description of catchment condition and to cover the range of variation in 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 increase in condition higher in the catchment. In the Brid River catchment the reverse is the case. Intensive agriculture is concentrated in the upper catchment and problems have been highlighted that include very poor condition of streamside zones (refer to Fig. 3) and large changes to physical form. The main tributaries seem to follow the more usual scenario of improved condition in the upper catchment, with overall quality increasing up the Little Brid River for example. Lack of water in the upper Shanty Creek inhibited full analysis for this tributary but the physical form and streamside zone parameters rated higher at the upper site. The small size of most of the remaining tributary streams made sampling from upper catchment zones impossible. The lowest section of the Brid River is also modified by agricultural activities and subsequently streamside zone ratings are down (sites 2 to 3). This is interspersed with near natural conditions in heavily forested regions that occur in a number of locations through the middle catchment.

Various management issues arise from this study. Appendix 2B lists potential management issues that could be addressed. Obvious factors that emerged as influencing site condition included the presence of non-native species in the stream-side zone (such as Crack Willow, blackberries and thistles) which were shown to be well established in certain sections of the Brid River and many of the tributaries. Blackberries appear as a streamside weed at 14 of the 27 sites. The excessive growth of blackberries is inhibitory to the growth of native species and may encroach on pasture. 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 showed that this is where most of the critical problems occurred. Unrestricted stock access to stream banks was clearly a widespread problem. This frequently creates excessive bank erosion 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 fulfils 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 available that sites within the catchment vary away from a natural state to a moderate degree but bordering on a major degree.

Main-stream Brid River

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

The available data indicates that there are few instream faunal problems (macroinvertebrate analysis only) which is supported by the findings of 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 not necessarily a problem since at this point data used to calculate the index is based on estimated outakes only. Physical form rated as in moderate condition overall but was poor for several of the upper sites (sites 8, 10, 12 & 13), while the condition of the streamside zone was clearly the most impacted, particularly in the upper catchment with 6 sites rating as in highly modified (very poor) condition (sites 8 to 13).

Management issues that may be considered include the presence of Crack Willow at 4 of the 14 sites once again only in the upper catchment, the presence of understory weed species such as blackberries and thistles (throughout the catchment), limited riparian zones at 10 out of 14 sites and some stock access problems 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. It is also clear that most of the problems occur in the upper catchment where there is intensive agriculture.

Tributaries of the Brid River

As with the main-stream of the Brid River, the tributary sites are apparently impacted by land practices such as farming and in certain areas forestry. Hydrology rates as moderate condition as does water quality and physical form. 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.

Shanty Creek. (Sites 15 and 16)

Shanty Creek is a system that rates as moderately modified. The upper site was dry so no water quality or ecology ratings could be determined. Nevertheless, the remaining ratings scored well and the overall site condition would have undoubtedly rated well if not for the missing data. In general, riparian structure is very poor at the lower site (site 15) and good at the upper site (site 16). Aquatic life is rated as in good condition at the lower site, although certain problems were encountered through the analysis used for the Aquatic Ecology section (refer to this report for full details). Water quality rated as very poor at the lower site. The lower site would be heavily influenced by farming practices.

Unnamed tributary off Carins Road.(Sites 17 and 18)

The upper site (17) is situated at the bottom of an extensive farming region whereas the lower site was located in the upper section of a heavily forested region. There were no significant faunal problems at either of these sites. Hydrology rating for both sites was moderately impacted but the physical parameters of streamside zone and physical form rated higher (good and excellent condition) for the lower catchment forested site than the upper site (moderate and very poor condition). Water quality and faunal parameters rated the same for both sites and this would be expected due to the upstream effect of agricultural activities influencing both sites. There were several management issues noted for the upper site including the presence of plant weed species such a blackberries and bulrushes, limited streamside zone and unrestricted stock access to the stream. No management issues were encountered for the lower site.

Little Brid River. (Sites 19, 20 and 21)

This catchment follows the usual trend of improved conditions higher in a system. The upper catchment site (21) is in good condition as recorded through most parameters except water quality and aquatic life (moderate condition). The upper catchment site was located in a forested area but the 2 lower catchment sites were located in heavily impacted agricultural land. Both the lower sites have very poor streamside zone conditions and poor physical conditions. Both these sites have clearly been impacted by farming activities. At the lower 2 sites a number of management issues were noted including, unrestricted stock access to the stream, limited riparian zone, presence of weed species such as blackberries and limited native plant regeneration. No management issues were encountered for the upper site.

Unnamed tributary of Little Brid River (Site 22)

Only one site was surveyed in this small tributary creek. The site was in moderate condition with very poor streamside vegetation, poor physical form, moderate water quality and hydrology and good instream fauna. Management issues include no streamside zone, no native plant regeneration and unrestricted stock access to the stream. Almost the entire catchment is in an agricultural zone.

Unnamed tributary of Brid R. off upper Sledge Road.(Site 23)

Only one site was surveyed in this small tributary creek. The site was in moderate condition with very poor streamside vegetation, poor physical form, moderate water quality, good instream fauna and excellent hydrology. Management issues include no streamside zone, no native plant regeneration, unrestricted stock access to the stream and the presence of blackberries.

Weelaty Creek (Sites 24 & 25)

Two sites were sampled on this small tributary of the Brid R. Both sites were in moderate condition overall. Both also had similar problems in limited streamside zone (poor condition), presence of blackberries, unrestricted stock access to the stream, similar aquatic life ratings (good condition), water quality in moderate (site 24) and poor (site 25) condition, physical form in moderate to good condition and hydrology in moderate condition.

Unnamed tributary of Brid R. off Upper Brid Road (Site 26)

This small tributary stream was dry at the time of sampling therefore water quality and aquatic life could not be recorded bringing down the overall score. Due to this lack of information the total score for the site cannot be compared with other sites. Nevertheless, the parameters that were recorded indicated that this site was heavily impacted most likely from agricultural practices. The hydrology rating was very poor, physical form was in moderate condition and streamside zone was also in very poor condition. Management issues include the presence of blackberries, limited to no streamside zone, unrestricted stock access to the stream and limited native plant regeneration.

West Arm Creek. (Site 27)

West Arm Creek was the highest catchment tributary stream sampled. This site was also located within a recently cleared forestry pine plantation. Other than this, no activities occur upstream. Therefore, the hydrology rating was excellent, physical form and water quality were moderate, and, due to the impact of the forestry operations, streamside zone was in poor condition. Blackberries were also present as a management issue and there was limited native plant regeneration, a factor which would be related to the age of the clearing operation.

As with the main-stream of the Brid 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 occurs in the stream side zone. There are few instream faunal problems, water quality is reasonable but not good and hydrology impacts vary from very poor to excellent. No single stream stood out as badly impacted, 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 from the Index of River Condition has clearly illustrated that it is a useful tool in assessing river condition. The technique 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:

- streamside zone management to allow the regeneration 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.

From the available data it is clear that the major management problems in the catchment revolve around riparian weed control, revegetation of riparian zones and controlled stock access to river banks. Physical form (bank and bed conditions, overall site disturbance) indicates moderate condition of these parameters. Aquatic fauna (freshwater invertebrates) are generally healthy but water quality is only fair (refer to the ‘Water Quality’ report for more details).

This project has illustrated the condition of representative sites of reaches within the Brid River catchment. 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.

REFERENCES

- Bobbi, C., Fuller, D. and Oldmeadow, D. (1996) South Esk Basin State of Rivers Report. Technical Report of Data Collected Between 1992 and 1995. Resource Assessment Branch, Department of Primary Industry and Fisheries, Tasmania. 254 pp. WRA Report 96/02, 1997.
- Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1995) Development of an Index of Stream Condition, report prepared for the Waterways unit of the Department of Conservation and Natural Resources.
- Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1997) An Index of Stream Condition: Reference Manual, report prepared for the Waterways and Floodplain Unit of the Department of Conservation and Natural Resources.
- Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1997) An Index of Stream Condition: User's Manual, report prepared for the Waterways and Floodplain Unit of the Department of Conservation and Natural Resources.
- Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1997) An Index of Stream Condition: Trial Application, report prepared for the Waterways and Floodplain Unit of the Department of Conservation and Natural Resources.
- Chessman, B.C. (1995) Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification and a biotic index. *Aus. J. Ecol.* 20, 122-129.
- Chessman, B.C., Grouns, J.E. and Kotlash, A.R. (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: application to the Hunter River system, New South Wales. *Mar. Freshwater Res.* 48, 159-172.
- Skills, A.P. and Pen, L. (1995) The condition of the Denmark and Hay river foreshores. A report prepared for the Wilson inlet management authority. Waterways Commission. Report No. 60.

Acknowledgements

The author would like to thank the following individuals from the DPIWE for their assistance in field data collection and for assistance in preparation of this report.

- Rebecca Pinto
- Bryce Graham
- Dave Horner
- Claire McKenny
- Kate Berry

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

APPENDIX 1 Sub-index and overall IRC ratings and associated values for all 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	5	5.7	5.3	6.9	10.0	32.8	532000 5459100
2	5	5.2	3.2	6.9	10.0	30.3	530200 5457400
3	5	6.4	3.2	6.9	10.0	31.5	530400 5455800
4	5	7.6	8.5	4.4	10.0	35.5	531700 5454600
5	5	6.4	3.2	7.5	10.0	32.2	535100 5452300
6	2.5	7.1	9.2	7.5	10.0	36.3	535700 5449200
7	5	6.7	7.6	7.5	10.0	36.7	537000 5446400
8	5	4.8	1.3	7.5	10.0	28.5	539000 5444500
9	5	5.6	2.7	6.3	5.0	24.5	540000 5440500
10	5	4.1	1.0	6.3	7.5	23.8	539000 5437100
11	5	5.0	1.4	7.5	7.5	26.4	538400 5435200
12	5	4.0	0.4	7.5	10.0	26.9	538400 5434000
13	7.5	4.8	0.4	6.9	10.0	29.5	538500 5432400
14	10	6.5	7.2	4.4	7.5	35.6	539600 5428800
15	10	5.2	2.0	2.5	7.5	27.3	531800 5458800
16	10	5.7	7.9	##	##	##	532800 5455100
17	5	5.7	1.9	5.0	7.5	25.1	534600 5444800
18	5	8.1	9.0	5.0	7.5	32.1	534600 5445200
19	5	4.5	1.2	6.3	10.0	26.9	538500 5444000
20	10	4.5	1.9	5.0	7.5	28.9	537800 5439300
21	10	7.4	9.4	6.3	5.0	38.0	537500 5436900
22	5	4.0	1.9	5.6	7.5	24.1	537700 5442100
23	10	3.6	0.4	5.6	7.5	27.1	538300 5436400
24	5	6.8	3.3	6.3	7.5	28.8	538200 5434900
25	5	7.6	3.90	3.8	7.5	27.8	536700 5433400
26	2.5	6.8	2.5	##	##	##	538500 5433300
27	10	6.5	3.2	6.9	7.5	34.1	537900 5431400

Actual average	10	10	10	10	10	10
Observ. average	6.1	5.8	3.8	6.1	8.4	30.0
Condition	Moderate	Moderate	Poor	Moderate	Good	Moderate
	Some modificat.	Some modification	Major modification	Some modification	Near natural	Some modification

= no data available.

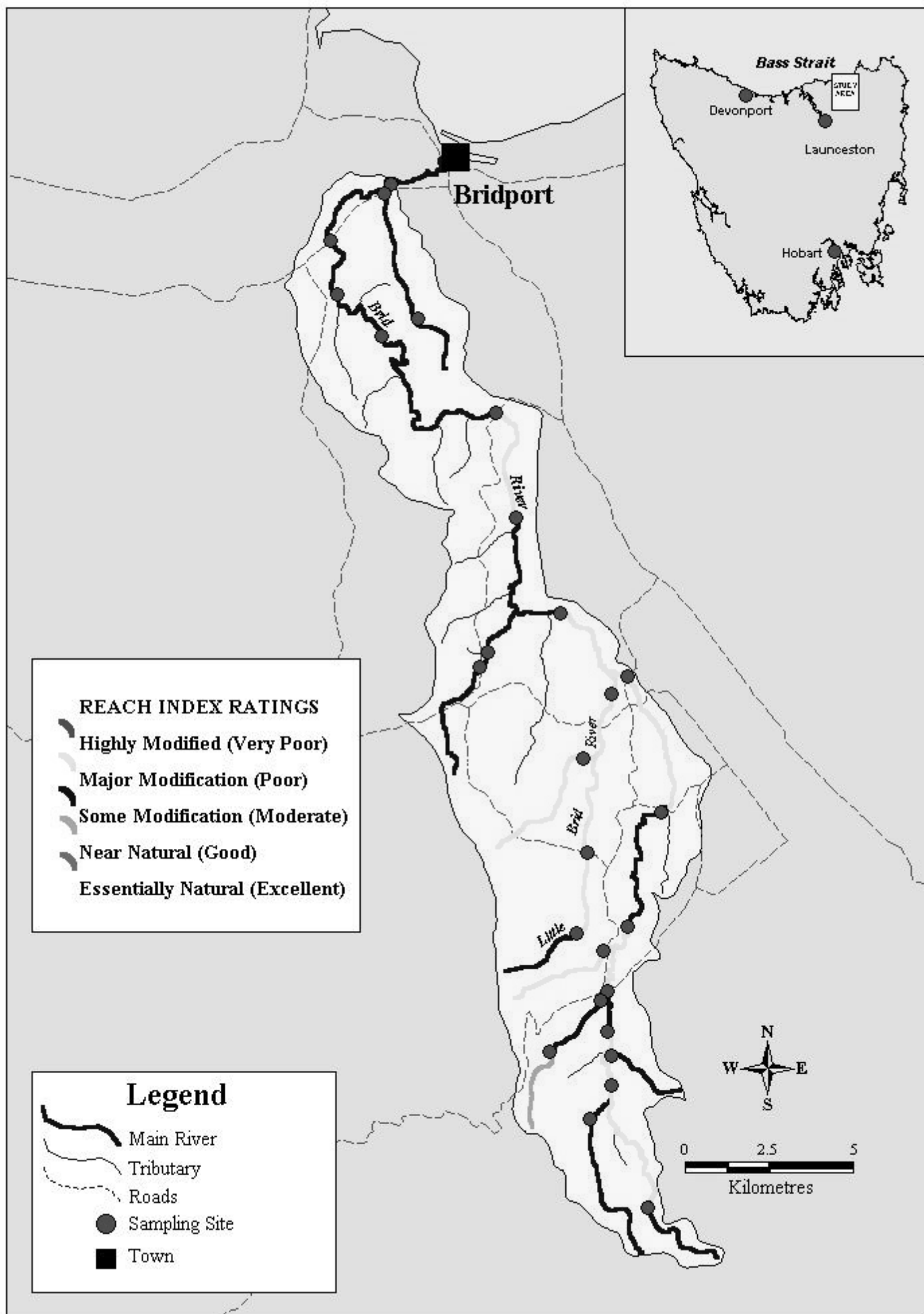
APPENDIX 2A. Site list with grid references for each study location.

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km²)
1	Brid d/s Gauging Station	532000	5459100	15	146.8
2	Brid @ Bridport Rd	530200	5457400	19	135.9
3	Brid @ Bridport Back Rd	530400	5455800	25	131
4	Brid off Forestry Rd	531700	5454600	28	125
5	Brid @ Duncraggen Rd	535100	5452300	45	110.8
6	Brid off forestry road	535700	5449200	57	104.1
7	Brid below confluence off Richs Rd	537000	5446400	65	74.1
8	Brid at Golconda Rd	539000	5444500	75	45.7
9	Brid @ Sledge Track	540000	5440500	128	37.9
10	Brid off Private Rd	539000	5437100	168	32.2
11	Brid Tasman H'way	538400	5435200	175	24.2
12	Brid off Unwins Rd	538400	5434000	195	17.8
13	Brid @ Upper Brid Rd	538500	5432400	228	11.8
14	Brid off East Diddleum Rd	539600	5428800	530	2.1
15	Shanty Ck @ Bridport Rd	531800	5458800	17	6
16	Shanty Ck Upper	532800	5455100	85	1.4
17	Tributary @ Carins Rd	534600	5444800	85	7.8
18	Tributary off Carins Rd	534800	5445200	83	1.1
19	Little Brid @ Dafts Rd	538500	5444000	78	24.6
20	Little Brid at McKays Rd	537800	5439300	175	7.4
21	Little Brid off Forestry Rd	537500	5436900	202	2.6
22	Trib off Little Brid @ Koomeela Rd	537700	5442100	98	6
23	Trib of Brid off Forestry Rd	538300	5436400	168	3.3
24	Weelaty Ck @ Private Rd	538200	5434900	170	4.7
25	Weelaty Ck at Oneira Rd	536700	5433400	290	1.6
26	Trib of Brid off Upper Brid Rd	538500	5433300	209	1.5
27	West Arm Ck @ Upper Brid Rd	537900	5431400	278	4.9

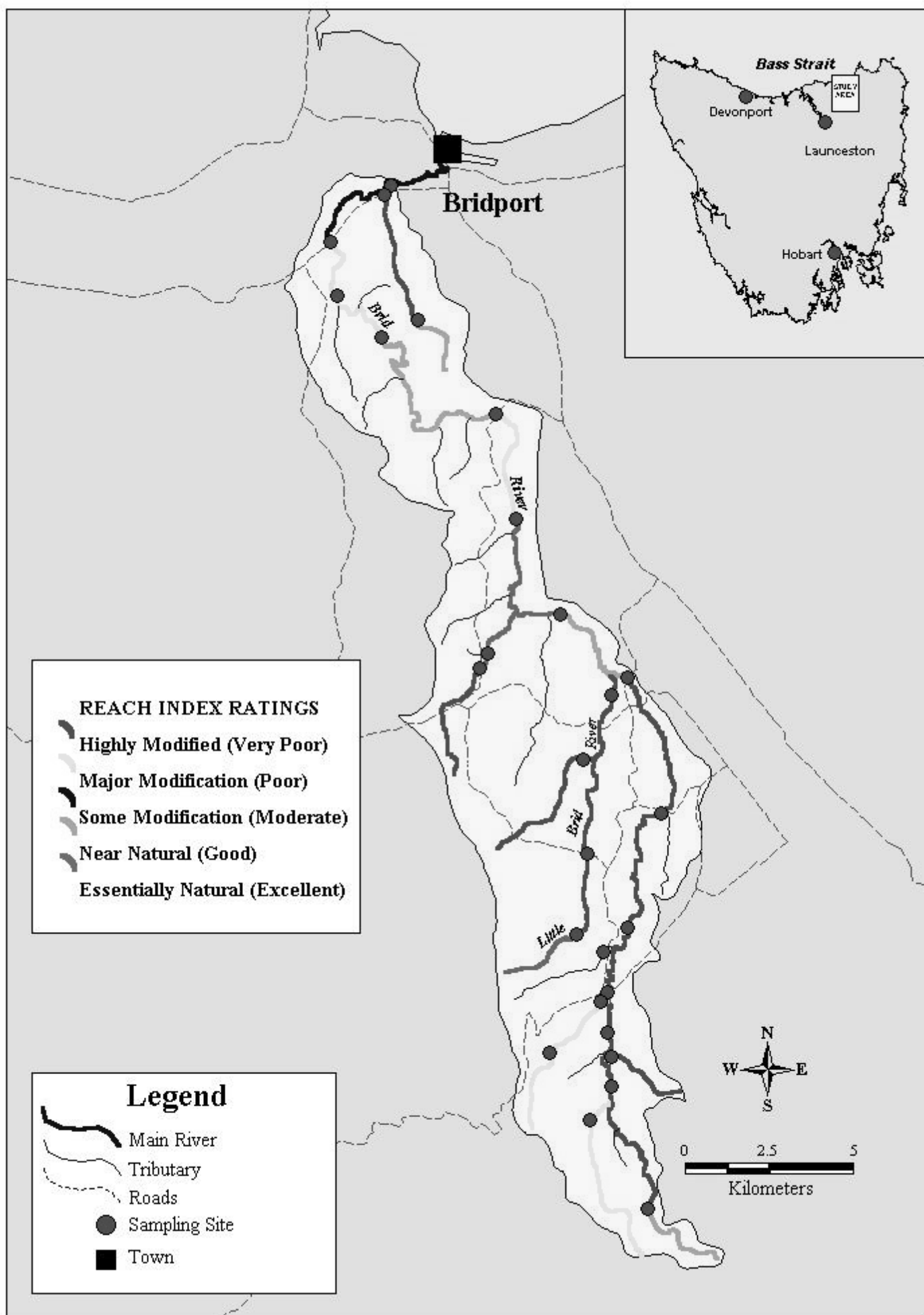
APPENDIX 2B. Management issues identified for the Brid River sites.

Reach	Management issues
1	Weeds - thistles, bulrushes. Limited riparian zone on one bank. Unrestricted stock access to river banks.
2	Weeds - thistles, bulrushes, blackberries, willows. Limited riparian zone. Stock access to river banks. Bank erosion.
3	Weeds - blackberries, thistles, ragwort. Limited riparian zone, unrestricted stock access to river banks. Limited indigenous plant regeneration.
4	None.
5	Weeds - thistles, ragwort. Limited riparian zone, some stock access. Some river bank instability. Limited indigenous plant regeneration.
6	None.
7	Presence of willows. Stock access to river banks.
8	Weeds - ragwort, blackberries, thistle. Limited to no riparian zone. Unstable banks and bed material. Limited indigenous plant regeneration. Stock access to river banks.
9	Weeds - blackberries, thistle, extensive willows. Limited to no riparian zone. Limited indigenous plant regeneration. Stock access to river banks.
10	Weeds - willows, blackberries, thistles. No riparian zone. Unstable bed material. No indigenous plant regeneration. Stock access to river banks.
11	Weeds - willows, blackberries. Limited to no riparian zone. No indigenous plant regeneration.
12	Weeds - blackberries, thistles, hawthorn. No riparian zone. No indigenous plant regeneration. Stock access to river banks.
13	Weeds - blackberries. Little instream woody debris. No riparian zone. No indigenous plant regeneration. Stock access to river banks. Unstable river banks.
14	None.
15	Weeds - willows, blackberries, thistles. Limited to no riparian zone. Limited indigenous plant regeneration. Unstable river banks.
16	None.
17	Weeds - blackberries, bullrushes. Limited to no riparian zone. Limited indigenous plant regeneration. Stock access to river banks.
18	None.
19	Weeds - blackberries, thistles. Limited riparian zone. No indigenous plant regeneration. Stock access to river banks.
20	No riparian zone. Limited instream woody debris. Stock access to river banks. No indigenous plant regeneration.
21	None.
22	Weeds - thistles. No riparian zone. No indigenous plant regeneration. Limited instream woody debris. Stock access to river banks.
23	Weeds - ragwort. No riparian zone. No indigenous plant regeneration. Limited instream woody debris. Stock access to river banks.
24	Weeds - blackberry. Limited riparian zone. Limited indigenous plant regeneration. Stock access to river banks.
25	Weeds - blackberry, thistles. Limited riparian zone. Limited indigenous plant regeneration. Some stock access to river banks.
26	Weeds - blackberry. Limited to no riparian zone. Limited indigenous plant regeneration. Stock access to river banks. Limited instream woody debris.
27	Weeds - blackberry, thistles. Limited riparian zone. Limited indigenous plant regeneration.

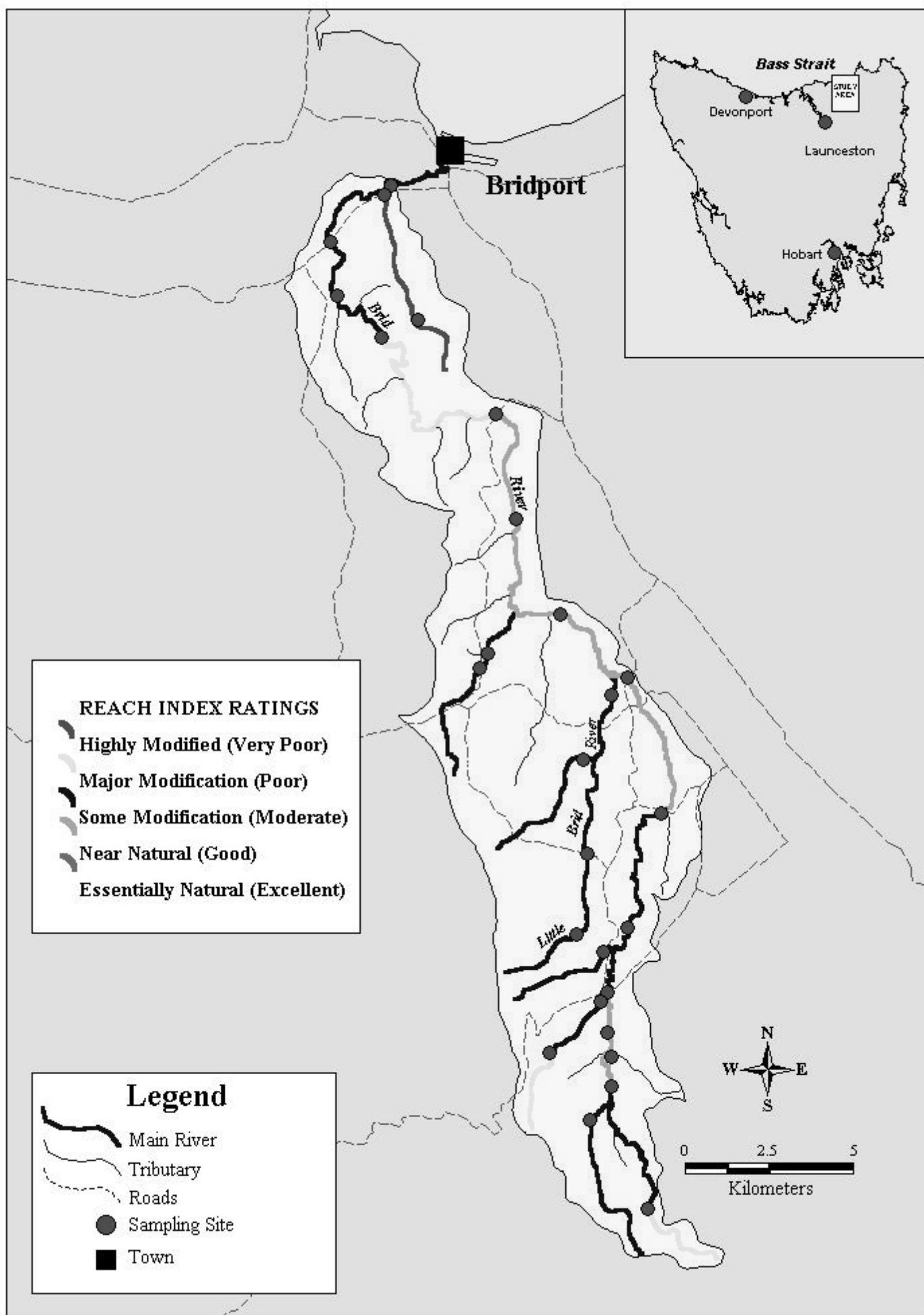
Appendix 3: Brid River catchment. Physical form sub-index ratings.



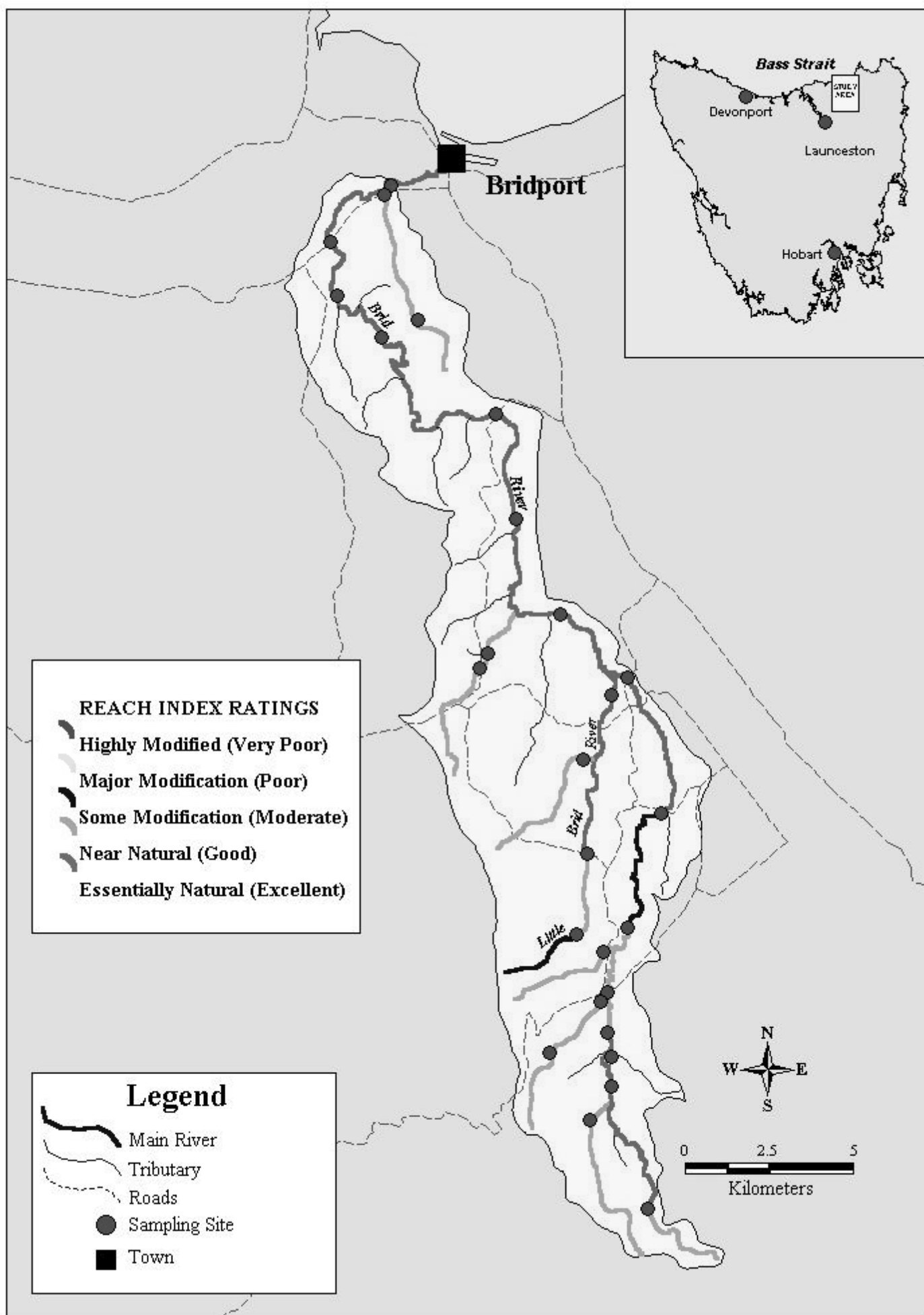
Appendix 4: Brid River catchment. Streamside sub-index ratings.



Appendix 5: Brid River catchment. Water quality sub-index ratings.



Appendix 6: Brid River catchment. Aquatic life sub-index ratings.



Appendix 7: Brid River catchment. Hydrological sub-index ratings.

