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

Tasmania

Index of River Condition for the Great Forester River Catchment

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

Report Series WRA 99/06
August, 1999.

Index of River Condition
Great Forester River Catchment

Executive Summary

This report provides a broad picture of stream condition in the Great Forester 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 34 representative sites within the Great Forester River catchment; 17 on the main-stream Great Forester River and 17 on tributary streams. An examination of the IRC for these sites indicates no section with a high or major modification to *overall condition*. Over 50% of the main-stream was found to be in near or essentially natural condition, while 38.1% is slightly modified. For the tributary streams 60.6% fall into the category of near natural condition, while 19.7% show some modification to condition and similarly 19.7% are essentially natural. From these results it is concluded that the general condition of the catchment is reasonably healthy.

Analysis of sub-indices indicates some degradation of water quality and aquatic fauna (freshwater invertebrates), but generally the catchment is in a reasonable condition. Some modifications to the hydrology of the catchment are evident indicating that summer extractions are significant at a number of locations. Significant degradation of physical stream form is also evident in a number of areas. Major disturbance to the catchment is evident in the riparian zones where high streamside habitat disturbance has been detected in about 30% of the catchment. Issues include the existence of extensive riparian weed species, unvegetated or poorly vegetated riparian zones, and uncontrolled stock access to river banks.

The application of the Index of River condition methodology to the Great Forester River catchment suggests that the technique can usefully be applied in Tasmania. 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).

The IRC suggests that the majority of sites in general within the catchment vary away from a natural state to no more than a moderate degree. Sub-indices provide additional information with regard to specific features of each measuring location and suggest a range of management issues for the future.

It is clear that riparian (streamside) zone management is a significant issue in the Great Forester 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.

TABLE OF CONTENTS

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 snap-shot 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 supplying 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.

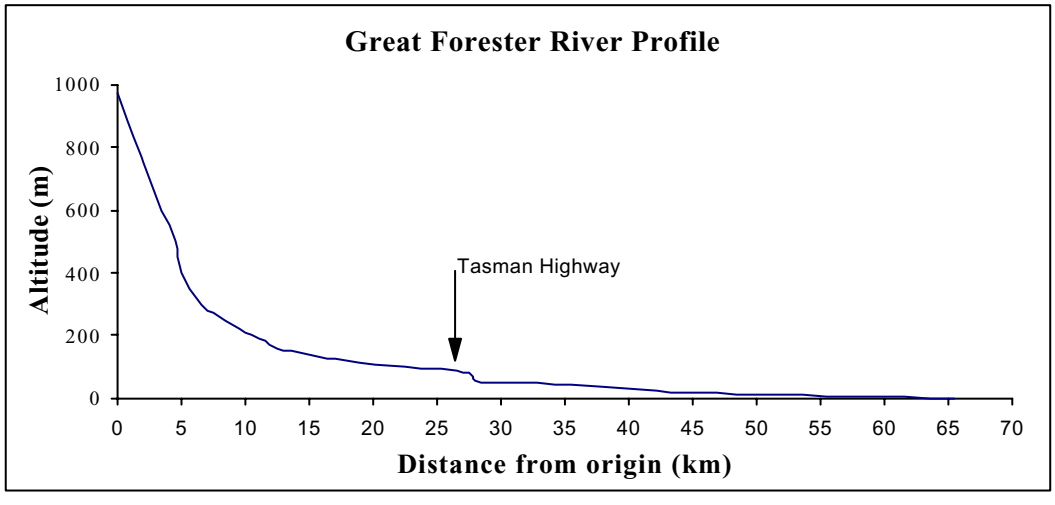
For the purposes of this report 'stream condition' is defined as the physical condition of the river as directly related to a 'natural condition'. The basis of the whole process is to analyse data against a benchmark of what is regarded as an unimpacted example. Each parameter is also viewed in terms 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 Great Forester River system. The catchment is situated in the north-east corner of the state. The river is 70 km long and originates at an altitude of 1000 m off Mt. Maurice (Figure 1). The main-stream is unregulated.

Figure 1. Great Forester R. altitudinal profile.



The river has been impacted by a number of activities in the catchment. Agricultural processes include hop growing, intensive cropping, pasture for stock, forestry, mining and industrial activities. Cleared agricultural land occurs throughout the catchment. Small scale aquaculture also occurs in the upper reaches. The upper reaches are typified by a cobble-gravel substrate grading to boulder-cobble in the higher reaches. The lower reaches are typified by a dominant sand substrate. The geology of the catchment is composed of largely granite in the upper reaches, precambrian metamorphics in the middle reaches and alluvial sequence in the lower catchment. The dominant vegetation structure is dry sclerophyll forest with *Eucalyptus obliqua* wet forest in the upper catchment.

The annual median flow is 1.7 cumecs and summer median flow is 0.8 cumecs. There was 6072 megaliters of water extracted from rivers in the catchment from a total of 46 users during the 1996-97 summer period (refer to the 'Hydrology Analysis' report for full details).

Field data collection for IRC parameters occurred at 34 sites within the catchment. 17 were on the main-stream Great Forester River, and 17 on tributary streams (Figure 2).

3. METHODOLOGY DESCRIPTION

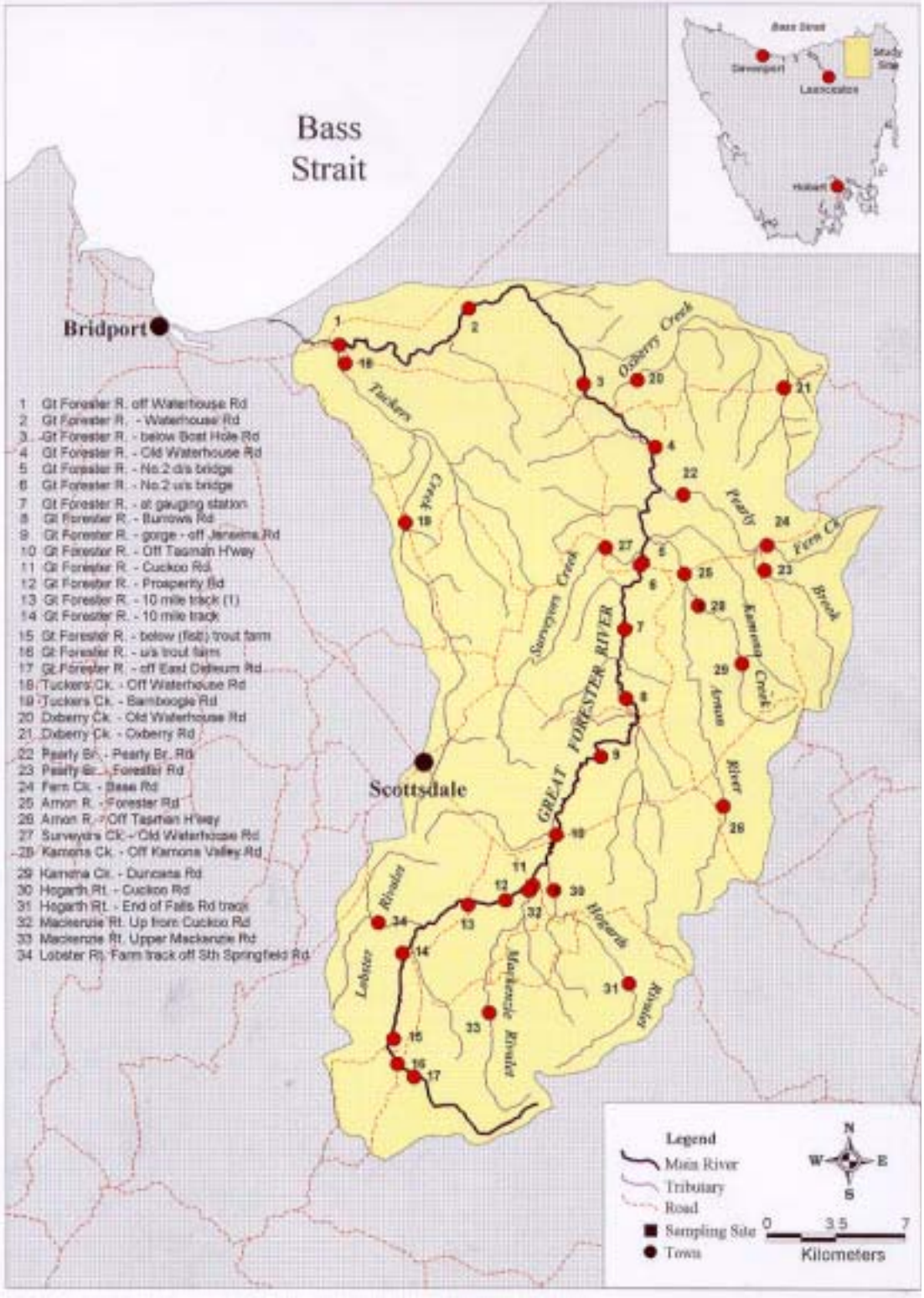
This technique is a modification of the methods adopted by the Queensland Department of Primary Industries 'State of the Rivers' studies and the 'Index of Stream Condition' developed by the Victorian Department of Conservation and Natural Resources. It involves the use of a 'snap-shot' approach, that 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 are 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

Figure 2: Great Forester River catchment. Index of River Condition (IRC) sites



communication between the teams, helping to standardise techniques and minimise potential problems.

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 (Table 1). 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 field training. Initial training is essential to maintain consistency in faunal sampling techniques and habitat assessment protocols. Training also highlights 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 categories.

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 AGS 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 the stream bank 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 is 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 effective 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 selected sites throughout the catchment with spot samples for the remainder. 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 (Table 4) is an approximate guide to what constitutes a high or low conductivity value with respect to dissolved salts. In Tasmania,

most of the lowland rivers will generally fall within the range of 100 -500 µS. In upper catchments most readings will be between 20 - 100 µS.

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 µS 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 250µm mesh dip net (dimensions 25 x 35 x 70 cm, height x width x depth). The substrate 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 all 34 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 affect water quantity. Many rivers are subject to hydro-electric regulation, many others are impacted by agricultural, industrial and domestic extraction requirements. The Great Forester 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 Commissional 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 Great Forester 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 Great Forester 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	**Very poor Highly modified**	**Poor Major modification**	**Moderate Some modification**	**Good Near natural**	**Excellent 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 Great Forester River sites

The IRC results for the main-stream Great Forester River are provided in Figure 3. 17 sites (reaches 1-17) 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 there is considerable variation in stream quality within the catchment. The uppermost site on the river was above all land use activities and clearly rated as in essentially natural condition (Figure 3 & 6). 7 sites rated as near natural and were spread throughout the catchment. Similarly 7 sites rated as partly modified also throughout the catchment. 2 sites were in poor condition (sites 4 and 11). This indicates the variable nature of land use throughout the catchment with intensive agriculture occurring in all zones except the very top of the catchment.

- The hydrology sub-index scores were low overall for most sites indicating extraction rates for the summer period are high and may be strongly influencing instream processes. No data was available for some of the lower sites (sites 4, 5 and 6) and near the top of the Great Forester R. off Didleum road (site 16).

- Physical form sub-index rated poorly throughout the catchment with conditions ranging between major modification from natural conditions (e.g. sites 8 & 10 mid catchment) to essentially natural (site 17 upper catchment).

- The streamside zone sub-index scores were lowest of all the sub-index values with 8 sites indicating very poor conditions (scattered throughout the stream length), 1 site in poor condition (site 15), 1 site moderately modified (site 16) and the remaining 7 sites in good condition. The parameter streamside cover revealed at least a major difference from ideal condition for 9 of the 15 sites. Structural intactness also revealed extreme difference from ideal condition for 7 sites and longitudinal continuity ratings showed extreme difference from natural conditions for 10 sites. Riparian width was also highly modified for 9 sites. The proportion of indigenous species was also low for 8 sites.

- Water quality at all sites was reasonably high. Data was missing for site 11 (Cuckoo road site).

- IRC results suggests that aquatic life within the main-stream is in a healthy state with 7 sites exhibiting good conditions and 10 sites with a maximum score of 10 (excellent condition).

- Data gaps present for the main-stream sites were minimal with information missing for extraction rates above sites 4, 5, 6 and 16 and water quality parameters for site 11.

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

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km^2)
1	Gt Forester R. - off Waterhouse Rd	540100	5459850	5	486
2	Gt Forester R. - Waterhouse Rd	545200	5461300	5	430
3	Gt Forester R. - below Boat Hole Rd	549700	5458300	18	378.9
4	Gt Forester R. - Old Waterhouse Rd	552500	5455700	25	199.2
5	Gt Forester R. - No.2 d/s bridge	552000	5451200	36	199.4
6	Gt Forester R. - No 2. u/s bridge	551900	5451100	36	199.5
7	Gt Forester R. - at gauging station	551300	5448550	42	182.8
8	Gt Forester R. - Burrows Rd	551350	5445800	45	164.9
9	Gt Forester R. - gorge off Jensens Rd	550350	5443500	95	141.8
10	Gt Forester R. - off Tasman H'way	548600	5440400	105	115.1
11	Gt Forester R. - Cuckoo Rd	547675	5438400	115	89.6
12	Gt Forester R. - Prosperity Rd	546600	5437800	125	61.8
13	Gt Forester R. - 10 Mile Track (1)	545125	5437625	135	56.1
14	Gt Forester R. - 10 Mile Track	542550	5435700	175	25.3
15	Gt Forester R. - below (fish) trout farm	542200	5432300	245	21.8
16	Gt Forester R. - u/s trout farm	5442100	5431700	265	12.9
17	Gt Forester R. - off East Didleum Rd	543000	5430800	320	7.5

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

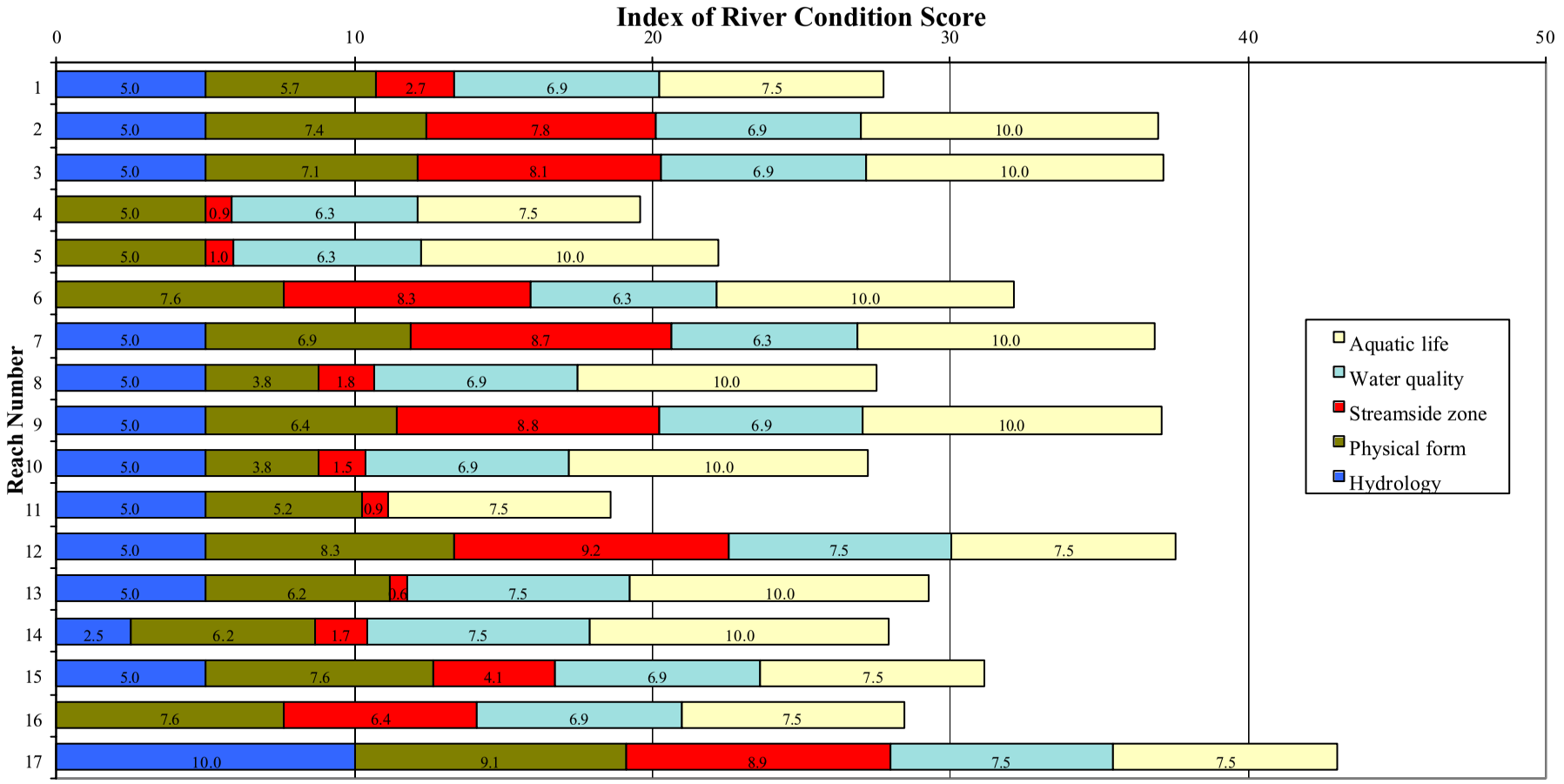


Table 9. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Great Forester R. main-stream sites.

		Hydrology (#)			Physical form (#)					Streamside zone (#)							Water quality (#)			Aquatic life (#)
Reach	M, V or F.	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																	
15	V	Yes	No																	
16	V	No	No																	
17	V	No	No																	

Key to table

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

Inadequate data to evaluate sub-index.

M = Mountain.
V = Valley.
F = Floodplain.
CWR = Commissional water rights.
CWD = Coarse woody debris (snags).

	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.

OSD = Overall site disturbance.
LC = Longitudinal continuity.
SC = Streamside cover.

4.2 Summary results for tributary streams of the Great Forester River.

The IRC results for the tributary streams of the Great Forester River are provided in Figure 4. A total of 10 tributaries consisting of 17 sites were sampled (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:

- A general observation is the change between upper and lower stream sites on each tributary throughout the entire catchment. Lower catchment tributary streams exhibit higher condition ratings at their lower stream sites than their upper sites (reach 18 & 19, Tuckers Ck., reach 20 & 21, Oxberry Ck., reach 22 & 23 Pearly Br., 25 & 26, Arnon R.) Upper catchment tributaries exhibit the reverse pattern with higher condition ratings at their upper sites than their lower sites (reach 30 & 31 Hogarth Rt., reach 32 & 33, Mackenzie Rt.). Kamona Creek (reach 28 & 29) sites are essentially identical in overall condition factor. Lobster R. (site 34) is clearly the most impacted throughout the catchment.

3 sites overall were classified as being in essentially natural condition (sites 27, 31 & 33), 9 sites spread throughout the catchment are in near natural condition (sites 18-20, 22, 24, 25, 28, 29, & 32) and 5 sites are in slightly modified condition (sites 21, 23, 26, 30 and 34).

- The hydrology sub-index varies amongst the tributaries with 7 out of 17 sites in moderate condition, 3 sites in good condition and the remaining 7 in excellent condition.

- The streamside zone sub-index varies considerably amongst the tributary streams. The results follow a similar pattern to overall condition ratings with lower catchment tributaries showing higher ratings for their lower sites than the upper, and the reverse for upper catchment streams. The most impacted site was at the upper Arnon River (site 26) whereby all indicators showed extreme modification from ideal. Upper Pearly Brook (site 23), lower Hogarth River (site 30) and Lobster River (site 34) were also all in very poor condition. Site 24 is in poor condition. In all these highly impacted sites riparian width, proportion of indigenous cover, longitudinal continuity and streamside cover were all highly modified. 3 sites (sites 19, 29 & 32) are in moderate condition and the remaining 9 sites are in good or near natural condition.

- The Water quality sub-index did not always rate well within the tributary sites. 2 sites exhibited major modification from a natural condition (site 20 and 34, Oxberry Creek and Lobster Rvt). Lobster Rvt had high turbidity and conductivity. 12 sites showed moderate impact and 2 sites were good or near natural (site 32 and 33 both on Mackenzie R.). Data was missing for the upper Oxberry Creek (site 21) therefore limiting analysis of the total IRC score for this site.

- The Aquatic life sub-index was extremely modified at site 20 on Oxberry Creek with some modification to natural for site 34 (Lobster Rt.). The remaining 15 sites were near natural or essentially natural in condition.

- Data gaps present for the tributary stream sites were minimal with information missing from site 21 in the form of and 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 Great Forester R.

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km^2)
18	Tuckers Ck. - off Waterhouse Rd	540300	5459100	5	66.2
19	Tuckers Ck. - Barnboogle Rd	542675	5452800	30	22.2
20	Oxberry Ck. - Old Waterhouse Rd	551800	5458450	15	36.4
21	Oxberry Ck. - Oxberry Rd	557550	5458150	115	7.8
22	Pearly Br. - Pearly Br. Rd	553600	5453900	40	34.4
23	Pearly Br. - Forester Rd	556800	5450900	115	14.8
24	Fern Ck. - Base Rd	556900	5451900	105	6.5
25	Arnon R. - Forester Rd	553650	5450750	45	54.8
26	Arnon R. - off Tasman H'way	555150	5441550	145	12.8
27	Surveyors Ck.- Old Waterhouse Rd	550550	5451800	45	20.7
28	Kamona Ck. - off Kamona Valley Rd	554200	5449500	55	15
29	Kamona Ck. - Duncans Rd	555900	5447200	85	6.4
30	Hogarth Rt. - Cuckoo Rd	548500	5438200	118	22.3
31	Hogarth Rt. - end of Falls Rd Track	551450	5434500	255	8
32	Mackenzie Rt. - up from Cuckoo Rd	547550	5438200	118	240
33	Mackenzie Rt. - Upper Mackenzie Rd	545950	5433350	250	10.6
34	Lobster Rt. Farm track off Sth Springfield Rd	541600	5436900	165	14.2

Figure 4. IRC results for the Great Forester River tributaries.

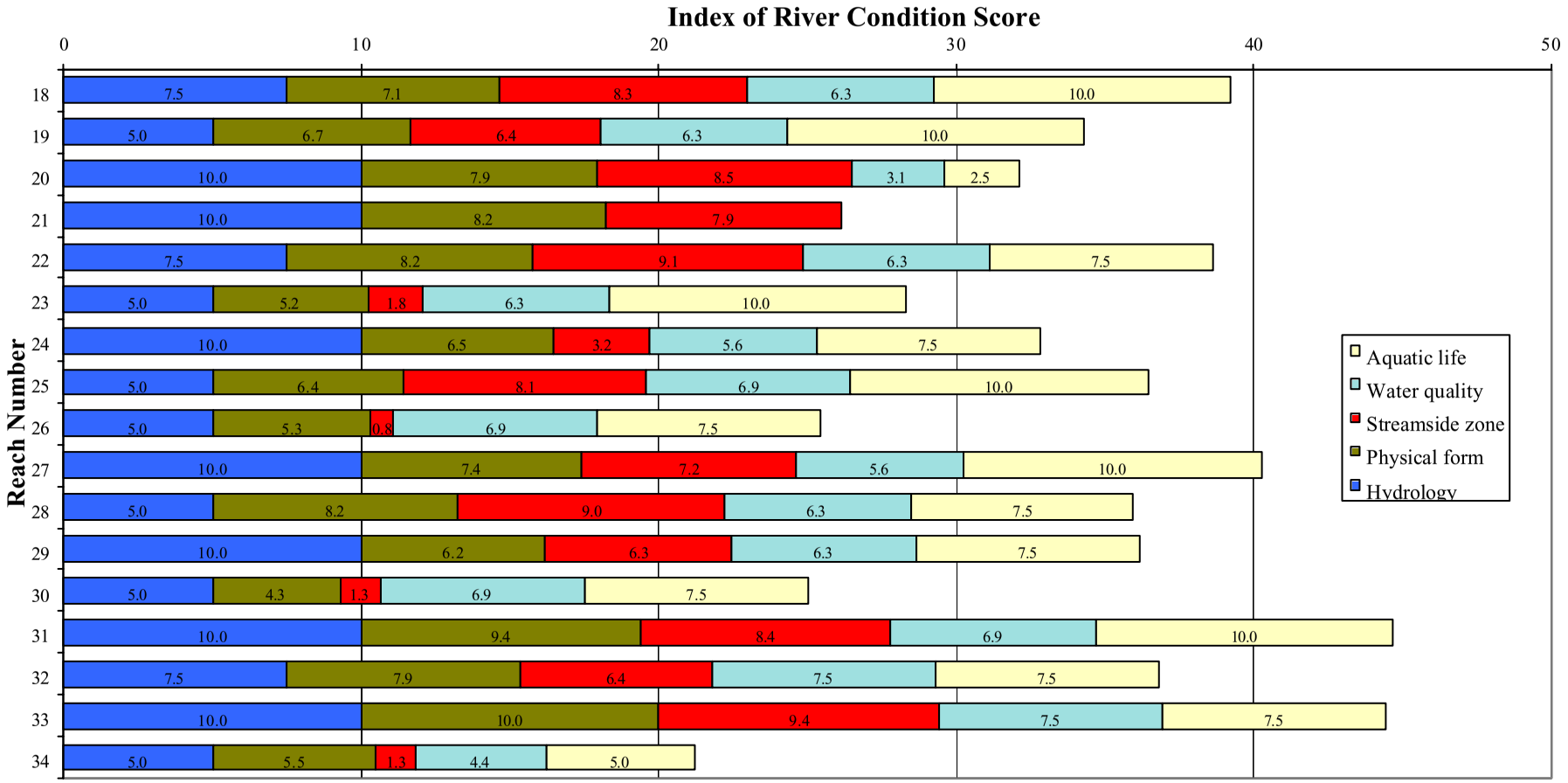


Table 11. Indicators suggesting a major or extreme difference from natural or ideal conditions, and data gaps, for the Great Forester R. tributary sites.

		Hydrology (#)			Physical form (#)					Streamside zone (#)							Water quality (#)			Aquatic life (#)
Reach	M, V or F.	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
18	F	No	No																	
19	F	No	No																	
20	V	No	No																	
21	V	No	No																	
22	V	No	No																	
23	F	No	No																	
24	V	No	No																	
25	F	No	No																	
26	V	Yes	No																	
27	F	No	No																	
28	V	No	No																	
29	V	No	No																	
30	F	No	No																	
31	V	No	No																	
32	F	No	No																	
33	V	No	No																	
34	F	Yes	No																	

Key to table

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

Inadequate data to evaluate sub-index.

M = Mountain.
V = Valley.
F = Floodplain.
CWR = Commissional water rights.
CWD = Coarse woody debris (snags).

	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.

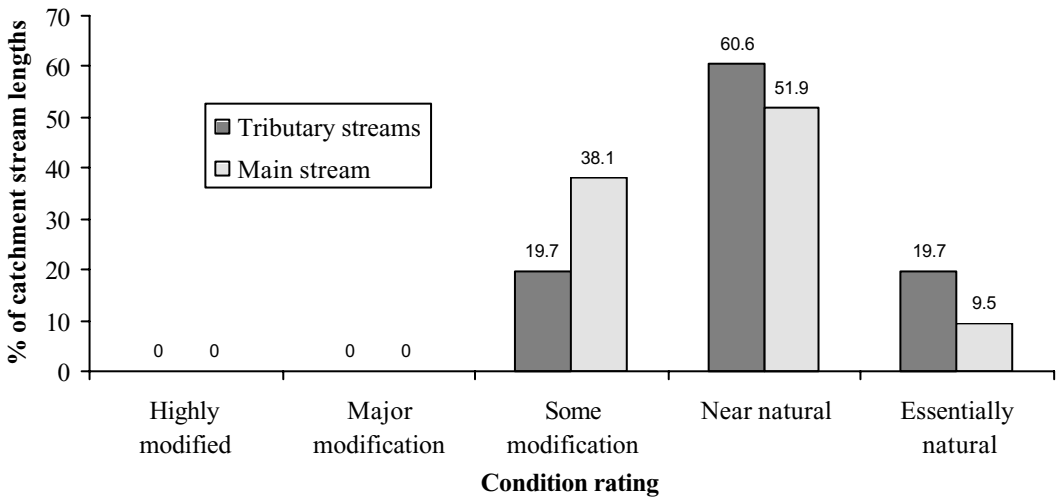
OSD = Overall site disturbance.
LC = Longitudinal continuity.
SC = Streamside cover.

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. Figure 5 details the rating structure of the proportion of stream lengths within the catchment. The data illustrated in the chart shows that over 50% of the main-stream is in near or essentially natural condition, while 38.1% is slightly modified. For the tributary streams 60.6% fall into the category of near natural condition, while 19.7% show some modification to condition and similarly 19.7% are essentially natural. The information available shows that the general condition of the catchment is reasonably healthy with the lowest score of moderate change from natural or ideal conditions. 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. The information available shows that overall condition of the catchment is respectably healthy.

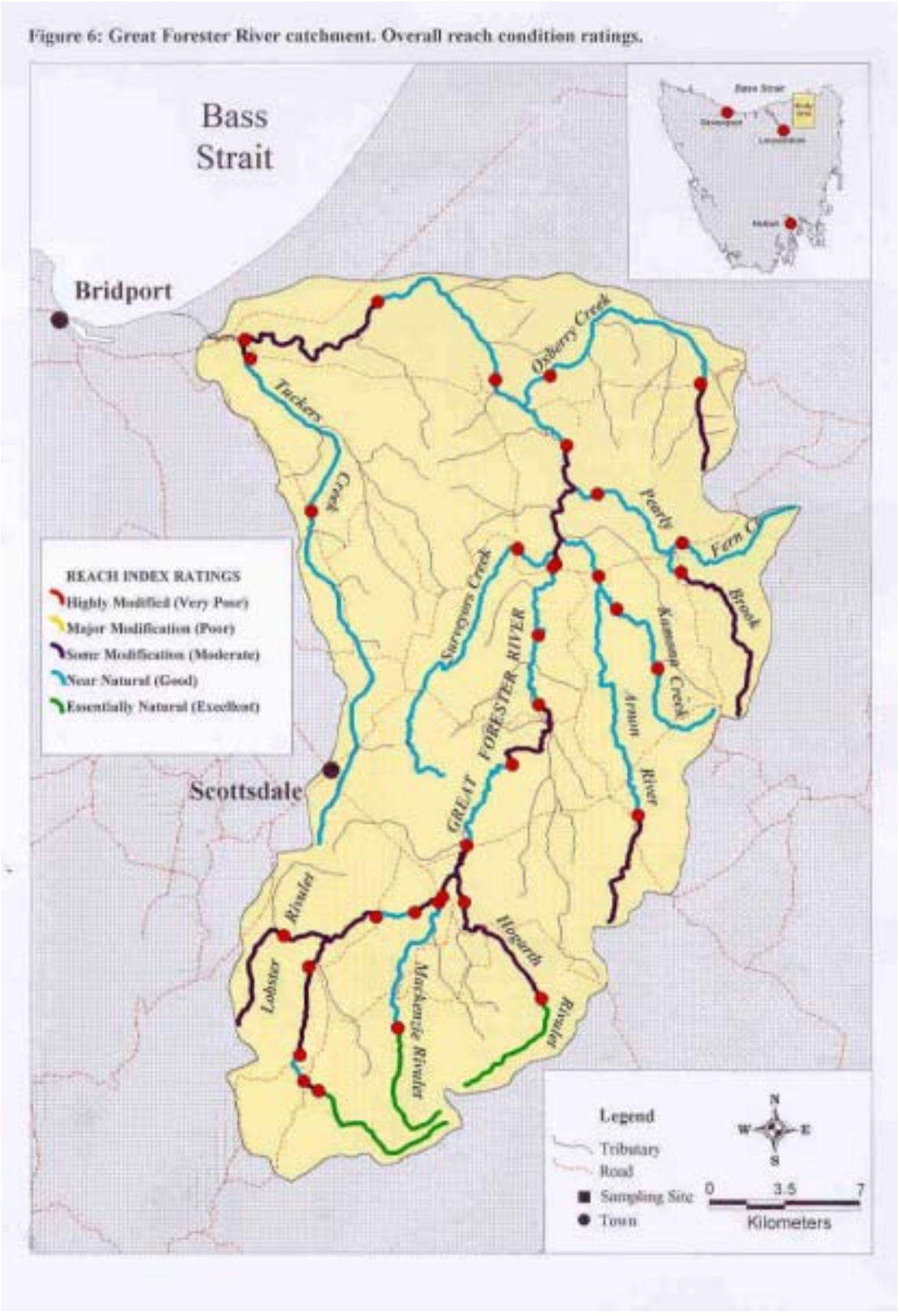
Figure 5. Overall river condition.



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 Great Forester R. catchment is highlighted by the reduced condition of some of the upper catchment reaches. Upper Pearly Brook has been modified by agriculture and forestry as has the upper Arnon River. The lowest section of the Great Forester R. is 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 throughout the catchment.

Figure 6 graphically illustrates the estimated distribution of overall condition ratings for stream length within the catchment. 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

Figure 6: Great Forester River catchment. Overall reach condition ratings.



reasonably representative of a particular reach. 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 but reasonably healthy environment with the lowest score of moderate 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 of 'near natural' condition (score greater than 30) indicating a respectively healthy environment. 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 aquatic fauna rates well indicating macroinvertebrate fauna is in reasonable condition (refer to the 'Aquatic Ecology' report for full details), followed by physical form and water quality. Hydrology rates well for the tributary streams. The greatest proportion of outakes occur on the main-stream Great Forester River and this has dragged the hydrology index rating down accordingly. The remaining rating, streamside zone, is quite low for both the mainstream and tributary streams. As can be seen this data varies 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.

	Numerical value (Rating)		
Category	**Main-stream Great Forester R. Sites**	**Great Forester R. Tributaries**	**Average for all catchment sites**
Hydrology	5.2	7.5	6.5
Physical form	6.4	7.1	6.8
Streamside zone	4.8	6.1	5.4
Water quality	6.9	6.2	6.5
Aquatic life	9.0	8.0	8.5
Overall IRC with	**33.3 (3)**	**34.5 (3)**	**34.0 (3)**

NB: bracketed 3 = good (near natural)

5. DISCUSSION

The Index of River Condition assessment protocol has effectively illustrated the state of specific sites and representative reaches within the Great Forester 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. The diverse nature of

land use in the Great Forester R. catchment is highlighted by the reduced condition of upper catchment reaches. Upper Pearly Brook has been modified by agriculture and forestry as has the upper Arnon River as opposed to limited activity in both lower catchments. The lowest section of the Great Forester R. is 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 throughout the catchment. Potential management issues may therefore occur throughout the catchment. Appendix 2B lists potential management issues that could be addressed. Obvious factors that came out as influencing site condition included the presence of non-native species in the stream-side zone, such as Crack willow, which was shown to be well established in certain sections of the Great Forester River and some tributaries such as the Lobster Rivulet. Blackberries also appear as a streamside weed at 16 of the 34 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:

- runoff patterns are altered due to a lack of understorey;
- instream habitat is altered; and
- canopy cover inhibits primary production through reduced light penetration.
- increased sedimentation and organic load - nutrient increases.
- reduced low flows - decreased dissolved oxygen levels.
- 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. It was noted at many sites that stock has unrestricted access to stream banks. 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. 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 but to no more than a moderate degree.

Main-stream Great Forester River

The information which has been collected indicates that the sites on the main-stream Great Forester River are in good 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, which was shown to be well established in the Great Forester River.

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 but seems to maintain a consistent rating along the length of the river (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 reasonable well overall but was low for several specific sites (sites 8 and 10), while the condition of the streamside zone was clearly the most impacted with 9 sites rating very poorly (sites 1, 4, 5, 8, 10, 11, 13, 14 and 15).

Management issues that may be considered include the presence of Crack Willow at 7 of the 17 sites at various locations along the system, the presence of understorey weed species such as blackberries and thistles, limited riparian zones at 9 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. There is no gradation of quality down the catchment indicating the diverse nature of land use along the system.

Tributaries of the Great Forester River

As with the main-stream of the Great Forester River, the tributary sites are apparently impacted by land practices such as farming, forestry and, in certain areas, mining. There is no indication of major impacts through modified flow regimes. However, these smaller streams are heavily influenced by riparian practices. Issues and impacts include the following:

- erosion due to the lack of streamside zones;
- uncontrolled stock access;
- exotic species in waterways;
- pollution inputs, and
- forestry practices including extensive plantations with no natural streamside zones and limited understorey.

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 and water quality is reasonable. Lobster Rivulet was the most heavily impacted system bordering on poor to moderate condition. The most common issues encountered for the tributary streams were excessive quantities of exotic weed species and limited streamside zones.

Tuckers Creek. (Sites 18 and 19)

The Tuckers Creek is a system that rates well through the index. In general, riparian structure is good at the lower site (18) and moderate at the upper site. Aquatic life is rated as in excellent condition which corresponds to the findings of the "Aquatic Ecology" report. Water quality is moderate. The upper site in general rates lower than the bottom site due to the impacts of riparian farmland.

Oxberry Creek.(Sites 20 and 21)

There were no significant physical or streamside zone problems encountered at either site on Oxberry Creek. The hydrology sub-index rated as essentially natural. The main impact was

that a bushfire had recently passed through the upper site (21). Instream parameters were significantly low at the bottom site (site 20) for instream fauna (poor condition) and water quality (very poor condition). No explanation could be found for this. Both these parameters were missing for the top site due to very low flow.

Pearly Brook. (Sites 22 and 23)

This catchment reverses the usual trend of improved conditions higher in the system. The lower catchment site (22) is in good condition as recorded through all parameters. The upper catchment has been impacted by farming activities, as a result the physical form rating is moderate and the streamside zone is heavily modified. At the upper site a number of management issues were noted including unstable banks, stock access to the stream, limited riparian zone and presence of weed species such as blackberries. Although it was noted that fencing had recently been erected to limit stock access to the stream and to protect stream banks.

Fern Creek (Site 24)

Only one site was surveyed in this small creek. The site was in good condition for most parameters except streamside zone. Management issues would include blackberry control and riparian zone rehabilitation.

Arnon R. (Sites 25 and 26)

This catchment also reverses the usual trend of improved conditions higher in the system. The lower catchment site (25) is in good condition as recorded through most parameters. The upper catchment is in moderate condition and has been impacted by farming activities. As a result physical form rating is down and the streamside zone is heavily modified and rated as being in very poor, highly modified condition. There are no obvious management issues at the lower site. The upper site would benefit from weed control, improvements to the riparian zone and restriction of stock access to stream banks.

Surveyors Creek (Site 27)

Only one site was targeted within this small catchment. The overall condition of the site rated as near natural. All sub-index parameters rated highly except for water quality which exhibited a moderate rating. No management issues were evident for this site.

Kamona Creek (Sites 28 and 29)

The lower site (28) was largely unimpacted except for a low hydrological index indicating potentially excessive irrigation out-takes. Both sites rated as in good overall condition, but the upper site had some issues in lower ratings for physical form and streamside zone. There were no evident management issues for the bottom site but the top site was within a pine plantation therefore natural regeneration of riparian species was limited. Due to the limited riparian zone careful control of harvesting of the pines may be necessary when this occurs.

Hogarth Rt. (Sites 30 and 31)

The Hogarth Rivulet catchment sites show a pattern of more natural condition in the upper reaches and less in the lower. The upper site (31) is the highest rated site in the entire catchment (i.e. closest site to a natural condition). All parameters rate well and no

management problems exist. In comparison the lower site rated as in moderate condition (some modification). This section is impacted by farming practices and influenced by upstream forestry operations. Management issues worth considering are limiting stock access to streamside zones and the watercourse, revegetation of riparian zones and control of weed species such as willows and blackberries**.**

Mackenzie R. (Sites 32 to 33)

Mackenzie River rated well for both sites with an excellent rating for the upper site and good for the lower. Condition of aquatic fauna and water quality was reasonable for both sites. Streamside zone rated as moderately modified for the lower site and essentially natural for the upper. No management issues were evident for the upper site which is essentially natural. For the lower site management consideration could include rehabilitation of the riparian zone and potential weed control. Blackberries are present but it could not be determined if this is a major problem.

Lobster Rt. (Site 34)

This was the most impacted site in the entire catchment. 2 other mainstream sites rated lower but had missing data sets. All sub-index parameters rated as moderate or lower with streamside zone rating as very poor. This site was highly impacted by farming practices with modifications to the stream channel, little to no riparian zone that consisted of willow species only, presence of blackberries, weed choked water course and unrestricted stock access to the watercourse. Management issues would be re-establishment of native riparian zones, exotic weed control and restricting stock access to the streambanks.

As with the main-stream of the Great Forester River, the tributary sites are apparently impacted by land practices such as farming and 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;
- choking of waterways from exotic species;
- pollution inputs;
- lack of streamside vegetation, and
- forestry practices including extensive plantations with no natural streamside zones and limited understorey.

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 and hydrology impacts are moderate. Lobster Rivulet was the most heavily impacted system bordering on major modification from a natural state. 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 illustrated that it is a useful tool in assessing river condition at selected sites within a catchment that are representative of a given reach. 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. This is evident through comparison with unimpacted and impacted reaches.

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:

- 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
- the assessment of pollution sources within the catchment.

From the available data it has become 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 reasonable condition of these parameters. Aquatic fauna (freshwater invertebrates) are generally healthy but water quality is only fair (refer to the 'Water Quality" report for a comprehensive breakdown of catchment conditions).

This project set out to illustrate the condition of specific sites as representatives of a given reach within the Great Forester River catchment and to this end the results indicate that this has been suitably 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.

7. REFERENCES

Apace Green Skills and Pen, L. (1995) The condition of the Denmark and Hay River foreshores 1995. Waterways Commission, Rep. No. 60.

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., (1997) An Index of Stream Condition: Reference Manual. Report prepared for the Waterway and Floodplain Unit of the Department of Natural Resources and Environment.

Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1997) An Index of Stream Condition: Trial Application. Report prepared for the Waterway and Floodplain Unit of the Department of Natural Resources and Environment.

Centre of Environmental Applied Hydrology (CEAH) and ID&A Pty. Ltd., (1997) An Index of Stream Condition: User's Manual. Report prepared for the Waterway and Floodplain Unit of the Department of Natural Resources and Environment.

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., Growns, 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.

Acknowledgements

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

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

The author would also like to acknowledge the support received from landowners within the Great Forester River catchment during the field program.

APPENDICES

APPENDIX 1 Sub-index and overall ISC 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	**5.0**	**5.7**	**2.7**	**6.9**	**7.5**	**27.7**	**486**
2	**5.0**	**7.4**	**7.8**	**6.9**	**10.0**	**37.0**	**430**
3	**5.0**	**7.1**	**8.1**	**6.9**	**10.0**	**37.2**	**378.9**
4	#	**5.0**	**0.9**	**6.3**	**7.5**	#	**199.2**
5	#	**5.0**	**1.0**	**6.3**	**10.0**	#	**199.4**
6	#	**7.6**	**8.3**	**6.3**	**10.0**	#	**199.5**
7	**5.0**	**6.9**	**8.7**	**6.3**	**10.0**	**36.9**	**182.8**
8	**5.0**	**3.8**	**1.8**	**6.9**	**10.0**	**27.5**	**164.9**
9	**5.0**	**6.4**	**8.8**	**6.9**	**10.0**	**37.1**	**141.8**
10	**5.0**	**3.8**	**1.5**	**6.9**	**10.1**	**27.2**	**115.1**
11	**2.0**	**5.2**	**0.9**	#	**7.5**	#	**89.6**
12	**5.0**	**8.3**	**9.2**	**7.5**	**7.5**	**37.6**	**61.8**
13	**5.0**	**6.2**	**0.6**	**7.5**	**10.0**	**29.3**	**56.1**
14	**2.5**	**6.2**	**1.7**	**7.5**	**10.0**	**27.9**	**25.3**
15	**5.0**	**7.6**	**4.1**	**6.9**	**7.5**	**31.1**	**21.8**
16	#	**7.6**	**6.4**	**6.9**	**7.5**	#	**12.9**
17	**10.0**	**9.1**	**8.9**	**7.5**	**7.5**	**43.0**	**7.5**
18	**7.5**	**7.1**	**8.3**	**6.3**	**10.1**	**39.2**	**66.2**
19	**5.0**	**6.7**	**6.4**	**6.3**	**10.0**	**34.3**	**22.2**
20	**10.0**	**7.9**	**8.5**	**3.1**	**2.5**	**32.1**	**36.4**
21	**10.0**	**8.2**	**7.9**	**DRY**	**DRY**	#	**7.8**
22	**7.5**	**8.2**	**9.1**	**6.3**	**7.5**	**38.6**	**34.4**
23	**5.0**	**5.2**	**1.8**	**6.3**	**10.0**	**28.3**	**14.8**

APPENDIX 1 (cont.)

24	**10.0**	**6.5**	**3.2**	**5.6**	**7.5**	**32.8**	**6.5**
25	**5.0**	**6.4**	**8.1**	**6.9**	**10.0**	**36.4**	**54.8**
26	**5.0**	**5.3**	**0.8**	**6.9**	**7.5**	**25.4**	**12.8**
27	**10.0**	**7.4**	**7.2**	**5.6**	**10.0**	**40.2**	**20.7**
28	**5.0**	**8.2**	**9.0**	**6.3**	**7.5**	**36.0**	**15**
29	**10.0**	**6.2**	**6.3**	**6.3**	**7.5**	**36.2**	**6.4**
30	**5.0**	**4.3**	**1.3**	**6.9**	**7.5**	**25.0**	**22.3**
31	**10.0**	**9.4**	**8.4**	**6.9**	**10.0**	**44.7**	**8**
32	**7.5**	**7.9**	**6.4**	**7.5**	**7.5**	**36.8**	**240**
33	**10.0**	**10.0**	**9.4**	**7.5**	**7.5**	**44.4**	**10.6**
34	**5.0**	**5.5**	**1.3**	**4.4**	**5.0**	**21.2**	**14.2**

Actual average	**10**	**10**	**10**	**10**	**10**	**50**
Observ. average	**6.5**	**6.8**	**5.4**	**6.5**	**8.5**	**34.0**
Condition	Moderate **Some modification**	Moderate **Some modification**	Moderate **Some modification**	Moderate **Some modification**	Good **Near natural**	Good **Near natural**

= no data available.

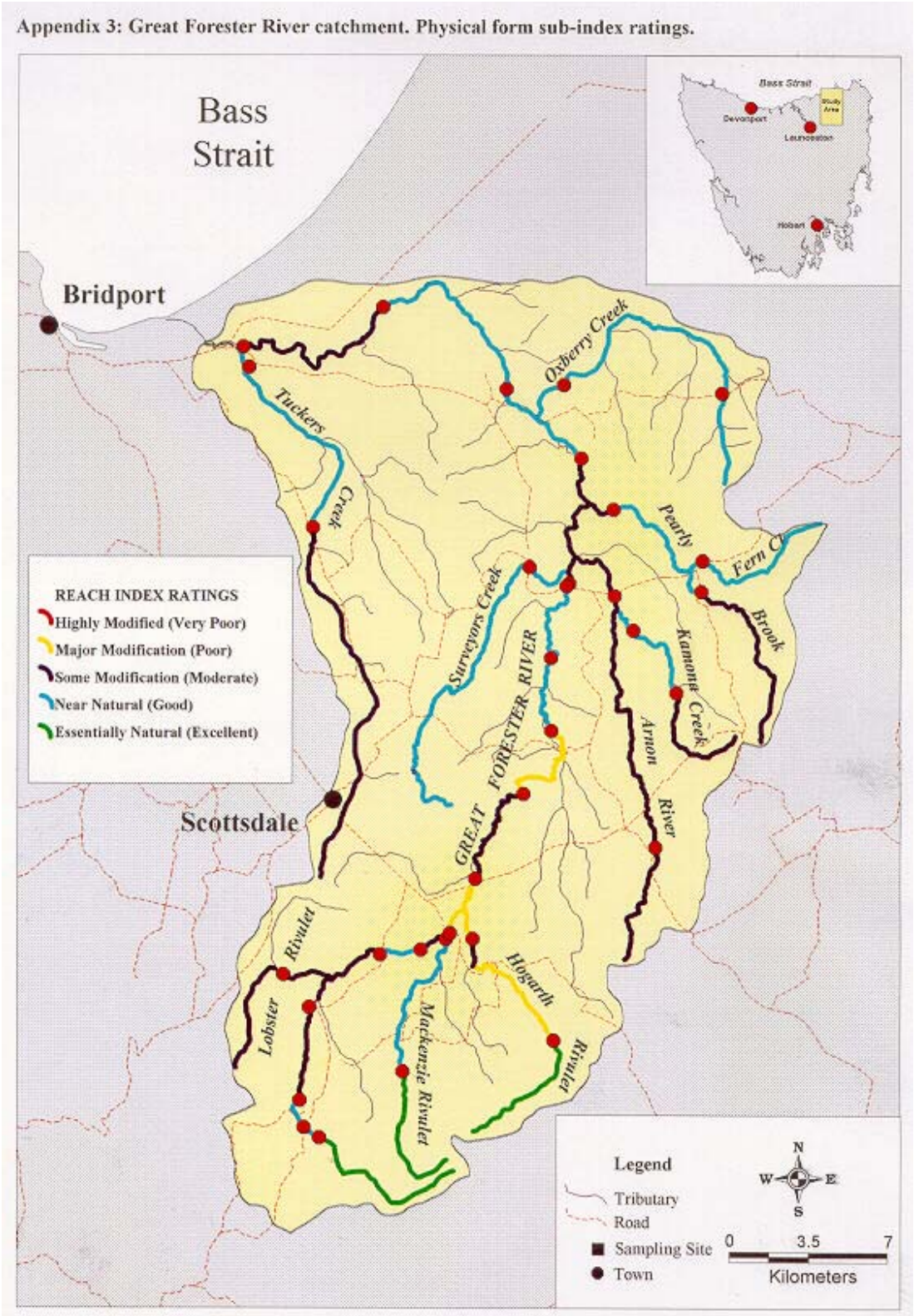
APPENDIX 2A. Site list with grid references for each study location.

Reach No.	Site	Easting (m)	Northing (m)	Altitude (m)	Area (Km^2)
1	Gt Forester R. - off Waterhouse Rd	540100	5459850	5	486
2	Gt Forester R. - Waterhouse Rd	545200	5461300	5	430
3	Gt Forester R. - below Boat Hole Rd	549700	5458300	18	378.9
4	Gt Forester R. - Old Waterhouse Rd	552500	5455700	25	199.2
5	Gt Forester R. - No.2 d/s bridge	552000	5451200	36	199.4
6	Gt Forester R. - No 2. u/s bridge	551900	5451100	36	199.5
7	Gt Forester R. - at gauging station	551300	5448550	42	182.8
8	Gt Forester R. - Burrows Rd	551350	5445800	45	164.9
9	Gt Forester R. - gorge off Jensens Rd	550350	5443500	95	141.8
10	Gt Forester R. - off Tasman H'way	548600	5440400	105	115.1
11	Gt Forester R. - Cuckoo Rd	547675	5438400	115	89.6
12	Gt Forester R. - Prosperity Rd	546600	5437800	125	61.8
13	Gt Forester R. - 10 Mile Track (1)	545125	5437625	135	56.1
14	Gt Forester R. - 10 Mile Track	542550	5435700	175	25.3
15	Gt Forester R. - below (fish) trout farm	542200	5432300	245	21.8
16	Gt Forester R. - u/s trout farm	5442100	5431700	265	12.9
17	Gt Forester R. - off East Didleum Rd	543000	5430800	320	7.5
18	Tuckers Ck. - off Waterhouse Rd	540300	5459100	5	66.2
19	Tuckers Ck. - Barnboogle Rd	542675	5452800	30	22.2
20	Oxberry Ck. - Old Waterhouse Rd	551800	5458450	15	36.4
21	Oxberry Ck. - Oxberry Rd	557550	5458150	115	7.8
22	Pearly Br. - Pearly Br. Rd	553600	5453900	40	34.4
23	Pearly Br. - Forester Rd	556800	5450900	115	14.8
24	Fern Ck. - Base Rd	556900	5451900	105	6.5
25	Arnon R. - Forester Rd	553650	5450750	45	54.8
26	Arnon R. - off Tasman H'way	555150	5441550	145	12.8
27	Surveyors Ck.- Old Waterhouse Rd	550550	5451800	45	20.7
28	Kamona Ck. - off Kamona Valley Rd	554200	5449500	55	15
29	Kamona Ck. - Duncans Rd	555900	5447200	85	6.4
30	Hogarth Rt. - Cuckoo Rd	548500	5438200	118	22.3
31	Hogarth Rt. - end of Falls Rd Track	551450	5434500	255	8
32	Mackenzie Rt. - up from Cuckoo Rd	547550	5438200	118	240
33	Mackenzie Rt. - Upper Mackenzie Rd	545950	5433350	250	10.6
34	Lobster Rt. Farm track off Sth Springfield Rd	541600	5436900	165	14.2

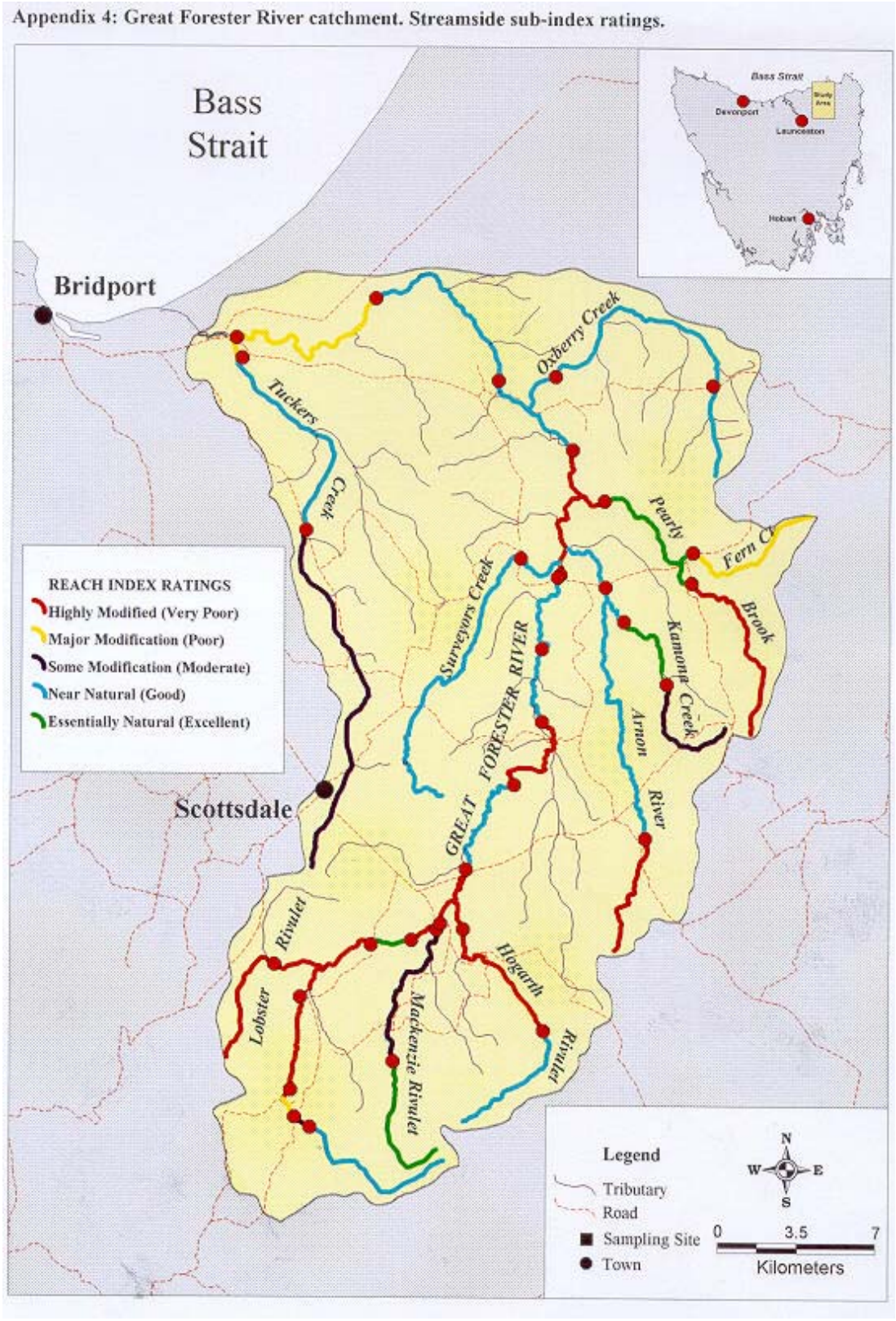
APPENDIX 2B. Management issues identified for the main-stream Great Forester River sites.

Reach	Management issues
1	Weeds: Thistles. Very limited riparian zone. Limited indigenous plant regeneration.
2	Some stock access.
3	Weeds: Blackberries, Thistles. No riparian zone, unrestricted stock access. unstable banks and bed. No indigenous plant regeneration.
4	None.
5	Weeds: Willows, Blackberries, Thistles. No riparian zone, some stock access. unstable banks and bed. No indigenous plant regeneration.
6	Weeds: Blackberries, Thistles.
7	None.
8	Weeds: Willows, Blackberries, Thistle. Limited to no riparian zone. Unstable bank and bed material. Limited indigenous plant regeneration.
9	None.
10	Weeds: Willows, Blackberries. No riparian zone. Unstable bed material. No indigenous plant regeneration.
11	Weeds: Willows, Blackberries, Thistles. Limited to no riparian zone. No indigenous plant regeneration.
12	None.
13	Weeds: Willows, Poplars. No riparian zone. No indigenous plant regeneration. Some stock access.
14	Weeds: Willows, Blackberries. Limited riparian zone. No indigenous plant regeneration. Some stock access.
15	Weeds: Willows, Blackberries. Limited to no riparian zone. No indigenous plant regeneration.
16	Exotic pines as riparian vegetation, Blackberries.
17	Weeds: Blackberries.
18	Unstable bed material.
19	Altered riparian zone. Some stock access.
20	None.
21	None.
22	None.
23	Weeds: Blackberries. Limited riparian zone, unstable banks, unrestricted stock access in some areas.
24	Weeds: Blackberries. Limited riparian zone, some as pines.
25	Unstable banks.
26	Weeds: Blackberries, Thistles. No riparian zone, some stock access.
27	None.
28	None.
29	Limited riparian zone, some as pines.
30	Weeds: Willows, Blackberries. No riparian zone, unstable banks, unrestricted stock access.
31	None.
32	Weeds: Blackberries. Alterred riparian zone.
33	None.
34	Weeds: Willows, Blackberries, Thistles. Limited to no riparian zone, unrestricted stock access. Stream channelization.

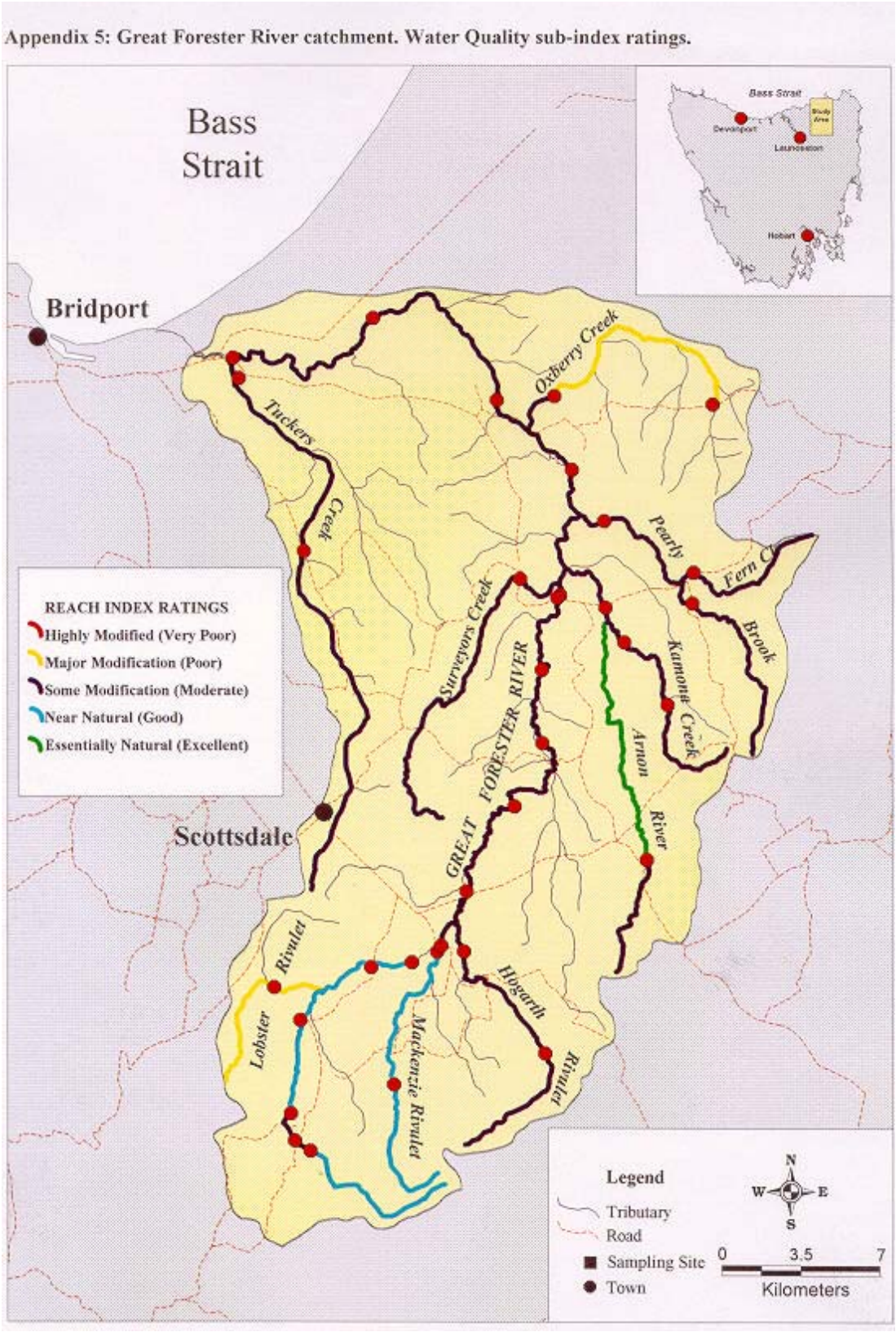
Appendix 3: Great Forester River catchment. Physical form sub-index ratings.



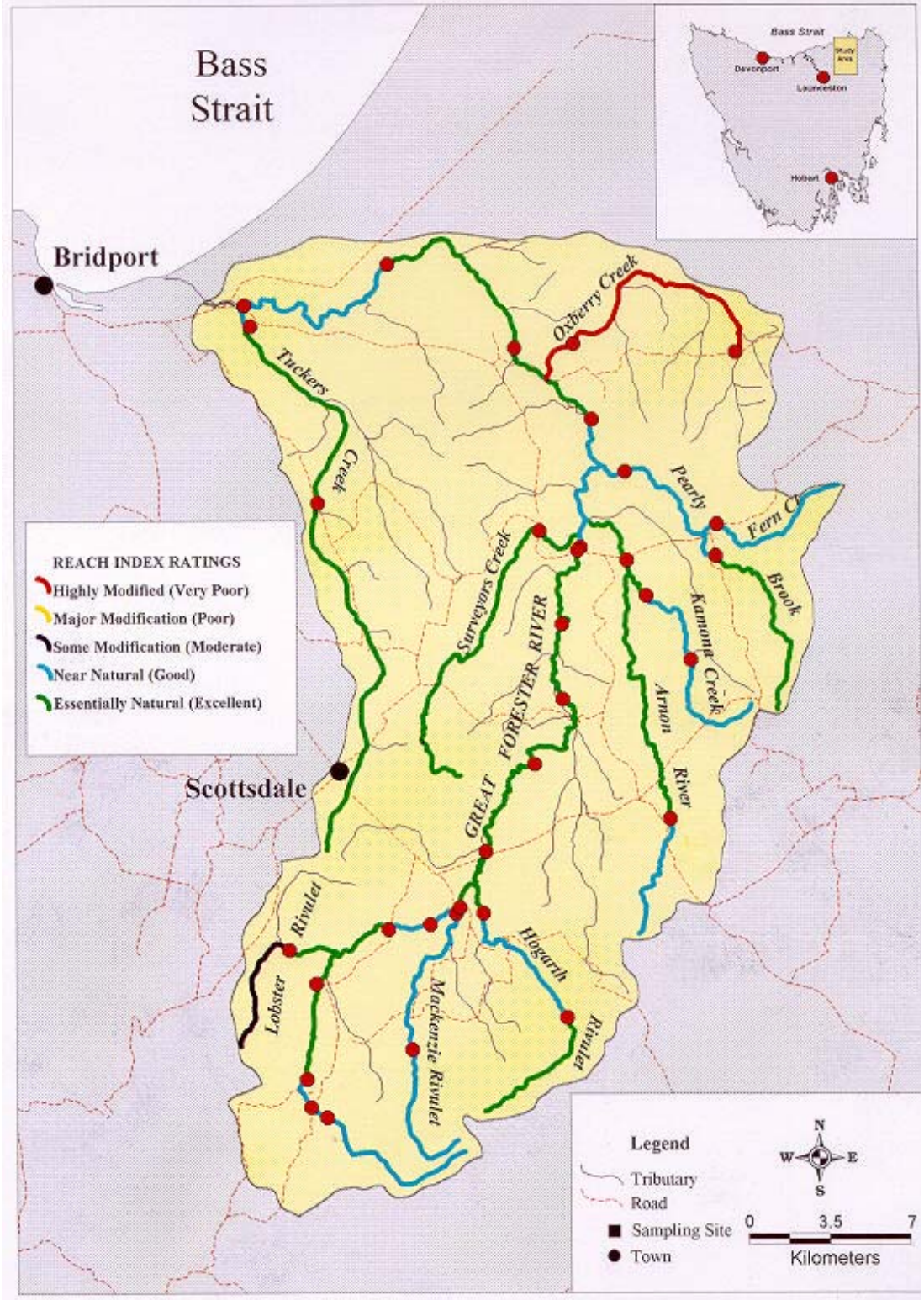
Appendix 4: Great Forester River catchment. Streamside sub-index ratings.



Appendix 5: Great Forester River catchment. Water Quality sub-index ratings.



Appendix 6: Great Forester River catchment. Aquatic Life sub-index ratings.



Appendix 7: Great Forester River catchment. Hydrological sub-index ratings.