STATE of the RIVERS
MAROOCHY RIVER
and
TRIBUTARY STREAMS

july 1993
An ecological and physical assessment of the condition of streams in the Maroochy River catchment

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and
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Preface

This report on the State of the Maroochy River is the first produced using the recently developed 'State of the Rivers' methodology developed by the author for the Department of Primary Industries (DPI), Queensland (Anderson 1993 a,b). The Maroochy River catchment was used as a pilot for testing and validating various aspects of the methodology, and for validating the approach taken. The pilot study was very successful and this enabled a complete survey of the catchment to be accomplished rather than the partial survey that was originally intended.

Using sponsorship from the Maroochy Shire Council and DPI the data collected have been analysed and the results summarised in this report.

The report is directed at providing an assessment of the State of the Maroochy River in terms of the physical and environmental condition of the rivers and streams throughout the catchment at the time of the survey, relative to the presumed pristine original condition of the catchment. Local remnant sites within the catchment that remain in very good condition provide an indication of the original state of the whole catchment. The method uses a 'snap-shot' approach to assess various components and an overall condition rating with the results presented in terms of the length of stream classified into various condition categories.

The methodology is directed at providing the basic data set required for effective integrated catchment management in terms of the instream parameters and condition ratings. It also provides a method for assessing the seriousness of stream degradation, locating where the major problems are occurring and their cause. The processes causing the problem may often be remote from the site of the degradation either occurring in the channel far upstream, on the local or upstream banks, or in remote sub-catchment areas.

The focus of the methodology is initially on the catchment itself to service the local and regional needs for diagnosing the condition of the rivers and streams within a local area. However, by employing the same standard objective approach throughout Queensland, on a catchment by catchment basis, a state-wide diagnosis of the State of the Rivers will be produced which can be used to establish state-wide priorities and programmes based on such an audit.

The methodology does not establish either current or historical trends nor the rate of change in condition. It was recognised during development of the methodology that consistent historical information was not available in sufficient detail or scope to establish this perspective. The rate of change in condition can be assessed by conducting follow-up surveys after the initial benchmark is established. The rapid survey approach was specifically designed for conducting these follow-up surveys.

Acknowledgements

This report was made possible through the assistance and sponsorship of the Maroochy Shire Council and DPI, Queensland. The Maroochy Shire council staff and the Maroochy Integrated Catchment Management Group, particularly Derek Foster also provided valuable local information and assistance during the planning phase of the project. The survey itself was conducted over a three week period from 11 September 1992 to 2 October 1992. It involved the author, Dr. John Anderson (consultant), Glen Moller, DPI, Brisbane and five officers from DPI, Gympie Office - Peter Boettcher, Greg Grainger, Bob Watson, Mark Perry and Helen Chalmers. The cheerfulness, dedication and thoroughness of the survey staff is gratefully acknowledged particularly their ability to quickly learn and apply new methods that were under development. The GIS implementation and mapping was carried out by the GIS unit of DPI Brisbane. The involvement of Chris Robson (DPI, South East Region), Glen Moller (DPI, Brisbane) and Councillor Elaine Green (Maroochy Shire Council) on the steering committee for this project is also gratefully acknowledged.
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Summary

The Method

The ‘State of the Rivers’ methodology (Anderson 1993 a,b) provides a comprehensive method for classifying the current physical and ecological condition of rivers and streams. This first State of the Rivers Report for the Maroochy River arose from the pilot surveys used to develop and validate the techniques. The survey was conducted from 11 September to 2 October 1992, during the drier part of the year, which is the preferred time for such surveys.

The method is focused on a ‘snap-shot’ survey approach directed at using rapid surveys of key components within the stream itself and along the banks. The basic sampling strategy is based on the notion of ‘homogenous streams sections’. The streams and rivers throughout the catchment are successively divided into smaller and smaller sections until the notion of homogeneity is satisfied in terms of the scale, natural features and condition deemed appropriate for the study. The target of the method is therefore:

- to identify these homogeneous sections of different length,
- to sample representative sites in these sections using instream survey techniques,
- to analyse and objectively rate the physical and ecological condition of the sections, and
- to generate summaries of the condition of the sections in the form of maps to locate problem areas and remnant sections of high value. Summary information is also required in the form of tables showing the percentages of stream sections classified into various condition categories. This provides a prognosis of the size and seriousness of the problem.

Finalising the boundaries and number of homogeneous sections is an iterative process. The initial subdivision used to allocate the sites is reviewed and modified using observations made during the surveys and after analysing the results.

The focus of the surveys is on collecting instream data, that is information about the stream itself, the banks and the channel. Such information cannot be obtained reliably by remote sensing methods. A direct survey approach is fundamental for the methodology.

Rapid survey methods are used to compile comprehensive information about sample reaches of varying length (usually 50m long). These reaches, chosen to be representative of the natural attributes and condition of the streams in the sections, form the survey sites. One or more of such sites are sampled in each section. Each site is surveyed by a team of two people. The survey requires about 45-60 minutes at each site allowing about 8-10 sites to be surveyed in a day. Two teams of two people can survey about 200 sites in a two week period.

The method is focused on a relatively large number of sites to adequately sample the variety of different stream types present in each catchment in terms of their natural features and their current condition. The 185 sites fully surveyed in the Maroochy catchment was considered adequate for its size, in terms of the resolution required and the variability in natural attributes and condition in the catchment. The time spent at each site has been limited to 45-60 minutes to allow a relatively large number of sites to be surveyed. This is crucial for the methodology.

The survey includes a number of different components, each of which is assessed independently to derive an objective condition rating. These ratings are then combined to provide an overall condition rating. There is a separate datasheet and database for each component surveyed. The components surveyed are:-

Reach Environons - the condition of the land immediately bordering the survey reach (the vegetative cover, land use, land tenure, etc.) on the floodplain and valley flat immediately adjacent to the stream in the reach.

Channel Habitat - the proportion and dimensions of the channel habitat types in the reach, classified into various habitat types (e.g. pool, riffle, run, rapid, cascade, etc.).

Channel Form and Dimensions - cross-section measurements are taken for pools and other habitats types. Sediment particles sizes are determined for the bed and banks. Depth, width, bank height, bank slope and various other measurements are taken in the channel for pools and other habitat types present (riffle, runs, etc.).

State of the Maroochy River, 1993
Bank Condition - the condition, slope, shape and dominant process are determined for each bank in each reach surveyed. The bank stability and processes affecting it are assessed.

Bed and Bar Condition - the condition, dominant process and stability of the stream bed are determined. The size, location and features of the bars are assessed. Also the ease of passage or migration for fish and other aquatic organisms is assessed by classifying the height and other features of the natural and artificial barriers along the reach.

Riparian and Aquatic Vegetation - the condition of the riparian vegetation along the stream verges is assessed in terms of the width, structural form and species composition of the remnant riparian zone. The aquatic vegetation (submerged, floating and emergent) is also assessed (cover and species composition).

Aquatic Habitat - the condition of the aquatic habitat is assessed in terms of channel habitat type, depth and width and substrates. The organic debris cover (logs branches, etc.), canopy cover, and cover along the banks (vegetation, roots, bank overhang, etc.) are also assessed.

Scenic, Recreational and Conservation Values - these values are assessed subjectively using various rating scales to provide relative overall value assessments for each reach.

Additional Components - additional datasheets and databases are used to compile, store and analyse information about the river and stream sub-sections and their immediate sub-catchments. They are also used to record the location and descriptive information about the survey sites and hydrological summaries. Water quality is not included in the methodology. It is not really appropriate for a 'snap-shot' approach. Analysis of long term records is required to classify stream sections in terms of the extent to which water quality standards are met or not met in terms of time, flow, concentrations, loads and maximum values. Such records are not adequate nor consistent enough for inclusion in the methodology. The long term record is simply not available. A single survey could be misleading, except in establishing the variability in water quality across the catchment at one point in time.

The Department of Environment and Heritage conducted a survey of 50 selected 'State of the Rivers' sites in the Maroochy catchment in late 1992 to assess the variability in water quality throughout the catchment. The results of their survey will be the subject of a separate report.

The various parameters recorded for each component are stored in a set of linked databases (DBASE IV). These databases are an integral part of the methodology as they provide access to the raw and processed information for detailed follow-up work and investigations. A set of 5 photographs taken at each site (a total of about 1000 colour slides) provide an additional record for future reference. These data provide a benchmark for follow-up surveys. Historical photographs can also be used to establish historical trends and the original condition of some of the sites.

The database package includes a set of data analysis and manipulation programs, and programs to generate summaries and condition ratings. These ratings are produced from a set of formulae which use combinations of the raw data which are appropriately weighed in terms of their relative importance in producing the ratings.

Each of these derived ratings is scored as a percentage, with 100% representing pristine conditions, and 0% highly degraded conditions. Condition ratings are produced for each component at each site surveyed. Ratings are also produced for the sections combining the data for the sites surveyed in each section. The condition assessment is therefore made in terms of the percentage change in condition from a presumed natural pristine state. An overall condition assessment is also produced for each river section which combines the individual ratings (using a cluster analysis technique).

Five standard condition categories have been used in summarizing the data:-

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>81-100%</td>
</tr>
<tr>
<td>Good</td>
<td>61-80%</td>
</tr>
<tr>
<td>Moderate</td>
<td>41-60%</td>
</tr>
<tr>
<td>Poor</td>
<td>21-40%</td>
</tr>
<tr>
<td>Very Poor</td>
<td>0-20%</td>
</tr>
</tbody>
</table>
Variations of this standard scheme are used for some of the components. The condition relationships are assumed to be linear.

A relative, rather than an absolute and fixed standard, has been used in setting the original bench mark condition for deriving the ratings. The methodology uses local standards of similar sites in pristine or very good condition to set the standard. The condition rating assesses the extent to which the condition of the banks, vegetation or some other survey component has deteriorated from this local standard. The methodology allows for different standards to be used in different catchments. Different standards may also be appropriate in sub-catchments or other areas within the one catchment, using altitude or land system classifications to define the areas. It also allows for the standards to vary in their original pristine ratings. The standard sites are all scaled to 100% for comparison, and the ratings for related sites are scaled proportionally a similar way. For example if the maximum rating for riparian vegetation at the standard site is only 60%, this is scaled upward to 100%, and all sites to be compared to this standard are scaled upward by a similar proportion (multiplied by 100/60).

This avoids the situation where streams in western Queensland, that naturally have less riparian vegetation than rainforest streams along the coast are a priori given poor condition ratings. It would be wrong to downgrade the ratings of the western streams, even those in pristine condition, by the use of an absolute and fixed standard applied throughout Queensland. All streams can then be compared in terms of the extent of change in condition from their original condition, scaled to 100% using local or regional standard sites in good or pristine condition.

No such scaling was required in the Maroochy catchment because the maximum score for all components was close to 100% and the differences between stream type were not sufficient to warrant different standards being applied to various sub-catchments or other areas.

Condition Assessment

An overall condition assessment was produced using a cluster analysis program which grouped sections with components in similar condition. Seven overall condition categories were recognised:- Very Good, Good, Moderate, Poor, Very Poor, Degraded and Highly Degraded.

The derivation of these categories in terms of the individual components is shown in the figure on the next page.

In terms of these overall condition ratings, about one third of the major stream length is in good condition, another third in moderate to poor condition, and a further third in degraded to highly graded condition.

- Only 14% of the total length of streams in the entire catchment was rated as being in very good condition, with virtually all ratings above 80% (i.e. components all in Very Good condition).
- 19% of the total length of streams in the entire catchment was rated as being in good condition, that is with moderate to poor environmental condition ratings but stable bed and banks.

State of the Maroochy River, 1993
32% of the total length of streams in the entire catchment was rated as being in *moderate to poor condition*, that is with poor to very poor environmental condition ratings but stable bed and banks.

29% of the total length of streams in the entire catchment was rated as being in *very poor or degraded condition*, that is with very poor environmental condition ratings but unstable bed and bars, and partially unstable banks.

### Derivation of the Overall Condition Ratings from the Component Ratings Using Cluster Analysis

<table>
<thead>
<tr>
<th>Overall Condition Category</th>
<th>Very Good</th>
<th>Good</th>
<th>Moderate</th>
<th>Poor</th>
<th>Very Poor</th>
<th>Degraded</th>
<th>Highly Degraded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Mean Component Ratings for the Overall Condition Categories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach Environ</td>
<td>82%</td>
<td>63%</td>
<td>23%</td>
<td>32%</td>
<td>30%</td>
<td>50%</td>
<td>34%</td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian Vegetation</td>
<td>76%</td>
<td>26%</td>
<td>4%</td>
<td>9%</td>
<td>9%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Very</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conserv. Value</td>
<td>88%</td>
<td>50%</td>
<td>17%</td>
<td>26%</td>
<td>18%</td>
<td>31%</td>
<td>23%</td>
</tr>
<tr>
<td>Very</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Habitat</td>
<td>65%</td>
<td>60%</td>
<td>50%</td>
<td>43%</td>
<td>30%</td>
<td>44%</td>
<td>31%</td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Vegetation</td>
<td>3%</td>
<td>3%</td>
<td>42%</td>
<td>4%</td>
<td>6%</td>
<td>6%</td>
<td>19%</td>
</tr>
<tr>
<td>Very</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank Condition</td>
<td>90%</td>
<td>80%</td>
<td>73%</td>
<td>80%</td>
<td>62%</td>
<td>60%</td>
<td>16%</td>
</tr>
<tr>
<td>Stable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank Condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed &amp; Bar Condition</td>
<td>90%</td>
<td>71%</td>
<td>90%</td>
<td>92%</td>
<td>36%</td>
<td>40%</td>
<td>36%</td>
</tr>
<tr>
<td>Stable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

State of the Maroochy River, 1993
0.4% of the total length of streams in the entire catchment was rated as being in *highly degraded condition*, that is with very poor environmental condition ratings and both the bed and banks being unstable.

Each of the major sub-catchments had sections classified into virtually all of the overall condition categories from Very Good to Highly Degraded. Most of these sections in better condition occurred in the State Forest areas in the headwaters of the catchment, which have been
protected from the clearing for grazing, crops, orchards and sugar cane that characterises most of the catchment. Isolated sections of streams in good condition occurred in the wetland areas in the lower parts of Coolum, Doonan and Eudlo Creeks. Much of the estuarine areas were also given good condition ratings. Extensive mangrove and salt marsh flats have been retained along much of the estuary banks. It should be noted that the condition of the bed, and aquatic vegetation (e.g. sea-grasses, and bed stability) in these estuary sections were not considered in deriving the overall condition ratings for the estuary.

Most of the sections rated in highly degraded condition occurred in the upland areas of Petrie, Eudlo, Browns and Paynter Creeks, and North Maroochy River. The lowland areas adjoining the extensively modified streams and drains in the sugar cane fields were also rated poorly.

The other major findings from the study in relation to the major components were:

Reach Environ - 50% of the length of major streams in the catchment was classified as being in poor or very poor condition, with 70-75% of Paynter and Petrie Creeks being poorly rated.

Only 16% of the length of the major streams were classified as being in very good condition. The generally poor ratings reflect the extent of clearing along the stream verges for sugar cane, grazing, orchards, crops and for residential developments.

Riparian Vegetation - Most of the riparian vegetation in the catchment was rated as in poor to very poor condition (83% of the major stream length). Only 8% of the stream length was rated as being in very good condition. This was mostly attributed to clearing of the riparian area.

Mean riparian zone widths were only 14m (after setting the maximum for any zone at 50m). Also 80% of the stream length has riparian zone widths less than 20m wide, 40% less than 10 m wide, and 30% less than 5 m wide. Lower ratings were also produced because much of the remnant riparian vegetation is dominated by exotic species (Camphor Laurel, exotic pines, para grass, chinese elm, willows and exotic grasses).

Aquatic Vegetation- There is very little aquatic vegetation in the catchment. 88% of the length of the major streams were rated as having very poor aquatic vegetation cover. Unlike the other components the poor aquatic habitat ratings does not necessarily imply that the condition of the aquatic vegetation has deteriorated from a pristine state where aquatic vegetation covers were higher in the undisturbed streams. The natural attributes of the streams would have meant that aquatic vegetation cover would have been naturally low. These attributes include the narrow width and steep banks of the streams, rocky substrates, and the closed canopy cover by rainforest and Eucalyptus forest over most of the river and stream sections.

Bank Stability - Over 80% of the bank length in the entire catchment was rated as being stable (81 100% stable) or quite stable (61-80% stable). Only 6% of the bank length was rated as unstable or very unstable (040% stable). Most of the instability in the bank appeared to be related to flow or wave action, stock damage and clearing of the bank vegetation. The dominant process was erosion (95%) rather than aggradation (5%). Most of the erosion and aggradation occurred irregularly, or was found along almost the entire length of the bank. Significant bank erosion was also found on bends (linked to a meandering process) and associated with obstacles along the banks.

Bed and Bar Stability - 60% of the length of the streams in the catchment was rated as stable or quite stable (rating >61%). Only 17% of the bed length was rated as unstable or very unstable (rating < 40%). Most of the bed was rated as eroding (59%), but the dominant process for the unstable sites was aggradation. Subjectively, 54% of the sites were rated as stable, 16% as eroding and 30% of sites as aggrading.

Aquatic Habitat - 17% of the length of streams in the non-estuarine parts of the catchment were rated as being in very poor condition; with a further 19% in poor condition. The majority (35%) of the stream length was in moderate condition. Only 5% was rated as very good and about 24% as in good condition.

Recreational Values - There was a broad range of recreational opportunities in the catchment:

- 11% of the sites rated as pristine natural (remote sites with restricted access and isolation from human impact and contact).
- 73% were rated as undeveloped rural, i.e. with natural, but highly modified settings, good road access and moderate human contact.
Very Good Overall Condition - Site 88 South Maroochy River on the Kiamba Road
- Very good environmental ratings, stable bed and banks

Good Overall Condition - Site 73 Mt Combe Creek, on the Wappa Falls Road
- Stable bed & banks, moderate to good environmental values
° 7% of the sites occurred at highly modified urban settings, but with no recorded resort developments along the streams.

There are therefore a wide range of recreational opportunities to cater for all tastes. The recreational potential of the streams and rivers was also subjectively recorded for a wide variety of activities, from passive nature appreciation and walking, to active pursuits such as picnicking, fishing, water skiing and canoeing. Clearly riverine areas are the focus for much of the recreation in the catchment, much of it related to the natural attributes and settings of these areas. This increases the value of the remnant areas and increases the need for conservation and rehabilitation.

Most of the more remote and natural settings occurred in the State Forest areas in the upper catchment. In a landscape that has been extensively cleared, the stream verges provide readily accessible semi-natural areas for walking and nature appreciation. The value of these areas is difficult to assess because it is a matter of a sub-conscious appreciation of the presence of these areas and their availability even though the actual use of these areas may be small.

Scenic Values - Once again scenic values were assessed subjectively, with the recorder being required to rank the scenic values of the site from 1-10, and to list the various features which contributed to this value assessment. At most of the sites the scenic value was linked to inherent natural beauty, scenic rural settings and artistic values. About 60% of the sites were ranked poorly (from 1-3), reflecting the rural setting and clearing of most of the catchment. About 15% of the sites highly ranked (from 8-10). These higher ranking sites were located in the upland areas, in the State Forest and at the sites of falls, rapids and cascades. Scenic values could be improved by re-establishing riparian vegetation.

Conservation Values - The conservation values were again determined subjectively at each site by the recorder. The distribution of known rare or endangered species in the catchment was not taken into account although the methodology does allow for this. The conservation ratings were therefore based on a broad scale ranking of the sites as remnant or representative habitat for aquatic and riparian plants or animal species, and the value of the stream verges as wildlife corridors. The majority of sites (>50%) were given a very poor rating (rank <3). Mostly these sections occurred in the degraded areas associated with sugar cane, and in the cleared upper reaches of Petrie and Paynter Creeks, and North Maroochy River. 19% of the stream length was rated as having good to very good conservation value. These sections occurred in the uncleared headwaters of the South Maroochy River, Browns & York Creeks, and in the estuary and scattered throughout the rest of the catchment. The conservation value ratings were strongly linked with the condition of the riparian vegetation and aquatic habitat.

Conclusions

Evaluation of the Method

The method was very successful and achieved its objectives by:

° Providing a comprehensive and objective 'snap-shot' view and analysis of the physical and ecological condition of the Maroochy River.

° Providing a solid database and method for integrated catchment management with links to other sources of data (hydrology and land use and other information about the catchment).

° Highlighting the seriousness of the river degradation in the catchment on a site by site basis. Also showing where in the catchment major problems are occurring and the processes causing these problems.

° Establishing a baseline against which the trends and future rate of change in condition can be assessed by follow-up surveys.

° Stimulating and encouraging direct action to find permanent solutions to the problems identified, through integrated catchment management. Also to create an awareness of the importance and value of rivers and the need to preserve, rehabilitate and re-establish the physical and ecological condition of rivers and streams so that their full value can be realised.
Moderate Overall Condition - Site 98 Paynter Creek near Woombye
Poor riparian vegetation and other environs but with stable bed and banks.

Poor Overall Condition - Site 117 Eudlo Creek near Eudlo
Moderate environmental values and aquatic vegetation, banks somewhat unstable
Promosis

The prognosis is therefore that the streams and rivers are mostly in poor to moderate condition with a major loss of environmental values but without major bank or bed stability problems that would have produced a far worse report. Fortunately serious problems with gully erosion or with severe bank erosion appear to be isolated to the lowland reaches of Petrie, Paynter, Eudlo Creeks. In some respects the prognosis was not as bad as would have been expected given the extent of clearing in the lowland areas of the catchment and the population size. Several natural attributes of the streams have so far acted to reduce the extent of degradation that may have otherwise occurred. These attributes include the retention of a narrow riparian fringe of vegetation along the steep bank faces beside most streams. Also many of the streams have rocky beds and rock outcrops along the banks which act as controls resisting the erosion that may otherwise have occurred. Also, there is relatively little severe bank or gully erosion in the catchment. These aspects are discussed further in the following section, however their occurrence has provided a unique opportunity to act now before the streams deteriorate any further. Much can be achieved now using 'natural remedies' because of this situation. Once the streams have severely degraded much more serious action will be required to restore their values, (‘major surgery’), and to overcome the problems they cause in terms of uncontrolled erosion and altered channel and flow patterns.

The message is therefore to take up the challenge and to seize this fortunate opportunity to prevent further deterioration in the rivers and streams and to re-habilitate them. The projected population growth, which will see the Maroochy Shire double its population size in the 20 years from 1980 to the year 2000, will put immense pressure on the streams and rivers in the near future.

Natural Stream Attributes which have Prevented More Serious Deterioration in River Condition

Despite the moderate to poor condition rating assigned to most of the streams and rivers in catchment many sections retain some values and the condition is perhaps better than expected because of several fortuitous natural attributes. These are:-

- Remnant riparian vegetation on steep bank slopes

Despite the extensive clearing of the catchment and the loss of much of the riparian vegetation, with 83% of the stream length in poor to very poor condition, a narrow but very vital strip or trees and shrubs remains along most of the banks. In many areas this strip may only be 2-10m wide and is confined to the slope of the banks, but these remnants remain along most of the banks.

Very few banks were completely bare. It is true that much of this remnant vegetation dominated by Camphor laurel and other exotic species, but there were some trees, shrubs, herbs and grasses present. There were also pockets of remnant rainforest and other native trees and shrubs along river sections despite the extensive clearing of the floodplain and valley flat areas.

Probably these vegetation remnants have been left, not because of a conscious decision to protect the streams, but simply because the banks were too steep and too difficult to clear. Or the vegetation on the banks has re-generated or been invaded by exotic species after originally being cleared.

Whatever their origin, the retention of these narrow, but highly valuable strips of shrubs and trees has protected the stream from the severe bed erosion and bed instability which would otherwise have occurred if this vegetation had been cleared. There are many dramatic demonstrations of this throughout the catchment. When moving downstream through the boundary of an area with a narrow riparian vegetation to a cleared area there are often dramatic changes in the stream. The stable banks and stable bed of the area with riparian vegetation quickly changes to steep, slumping and eroding banks, and to beds almost completely infilled with sediments. These changes are accompanied by an almost complete loss of ecological values, and the creation of stream problems that require on-going and often expensive and ineffective management, rather than streams which essentially 'look after themselves'.

- High incidence of boulder and rock substrates provides controls restricting bed and bank erosion

The boulder and rock substrates along much of the streams, particularly in the South Maroochy have also provided another de-facto control measure which has prevented the deterioration in stream condition which would have otherwise occurred.
Very Poor Overall Condition - Site 102 Unnamed Tributary of Paynter Creek, Shurvells Road
- Poor environmental values, with somewhat unstable bed and banks.

Degraded Overall Condition - Site 104 Paynter Creek, tributary MacDonald Road
- Poor riparian vegetation, banks unstable, with some sediment buildup in the bed.
Given the extent of clearing of vegetation in the catchments, and along the stream banks, many more areas would have eroded but for this natural protection. Once again the ecological values of these sections of stream may be very low but they can be restored by re-establishing riparian vegetation and other measures. The presence of these natural erosion controls can be used for advantage in accomplishing this restoration.

Severe headward gullying erosion and other processes de-stabilising the bed and banks are not prevalent in the catchment.

Fortunately channel avulsion (where a "perched" stream assumes a new course on the floodplain), and headward gully erosion (where the bed erodes and deepens and this progresses upstream) are not prevalent in the catchment. Similarly severe erosion in the catchment leading to excessive sediment dumping into the stream is also not prevalent, though soil erosion associated with horticulture is a concern. These processes can irrevocably damage streams.

- Remnant patches of streams and rivers sections in good condition are scattered throughout the catchment in both upland and lowland areas.

The 14% of stream length in very good condition, and the further 19% in good condition are scattered throughout the catchment. Each of the major sub-catchments has a range of sections in various conditions including the very good and good categories. The streams in good condition occur in the State Forest areas in the headwaters, but there are also remnant patches on private land in the slopes and in the lowland areas including freshwater wetland and mangrove/salt marsh swamps. These remnants act as buffer strips enhancing the value of the surrounding areas and also provide the 'seeds' or foci for restoration initiatives. They also provide dramatic examples of what all the streams once looked like, and 'working models' of how streams in good condition operate. They also provide goals and models of the direction and objectives for restoration of different areas.

**Major Initiatives and Objectives for Improving the State of the Maroochy River Catchment**

The overall classification and condition assessment clearly establishes that riparian vegetation management and re-establishment should be the major priority in the Maroochy catchment. The loss or the riparian vegetation is not only the reason for the poor rating of many of the stream sections, but is also a fundamental cause of the more serious problems with bank erosion and loss of ecological values. Despite the poor rating of the riparian vegetation condition (83% in poor to very poor condition), what remains is highly valuable and is saving the banks from erosion and preventing further degradation of the condition.

- Protect Existing Riparian Vegetation

The existing riparian vegetation should be protected. This applies not only in the State Forest and other public land areas but also on private lands.

- Increase the Value of Existing Degraded Riparian Vegetation by Increasing its Width and Structural Diversity

The value and effectiveness of riparian vegetation is related to its many roles in:-

- stabilising banks,
- intercepting sediments and nutrients in runoff from the catchment,
- providing a corridor for terrestrial and amphibian wildlife (birds, mammals, frogs, reptiles and invertebrates), and
- providing shelter, shade, organic debris which feed and support the instream communities in many ways.

These roles depend on the width, structural diversity and species composition of the riparian vegetation zone. Enhancement programmes should therefore be directed at these objectives in staged exercises with practical and realistic aims. Ideally riparian vegetation strips of 25-50m are desired, but clearly this may be an unrealistic objective. The value to width relationship is probably not linear but increases rapidly at first and then tapers off. The first objective should be focused on the banks themselves, and then further out along a strip of the floodplain bordering the stream.

The structure of the riparian vegetation is also important. A diversity of structural types is required that is a mixture of tall trees, low trees, shrubs and other understorey species, herbs and grasses. Closing the canopy over the smaller streams is also important if the streams are to regain their original nature.
° Replace Exotic Species with Endemic Native Species

Strategies for replacing exotic species such as Camphor laurel and preventing their regeneration in the restoration areas should be investigated. The emphasis should be on effective replacement not simple removal which may leave the banks temporarily prone to erosion.

° Restore Lost Riparian Vegetation

Restoration of riparian vegetation in areas where it has been removed would provide the most effective means of improving the condition of the streams and rivers. This should be seen as a general programme and as an integral part of efforts to stabilise and overcome areas of severe bed and bank erosion and other forms of instability.

This is not an easy task as there are many problems and it involves the cooperation and assistance of many land holders and community groups. There are problems with financing, weed control, fire management, stock watering issues, fencing maintenance and all the difficulties inherent in undertaking works in areas where the beneficiaries may be remote from where the action need to be directed. However, there are case histories where rainforest has been successfully restored along streams in a cooperative ventures involving landowners, residents in nearby towns and various government agencies. Such activities are at the foundation of what integrated catchment management is really about. Such schemes also have the advantage that they can be initiated as pilot schemes building on the initial enthusiasm of local groups. If successful such pilot schemes will act as catalysts for future expansions of the programmes involving whole communities through schools and other community groups.

Recommendations

The major recommendations from the study are:-

1. Re-establish and Protect Riparian Vegetation

The major focus for action should be directed at re-establishing riparian vegetation:-

a) Protect existing remnant pockets of riparian vegetation in State Forest areas, other remnants on public and private land, remnant freshwater wetland and mangrove/saltmarsh areas.

b) Enhance existing riparian vegetation by

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Highly Degraded Overall Condition - Site 11 Petrie Creek NE of Menarys Road
- Severe bank erosion and major buildup of bars, highly degraded environmental values.

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increasing its width and encouraging the fencing of stream verges and the establishment of defined hardened stock watering points to reduce stock damage. Efforts should also be made to increase the structural diversity of remnant zones and the replacement of exotic species.

c) Restore lost riparian vegetation through appropriate integrated programmes.

2. Establish the Need for Temporary Bed and Bank Stabilisation Measures in Highly Degraded Areas and Investigate Long-term Solutions through Integrated Catchment Management.

The stream sections in degraded and high degraded condition with severe bank erosion and/or bed erosion or excessive build-up of instream sediments may require urgent rehabilitation measures. This may involve well designed artificial bank protection techniques as interim, temporary measures. Further more detailed study of these areas, including the resourcing, would be required to identify the cause of the problem and the appropriate long term solution using an integrated catchment approach. Such bed and bank stabilisation measures should be seen only as stop-gaps to arrest the degradation until the long term cause can be identified and solved permanently.

3. Follow-up Survey in 3-5 years to establish trends and rates of degradation in condition and the effectiveness of rehabilitation and protection measures.

It is suggested that this condition assessment be repeated in 3-5 years dependent on the availability of the required resources and the perceived need for such a follow-up. Repeat surveys are required to determining the trends in the changes in condition in different parts of the catchments. The projected increase in population in the catchment will put extra pressure on the streams and rivers. Establishing the trends and the time-frame for degradation are important for setting priorities and establishing the seriousness of the problem. Follow-up surveys would also be very useful for establishing the effectiveness of re-habitation or riparian vegetation and various other management initiative stimulated by this report. The methodology has been designed to allow for this replication as the survey sites have been carefully described and located.
1. Introduction

The State of the Rivers Project was initiated in 1992 with the development and validation of a methodology (Anderson 1993a) and an implementation strategy (Anderson 1993b). A summary of the objectives of the project, the approach taken and the methodology is provided in Appendix 1. The methodology which has been developed includes an implementation strategy, catchment sub-division and sampling procedures. It also included survey methods and datasheets, a database system (Dbase IV) for storing the survey data and data derived from other sources. Data analysis and classification programs are included to generate reports and linkage with the GIS system and other databases (HYDSYS).

The Maroochy River was used as a pilot study for developing and validating the methodology. The pilot was so successful that it enabled the results to be analysed and presented as the first state of the rivers report.

The aim of this report is to provide an assessment of the physical and ecological condition of the Maroochy River to service the information needs integrated catchment management and to provide a bench mark against which future changes in condition can be monitored. The report also provides a demonstration of what the 'State of the River' methodology can achieve. It is the first of a series of catchment based studies which will culminate in an assessment of the State of the Rivers assessment for all rivers in Queensland.

2. Background

The Maroochy River Catchment

The Maroochy River and its tributaries drain an area of undulating hills of approximately 400 sq. km in South-Eastern Queensland with the mouth at Maroochydore. The catchment extends approximately 22 km inland, and there are broad low-lying land and swamps along a coastal strip and floodplain area extending 8 km inland of Coolum. The coastal plain and floodplain, which occupy 83 sq. km, were the subject of a report MSC (1983).

The coastal Maroochy River catchment (see locality map) extends south from the low hills inland of Peregrine Beach, and Lake Weyba to Maroochydore, Buderim Mountain and the northern slope of the Mooloolah Range in the south and south-west. The western boundary is the ridge line of the Blackall Range to Montville, Mapleton, just west of Cooloolabin Dam and north-west of Eumundi. Most of the catchment is low elevation coastal areas, floodplains and undulating hills. Maximum elevation is about 400m along the ridge line in the Blackall Range.

The Maroochy River has two main arms, the North and South Maroochy River which join at about the tidal limit 24 km upstream from the mouth. Two large tributaries Petrie Creek (with its major tributary Paynter Creek) and Eudlo Creek enter the river about 5 km from the mouth. Coolum,

Features of the Method

- Specific purpose surveys focused on instream features.
- 'Snap-shot' approach designed to assess the relative physical and ecological condition of sites compared with a regional or catchment standard.
- Simple techniques for use by inexperienced staff after a short training programme.
- Interfaces with GIS and other sources of data.
- Minimal requirements for equipment and resources.
- Rapid surveys requiring less than 1 hour per site.
- Designed to provide data and analysis and classification systems for Integrated Catchment Management.
- Site locations are precisely designed to allow follow-up surveys to be conducted to establish trends, rates of change and effectiveness of remedial measures.
- Objective and comprehensive with all steps involved in deriving the ratings being explicitly defined.
- Scaling system is used to allow the relative condition of different habitat types to be compared using the same method.

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Doonan and Yandina Creeks drain the low-lying areas north-eastern parts of the catchment. The major sub-catchments used in the study are listed below:

- Estuary - includes the lower Maroochy River, and Petrie Eudlo and Coolum Creeks.
- Coolum and Yandina Creeks - including Doonan Creek
- Minor Tributaries - including Martins Creek, Rocky Creek, Caboolture Creek, Ferntree Creek, Mt Combe Creek, Tuckers Creek, Wappa Falls Creek and various unnamed creeks were grouped together into a single category.
- Paynter Creek
- Petrie Creek
- North Maroochy River
- Browns and York Creeks
- Eudlo Creek
- South Maroochy River

There are two major reservoirs in the South Maroochy catchment, Cooloolabin and Wappa Dams on the South Maroochy River, and there is a further small intake weir on the upper South Maroochy River. Poona Dam is used as a holding reservoir for water diverted from the Mary River catchment.

**Climate, Land Resource Classification and Land Use**

Capelin (1987) provides a broad general background on the soils and land suitability for horticulture in the region, and also lists various previous studies of the climate, geology, and general land resource information.

**Climate** - (after Capelin 1987) Rainfall is received in all months, but with a summer dominance (November to March at Nambour). Evaporation exceeds rainfall from August to December. The hottest months are December and January, when daily mean maximum temperatures reach 28-29 °C. Daily maximum temperatures at Nambour exceed 30°C from November to March in 14% of years. July is the coldest month and daily minimum temperatures at Nambour are below 2°C in 14% of years. Frosts are more prevalent in the lower parts of sheltered valleys and depression

and there is an average of about 58 days of light frost and 15 days of severe frost annually at the Maroochy Horticultural Research Station at Nambour.

**Geology and Soils** - The land resources (geology, landform, vegetation) and soils of the area are summarized by Capelin (1987) and various references cited by this author. The Sunshine Coast area was divided into 11 land resource areas by Capelin (1987) each with its own geology, soils, landform, vegetation and land suitability for horticulture. The major land resources areas in the Maroochy catchment, their features and distribution in the catchment are shown in the table adapted from Capelin (1987).

**Land Use** - Capelin (1987) found that rural land use in the Sunshine Coast region (240,000 ha) in the early 1980's was dominated by beef and dairy production (70%) of the area, State and Plantation Forestry (17%), sugar cane (3%) and horticultural cropping (3%). The horticultural crops, in order of crop area, include pineapples, bananas, citrus, avocados, macadamias, pumpkins, potatoes, green beans, watermelons (also strawberries, pawpaws,
<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Geology</th>
<th>Landform</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary Alluvia Q1</td>
<td>Coastal sand dunes, sand plains, lowlands (estuarine areas, lower Coolum Creek)</td>
<td>Holocene wind blown sands; Pleistocene tidal and lagoon sand, silt and day deposits</td>
<td>Rolling rise level and undulating plains</td>
<td>Casuarina, banksia low woodland, wallum heath Melaleuca open and dosed forest</td>
</tr>
<tr>
<td>Q2</td>
<td>Stream alluvia and floodplains - mostly N. Maroochy, S. Maroochy down of Nambour, Petrie, Paynter, and Eudlo Creeks</td>
<td>Quaterary alluvium of gravel, sand silt and clay</td>
<td>Level to undulating plains &amp; rises</td>
<td>Forest red-gum forest and Melaleuca open Forest</td>
</tr>
<tr>
<td>Tertiary Volcanics T1</td>
<td>Maleny Plateau Blackall range Buderim, forms the western upland boundary south of Cooloolabin Dam &amp; west of Nambour</td>
<td>Teary lateritised basalt</td>
<td>Rolling low hills bounded by very steep hills</td>
<td>Remnants of dosed forest</td>
</tr>
<tr>
<td>Triassic - Jurassic Sandstones J1</td>
<td>Catchments south of Petrie Creek (Nambour) to Eudlo Creek</td>
<td>Lateritised Triassic to Jurassic Landsborough Sandstone</td>
<td>Undulating to steep low hills and hills</td>
<td>Blackbutt and bloodwood open forest</td>
</tr>
<tr>
<td>J3</td>
<td>Upland southern and south-western boundary areas of the catchment, Eudlo Creek</td>
<td>Lateritised Triassic to Jurassic Landsborough Sandstone</td>
<td>Undulating to steep hills</td>
<td>Blackbutt and bloodwood open forest</td>
</tr>
<tr>
<td>Triassic Volcanics and Intrusives Permian- &amp; Permian - Carboniferous Metamorphics R1</td>
<td>Along N. Maroochy between Eumundi and Yandina</td>
<td>Lateritised Triassic rhyolite</td>
<td>Gently undulating &amp; rolling low hills</td>
<td>Remnants of grey gum &amp; tallowood open forest</td>
</tr>
<tr>
<td>R2</td>
<td>Most land north &amp; NW of Nambour North and South Maroochy River, upper Yandina Cr. minor tributaries</td>
<td>Triassic andesite &amp; rhyolite. Diorite &amp; tonalite intrusions</td>
<td>Undulating low hills to very steep mountains</td>
<td>Blackbutt and grey-gum open forest</td>
</tr>
</tbody>
</table>

State of the Maroochy River, 1993
Introduction

custard apples and other tropical fruits, cucumbers, passionfruit, ginger). There are also small intensive hydroponic farms and other specialist agriculture ventures developing in the area. The land use in the Maroochy Shire is summarised on page 3 (1981-1983 figures from Capelin (1987)).

Capelin (1987)) concluded that only 18% of the total private land on the Sunshine Coast (188,000 ha) was suitable for horticulture, of which about 45% was on steeper land were only permanent trees and vines should be grown. Significant examples of inappropriate land use exist with 90% of all horticultural land being affected by soil erosion to some degree, and 53% to a serious degree. It was also recommended that rezoning land for urban or rural-residential purposes should be directed at land suitable for this purpose in terms of drainage, flooding, slope and topography.

Population Growth - the rate of population growth has been increasing over the last 30 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Increase</th>
<th>% Increase</th>
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<tbody>
<tr>
<td>1961</td>
<td>19,071</td>
<td>1,202</td>
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<tr>
<td>1966</td>
<td>21,454</td>
<td>2,383</td>
<td>2</td>
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<tr>
<td>1971</td>
<td>25,522</td>
<td>4,068</td>
<td>4</td>
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<tr>
<td>1976</td>
<td>35,266</td>
<td>9,744</td>
<td>7</td>
</tr>
<tr>
<td>1981</td>
<td>53,428</td>
<td>18,162</td>
<td>10</td>
</tr>
<tr>
<td>1986</td>
<td>61,630</td>
<td>8,202</td>
<td>15</td>
</tr>
<tr>
<td>1991</td>
<td>88,730</td>
<td>27,100</td>
<td>44</td>
</tr>
<tr>
<td>1996</td>
<td>#</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>2000</td>
<td>#</td>
<td>#</td>
<td>#</td>
</tr>
</tbody>
</table>

Source :  
* Capelin (1987)  
# Census data supplied by Maroochy Shire Council  
## Projection data supplied by Maroochy Shire Council

The majority of population growth has occurred in the coastal strip and adjoining coastal hill settlements (MSC,1983). The population doubled in the 10 years from 1971 to 1981, and will probably more than double again by the year 2000, to reach around 120,000. This has and will put increasing pressure on the streams and will enhance the value of natural remnants and re-habilitated areas.

Vegetation - The recent study by Turnbull and Olsen (1992) identified 24 vegetation units in the Maroochy Shire boundaries. The most significant vegetation types and habitats were identified as the rainforest and heathlands and their associated communities. These vegetation types occur from the coastal lowlands to the ranges in the hinterland. They contain many noteworthy species of flora and fauna and are important habitat for rare and threatened species some of which are restricted to the shire. Land clearance was identified as the major reason for the loss of the vegetation units, both through the clearing itself and the chronic impacts of sedimentation, excessive nutrients, drainage of wetlands, fire, grazing which impact on the unclear remnants of the natural vegetation.

Three remnant riverine communities were identified. There is a remnant rainforest unit in which the fringing vegetation is dominated by rainforest. These rainforest remnants should be preserved for their value in erosion control and for conservation of rare and threatened species. There is also a remnant Eucalyptus open forest element on less fertile strips than the rainforest remnants. These riparian strips have Eucalyptus species dominant in the canopy but may have rainforest species as understorey species. There were also remnants dominated by exotic species Camphor Laurel (Cinnamomum camphora) and Chinese Elm (Celtis sinensis). This type often occurs as a mosaic with the other type. These remnants also provide useful protection against stream bank erosion and habitat. Long-term replacement of them with native vegetation is recommended, most sites being suitable for the re-establishment of riparian rainforest. Re-establishment of corridors of vegetation along streams and between existing large vegetation remnants (>100ha) would have the added advantage of re-establishing migration corridors for wildlife (Turnbull and Olsen 1992).

MSC (1983) also provide information on the distribution of vegetation types on the Maroochy River floodplain. It found that 65% of this area had been cleared and the remnant terrestrial vegetation is fragmented and has been degraded by fire, weed infestation, and construction of drains. This report stresses the high conservation value of the estuary as containing the best and largest remnant estuary and mangrove community in Southern Queensland. This report also discusses water quality and other important management issues.

Arthington (1992) provides an annotated bibliography of the condition of Queensland Streams and Rivers.
3. Methods

The 'State of the Rivers' methodology (Anderson 1993 a,b) provides a comprehensive method for classifying the current physical and ecological condition of rivers and streams. The classification is applied to rivers and streams divided into sections of different lengths which share similar natural features and condition ratings (homogeneous streams sections). The concept used is to successively divide the streams into smaller and smaller sections using a variety of information to select appropriate boundaries until the notion of a homogeneous stream section is realised. The catchment is first divided into its major sub-catchments each of which have different characteristics which will influence the type of streams present. Other boundaries are located at natural (waterfalls and wetlands) and artificial (weirs and dams) barriers and at other sites where there are major changes likely to affect the natural features of the stream and its condition.

The process continues using other attributes such as vegetative cover, soils and geology, slope and streams gradient, stream substrates and general characteristics. An extensive reconnoitre survey is used to make this initial sub-division of the streams into homogeneous sections. The subdivision process is continued during the survey and after the results have been analysed.

Once completed the local catchment for each of the streams sections are defined. The combination of streams sections and their local immediate catchments are the fundamental units for the methodology for assessing the physical and ecological condition of the streams. The survey methods are focused on a 'snap-shot' approach.
Methods

directed at using rapid surveys of key components within the stream itself and along the banks.

Survey sites are selected which are representative of each stream section and the assessment is made along reaches of varying length at each site. About 45-60 minutes is spent at each site surveyed by a team of 2 people allowing about 8-10 sites to be surveyed in a day. Two teams of two can survey about 200 sites in a two week period.

The method is focused on a large number of sites to adequately sample the variety of different stream types present in each catchment in terms of their natural features and their current condition.

There is a separate datasheet and database for each of these components which include:-

- Reach Environ - the condition of the land immediately bordering the survey reach (the vegetative cover, land use, land tenure, etc.) on the floodplain and valley flat immediately adjacent to the reach.

- Channel Habitat - the proportion and dimensions of the channel habitat types in the reach, classified into various habitat types (e.g. pool, riffle, run, rapid, cascade, etc.).

- Channel Form and Dimensions - cross-section measurements are taken for pools and other habitats types. Sediment particles sizes are determined for the bed and banks. Depth, width, bank height, bank slope and various other measurements are taken in the channel for pools and other habitat types present.

- Bank Condition - the condition, slope, shape and dominant process are determined for each bank in each reach surveyed. The bank stability and processes affecting it are assessed.

- Bed and Bar Condition - the condition and dominant process and stability of the stream bed are determined. The size, location and features of the bars are assessed. Also the passage through the reach for fish and other aquatic organisms is assessed by classifying the barriers present (natural and artificial).

- Riparian and Aquatic Vegetation - the condition of the riparian vegetation along the stream verges is assessed in terms of the width, structural form and species composition of the remnant riparian zone.

Surveys are conducted by a team of two - Site 68 South Maroochy River at ford downstream of Yandina.

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The aquatic vegetation (submerged, floating and emergent) is also assessed (cover and species composition).

Aquatic Habitat - the condition of the aquatic habitat is assessed in terms of channel habitat type, depth and width and substrates. The organic debris cover (logs branches, etc.), canopy cover, and cover along the banks (vegetation, roots, bank overhang, etc.) are also assessed.

Scenic, Recreational and Conservation Values - these values are assessed subjectively using various rating scales to provide relative overall value assessments for each reach.

Additional Components - additional datasheets and databases are used to compile, store and analyse information about the river and stream sub-sections and their immediate sub-catchments. They are also used to record the location and descriptive information about the survey sites and hydrological summaries.

### Site Coverage in the Maroochy River

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Total Catchment Area Surveyed (hectares)</td>
<td>62, 140 ha</td>
</tr>
<tr>
<td>Total Length of Major Streams (km)</td>
<td>507 km</td>
</tr>
<tr>
<td>Total Number of Full Survey Sites</td>
<td>185</td>
</tr>
<tr>
<td>Sites / hectare</td>
<td>0.003</td>
</tr>
<tr>
<td>Sites / km of major stream</td>
<td>0.36</td>
</tr>
<tr>
<td>Reach Length (mean)</td>
<td>75.6 m</td>
</tr>
<tr>
<td>Reach Length (range)</td>
<td>7 - 500 m</td>
</tr>
</tbody>
</table>

<p>| | |</p>
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<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Sections Surveyed</td>
<td>211</td>
</tr>
<tr>
<td>Sub-section Catchment Area (mean)</td>
<td>294.5 ha</td>
</tr>
<tr>
<td>Sub-section Catchment Area (range)</td>
<td>14 - 2254 ha</td>
</tr>
<tr>
<td>Length of Major Stream in Sub-Sections (mean)</td>
<td>2.4 km</td>
</tr>
<tr>
<td>Length of Major Stream in Sub-Sections (range)</td>
<td>0.5 - 8.5 km</td>
</tr>
<tr>
<td>Number of Sites / Sub-section (mean)</td>
<td>1</td>
</tr>
<tr>
<td>Number of Sites / Sub-section (range)</td>
<td>1 - 5</td>
</tr>
</tbody>
</table>

### Major Sub-Catchments

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Catchment Area (ha)</th>
<th>Length of Major Streams (km)</th>
<th>Full Survey Sites</th>
<th>Sub-Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estuary</td>
<td>5,227</td>
<td>38</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Non-Estuarine</td>
<td>50,291</td>
<td>432</td>
<td>168</td>
<td>173</td>
</tr>
<tr>
<td>Coolum / Yandina Cr.</td>
<td>12,516</td>
<td>82</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Minor Tributaries</td>
<td>6,610</td>
<td>65</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Paynter Creek</td>
<td>5,276</td>
<td>41</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Petrie Creek</td>
<td>5,438</td>
<td>55</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>North Maroochy R.</td>
<td>4,919</td>
<td>34</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Browns / York Cr.</td>
<td>2,957</td>
<td>24</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Eudlo Creek</td>
<td>6,104</td>
<td>48</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>South Maroochy R.</td>
<td>6,580</td>
<td>74</td>
<td>31</td>
<td>35</td>
</tr>
</tbody>
</table>

State of the Maroochy River, 1993
Water quality is not included in the methodology. It is not really appropriate for a 'snap-shot' approach.

Analysis of long terms records is required to classify streams sections in terms of the extent to which water quality standards are met or not met in terms of time, flow, concentrations, loads and maximum values. These records are not adequately nor consistently available for summaries of this information to be included in the methodology.

The Department of Environment and Heritage conducted a survey of 50 selected 'State of the Rivers' sites in the Maroochy catchment in late 1993 to assess the variability in quality throughout the catchment at the same time. The results of this survey will be the subject of a separate report.

The various parameters recorded for each component are stored in a set of linked databases (DBASE IV). These databases are an integral part of the methodology as they provide access for the raw and processed information for detailed follow-up work and investigations.

A set of 5 photographs taken at each site (1000 colour slides in total) provide an additional record for future reference.

The package includes a set of analysis and data manipulation programs. The condition ratings are produced from a set of formulae which use variously weighed combinations of the raw data to produce condition ratings.

Each of these derived ratings is scored as a percentage with 100% representing pristine conditions, and 0% highly degraded conditions.

The State of the Rivers condition assessment is based on the condition ratings produced from these formulae for each of the components.

Various condition categories are used for the condition ratings which mostly have the following form:-

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>81-100</td>
</tr>
<tr>
<td>Good</td>
<td>61-80%</td>
</tr>
<tr>
<td>Moderate</td>
<td>41-60%</td>
</tr>
<tr>
<td>Poor</td>
<td>21-40%</td>
</tr>
<tr>
<td>Very Poor</td>
<td>0-20%</td>
</tr>
</tbody>
</table>

Recording Vegetation Condition - Site 174 Browns Creek East of Point Glorious

State of the Maroochy River, 1993
Background and Survey Information

This first State of the Rivers Report provides a summary of the condition of rivers and streams in the Moroochy River Catchment of in South Eastern Queensland. The survey was conducted from 11 September to 2 October 1992, during the drier party of the year which is ideal time for the stream assessments.

There were a total of 507 km of 'major' streams ill 9 sub-catchments in the entire surveyed catchment of 62,000 hectares. These 'major' streams had permanent defined channels, were deeper than about 0.5 m, and included persistent and intermittent stream types. Smaller streams were not surveyed as the focus was on the large streams providing more or less permanent habitat.

A total of 192 sites were surveyed throughout the catchment of which 185 were fully surveyed. A map is provided showing the location of the sites.

Nineteen of the sites were in the estuary. These sites were surveyed by boat. The remainder of the sites were distributed throughout the catchment.

The streams and rivers were subdivided into a total of 211 sub-sections. Of these 191 were surveyed with at least one site being present. A map is provided showing the sub-section boundaries.

The unsurveyed sections included the major reservoirs (Wappa Dam, Cooloolabin Dam, Poona Dam, and the Intake Weir in the Upper reaches of the South Maroochy River), each of which were designated as a separate section. The sections near the mouth of the estuary were also not surveyed, and there were additional sections throughout the catchment which contained only minor streams.

Some of the components were not surveyed in individual sections. These sections have also been designated as not surveyed.

These stream sections and their associated sub-catchment land parcels were the fundamental units upon which the classification was based. The sub-catchment polygons were also used for the GIS system used to output the results.

These elements also form the basic units for establishing linkages between the instream survey information and the catchment based information derived from other sources (such as soils, vegetation type and cover, climate, land use).
4. Results and Discussion

Data summaries have been prepared to assess the physical and ecological condition of the Maroochy River in terms of the individual components and art overall assessment.

The data summaries consist of a set of 'pie diagrams' and maps of the sub-sections classified into various condition categories. The data are presented in terms of the percentage of major streams and rivers classified into each category.

Tables provide summaries of additional information.

There are also maps showing the distribution of the sections classified into the same condition categories throughout the catchment.

The analysis is first made using the whole catchment (with and without the estuarine areas).

Data is then presented for each of the major sub-catchments, each with its own set of 'pie-diagrams'.

The overall classification for the whole catchment, using all the components is discussed after dealing with each of the individual components.

4.1 Components in the Entire Catchment

Each of the survey components has been used to produce a separate condition rating using the rating formulae included in the package.

Generally these ratings have been classified into 5 percentage categories.

The rating formulae are designed to generate scores out of 100%, where 100% represents pristine condition or no loss of amenity, value or use, and 0% represents total degradation or complete loss of value.

Some variation on this common theme are used for some of the different components.

Falls on Tuckers Creek - Site 207 Cilento Park area.

State of the Maroochy River, 1993
Entire Maroochy River Catchment

Bank Condition
- Very Unstable: 1%
- Unstable: 5%
- Moderate: 11%
- Quite Stable: 43%
- Stable: 40%

Bank Process
- Eroding: 5%
- Aggrading: 95%

Bed & Bar Condition
- Very Unstable: 7%
- Unstable: 25%
- Moderate: 25%
- Quite Stable: 11%
- Stable: 25%

Bed & Bar Process
- Eroding: 59%
- Aggrading: 41%

Pool Depths
- < 1 m: 26%
- 1.0 - 1.5 m: 30%
- 1.6 - 2.0 m: 21%
- 2.1 - 3.0 m: 13%
- 3.1 - 4.0 m: 2%
- 4.1 - 5.0 m: 2%
- > 5.0 m: 5%

Pool - Width/Depth Ratios
- < 5.0: 20%
- 5.0 - 7.5: 16%
- 7.6 - 10: 26%
- 11 - 20: 26%
- 21 - 30: 26%
- 31 - 40: 26%
- > 40: 26%

Pool Sediments
- < 0.5 mm: 11%
- 0.5 - 2.0 mm: 5%
- 2.1 - 5.0 mm: 6%
- 5.1 - 20 mm: 8%
- 21 - 60 mm: 9%
- 61 - 100 mm: 60%
- > 100 mm: 6%

Non-Pool Sediments
- < 0.5 mm: 3%
- 0.5 - 2.0 mm: 3%
- 2.1 - 5.0 mm: 3%
- 5.1 - 20 mm: 2%
- 21 - 60 mm: 11%
- 61 - 100 mm: 66%
- > 100 mm: 66%

Sites = 187  Sub-sections = 211  Catchment Area = 62,139 hectares  Length of Major Streams = 506 km
All Non-Estuarine Maroochy River Catchment

Overall Rating
- Highly Degraded: 14%
- Degraded: 25%
- Very Poor: 16%
- Poor: 17%
- Moderate: 6%
- Good: 20%
- Very Good: 5%

Environ
- Very Poor: 24%
- Poor: 17%
- Moderate: 27%
- Good: 16%
- Very Good: 14%

Channel Diversity
- Very Low: 54%
- Low: 15%
- Moderate: 30%
- High: 1%

Aquatic Habitat
- Very Poor: 19%
- Poor: 17%
- Moderate: 24%
- Good: 5%
- Very Good: 5%

Aquatic Vegetation
(Not naturally sparse in catchment - see text)
- Very Poor: 35%
- Poor: 8%
- Moderate: 8%
- Good: 3%
- Very Good: 1%

Riparian Vegetation
- Very Poor: 70%
- Poor: 13%
- Moderate: 4%
- Good: 8%
- Very Good: 8%

Scenic & Recreation Values
- Very Poor: 41%
- Poor: 37%
- Moderate: 9%
- Good: 6%
- Very Good: 7%

Conservation Values
- Very Poor: 34%
- Poor: 10%
- Moderate: 16%
- Good: 31%
- Very Good: 9%

Sites = 168  Sub-sections = 173  Catchment Area = 50,291 hectares  Length of Major Streams = 432 km
4.1.1. Reach Environ

This component concerns the condition of the floodplain and valley flat, that is the land immediately adjacent to the riparian zone for the reach. The derived rating is produced by assessing the extent of disturbance to the riparian vegetation and the vegetation on the adjacent lands (i.e. the extent of clearing and invasion by exotic species). The land tenure, land use, vegetation type, and types of disturbance are all used to produce the derived rating. The highest rating of 100% is only given to sites in protected areas (e.g., National Parks and State Forests) which have undisturbed vegetation and no local disturbances likely to impact directly on the stream. Sites in areas where the floodplain and valley flat areas have been cleared for grazing, intensive agriculture or for rural residential occupancy are rated poorly. Low ratings are produced when the land on both sides of the stream has been cleared or is used for agriculture and the shoreline vegetation is absent or severely reduced and dominated by exotic species (rating <20%).

![Vegetative cover and type, land use, land tenure, floodplain features (erosion, billabongs etc.) on the floodplain and land immediately adjacent to the reach](image)

### Condition of the Reach Environ

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
<th>Number of Sections (%)</th>
<th>Length of major streams (km) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entire Catchment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>43 (23%)</td>
<td>105 (23%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>51 (27%)</td>
<td>121 (23%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>37 (19%)</td>
<td>84 (18%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>29 (15%)</td>
<td>74 (16%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>31 (16%)</td>
<td>74 (16%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>191</td>
<td>458</td>
</tr>
<tr>
<td><strong>Non-Estuarine Catchment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>41 (24%)</td>
<td>101 (24%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>48 (28%)</td>
<td>114 (27%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>28 (16%)</td>
<td>67 (16%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>28 (16%)</td>
<td>71 (17%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>27 (16%)</td>
<td>76 (16%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>173</td>
<td>429</td>
</tr>
</tbody>
</table>
Components

Very Good Environs - Site 21 Browns Creek, 500m downstream of the junction with Carol Creek
- Rainforest with closed canopy along the stream verge

Good Environs - Site 73 Mt Combe Creek, crossing on the Wappa Fails Road
- Adjacent land cleared on one side of the stream

State of the Maroochy River, 1993
A moderately disturbed site rating at 50% would have the valley flat vegetation completely cleared on one side of the stream with native vegetation on the other side in a reasonably undisturbed state. The riparian vegetation would be mostly native species and reasonably intact. The dominant land uses in the land bordering the streams were:

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Cane</td>
<td>27</td>
</tr>
<tr>
<td>Horticulture</td>
<td>5</td>
</tr>
<tr>
<td>Grazing - sown pasture</td>
<td>10</td>
</tr>
<tr>
<td>Grazing - native cleared</td>
<td>33</td>
</tr>
<tr>
<td>Grazing - native thinned</td>
<td>5</td>
</tr>
<tr>
<td>Urban Residential</td>
<td>5</td>
</tr>
<tr>
<td>Urban - Industry</td>
<td>3</td>
</tr>
<tr>
<td>State Forest Park or Reserve</td>
<td>12</td>
</tr>
<tr>
<td>Urban Park or Reserve</td>
<td>5</td>
</tr>
<tr>
<td>Rural Residential</td>
<td>20</td>
</tr>
</tbody>
</table>

Sugar cane, grazing and rural residential were the major land uses (20-30% of sites). State Forest or other Reserves occurred at 15 sites (12%). Most of the adjacent land was privately owned (84% of sites). There were 10 sites in State Forests, 4 in Urban park areas and 4 sites in urban residential areas.

The major types of disturbances identified in the adjacent land which are likely to affect the streams were:

<table>
<thead>
<tr>
<th>Disturbance Type</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand / gravel extraction</td>
<td>1</td>
</tr>
<tr>
<td>Roads</td>
<td>26</td>
</tr>
<tr>
<td>Bridges / culverts</td>
<td>43</td>
</tr>
<tr>
<td>Fords</td>
<td>5</td>
</tr>
<tr>
<td>Discharge site</td>
<td>2</td>
</tr>
<tr>
<td>Forestry Activities</td>
<td>2</td>
</tr>
<tr>
<td>Sewerage Effluent Discharge</td>
<td>2</td>
</tr>
<tr>
<td>Irrigation Runoff / drainage</td>
<td>3</td>
</tr>
<tr>
<td>Channelisation</td>
<td>5</td>
</tr>
<tr>
<td>River Improvement</td>
<td>3</td>
</tr>
<tr>
<td>Water Extraction</td>
<td>6</td>
</tr>
<tr>
<td>Dredging</td>
<td>1</td>
</tr>
<tr>
<td>Grazing damage</td>
<td>35</td>
</tr>
</tbody>
</table>

50% of the length of major streams in the catchment was classified as being in poor or very poor condition. Anon (1982) found that 62% of the Maroochy floodplain area had been cleared and the remaining native vegetation was fragmented and had been degraded by fire, weed infestations and drainage. The sections in poor condition were distributed throughout the cane field areas in the lower catchment, but were also found in the cleared areas in the upper North Creek catchment and in Eudlo and Paynter Creeks.

Only 16% of the length of the major streams were classified as being in very good condition. These sections occurred in the State Forest areas of York Creek, Carol Creek and Chambers Gully and in the area around Coolabin Dam.

Many of the estuarine sections were also given high ratings because of the extensive mangrove areas which have been left undisturbed. The freshwater wetland areas in lower Yandina, Doonan and Eudlo Creeks have also been given high ratings.

Of the sub-catchments Petrie and Paynter Creeks rated the worst with 70% and 75% of stream lengths rated as being in poor to very poor condition.

The South Maroochy and North Maroochy sub-catchments, Browns and York Creeks were rated best with about 40% of the stream length in good to very good condition.

However the best and worst categories were found in all the sub-catchments.
Poor Environments - Site 105 Paynters Creek tributary, Lower Landershute Road
- Floodplain and valley flat vegetation cleared both sides, remnant riparian strip.

Very Poor Environments - Site 115 Eudlo Creek, 1.3km downstream of Eudlo
- Floodplain and valley flat vegetation cleared both sides, and riparian vegetation also cleared.

State of the Maroochy River, 1993
LEGEND

1 - 20% Very Poor
21 - 40% Poor
41 - 60% Moderate
61 - 80% Good
81 - 100% Very Good

Catchment Not Surveyed
Permanent Water Supply
Swamp
Population Centre

NOTE

Reach Environments Condition – is a determination of the condition of land immediately bordering the survey reach (the vegetation cover, landuse, land tenure, etc.) on the floodplain and valley flat immediately adjacent to the reach.
4.1.2 Riparian & Aquatic Vegetation

The vegetation in the riparian zone and the aquatic vegetation were assessed at each site in terms of the percentage cover by structural vegetation types (trees, shrubs, herbs, emergent aquatics, floating aquatics, etc.) and the percent cover over of the bed or riparian zone estimated.

For the riparian vegetation the vegetation was grouped into Trees > 30m, Trees 10-29m, Trees <10m, Woody Shrubs, Vines, Rushes and Sedges, Herbs, Grasses, Tree Ferns, Ferns & Bracken, Mosses, Mangroves, Salt Marsh, and Palms.

The aquatic vegetation was grouped into Submerged Rooted Plants (with and without floating leaves), Floating Plants, and Emergent Plants, each of which were divided into broad common types.

A checklist of the more important native and introduced species was also recorded, though details of this are not included in this report.

The condition of the riparian vegetation was determined using the recorded width of the remnant riparian zone (usually 1-50m wide). The width of the remnant vegetation is an obvious indicator of how effective the riparian zone is in performing its various functions in stabilising the banks, providing shelter for terrestrial animals and shade for the stream, acting to intercept sediments and nutrients carried in the runoff, and contributing organic matter directly to the stream itself. The condition of the riparian vegetation is therefore a function of the width of the remnant riparian zone. A quadratic equation is used to scale the actual recorded width (maximum 50m) to give a higher weighting to the wider zones. A vegetation factor is used to further modify the index based on the width of the zone. This places greater emphasis on diversity of the structural types of vegetation. The individual types of vegetation are also given separate weightings in terms of their relative values.

A remnant riparian zone with a diverse mixture of tall trees and understorey plants (low trees, shrubs, herbs and grasses) was rated more highly than a zone consisting only of trees or only of shrubs and grasses. Mangroves were given a weighting of 100%, tall trees 85%, shrubs 55%, and grasses 30%, etc., in producing the vegetation factor which was used as a multiplier to adjust the index based on the width of the zone. The contribution of the vegetation types was assessed as percent cover.
Very Good Riparian Vegetation - Site 88 Rocky Creek, Kiamba Road
- Good wide zone, dense cover and diversity of structural types: tall trees, shrubs, rushes, etc.

Moderate Riparian Vegetation - Site 9 Petrie Creek, 2.5 km upstream of Nambour
- Diversity of structural forms present, but with reduced cover and evidence of clearing.
The contribution for each type was reduced by 30% times the percentage of exotic species in each type, and the vegetation factor was reduced for areas of bare ground in the riparian zone. The vegetation factor acted to increase or decrease the initial index derived from the width of the remnant riparian zone. The maximum condition rating of 100% was only achieved for sites with remnant riparian zones of greater than 40m where there was a diversity of structural types present. Moderate condition ratings of 50% were assigned to sites with zones of 20-25m wide or low diversity.

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
<th>Number of Sections (%)</th>
<th>Length of major streams (km) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>132 (71%)</td>
<td>310 (70%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>19 (10%)</td>
<td>58 (13%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>12 (6%)</td>
<td>24 (5%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>8 (5%)</td>
<td>19 (4%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>15 (8%)</td>
<td>36 (8%)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>186</td>
<td>447</td>
</tr>
<tr>
<td>Non- Estuarine Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>120 (72%)</td>
<td>290 (71%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>16 (10%)</td>
<td>47 (12%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>10 (5%)</td>
<td>19 (5%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>8 (5%)</td>
<td>19 (5%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>13 (8%)</td>
<td>33 (8%)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>167</td>
<td>410</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
<th>Number of Sections (%)</th>
<th>Length of major streams (km) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>146 (85%)</td>
<td>351 (88%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>16 (9%)</td>
<td>33 (8%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>8 (5%)</td>
<td>12 (3%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>2 (1%)</td>
<td>5 (1%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>172</td>
<td>401</td>
</tr>
<tr>
<td>Non- Estuarine Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>127 (83%)</td>
<td>313 (86%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>16 (10%)</td>
<td>33 (9%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>8 (5%)</td>
<td>12 (3%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>2 (1%)</td>
<td>5 (1%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>153</td>
<td>363</td>
</tr>
</tbody>
</table>
Poor Riparian Vegetation - Site 104 Paynter Creek tributary, MacDonald Road
- Riparian vegetation reduced to grass, no trees or shrubs present.

Very Poor Riparian Vegetation - Site 214 tributary, S. Maroochy River, 500 m South James Low Bridge
- Riparian vegetation mostly cleared and large bare patches present along the banks.

State of the Maroochy River, 1993
The condition ratings for the aquatic vegetation was based on the percentage cover by the various types. The contribution for the different types was 50% for the submerged vegetation, 30% for emergent and 20% for floating vegetation types. Again the emphasis was on a diversity of types with the maximum rating only being reached when all types were present and covered a reasonable proportion of the submerged stream bed. The percentage cover scores were reduced if the type was dominated by exotic species.

**Condition of the Riparian Vegetation**

The remnant shoreline vegetation types were mostly classified as rainforest (55% of sites) in the lowland areas or Eucalypt Wet Sclerophyll (15% of sites) or Open Forest (13% of sites) in the upland areas. Mangrove (13% of sites), saltmarsh (13% of sites), Melaleuca forest (5% of sites) and freshwater forest (4% of sites) were the other more abundant types (see datasheet for the other classifications).

Most of the riparian vegetation in the catchment was rated as in poor to very poor condition (83% of the major stream length). Only 8% of the stream length was rated as being in very good condition. This was mostly attributed to clearing of the riparian area.

Mean riparian zone widths were only 14m (after setting the maximum for any zone at 50m), and 80% of the stream length were less than 20m wide, 40% less than 10m wide and 30% less than 5m wide. Widths at the sites ranged from 200m (for the estuarine mangrove fiat area) to only 1m.

The low condition ratings were also related to a high incidence of exotic species especially in the lowland reaches. The mean percentage of exotic species was 15% for medium trees, 10% for low trees and shrubs, 15% for herbs and 27% for grasses. Many sites had 100% exotic species.

Camphor laurel was the most widely spread exotic species. It was recorded as present at 60% of the sites and of these it was abundant at 35% of the sites. Lantana was present at 40% of the sites and was abundant at 15% of sites. Other exotic species were also recorded during the survey of 185 sites - Rubber vine (1 site), privet (4 sites), exotic pines (11 sites), para grass (21 sites), Chinese elm (2 sites), willows (7 sites) and exotic grasses (63 sites).

The natural features of the rivers and streams in the area have helped to provide protection for a remnant riparian zone. For example, the only remnant vegetation left along the streams is confined to the steep banks which have not been cleared or some vegetation has regenerated. The mean width of the upper bank for the entire estuary is 17m, very similar to the mean riparian zone width. Mean bank slopes are 40 degrees. This particularly applies to the North Maroochy catchment where there is an obvious riparian zone remnant confined to the steeper bank itself along most of the river. For the North Maroochy catchment the average widths of the upper banks is 3m, slopes are 30 degrees and the riparian remnant is often confined to this narrow bank area.

The fundamental importance of the riparian vegetation in stabilising the banks and protecting the aquatic habitat and conservation values of the stream is clearly seen in many areas throughout the catchment at the boundaries between areas with cleared and uncleared riparian vegetation. Immediately downstream in the cleared areas, bank erosion and a build up of the sediment from the collapsed banks are obvious but they are absent in the neighbouring areas just upstream with the intact riparian vegetation.

Although the exotic species such as the Camphor laurel do degrade the value of the riparian vegetation classification, some vegetation, even these weed species, is better than none in terms of stabilising the banks, and reducing sediment input to the streams. Likewise the narrow rainforest remnants along many of the streams, although too narrow to rate very highly, do provide some value, even partly covering the stream with an incomplete canopy. The remnant forest riparian zones, even when only 10-20m wide are of high value and need protection. A feature of the Maroochy River catchment is these narrow remnant vegetation zones which are completely absent from many rivers in the State.

72% of the sites have riparian zones wider than 5m which represents 67% of the total length of the major streams in the catchment. A major focus for improving the condition of the streams and rivers in the catchment should be on protecting these remnants and enhancing their value by increasing their width and diversity, and replacing exotic species with natives. Riparian vegetation in cleared areas should wherever possible be protected, re-established or allowed to regenerate. Turnbull and Olsen (1992) rated the remnant riparian rainforest as having high conservation value for stream protection and for providing habitat for rare and threatened plant species.

State of the Maroochy River, 1993
Good Aquatic Vegetation - Site 66 Ferntree Creek, dam in the golf course area
- Diverse aquatic vegetation has developed in this cleared, artificial pool.

Very Good Aquatic Vegetation - Site 127 Eudlo Creek, swamp on Winston Road
- Dense and diverse aquatic vegetation including submerged and emergent species.

State of the Maroochy River, 1993
**Condition of the Aquatic Vegetation**

There is very little aquatic vegetation in the catchment.

88% of the length of the major streams were rated as having *very poor* aquatic vegetation cover.

Unlike the other components the poor aquatic habitat ratings does not necessarily imply that the condition of the aquatic vegetation has deteriorated from a pristine state where aquatic vegetation covers were higher in the undisturbed streams.

Generally the sites with higher aquatic vegetation covers were found at sites where the riparian vegetation had been cleared.

Under natural conditions the closed canopy over the smaller streams in the rainforest areas would have prevented the establishment of dense aquatic vegetation.

Large, wide, deep permanent pools are not found in the Maroochy River catchment.

Likewise large areas of stream bed, especially in the South Maroochy catchment have very coarse sediments (gravel, cobbles and rock) which are unsuitable for the establishment of aquatic vegetation.

The absence of dense and diverse aquatic vegetation is therefore probably a natural feature of the catchment rather than a product of disturbance.

Despite this the low ratings are still valid. The low density of aquatic vegetation is an important feature of the catchment, when compared with other catchments.

---

**Moderate Aquatic Vegetation - Site 204 Tuckers Creek, near Nambour Cemetery**

- Cleared riparian vegetation and the open canopy has allowed aquatic vegetation to develop.
State of the Maroochy River, 1993
LEGEND

1 - 20%  Very Poor
21 - 40%  Poor
41 - 60%  Moderate
61 - 80%  Good
81 - 100%  Very Good

Catchment Not Surveyed
Permanent Water Supply
Swamp
Population Centre

NOTE

Riparian Vegetation Condition – is assessed in terms of the width, structural form and species composition of the remnant riparian vegetation along the stream verges.
4.1.3 Bank Condition

The bank condition ratings were determined from the recorded percentages of the banks on each side of the reach which were rated as stable. The derived rating was produced by assigning 80% of the score to the upper bank and 20% to the lower banks. The values were then averaged for all the banks assessed in each sub-section. The dominant process at each site (either eroding/slumping or aggrading) was also recorded. The final ratings record the average percentage of the bank which was unstable at the site. A score of 100% was recorded for sites where the entire banks are completely stable. Low scores occurred when a high proportion of the banks were unstable (eroding, slumping or aggrading). Over 80% of the bank length in the entire catchment was rated as being stable (100-81% stable) or quite stable (80-61% stable). Only 6% of the bank length was rated as unstable or very unstable (40-0% stable).

Most of the instability in the bank appeared to be related to flow & waves, stock damage and clearing of the bank vegetation. Most of the erosion and aggradation occurred irregularly or was found along almost the entire length of the bank.

Significant bank erosion was also found on bends (linked to a meandering process) and associated with obstacles along the banks.

Generally the amount of bank erosion was low given the relatively high population in the area and the extent of clearing throughout the catchment. This appeared to be related to the narrow band of riparian vegetation left along the relatively steep banks. Ironically the steepness of the banks has allowed this vegetation to remain, when it would otherwise tend to increase the susceptibility of the banks to erosion.

<table>
<thead>
<tr>
<th>Factors Affecting Stability</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow &amp; Waves</td>
<td>25</td>
</tr>
<tr>
<td>Floodplain Runoff</td>
<td>11</td>
</tr>
<tr>
<td>Floodplain scour</td>
<td>7</td>
</tr>
<tr>
<td>Stock damage</td>
<td>25</td>
</tr>
<tr>
<td>People tracks</td>
<td>11</td>
</tr>
<tr>
<td>Ford, road or bridge</td>
<td>22</td>
</tr>
<tr>
<td>Clearing of bank veg</td>
<td>38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of Instability</th>
<th>Erosion</th>
<th>Aggradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>bends</td>
<td>25</td>
<td>58</td>
</tr>
<tr>
<td>floodplain scour</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>obstacles</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>seepage sites</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>irregular</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>all along</td>
<td>35</td>
<td>17</td>
</tr>
</tbody>
</table>
Stable Banks - Site 99 Paynter Creek, just upstream of Woombye
- Vegetation is helping to stabilise the banks

Banks in Good Condition - Site 117 Eudlo Creek, near Eudlo
Some erosion but vegetation is acting as a control

State of the Maroochy River, 1993
Most of the substrates on the banks are fine sands and muds. Rock outcrops in the upper and lower banks, acting to stabilise the banks, occurred at about 15% of the sites.

Only 14% of the banks at the sites were rated during the survey as being highly unstable or highly susceptible to erosion.

The highest proportion of stable banks were found in the South Maroochy River (59% of bank length stable), Minor Tributaries (53%), and the Estuary (48%).

The most unstable banks were found in Browns and York Creeks (21% of bank length unstable) and Paynter Creek (15% unstable).

<table>
<thead>
<tr>
<th>Bank Dimensions</th>
<th>mean</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Bank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width (m)</td>
<td>1.0</td>
<td>0.0 - 16.0</td>
</tr>
<tr>
<td>Height (m)</td>
<td>0.4</td>
<td>0.0 - 0.8</td>
</tr>
<tr>
<td>Slope (degrees)</td>
<td>47.3</td>
<td>3.0 - 90</td>
</tr>
<tr>
<td>Sediment size (mm)</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>Rock outcrops (%sites)</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

| **Upper Bank**   |      |       |
| Width (m)       | 5.2  | 0.0 - 200 |
| Height (m)      | 1.9  | 0.0 - 13.0 |
| Slope (degrees) | 37.9 | 1.0 - 90   |
| Sediment size (mm) | 0.14 |     |
| Rock outcrops (%sites) | 13 |     |

<table>
<thead>
<tr>
<th>Condition of the Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition Category</td>
</tr>
<tr>
<td><strong>Entire Catchment</strong></td>
</tr>
<tr>
<td>Very Unstable</td>
</tr>
<tr>
<td>Unstable</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>Quite Stable</td>
</tr>
<tr>
<td>Stable</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
</tr>
</tbody>
</table>

**Dominant Process**

| Eroding/Slumping | 173 (94%) | 425 (95%) |
| Aggrading        | 12 (6%)   | 24 (5%)   |

<table>
<thead>
<tr>
<th><strong>Non-Estuarine Catchment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Unstable</td>
</tr>
<tr>
<td>Unstable</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>Quite Stable</td>
</tr>
<tr>
<td>Stable</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
</tr>
</tbody>
</table>

**Dominant Process**

| Eroding/Slumping | 155 (93%) | 389 (95%) |
| Aggrading        | 11 (7%)   | 22 (5%)   |
Banks in Poor Condition - Site 109 Paynter Creek, near quarry in headwaters
- Banks eroding and undercut, bar buildup linked to active bank erosion.

Banks in Very Poor Condition - Site 11 Petrie Creek, 200m downstream of the Menarys Road crossing
-Severely eroding vertical banks, with large bars.

State of the Maroochy River, 1993
Bank Condition - ratings are determined from the recorded percentages of the banks on each side of the reach which are rated as stable.
4.1.4 Bed & Bar Condition

The bed and bar condition ratings were determined from the recorded proportion of the bed forming a bar (for aggrading beds) and the overall bed stability rating (for eroding beds).

16% as eroding and 30% of sites as aggrading. The sub-catchments with the poorest bed and bar condition were Paynter Creek (50% of major stream <40%), Petrie Creek (40% of major stream length <40%) and North Maroochy River (24% of major stream length <40%). Most of these sites were in the headwater streams where substantial bars have developed. Many of these sites coincide with areas where the banks were unstable (see maps). Bank erosion (28% of the sites) was recognised as a major cause of instability leading to the development of bars.

Sites with no bar present, or with stable beds were rated at 100% (i.e. stable).

Sites with large bars or with severely eroding beds were rated as unstable (< 20% stable) for bed and bar condition.

The bed and bar condition in the estuary was not assessed.

About 60% of the length of the streams in the catchment was rated as stable or quite stable (rating >61%).

Only 17% of the bed length was rated as unstable or very unstable (rating < 40%). Most of the bed was rated as eroding (59%), when all sites were considered, but the dominant process for the unstable sites was aggradation.

Subjectively, 54% of the sites were rated as stable,
Components

Stable Bed Condition - Site 121 Eudlo Creek, Ramberts Road crossing, in the headwaters
- Cobbles and rock in the bed acting as controls

Good Bed Condition - Site 170 Bunya Bunya Creek, Bunya Road crossing
- bed in good condition

State of the Maroochy River, 1993
Agricultural practices and grazing (45% of sites) were also recognised as causes of instability through their effects on bank stability and sediment discharge to the streams. Bar size (for sites with bars) averaged 27% of the bed (range 5-85%). Most of the bars were point or alternate associated with processes in the channel and associated with obstructions.

Only 16% of the sites were subjectively rated as eroding. Deep gully erosion or other forms of severe erosion of the bed were not encountered during the surveys. Bridges and fords (27% of sites), rock outcrops (21%) of sites and trees (27% of sites) provided controls for stabilising the bed.

Few of the beds were armoured (4% of sites), but many were moderately well packed (30% of sites).

Generally severe bed erosion or severe build-up of excessive sediment loads were not a major problem in the estuary. The problem areas have been identified and episodes of bed erosion may occur at other times associated with cyclonic rainfall and floods. Unstable beds occurred primarily in upper Petrie, Paynter and Eudlo Creeks (aggrading). They were also found in the minor tributaries and in the upper North Maroochy River. Unstable beds that were eroding mostly occurred in upper Browns Creek, North Maroochy River and Doonan Creek.

Again the geomorphological features of the catchment appear to provide natural controls acting to stabilise the beds. Maintaining stable banks through protecting the riparian vegetation would appear to the a key priority for reducing the instability of the bed and bars in the channel.

<table>
<thead>
<tr>
<th>Bar Type</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>53</td>
</tr>
<tr>
<td>Point</td>
<td>30</td>
</tr>
<tr>
<td>Alternate</td>
<td>15</td>
</tr>
<tr>
<td>Islands</td>
<td>9</td>
</tr>
<tr>
<td>Encroaching Vegetation</td>
<td>4</td>
</tr>
<tr>
<td>Obstructions</td>
<td>12</td>
</tr>
<tr>
<td>Bar plain</td>
<td>3</td>
</tr>
<tr>
<td>Infilled Channel</td>
<td>4</td>
</tr>
<tr>
<td>High Flow Deposits</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjective Rating</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severely Eroding</td>
<td>2</td>
</tr>
<tr>
<td>Eroding</td>
<td>14</td>
</tr>
<tr>
<td>Stable</td>
<td>54</td>
</tr>
<tr>
<td>Aggrading</td>
<td>22</td>
</tr>
<tr>
<td>Severely Aggrading</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
<th>Number of Sections (%)</th>
<th>Length of major streams (km) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Estuarine Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Unstable</td>
<td>0 - 20%</td>
<td>16 (9%)</td>
<td>32 (7%)</td>
</tr>
<tr>
<td>Unstable</td>
<td>21 - 40%</td>
<td>19 (11%)</td>
<td>42 (10%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>41 (24%)</td>
<td>105 (25%)</td>
</tr>
<tr>
<td>Quite Stable</td>
<td>61 - 80%</td>
<td>21 (12%)</td>
<td>45 (11%)</td>
</tr>
<tr>
<td>Stable</td>
<td>81 - 100%</td>
<td>76 (44%)</td>
<td>200 (47%)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>173</td>
<td>424</td>
</tr>
</tbody>
</table>

Dominant Process
- Eroding 95 (55%) 250 (59%)
- Aggrading 78 (45%) 174 (41%)

State of the Maroochy River, 1993
Poor Bed Condition - Site 139 Coes Creek, Coes Creek Road crossing
- Buildup of large point bars

Very Poor Bed Condition - Site 179 Petrie Creek, Blackall Range Road crossing
- Buildup of large bar filling most of the bed above the 'water mark'

State of the Maroochy River, 1993
LEGEND

1 - 20%  Very Unstable
21 - 40%  Unstable
41 - 60%  Moderate
61 - 80%  Quite Stable
81 - 100%  Stable

Eroding
Aggrading
Catchment Not Surveyed
Permanent Water Supply
Swamp
Population Centre

NOTE

Bed and Bar Condition – ratings are determined from the recorded proportion of the bed forming a bar (for aggrading beds) and the overall bed stability rating (for eroding beds).
4.1.5 Channel Dimensions and Habitat Types

The channel dimensions and channel habitat types (pools, runs, riffles, cascades, rapids etc.) are important attributes both physically and ecologically. About 80% of the sites had pools, and most of these sites also had either a riffle or a run habitat at the same site. Riffles were present at 42% of the sites and runs at 36% of the sites. The relatively small number of waterfalls, cascades and rapids reflects the low altitude and low gradient of the majority of the catchment. An average of 73% (range 10-100%) of the length of the reaches surveyed was classified as a pool.

Most pool depths at the water mark (the normal water level in the channel) were shallow, with a mean depth of 1.4 m (range 0.2-4.5m). Actual water depths at the time of sampling varied throughout the catchment but were about 0.4m below the water mark (mean water depth in pools was about 1 m). Mean pool depths in the estuary at the water mark were 4.8m. In the non-estuarine catchment 58% of the stream length had pools <1.5m maximum depth, and only 4% had pools >4.0 maximum depth. The shallow depth of the pools is an important feature of the channel habitats in the Maroochy River.

Most pools were also narrow with mean width at the water mark being 7.7m (range 1.5-32.1m). Width to depth ratios were also small averaging 5.8 in the non-estuarine areas.

About 70% of the length of the streams in the non-estuarine areas had pool width/depth ratios at the water mark of <10.

The estuarine channel was much deeper (mean depth 4.8m at the water mark) and much wider (mean width 95m at the watermark) than the freshwater sections.

The lower banks (the bank between the water surface and the water mark) were generally narrow (mean width 0.4m) and low (mean height

<table>
<thead>
<tr>
<th>Channel Habitat Type</th>
<th>Number of Sites</th>
<th>Depth (D) or Height (H)</th>
<th>Mean (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterfall</td>
<td>7 (4%)</td>
<td>H 18 (2.5-40) m</td>
<td></td>
</tr>
<tr>
<td>Cascade</td>
<td>28 (17%)</td>
<td>H 1.5 (0.2-5.0) m</td>
<td></td>
</tr>
<tr>
<td>Rapid</td>
<td>6 (4%)</td>
<td>D 0.1 (0.1-0.2) m</td>
<td></td>
</tr>
<tr>
<td>Riffle</td>
<td>71 (42%)</td>
<td>D 0.1 (0.1-0.6) m</td>
<td></td>
</tr>
<tr>
<td>Glide</td>
<td>3 (2%)</td>
<td>D 0.1 (0.1-0.2) m</td>
<td></td>
</tr>
<tr>
<td>Run</td>
<td>61 (36%)</td>
<td>D 0.5 (0.1-3.0) m</td>
<td></td>
</tr>
<tr>
<td>Pool</td>
<td>130 (77%)</td>
<td>D 0.9(0.1-15.0) m</td>
<td></td>
</tr>
<tr>
<td>Backwater</td>
<td>5 (3%)</td>
<td>D 1.3 (0.3-2.5) m</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>168</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The entire estuary was classified as pool habitat.

State of the Maroochy River, 1993
Site 122 Eudlo Creek, near crossing on the Maroochydore Road
- Deep, slow flowing, wide river with logs and branches in the stream

Site 37 Yandina Creek, crossing on the Yandina Coolum Road
- Channelised drains in sugar cane growing areas

State of the Maroochy River, 1993
0.4m). In the estuary this corresponded with the intertidal mangrove and salt marsh areas and the widths were much larger (mean 19m, range 0.2-400m), and heights averaged 1.5m.

The upper banks in the non-estuarine areas were relatively high, steep and narrow at most sites and the channels were generally a pronounced "V" or "U" shape. Bank heights were generally about twice the depth of the channel at the water mark (mean 2.2m, range 0.2-13.0m). Bank slopes averaged 41 degrees (range 5-90). Bank widths averaged 4.0m (range 0-15m).

### Petrie Creek, South Maroochy River and the Minor tributaries
had the highest width to depth ratios with more than 10% of their stream lengths with ratios >20 to 1.

### Bed Substrates
Most of the pools had sand and mud substrates with 69% of the major stream lengths with a mean particle size of < 2.0mm.

Coarser materials were found in many of the pools (25% > 5.0mm; 11% > 100mm). The finer sediments also predominated in the non-pool habitats (77% of the stream length). These included runs and backwaters and were not confined to the riffles, cascades and rapids. This explains why the proportion of finer sediments exceeded in the non-pools sometimes exceeded that in the pools when considering the entire sample.

About 20% of the length of major streams in non-pool sections had means sediment particle sizes coarser than 5.0mm, and 12% coarser than 100mm (cobbles, boulders and rock). The highest proportion of stream lengths with very coarse sediments (mean >100mm) were found in the South Maroochy River (pool 37%; non-pool 37%), Minor Tributaries (pool 3%; non-pool 21%), and Brown and York Creeks (pools 18%; non-pools 10%).

The finer sediments (<2.00mm) occurred in Paynter Creek (pools 100%; non-pools 89%) Coolum and Yandina Creeks (pools 72%; non-pools 85%), and Petrie Creek (pools 57%; non-pools 93%).

### Channel Dimensions

#### Non-Estuarine Catchment

<table>
<thead>
<tr>
<th>Channel Dimensions (Pools)</th>
<th>At the water mark</th>
<th>At the bank top</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth (m)</strong></td>
<td>1.4 (0.2-4.5)</td>
<td>3.9 (1.1-16.7)</td>
</tr>
<tr>
<td><strong>Width (m)</strong></td>
<td>7.7 (1.5-32.1)</td>
<td>16.8 (2.7-165)</td>
</tr>
<tr>
<td><strong>Width/Depth</strong></td>
<td>5.8 (1.7-18.5)</td>
<td>4.7 (1.4-61.0)</td>
</tr>
<tr>
<td><strong>Cross-Section Area (m²)</strong></td>
<td>194 (1-529)</td>
<td>226 (5-588)</td>
</tr>
</tbody>
</table>

| Lower Bank width (m)     | 0.4 (0.0-9.0)     |
| Lower Bank height (m)    | 0.4 (0.0-1.7)     |
| Lower Bank slope (deg.)  | 59 (3-90)         |
| Upper Bank width (m)     | 4.0 (0.0-15.0)    |
| Upper Bank height (m)    | 2.2 (0.2-13.0)    |
| Upper Bank slope (deg.)  | 41 (5-90)         |

#### Estuary

| Depth (m) | 4.8 (2.3-7.1) | 6.6 (2.8-10.0) |
| Width (m) | 95 (25-400)   | 133 (37-521)  |
| Width/Depth | 24.6 (4-160) | 25.8 (4-122) |
| Cross-Section Area (m²) | 526 (80-1361) | 645 (113-1514) |

Apart from the estuary areas the deepest pools and channels were found in the North Maroochy River (58% of stream length with maximum pool depths at the water mark >1.5m) and South Maroochy River (22%). The shallower pools were found in Coolum and Yandina Creeks, and the minor tributaries with about 30% of stream length with maximum pool depths at the water mark <1.0m, and 60% less than 1.5m deep.
Site 5 Coes Creek, crossing on Mayers Road
- Narrow infilled eroding streams with gravel and sand substrates

Site 16 Unnamed tributary of Petrie Creek, near Hunchy
- Headwater stream with rock and boulder substrates

State of the Maroochy River, 1993
Site 79 South Maroochy River, about 1 km downstream of Wappa Dam
- River with large deep, long and wide pools with rock substrates and cascade sections

Site 208 Headwaters of Wappa Dam Road Creek
- Shallow sandy stream with a heavy organic debris load

State of the Maroochy River, 1993
Site 77 - Chambers Gully
- Rocky falls and cascades

Site 67 - Ferntree Creek
- "V" shaped sandy rainforest streams

State of the Maroochy River, 1993
Channel Diversity – indicates the variability of stream channel types (fast flowing, rocky bed; slow, deep meandering channel, wetlands) within the sub-catchments.
LEGEND

- Less than 0.5 millimetres
- 0.5 – 2.0 millimetres
- 2.1 – 5.0 millimetres
- 5.1 – 20.0 millimetres
- 21.0 – 60.0 millimetres
- 61.0 – 100.0 millimetres
- Greater than 100.0 millimetres
- Catchment Not Surveyed
- Permanent Water Supply
- Swamp
- Population Centre

NOTE

Pool Sediments – indicates the range of sizes of the soil particles in sections of streams which are pools.
Non-Pool Sediments – indicates the range of sizes of the soil particles in sections of streams which are not pools.
4.1.6 Aquatic Habitat Condition

The rating for the condition of the aquatic habitat was based in a combination of the percentage cover by organic debris and other habitat types (such as rock, cobble and vegetation) on the bed and the cover provided along the bank as canopy cover and various types of vegetation and bank overhangs.

The rating formula gave higher ratings to sites with a diversity of types present as well as the proportion of the bed or banks with each individual cover types present.

The individual cover types were also weighed according to their relative importance. For example dense log jams were weighed at 100%, single logs at 90%, single branches at 80%, roots along the banks at 90%, access to boulders and rock crevices at 75% and macrophyte debris at 50%. In deriving the final rating 60% contribution was given for the instream cover, and 40% for the bank cover.

The bank cover contribution was derived by using a combination of the width of cover and a weighting for each type (canopy, vegetation overhang, root overhang, bank overhang, etc.).

The highest rating of 100% was assigned to sites where there was a diverse range and high percentage covers in the stream and along the banks. Various other components are also important for classifying the aquatic habitat, for example channel dimensions, channel habitat diversity (pools, riffles, runs etc.), flow regime, bed sediments etc. However, the aquatic habitat rating itself only considers the bank and bed covers. There are however special categories for 'pools deeper than 1m' and 'access to rock faces' which allow these attributes to contribute to the condition rating.

The majority of the catchment was rated as having aquatic habitat in moderate to very good condition (about 65% of the length of the major streams in the non-estuary, and entire catchment). Only 5% was rated as very good and about 25% as in good condition.

About 15% was rated as being in very poor condition.

The highest proportion of aquatic habitat in good condition was found in South Maroochy River (60% of major stream length > 60%), Eudlo Creek (39%), North Maroochy River (29%).

The least proportions were found in Coolum and Yandina Creeks (83% of major streams length rated as <20%), and in Petrie (32%) and Paynter Creeks (25%).

State of the Maroochy River, 1993
Very Good Aquatic Habitat - Site 218 Yandina Creek, headwaters East of Eumundi
- Good cover of logs and branches in the stream and also good vegetation, bank and canopy cover

Good Aquatic Habitat - Site 82 Wappa Dam Road Creek, in gully 1.5 km upstream of Wappa Dam
- Rock surfaces, deep pools, and vegetation overhangs provide a diversity of aquatic habitats

State of the Maroochy River, 1993
The more widespread instream cover types contributing to the condition ratings were single logs (44% of sites), single branches (50% of sites), leaf and twigs (50% of sites), root cover (14% of sites) rock cover (30% of sites) and sites with pools deeper than 1m (23% of sites).

Log jams and branch piles were found at only few sites at the absence of the larger type of organic debris is a reflection of the small size of the channel and widespread clearing throughout much of the catchment.

The relatively high proportion of the sites with some canopy cover present and the mean width of 4.4m again points to the riparian remnant which is present at most sites, even if it is narrow and invaded by exotic species. The narrow width of most of the streams and the widespread distribution of rainforest along the banks when the streams were undisturbed, points to the probable complete canopy cover over the streams in their original condition.

Root and vegetation overhang were also present at many of the sites.

In general the bank cover attributes appeared to be in better condition and were more widespread than the instream attributes.

### Aquatic Habitat

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Number of Sites (%)</th>
<th>Width of Sites (m)</th>
<th>Percent Cover (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Estuary Sites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logs</td>
<td>72(44)</td>
<td>9 (4-60)</td>
<td></td>
</tr>
<tr>
<td>Log Jams</td>
<td>16(10)</td>
<td>8 (4-30)</td>
<td></td>
</tr>
<tr>
<td>Branches</td>
<td>80(50)</td>
<td>10 (4-60)</td>
<td></td>
</tr>
<tr>
<td>Branch piles</td>
<td>55(33)</td>
<td>8 (1-30)</td>
<td></td>
</tr>
<tr>
<td>Leaf &amp; twig</td>
<td>79(50)</td>
<td>17 (4-80)</td>
<td></td>
</tr>
<tr>
<td>Algae</td>
<td>18(10)</td>
<td>36 (4-90)</td>
<td></td>
</tr>
<tr>
<td>Fresh. plants</td>
<td>64</td>
<td>41 (4-80)</td>
<td></td>
</tr>
<tr>
<td>Floating Veg</td>
<td>53</td>
<td>27 (9-60)</td>
<td></td>
</tr>
<tr>
<td>Emergent Veg</td>
<td>12(7)</td>
<td>32 (4-90)</td>
<td></td>
</tr>
<tr>
<td>Root Cover</td>
<td>25(14)</td>
<td>9 (1-80)</td>
<td></td>
</tr>
<tr>
<td>Rock Faces</td>
<td>50(30)</td>
<td>62 (4-99)</td>
<td></td>
</tr>
<tr>
<td>Pool &gt;1m deep</td>
<td>38(23)</td>
<td>43 (4-99)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bank Cover (percent of bank length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canopy</td>
</tr>
<tr>
<td>Veg. o/hang</td>
</tr>
<tr>
<td>Root o/hang</td>
</tr>
<tr>
<td>Bank o/hang</td>
</tr>
</tbody>
</table>

| Total | 165 |

### Condition of the Aquatic Habitat

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Rating</th>
<th>Number of Sections (%)</th>
<th>Length of major streams (km) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Maroochy Catchment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Poor</td>
<td>0 - 20%</td>
<td>27 (14%)</td>
<td>72 (15%)</td>
</tr>
<tr>
<td>Poor</td>
<td>21 - 40%</td>
<td>37 (19%)</td>
<td>87 (19%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>41 - 60%</td>
<td>67 (35%)</td>
<td>160 (35%)</td>
</tr>
<tr>
<td>Good</td>
<td>61 - 80%</td>
<td>53 (28%)</td>
<td>122 (26%)</td>
</tr>
<tr>
<td>Very Good</td>
<td>81 - 100%</td>
<td>8 (4%)</td>
<td>22 (5%)</td>
</tr>
<tr>
<td>Totals</td>
<td>192</td>
<td>463</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Estuarine Catchment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor</td>
</tr>
<tr>
<td>Poor</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Very Good</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>

State of the Maroochy River, 1993
Poor Aquatic Habitat - Site 123 Eudlo Creek, near Rafting Ground Road
- No organic debris, bank cover, nor deep pools, low channel habitat diversity.

Very Poor Aquatic Habitat - Site 45 Unnamed tributary of Yandina Creek, crossing on Grajeski Road
Channelised stream, with no organic debris cover, bank cover nor habitat diversity

State of the Maroochy River, 1993
Aquatic Habitat Condition is assessed in terms of channel habitat type, depth and width of substrates. It also takes into account the organic debris cover (logs, branches, etc.) in the stream bed and canopy cover along the streams banks (vegetation, roots, bank overhang, etc.).
4.1.7 Scenic and Recreational Values

The scenic and recreational values were determined subjectively at each site.

Recreational Value - Recreation is an important activity in the catchment and much of this recreation is focused on river in the estuarine areas. The recreational value of the catchment was determined by generating a recreational opportunity spectrum and assessing potential and actual recreation types for each site surveyed. A recreational opportunity spectrum with 3 Natural setting categories, 2 Urban and 3 Rural were used to summarise the recreational opportunities associated with the streams and rivers in the catchment. The various types were classified in terms of remoteness, access, human impact, expected human contact, and facilities, regulations and structures.

<table>
<thead>
<tr>
<th>Recreational Opportunity Type</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural 1.</td>
<td>11</td>
</tr>
<tr>
<td>(Pristine Natural)</td>
<td></td>
</tr>
<tr>
<td>Natural 2.</td>
<td>4</td>
</tr>
<tr>
<td>(Semi-Natural)</td>
<td></td>
</tr>
<tr>
<td>Natural 3.</td>
<td>2</td>
</tr>
<tr>
<td>(Roaded Natural)</td>
<td></td>
</tr>
<tr>
<td>Rural 1.</td>
<td></td>
</tr>
<tr>
<td>(Undeveloped Rural)</td>
<td>73</td>
</tr>
<tr>
<td>Rural 2.</td>
<td>3</td>
</tr>
<tr>
<td>(Developed Rural)</td>
<td></td>
</tr>
<tr>
<td>Urban 1.</td>
<td></td>
</tr>
<tr>
<td>(Undeveloped Urban)</td>
<td>4</td>
</tr>
<tr>
<td>Urban 2.</td>
<td>3</td>
</tr>
<tr>
<td>(Developed Urban)</td>
<td></td>
</tr>
<tr>
<td>Urban 3.</td>
<td>0</td>
</tr>
<tr>
<td>(Highly Developed)</td>
<td></td>
</tr>
</tbody>
</table>

There was a broad range of recreational opportunities throughout the catchment with 11% of the sites rated as pristine natural (that is remote sites with restricted access and isolation from human impact and contact).

Most of the sites (73%) were rated as undeveloped rural (that is cleared and modified areas with rural settings, with good road access and moderate human contact).

Undeveloped and developed urban settings occurred at 7% of the sites. Highly developed urban types, with resort developments and other facilities were nor recorded along the streams surveyed. There is therefore a wide range of recreational opportunities to cater for all tastes.

Most of the more remote and natural settings occurred in the State Forest areas in the upper catchment. Streams and river have value not only for active recreation but for passive recreation of various types. In a landscape that has been extensively cleared the stream verges provide readily accessible semi-natural areas for walking and nature appreciation. The value of these areas is difficult to assess because it is a matter of a sub-conscious appreciation of the presence of these areas and their availability even though the actual use of these areas may be small.

The survey teams were also asked to record the potential and actual recreational activity types available at each site with emphasis on the activities associated with the rivers and streams and the stream verges. The assessment was subjective, but it nevertheless provides a general overview of the types of recreational activities available in the area.

<table>
<thead>
<tr>
<th>Recreational Type</th>
<th>Percent of Sites Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbeques/picnics</td>
<td>46</td>
</tr>
<tr>
<td>Bush walking (day trip)</td>
<td>18</td>
</tr>
<tr>
<td>Bush walking (camping)</td>
<td>12</td>
</tr>
<tr>
<td>Camping (car access)</td>
<td>8</td>
</tr>
<tr>
<td>Canoeing/Kyaking</td>
<td>22</td>
</tr>
<tr>
<td>Dog exercising</td>
<td>6</td>
</tr>
<tr>
<td>Fishing Shore</td>
<td>35</td>
</tr>
<tr>
<td>Fishing (small boat)</td>
<td>11</td>
</tr>
<tr>
<td>Fishing (large boat)</td>
<td>6</td>
</tr>
<tr>
<td>Off-road 4-Wheel driving</td>
<td>2</td>
</tr>
<tr>
<td>Horse Riding</td>
<td>9</td>
</tr>
<tr>
<td>Rowing</td>
<td>9</td>
</tr>
<tr>
<td>Sailing</td>
<td>4</td>
</tr>
<tr>
<td>Photography</td>
<td>31</td>
</tr>
<tr>
<td>Nature Appreciation</td>
<td>31</td>
</tr>
<tr>
<td>Swimming</td>
<td>17</td>
</tr>
<tr>
<td>Water Skiing</td>
<td>5</td>
</tr>
<tr>
<td>Bird watching</td>
<td>14</td>
</tr>
</tbody>
</table>

Scenic Value - Once again this was subjectively assessed with the recorder asked to rank the scenic value of the site from 1-10 and to list the various features which contributed to this value assessment. At most of the sites the scenic value was linked to inherent natural beauty, scenic rural settings and artistic values. About 60% of the sites were ranked as having low scenic value (from 1-3), reflecting the rural setting and clearing of most of...
Good Scenic and Recreational Values - Site 69 S. Maroochy River, upstream of James Low Bridge
- Deep, large rocky pools provide swimming, canoeing, fishing and scenic values.

Good Scenic and Recreational Values - Site 77 Chambers Gully
- Scenic rock falls and cascades are a feature of the catchment.
The higher ranking sites were located in the upland areas, in the State Forest and at the sites of falls, rapids and cascades.

<table>
<thead>
<tr>
<th>Scenic Value Rating</th>
<th>Percent of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>1</td>
<td>28</td>
</tr>
</tbody>
</table>

Scenic and Recreation Value Ratings - A combined rating was produced using the ranked and reordered recreational opportunity value (42%), the logarithm of the number of different types of recreation available at the sites (18%) and the scenic value rating (40%). This formula tended to rate sites with natural settings and high scenic values as close to 100%. Rural and urban settings were ranked lower, but the value was increased at sites with a diversity of recreational types available.

Most of the stream length in the catchment were ranked as moderate (40%) to poor (39%) in value.

Only 7% of the stream length was rated very good, and 8% as very poor.

The sites with higher values occurred mostly at the falls and rapids in the upper South Maroochy catchment and in the estuarine areas.

Sections with poor values occurred in the sugar cane areas and in the cleared areas of Petrie and Paynter Creeks and North Maroochy River.

Recreation and scenic values are very important to the local community and to support tourism.

Although the surveys are subjective, they again suggest that considerable value and amenity of rivers and streams has been lost.

Existing values need to be protected and enhanced if the recreation and tourism potential of the areas is to be maintained or enhanced to service the needs of the growing population in the area.
Good Scenic and Recreational Values - Site 77 Chambers Gully
- Scenic rock pools below fails and cascades provide excellent recreational opportunities.

Very Good Scenic and Recreational Values - Site 64 Caboolture Creek, Yandina Bli Bli Road
- Remnant riparian rainforest pockets provide unique nature appreciation and picnic areas.

State of the Maroochy River, 1993
Good Scenic and Recreational Values - Site 209 Tuckers Creek, crossing on Image Flat Road
- Picturesque riparian vegetation and trees enhance scenic and recreational values.

Very Good Scenic and Recreational Values - Maroochy River Estuary
- High value scenic and recreational area because of retention of mangrove and salt marshes.
4.1.8 Conservation Values

The conservation values were again determined subjectively at each site by the recorder (ranked 1-10). The distribution of known rare or endangered species in the catchment was not taken into account although the methodology does allow for this. The conservation ratings therefore refer to the broad scale assessment based on the ranking of the sites as remnant and representative habitat for aquatic and riparian plants or animal species, and the value of the stream verges as wildlife corridors.

The majority of sites (>50%) were given a very poor rating (<3), but about 10% were highly rated in all the conservation types. The overall conservation value rating was produced by summing the individual ratings which were doubled to give a score out of 100%.

64% of the length of streams was rated as having poor to very poor conservation value. Mostly these sections occurred in the degraded areas associated with sugar cane, and in the cleared upper reaches of Petrie and Paynter Creeks, North Maroochy River.

19% of the stream length was rated as having good to very good conservation value. These sections occurred in the uncleared headwaters of the South Maroochy River, Brown & York Creeks, and in the estuary and scattered throughout the rest of the catchment.

The conservation value ratings were strongly linked with the condition of the riparian vegetation and aquatic habitat. Turnbull and Olsen (1992) discuss the rare and endangered plant species in the Maroochy Shire.
Very High Conservation Value - Site 87 South Maroochy River, gully 1 km upstream Kiamba Falls
- Good instream habitat, good riparian vegetation providing a wildlife corridor.

Good Conservation Value - Site 108 Paynter Creek, upper end of Upper Landershute Road
- Good instream values with some loss of riparian and shoreline values.

State of the Maroochy River, 1993
Poor Conservation Value - Site 40 Coolum Creek, crossing on Yandina Coolum Road. Wetland Values degraded by clearing of riparian vegetation.

Very Poor Conservation Value - Site 60 Drain South-East of Dunethin Rock. Channelised stream with poor instream and shoreline values.

State of the Maroochy River, 1993
LEGEND

1 - 20%  
21 - 40%  
41 - 60%  
61 - 80%  
81 - 100%  

Very Poor  
Poor  
Moderate  
Good  
Very Good  

Catchment Not Surveyed  
Permanent Water Supply  
Swamp  
Population Centre  

NOTE

Conservation Values – are assessed using various subjective rating scales to provide relative overall assessments for each stream reach.
4.1.9 Overall Condition Rating

In order to provide an objective overall condition assessment the cluster package of SYSTAT was used with a selection of the individual component ratings. This package allocates the sections to a specified number of groups (in this case 7 groups). The component ratings were first standardized so that they each had the same mean of 1 unit and a standard deviation of 1. This ensured that each of the components used would make an equal and unbiased contribution to the allocation of the sections to the groups. The package uses a statistical procedure to allocate the sections to groups whose members share the same characteristics. The key attributes for separating the groups were found to be riparian vegetation, bed & bar condition, and aquatic habitat condition. The mean values for the classified clustered groups were then determined, and the major components affecting the groupings were identified and listed using the standard condition categories (see table). The 7 categories of overall condition produced in this way are described below.

Very Good Overall Condition - sections have high mean ratings for all attributes, (> 80%) including reach environs and riparian vegetation.

Good Overall Condition - sections are similar to the previous group but with the riparian vegetation ratings with a mean of only 26%. All the more degraded sites have even worse mean riparian vegetation ratings at less than 10%. Reach environs was rated as good, and conservation value moderate. Reach environs ratings and conservation values are lower for the more degraded groups.

Moderate Overall Condition - these sections have moderate aquatic habitat and good bed and bar, and bank condition, but poor reach environs and very poor riparian vegetation and conservation values. This group also has the highest mean aquatic vegetation rating.

Poor Overall Condition - these sites are very similar to the group rated as moderate condition, but they have the lower aquatic habitat condition and lower channel habitat diversity (i.e. less variety in terms of pools, runs, riffles etc. in the reach). Banks and bed and bar condition are very good for this group, as for the previous groups.

Very Poor Overall Condition - these sections have low mean condition ratings for most attributes, but with quite stable banks (rating 61-80%). The bed & bar condition is poor and the dominant process on the bed is aggradation.

Degraded Overall Condition - these sections are
Components

very similar the very poor category, but the
dominant bed process is erosion rather than
aggradation, and this group has been given a lower
score because of this.

Highly Degraded Overall Condition - this last
group includes sites that have banks in very poor
condition as well as poor condition for all other
attributes. Both the bed and banks are unstable
and none of the condition attributes rate above
poor to very poor condition. These are the most
highly degraded sites.

Using this classification of the sites only 14% of
the total length of the streams in the entire catchment was rated in very good overall condition, and 19% in good condition. Most of these sections were in the State Forest areas in the headwater streams of the South Maroochy River catchment, and in the minor tributaries in the vicinity of Cooloolabin Dam. Sites in very good condition also occurred in the estuary between the Petrie Creek and Coolum Creek junctions where there are large remnant stands of mangroves. The remnant freshwater wetland areas of the middle sections of Eudlo Creek and Doonan Creek also rate highly.

About one third of the total length of streams (33%) were rated as being in very poor, degraded or highly degraded overall condition with loss of most of the condition attributes and with highly unstable bed and banks condition.

The remaining third of the length of major stream sections in the catchment were rated as being in moderate to poor condition (33%). These ratings generally reflect a loss of riparian vegetation, reach environs, conservation values, and some loss of aquatic habitat values, but without the poor bed and bank condition that characterises the very poor, degraded and highly degraded categories.

Sections in all the overall rating categories were distributed throughout the catchment in headwater and lowland streams. All types also occurred in all of the sub-catchments.

The South Maroochy River had the highest proportion of good to very good condition sections (60% of the major stream length). The North Maroochy River had 28% of the major stream length rated as degraded to highly degraded and Browns and York Creeks (62%) and Eudlo Creek (36%) also have high proportions of degraded streams. These differences between the catchments will be discussed further in the next section.
Overall Condition of the Maroochy River

<table>
<thead>
<tr>
<th>Overall Condition Rating</th>
<th>Highly Degraded</th>
<th>Degraded</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Moderate</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Sections</td>
<td>11</td>
<td>24</td>
<td>33</td>
<td>44</td>
<td>14</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>Percent of Sections</td>
<td>6%</td>
<td>13%</td>
<td>17%</td>
<td>23%</td>
<td>7%</td>
<td>19%</td>
<td>14%</td>
</tr>
<tr>
<td>Length of Major Stream</td>
<td>18 km</td>
<td>44 km</td>
<td>73 km</td>
<td>119 km</td>
<td>27 km</td>
<td>88 km</td>
<td>65 km</td>
</tr>
<tr>
<td>% of Stream Length</td>
<td>(4%)</td>
<td>(13%)</td>
<td>(16%)</td>
<td>(26%)</td>
<td>(6%)</td>
<td>(19%)</td>
<td>(14%)</td>
</tr>
</tbody>
</table>
Good Overall Condition - Site 73 Mt Combe Creek, on the Wappa Falls Road
- stable bed & banks, moderate to good environmental values

Moderate Overall Condition - Site 98 Paynter Creek near Woombye
- Poor riparian vegetation and other environs but with stable bed and banks.
Poor Overall Condition - Site 117 Eudlo Creek near Eudlo
- Moderate environmental values and aquatic vegetation, banks somewhat unstable.

Very Poor Overall Condition - Site 102 Unnamed Tributary of Paynter Creek, Shurvells Road
- Poor environmental values, with somewhat unstable bed and banks.
Degraded Overall Condition - Site 104 Paynter Creek, tributary MacDonald Road
- Poor riparian vegetation, banks unstable, with some sediment buildup in the bed.

Highly Degraded Overall Condition - Site 11 Petrie Creek NE of Menarys Road
- Severe bank erosion and major buildup of bars, highly degraded environmental values.
4.2 Sub-Catchments

In this the condition of each of the sub-catchments will be compared using sets of 'pie-diagram' summaries. Photographs are used to illustrate the range of condition types present.

Maroochy River Estuary

This includes the lower reaches of the Maroochy River itself, as well as Petrie Creek, Paynter Creek, Eudlo Creek and Coolum Creek. Apart from the reaches in the vicinity of Maroochydore near the mouth of the river, where the southern bank is lined by housing developments, most of the salt marsh and mangrove areas are in good condition. Much of the adjacent land has been extensively modified for sugar cane. These aspects, and the deeper water and generally good condition of the aquatic habitat in the tidal areas have produced a wide range of ratings for the various components.

About 50% of the estuarine areas has been rated as good to very good condition in terms of the overall rating. This can be attributed to the mangrove and salt marsh fringe, good rating of the aquatic habitat (54% good) and high stability of the banks (77% rated as good to very good condition). Most of the estuarine areas are deeper than 4m and have sand and mud sediments.

29% of the environs was rated as poor to very poor primarily because of the extensive clearing of the adjacent lands.

The mangrove and salt marsh areas are obviously important habitat areas that need protection if current values are to be maintained.

The estuarine areas are also very important recreation areas and the scenic and recreation values were high (85% good or very good).

Bed and bar condition was not relevant for the estuary and it was not assessed. Likewise the aquatic vegetation was not assessed and there were no non-pool habitats.
Good Overall Condition - Estuary Site 304, 500 m downstream S. and N. Maroochy River junction
- Thin strip of remnant riparian vegetation along the banks.

Poor Overall Condition - Estuary Site 303, N. Maroochy River 2 km upstream S. Maroochy junction
- Riparian vegetation cleared degrading environmental values.
Maroochy River Estuary

Overall Rating
- Highly Degraded: 3%
- Degraded: 18%
- Very Poor: 49%
- Poor: 30%
- Moderate: 4%
- Good: 4%
- Very Good: 1%

Environs
- Very Poor: 20%
- Poor: 19%
- Moderate: 44%
- Good: 19%
- Very Good: 4%

Channel Diversity

Aquatic Habitat
- Very Low: 16%
- Low: 54%
- Moderate: 30%
- High: 4%
- Very High: 5%

Riparian Vegetation
- Very Poor: 9%
- Poor: 11%
- Moderate: 53%
- Good: 27%
- Very Good: 8%

Aquatic Vegetation
- Not Assessed

Scenic and Recreation Values
- Very Poor: 9%
- Poor: 12%
- Moderate: 8%
- Good: 71%
- Very Good: 1%

Conservation Value
- Very Poor: 9%
- Poor: 5%
- Moderate: 33%
- Good: 39%
- Very Good: 14%

Sites = 19  Sub-sections = 19  Catchment Area = 5,227 hectares  Length of Major Streams = 38 km
Maroochy River Estuary

Sites = 19  Sub-sections = 19  Catchment Area = 5,227 hectares  Length of Major Streams = 38 km
Coolum, Doonan, and Yandina Creeks

These creeks form the north-eastern part of the catchment between the North Maroochy and the coast. Much of the lowland areas have been drained for sugar cane, but there are important tea-tree swamps on the Coolum Creek between Doonan Bridge and the estuary.

About 50% of the length of major streams was rated as poor in terms of the overall rating and only 25% rated as good to very good.

The better sites were in the wetland areas of Coolum Creek, in the headwaters adjoining Sunrise road, and it the State Forest areas south-east of Eumundi. These sites had very good reach environs; stable bed, bars and banks and good to very good aquatic habitat.

The lowest rating sites occurred in the lowland areas which have been drained for sugar cane. Sites in these areas were rated as being in poor condition rather than degraded or highly degraded. This was primarily because the bed, bars and banks were stable and despite the artificial nature of the channels, the drains still provide some aquatic habitat values.

The riparian vegetation was mostly in good to very good condition (86% of the stream length). The aquatic habitat was mostly in moderate to very good condition (55%).

Most of the bed, bar and banks were in a relatively stable condition and the dominant process was erosion.

Pools were relatively shallow (90% of stream length <2.0m deep), and narrow (82% of width/depth ratios <10) with fine sediments (91% < 5 mm). Non-pool sites also had finer sediments (85% <0.5 mm).

Highly Degraded Overall Condition - Yandina Creek Site 45, tributary near the Grajewski Road
- Drain with bed and bank erosion and poor ecological values

State of the Maroochy River, 1993
Poor Overall Condition - Yandina Creek  Site 39, northern drain on the Yandina Coolum Road
- Channelised but with stable banks and a narrow riparian fringe including mangroves.

Very Good Overall Condition - Doonan Creek  Site 46, crossing at Doonan Bridge
- Remnant rainforest and good aquatic habitat.
Coolum & Yandina Creeks

Overall Rating
5% Highly Degraded
19% Degraded
18% Very Poor
9% Poor
3% Moderate
1% Good
5% Very Good

Environ
13% Very Poor
27% Poor
35% Moderate
6% Good
1% Very Good

Channel Diversity
6% Very Low
94% Low

Aquatic Habitat
8% Very Poor
27% Poor
18% Moderate
25% Good

Aquatic Vegetation
17% Very Poor
83% Poor
7% Moderate

Scenic & Recreation Values
14% Very Poor
51% Poor

Conservation Values
14% Very Poor
44% Poor
Coolum & Yandina Creeks

**Bank Condition**
- Very Unstable: 26%
- Unstable: 7%
- Moderate: 26%
- Quite stable: 60%
- Stable: 7%

**Bank Process**
- 100% Eroding

**Bed & Bar Condition**
- Very Unstable: 7%
- Unstable: 25%
- Moderate: 25%
- Quite stable: 68%
- Stable: 7%

**Bed & Bar Process**
- Eroding: 75%
- Aggrading: 25%

**Pool Depth**
- < 1 m: 10%
- 1.0 - 1.5 m: 35%
- 1.6 - 2.0 m: 21%
- 2.1 - 3.0 m: 21%
- 3.1 - 4.0 m: 10%
- 4.1 - 5.0 m: 19%
- > 5.0 m: 5%

**Pool Width / Depth Ratio**
- < 5.0: 18%
- 5.0 - 7.5: 21%
- 7.6 - 10: 21%
- 11 - 20: 21%
- 21 - 30: 20%
- 31 - 40: 19%
- > 40: 5%

**Pool Sediments**
- < 0.5 mm: 5%
- 0.5 - 2.0 mm: 4%
- 2.1 - 5.0 mm: 19%
- 5.1 - 20 mm: 72%
- 21 - 60 mm: 7%
- 61 - 100 mm: 4%
- > 100 mm: 8%

**Non-Pool Sediments**
- < 0.5 mm: 7%
- 0.5 - 2.0 mm: 85%
- 2.1 - 5.0 mm: 8%
- 5.1 - 20 mm: 4%
- 21 - 60 mm: 2%
- 61 - 100 mm: 1%
- > 100 mm: 0%

Sites = 19  Sub-sections = 24  Catchment Area = 12,516 hectares  Length of Major Streams = 87 km
Minor Tributaries

This category includes all the minor tributaries which flow directly into one of the major rivers that are not part of the major sub-catchment formed by these rivers. It includes Martins Creek, Ferntree and tributaries, Caboolture Creek and tributaries, Tuckers Creek, Wappa Falls Creek, Unnamed tributaries in the lower Petrie Creek, Rocky Creek, Mt Crombie Creek, Remnant Creek Drain (Burtons Road). These minor tributaries are too small to be considered individually.

The grouping is somewhat artificial but all have small catchment areas, occur in low altitude areas, and apart from Tuckers Creek are generally in good condition.

The overall rating for the streams were 38% good to very good, and 15% degraded to highly degraded.

The sites in worst condition occurred in Tuckers, Ferntree and Wappa Falls Creek.

The least disturbed sites occurred in the uncleared sections of Martins, Tuckers, Mt Combe, Rocky, and Wappa Falls Creeks. Riparian and aquatic vegetation were generally in poor to very poor condition (80% and 95% respectively). Aquatic habitat was moderate, and environs condition also moderate to very good (67%). Conservation values were generally poor to very poor (75% of stream length). Bed, bar and bank conditions were mostly stable (bank 53% stable; bed & bar 61% stable), and the dominant process was erosion. 80% of the pools were less than 2 m deep at the water mark. The sediments were mostly fine sands and muds (pools 76% < 2 mm; non-pools 67% < 2mm), but there were significant coarser sediments present (pools 17% > 20mm; non-pools 33% >60mm).

Very Good Overall Condition - Mount Combe Creek Site 74, near speedway
Good riparian vegetation on steep stable banks, good aquatic habitat.
Poor Overall Condition - Remnant Creek Site 60, drain North of Bli BU
- Channelised drain, with stable bed and banks, riparian vegetation cleared & low other values.

Degraded Overall Condition - Tuckers Creek Site 205, near Nambour Cemetery
- Severely eroding banks and loss of almost all environmental values.
Minor Tributaries

Overall Rating

- Highly Degraded: 5%
- Degraded: 17%
- Poor: 23%
- Moderate: 10%
- Good: 23%
- Very Good: 7%

Environments

- Very Poor: 26%
- Poor: 15%
- Moderate: 22%
- Good: 17%
- Very Good: 20%

Channel Diversity

- Very Low: 63%
- Low: 63%
- Moderate: 21%
- High: 21%
- Very High: 16%

Aquatic Habitat

- Very Poor: 53%
- Poor: 24%
- Moderate: 16%
- Good: 7%
- Very Good: 5%

Riparian Vegetation

- Very Poor: 68%
- Poor: 12%
- Moderate: 11%
- Good: 2%
- Very Good: 7%

Aquatic Vegetation

- Naturally sparse in catchment - see text

Scenic & Recreation Values

- Very Poor: 52%
- Poor: 34%
- Moderate: 12%
- Good: 2%
- Very Good: 2%

Conservation Values

- Very Poor: 50%
- Poor: 25%
- Moderate: 10%
- Good: 3%
- Very Good: 12%

Sites = 30  Sub-sections = 27  Catchment Area = 6.510 hectares  Length of Major Streams = 65 km
Minor Tributaries

**Bank Condition**
- 53% Stable
- 34% Quite stable
- 6% Moderate
- 2% Unstable
- Very Unstable: 5%

**Bank Process**
- All Eroding: 41%
- Eroding: 34%
- Aggrading: 15%

**Bed & Bar Condition**
- 61% Stable
- 26% Quite stable
- 13% Moderate
- Unstable: 16%
- Very Unstable: 2%

**Bed & Bar Process**
- 59% Aggrading
- Eroding: 34%
- Aggrading: 15%

**Pool Depth**
- 31% > 5.0 m
- 25% 4.1 - 5.0 m
- 24% 3.1 - 4.0 m
- 18% 1.6 - 2.0 m
- 2% < 1 m

**Pool Width / Depth Ratio**
- 34% > 40
- 15% 31 - 40
- 14% 21 - 30
- 26% 11 - 20
- 6% 7.6 - 10
- 5% 5.0 - 7.5
- < 5.0: 2%

**Pool Sediments**
- 62% > 100 mm
- 14% 61 - 100 mm
- 14% 21 - 60 mm
- 4% 5.1 - 20 mm
- 3% 2.1 - 5.0 mm
- < 0.5 mm: 3%

**Non-Pool Sediments**
- 58% > 100 mm
- 21% 61 - 100 mm
- 12% 21 - 60 mm
- 9% 5.1 - 20 mm
- 4% 2.1 - 5.0 mm
- 0.5 - 2.0 mm: 3%
- < 0.5 mm: 3%

Sites = 30  Sub-sections = 27  Catchment Area = 6,510 hectares  Length of Major Streams = 65 km
Petrie Creek

Most of the stream length in Petrie Creek was given an overall rating of poor to very poor condition (71%). Petrie Creek was one of the most disturbed sub-catchments. The highest rating sites (21% rated as good) occurred in the uncleared headwater areas in the vicinity of Blackall Range, and Carruthers Roads.

Most of the habitat components were rated as moderate or worse condition (environs 79%; aquatic habitat 90%; riparian vegetation 92%; aquatic vegetation 100%; conservation values 95%). Banks were generally stable and eroding, but 40% of the bed & bars were rated as unstable to very unstable mostly through aggradation. Most of the excess sediment appeared to be derived from runoff rather than the bank erosion. Most of the pool and non-pool sediments were sands and muds (pool 57% < 2mm; non-pool 93% < 2mm), but 17% of the pools were boulders or rocks.

80% of the pools were shallower than 2 m, and about 50% of the stream length had width/depth ratios in excess of 10:1, signifying once again the infilling of the channel with sediments and/or widening of the channel. There are many dramatic examples of the effects of clearing of the riparian vegetation on instream processes in the Petrie Creek catchment (e.g. Coes Creek). In the areas where remnant riparian vegetation remains the banks, bed and bars are stable and condition is good. Immediately downstream in areas where the vegetation has been cleared, there is often pronounced bars filling most of the channel, and the banks are steep and eroding. 50% of sites have a riparian width < 10m (average both sides) and 30% of sites <5m wide.

Very Good Overall Condition - Petrie Creek Site 27, at loop NorthWest of Woombye. Remnant patch of riparian vegetation in very good condition.
Very Poor Overall Condition - Coes Creek Site 139, crossing on Coes Creek Road
- Poor riparian vegetation, bed and bank quite unstable

Highly Degraded Overall Condition - Petrie Creek Site 11,100m downstream of Menarys Rd. bridge
- Severe bank erosion leading to bar buildup in the bed, poor environmental ratings.

State of the Maroochy River, 1993
Petrie Creek

**Overall Rating**
- Highly Degraded: 3%
- Degraded: 2%
- Very Poor: 3%
- Poor: 19%
- Moderate: 52%
- Good: 21%

**Environrs**
- Very Poor: 21%
- Poor: 40%
- Moderate: 30%
- Good: 9%
- Very Good: 2%

**Channel Diversity**
- Very Low: 3%
- Low: 34%
- Moderate: 45%
- High: 18%
- Very High: 8%

**Aquatic Habitat**
- Very Poor: 32%
- Poor: 39%
- Moderate: 19%
- Good: 10%
- Very Good: 10%

**Riparian Vegetation**
- Very Poor: 81%
- Poor: 11%
- Moderate: 8%
- Good: 8%
- Very Good: 8%

(Note: Naturally sparse in catchment - see text)

**Aquatic Vegetation**
- Very Poor: 14%
- Poor: 86%

**Scenic & Recreation Values**
- Very Poor: 34%
- Poor: 51%
- Moderate: 10%
- Good: 5%
- Very Good: 5%

**Conservation Values**
- Very Poor: 26%
- Poor: 50%
- Moderate: 19%
- Good: 5%
- Very Good: 5%

Sites = 27  Sub-sections = 25  Catchment Area = 5,438 hectares  Length of Major Streams = 55 km
Petrie Creek

Bank Condition

- Very Unstable: 3%
- Unstable: 18%
- Moderate: 35%
- Quite stable: 18%
- Stable: 44%

Bank Process

- Eroding: 9%
- Aggrading: 91%

Bed & Bar Condition

- Very Unstable: 21%
- Unstable: 19%
- Moderate: 27%
- Quite stable: 19%
- Stable: 27%

Bed & Bar Process

- Eroding: 67%
- Aggrading: 33%

Pool Depth

- < 1 m: 25%
- 1.0 - 1.5 m: 19%
- 1.6 - 2.0 m: 27%
- 2.1 - 3.0 m: 20%
- 3.1 - 4.0 m: 19%
- 4.1 - 5.0 m: 19%
- > 5.0 m: 19%

Pool Width / Depth Ratio

- < 5.0: 14%
- 5.0 - 7.5: 16%
- 7.6 - 10: 21%
- 11 - 20: 25%
- 21 - 30: 25%
- 31 - 40: 15%
- > 40: 4%

Pool Sediments

- < 0.5 mm: 7%
- 0.5 - 2.0 mm: 24%
- 2.1 - 5.0 mm: 18%
- 5.1 - 20 mm: 18%
- 21 - 60 mm: 3%
- 61 - 100 mm: 3%
- > 100 mm: 33%

Non-Pool Sediment

- < 0.5 mm: 69%
- 0.5 - 2.0 mm: 24%
- 2.1 - 5.0 mm: 7%
- 5.1 - 20 mm: 3%
- 21 - 60 mm: 2%
- 61 - 100 mm: 1%
- > 100 mm: 1%

Sites = 27  Sub-sections = 25  Catchment Area = 5,438 hectares  Length of Major Streams = 55 km
Paynter Creek

Paynter Creek runs south and parallel to Petrie Creek. It is generally rated in worse condition.

27% of the stream length were rated as degraded or highly degraded overall condition and only 16% as good. The best sites were in the vicinity of Palmwoods.

Most of the habitat components were rated as poor to very poor (environ 75%; aquatic habitat 39%; riparian vegetation 92%; aquatic vegetation 86%, conservation value 86%).

The banks were generally stable (69% quite stable), but the bed and bar were aggrading with 50% of the bank length rated as unstable or very unstable, and only 4% as stable.

Pools were generally shallow (62% <2 m) and the channels were also narrower than for Petrie Creek (65% width/depth ratio < 10 : 1). Sediments were predominantly sands and muds (pools 95% <2mm; non-pools 87% <2mm).
Poor Overall Condition - Paynter Creek Site 109, near quarry in headwaters
- Eroding banks and loss of structural diversity in the riparian vegetation.

Degraded Overall Condition - Paynter Creek Site 74, near speedway
- Good riparian vegetation on steep stable banks, good aquatic habitat
Paynter Creek

Overall Rating
- Highly Degraded: 16%
- Degraded: 10%
- Very Poor: 17%
- Poor: 15%
- Moderate: 24%
- Good: 18%
- Very Good: 38%

Environa
- Very Poor: 14%
- Poor: 37%
- Moderate: 38%
- Good: 37%
- Very Good: 38%

Channel Diversity
- Very Low: 40%
- Low: 43%
- Moderate: 17%
- High: 8%
- Very High: 92%

Aquatic Habitat
- Very Poor: 16%
- Poor: 25%
- Moderate: 37%
- Good: 14%
- Very Good: 86%

Riparian Vegetation
- Very Poor: 8%
- Poor: 48%
- Moderate: 37%
- Good: 34%
- Very Good: 52%

Aquatic Vegetation
(Note: Naturally sparse in catchment - see text)
- Very Poor: 14%
- Poor: 86%
- Moderate: 37%
- Good: 38%
- Very Good: 38%

Scenic & Recreation Values
- Very Poor: 15%
- Poor: 48%
- Moderate: 37%
- Good: 34%
- Very Good: 52%

Conservation Value

Sites = 18  Sub-sections = 18  Catchment Area = 5, 276 hectares  Length of Major Streams = 41 km
North Maroochy River

Most of the streams in the North Maroochy River catchment have been given an overall rating of less than poor (28% rated as degraded or highly degraded; only 24% as good). The poor rating is generally attributed to the very poor riparian vegetation (82% very poor), poor environs (only 6% rated as good) and unstable bed and bars (63% less than moderate).

The banks were generally rated as stable or quite stable (81%). The bed sediments were mostly sands and muds (pool 85% < 2 mm; non-pool 85% < 2 mm). No sites with mean particle sizes greater than 20 mm were found.

The riparian zone was dominated by *Camphor laurel* and at most sites the zone was narrow (mean width 9 m). Despite the predominance of exotic species the presence of these large trees was important in reducing the incidence of bank erosion. The condition ratings would be improved if the exotics species were replaced by natives.

The riparian vegetation has been left uncleared on the steep banks and this has protected the habitat values. The sections in best condition were in the vicinity of Eumundi. Most of the catchment, even in the headwaters has been extensively cleared (mostly grazing).

Good Overall Condition - North Maroochy River Site 30, near Gold Creek junction
- Good riparian vegetation, stable bed and banks.
Moderate Overall Condition - North Maroochy River Site 176, unnamed tributary South of Cooroy
- Stable bed and banks but riparian vegetation highly modified.

Degraded Overall Condition - North Maroochy River Site 22, headwaters due North of Point Glorious
- Bank erosion and loss of riparian vegetation and aquatic habitat values.
North Maroochy River

Overall Rating
- Highly Degraded: 15%
- Degraded: 13%
- Very Poor: 24%
- Poor: 13%
- Moderate: 19%
- Good: 17%
- Very Good: 12%

Environs
- Very Poor: 6%
- Poor: 51%
- Moderate: 11%
- Good: 32%
- Very Good: 13%

Channel Diversity
- Very Low: 8%
- Low: 51%
- Moderate: 41%
- High: 8%
- Very High: 8%

Aquatic Habitat
- Very Poor: 29%
- Poor: 11%
- Moderate: 29%
- Good: 29%
- Very Good: 11%

Riparian Vegetation
- Very Poor: 18%
- Poor: 82%
- Moderate: 6%
- Good: 4%

Aquatic Vegetation
(Notes: Naturally scarce in catchment - see text)
- Very Poor: 6%
- Poor: 75%
- Moderate: 19%
- Good: 3%

Scenic & Recreation Value
- Very Poor: 2%
- Poor: 61%
- Moderate: 27%
- Good: 10%

Conservation Value
- Very Poor: 37%
- Poor: 22%
- Moderate: 34%
- Good: 7%
- Very Good: 2%

Sites = 14  Sub-sections = 19  Catchment Area = 4,919 hectares  Length of Major Streams = 34 km
North Maroochy River

Bank Condition

- Very Unstable: 20%
- Unstable: 6%
- Moderate: 13%
- Quite Stable: 61%
- Stable: 19%

Bed & Bar Condition

- Very Unstable: 22%
- Unstable: 17%
- Moderate: 19%
- Quite Stable: 35%
- Stable: 7%

Pool Depth

- < 1 m: 25%
- 1.0 - 1.5 m: 51%
- 1.6 - 2.0 m: 17%
- 2.1 - 3.0 m: 15%
- 3.1 - 4.0 m: 7%
- 4.0 - 5.0 m: 6%
- > 5.0 m: 6%

Pool Width / Depth Ratio

- < 5.0: 45%
- 5.0 - 7.5: 28%
- 7.6 - 10: 18%
- 11 - 20: 9%
- 21 - 30: 7%
- 31 - 40: 4%
- > 40: 3%

Pool Sediments

- < 0.5 mm: 15%
- 0.5 - 2.0 mm: 22%
- 2.1 - 5.0 mm: 63%
- 5.1 - 20 mm: 4%
- 21 - 60 mm: 25%
- 61 - 100 mm: 11%
- > 100 mm: 0%

Non-Pool Sediments

- < 0.5 mm: 11%
- 0.5 - 2.0 mm: 4%
- 2.1 - 5.0 mm: 25%
- 5.1 - 20 mm: 60%
- 21 - 60 mm: 6%
- 61 - 100 mm: 3%
- > 100 mm: 0%

Sites = 14  Sub-sections = 19  Catchment Area = 4,919 hectares  Length of Major Streams = 34 km
Browns and York Creeks

These tributaries of the North Maroochy River are different habitat types from the North Maroochy itself, and they have been dealt with separately.

The sites in these catchments are a mixture of sites in good overall condition (13% of the stream length in the State forest areas) and those in degraded (23%) and highly degraded (39%) condition in the upland and lowland areas of the catchment.

The environs for most of the sites was good to very good condition (62% of the stream length), but the riparian vegetation and aquatic habitat were in poor to very poor general condition (81% and 65% respectively).

Sites in the middle reaches (State Forest areas) had very good riparian vegetation and aquatic habitat, but even in the forest areas the shoreline fringing areas have been cleared along roadsides which has reduced their condition ratings. The overall ratings for these sites was good rather than very good.

21% of the banks and 28% of the bed and bars were rated as being in poor condition with erosion as the dominant process (mostly in the lower reaches) downstream of the forest areas. The majority of pools were < 2m deep and the bed sediments were predominantly sands and muds, but there were large areas of boulder and rock substrates in the higher gradient middle reaches of the catchment (pools 18% >100ram; non-pools 10% > 100 mm).

Despite the relatively large proportion of the catchments which are uncleared the condition assessments for these catchments were lower than expected because of clearing along the banks and the bed and bank erosion.
Good Overall Condition - Browns Creek Site 21.1 km downstream of the Carol Creek junction
Riparian vegetation zone narrowed by clearing, but banks are stable.

Degraded Overall Condition - Running Creek Site 272, North Maroochy Tributary
- Eroding banks, aggrading bed, poor riparian vegetation
Browns & York Creeks

Overall Rating
- Highly Degraded: 13%
- Degraded: 23%
- Very Poor: 12%
- Poor: 13%
- Moderate: 39%
- Good: 16%
- Very Good: 46%

Environ
- Very Poor: 26%
- Poor: 12%
- Moderate: 46%
- Good: 16%
- Very Good: 23%

Channel Diversity
- Very Low: 7%
- Low: 29%
- Moderate: 64%
- High: 65%
- Very High: 11%

Aquatic Habitat
- Very Poor: 24%
- Poor: 65%
- Moderate: 11%
- Good: 26%
- Very Good: 12%

Riparian Vegetation
- Very Poor: 12%
- Poor: 60%
- Moderate: 21%
- Good: 6%
- Very Good: 7%

Aquatic Vegetation
(Note: Naturally sparse in catchment - see text)

Scenic & Recreation Values
- Very Poor: 19%
- Poor: 43%
- Moderate: 25%
- Good: 6%
- Very Good: 7%

Conservation Value
- Very Poor: 12%
- Poor: 13%
- Moderate: 33%
- Good: 30%
- Very Good: 12%

Sites = 14  Sub-sections = 11  Catchment Area = 2,957 hectares  Length of Major Streams = 24 km
Browns & York Creeks

- **Bank Condition**
  - Very Unstable: 21%
  - Unstable: 37%
  - Moderate: 41%
  - Quite Stable: 37%
  - Stable: 36%

- **Bank Process**
  - Eroding: 63%
  - Aggrading: 37%

- **Bed & Bar Condition**
  - Very Unstable: 24%
  - Unstable: 28%
  - Moderate: 12%
  - Quite Stable: 36%
  - Stable: 36%

- **Bed & Bar Process**
  - Eroding: 60%
  - Aggrading: 40%

- **Pool Depth**
  - < 1 m: 12%
  - 1.0 - 1.5 m: 6%
  - 1.6 - 2.0 m: 28%
  - 2.1 - 3.0 m: 54%
  - 3.1 - 4.0 m: 21%
  - 4.1 - 5.0 m: 11%
  - > 5.0 m: 6%

- **Pool Width / Depth Ratio**
  - < 5.0: 24%
  - 5.0 - 7.5: 43%
  - 7.6 - 10: 21%
  - 11 - 20: 11%
  - 21 - 30: 11%
  - 31 - 40: 6%
  - > 40: 6%

- **Pool Sediments**
  - < 0.5 mm: 25%
  - 0.5 - 2.0 mm: 39%
  - 2.1 - 5.0 mm: 11%
  - 5.1 - 20 mm: 18%
  - 21 - 60 mm: 18%
  - 61 - 100 mm: 7%
  - > 100 mm: 7%

- **Non-Pool Sediment**
  - < 0.5 mm: 10%
  - 0.5 - 2.0 mm: 56%
  - 2.1 - 5.0 mm: 34%
  - 5.1 - 20 mm: 56%
  - 21 - 60 mm: 31%
  - 61 - 100 mm: 21%
  - > 100 mm: 11%

Sites = 14  Sub-sections = 11  Catchment Area = 2,957 hectares  Length of Major Streams = 24 km
Eudlo Creek

Eudlo Creek forms the southern boundary of the Maroochy Catchment. Again there is a wide range of condition ratings from very good to highly degraded.

36% of the stream length was rated as good to very good in overall condition, with 46% of the environs and 25% of the riparian vegetation similarly rated. The sections in the best condition are the wetland areas in the Forest Glen area, and in the headwaters (south east of Landershute).

The wetland area is important and should be protected. The area is also used for sand and gravel extraction and this is causing obvious problems with turbidity downstream of the mining sites. Much of the remainder of the catchment is degraded. Most of the aquatic habitat was rated as moderate to good (87%).

Most of the banks were stable to quite stable (85%), with the bed and bars in poorer condition (only 40% stable to quite stable). The dominant process on the bed and banks was erosion.

Pool depths were shallow (88% < 1.5m and the channels narrow (85% of the width / depth ratios were less than 10). Sediments were predominantly sands and muds (pools 88% < 2 mm; non-pools 92% < 2 mm).

Very Good Overall Condition - Eudlo Creek Site 122, at crossing on Maroochydore Road. Stable bed and banks, good aquatic habitat with logs in the stream, good riparian vegetation.
Very Poor Overall Condition - Eudlo Creek Site 117, just upstream of Eudlo
- Bank erosion and loss of riparian zone width

Highly Degraded Overall Condition - Eudlo Creek Site 119, 3 km due West of Eudlo
- Unstable bed and banks, loss of riparian vegetation

State of the Maroochy River, 1993
Eudlo Creek

Overall Rating
- Highly Degraded: 6%
- Degraded: 30%
- Very Poor: 25%
- Poor: 16%
- Moderate: 5%
- Good: 7%
- Very Good: 11%

Environs
- Very Poor: 12%
- Poor: 32%
- Moderate: 33%
- Good: 10%
- Very Good: 7%

Channel Diversity
- Very Low: 5%
- Low: 46%
- Moderate: 32%
- High: 17%
- Very High: 5%

Aquatic Habitat
- Very Poor: 6%
- Poor: 48%
- Moderate: 39%
- Good: 7%
- Very Good: 5%

Aquatic Vegetation
(Note: Naturally sparse in catchment - see text)
- Very Poor: 5%
- Poor: 95%
- Moderate: 5%
- Good: 61%
- Very Good: 10%

Riparian Vegetation
- Very Poor: 5%
- Poor: 61%
- Moderate: 61%
- Good: 30%
- Very Good: 10%

Scenic & Recreation Values
- Very Poor: 21%
- Poor: 44%
- Moderate: 44%
- Good: 12%
- Very Good: 10%

Sites = 15  Sub-sections = 14  Catchment Area = 6,104 hectares  Length of Major Streams = 48 km
South Maroochy River

The South Maroochy River is quite different from the other catchments in many respects.

In terms of the overall ratings it had 34% of its stream length rated as in very good condition and 25% in good condition. This occurred despite 60% of the riparian vegetation being rated as poor to very poor, and the riparian zone widths averaged 21 m. This higher rating arose because the banks and beds were in stable conditions (banks 86% stable or quite stable; beds 84% stable or quite stable).

Aquatic habitat was also rated highly with 16% rated as very good and 44% as good condition. The reach environs were also rated as in reasonable condition, with 29% rated as very good, 23% as good and only 12% in very poor condition. Some of the high general ratings can be attributed the good condition of much of the headwater streams in the State Forest areas near. However, many of the lowland sites were given higher ratings than expected despite the poor riparian vegetation, poor environs (mostly grazing country) and extensive clearing of the lower catchment. This can be attributed to the relatively high proportion of the bed which was boulders or rock (37% of the pools and 37% of the non-pools), or coarse gravels (pools 19% 20-100 mm; non-pools 14% 20-100 mm). The rock outcrops in the bed and also in the banks have had a major influence on the high stability of the bed and banks. About 50% of the sites had rock outcrops acting as controls reducing erosion. The rock substrates, deeper pools (75% deeper than 1 m), larger catchment size and channel leading to more organic debris also contributed to the generally good rating of the aquatic habitat (60% rated as good or very good). These natural attributes have helped to retain good condition rating despite the clearing of the catchment, the clearing of the riparian vegetation which in other sub-catchments have led to bank and bed erosion or channel infilling and led to degraded conditions.

Very Good Overall Condition - South Maroochy River Site 79, 1.5 km downstream of Wappa Dam - Good riparian vegetation, rocky bed.
97 Sub-Catchment Summaries

Good Overall Condition - South Maroochy River Site 85, at crossing below intake weir
- Good riparian vegetation, rocky stable bed, good aquatic habitat.

Very Poor Overall Condition - South Maroochy River Site 68, at ford 1 km downstream of Yandina
- Severe bank erosion, poor riparian vegetation, large bar deposits.
South Maroochy River

Overall Rating

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Channel Diversity

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Aquatic Vegetation

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Conservation Value

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<tr>
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<td>22 %</td>
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<tr>
<td>Very Good</td>
<td>12 %</td>
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Sites = 31  Sub-sections = 35  Catchment Area = 6,580 hectares  Length of Major Streams = 73.5 km
South Maroochy River

Bank Condition

- Very Unstable: 12%
- Unstable: 27%
- Moderate: 59%
- Quite Stable: 2%
- Stable: 69%

Bank Process

- Eroding: 98%
- Aggrading: 2%

Bed & Bar Condition

- Very Unstable: 2%
- Unstable: 13%
- Moderate: 15%
- Quite Stable: 2%
- Stable: 69%

Bed & Bar Process

- Eroding: 78%
- Aggrading: 22%

Pool Depth

- < 1 m: 12%
- 1.0 - 1.5 m: 25%
- 1.6 - 2.0 m: 4%
- 2.1 - 3.0 m: 5%
- 3.1 - 4.0 m: 25%
- 4.1 - 5.0 m: 4%
- > 5.0 m: 53%

Pool Width / Depth Ratio

- < 5.0: 10%
- 5.0 - 7.5: 14%
- 7.6 - 10: 21%
- 11 - 20: 25%
- 21 - 30: 25%
- 31 - 40: 25%
- > 40: 5%

Pool Sediments

- < 0.5 mm: 37%
- 0.5 - 2.0 mm: 6%
- 2.1 - 5.0 mm: 7%
- 5.1 - 20 mm: 7%
- 21 - 60 mm: 6%
- 61 - 100 mm: 12%
- > 100 mm: 7%

Non-Pool Sediment

- < 0.5 mm: 34%
- 0.5 - 2.0 mm: 15%
- 2.1 - 5.0 mm: 12%
- 5.1 - 20 mm: 7%
- 21 - 60 mm: 7%
- 61 - 100 mm: 6%
- > 100 mm: 2%

Sites = 31  Sub-sections = 35  Catchment Area = 6,580 hectares  Length of Major Streams = 73.5 km
5. Conclusions and Recommendations

5.1 Conclusions

Evaluation of the Method

The method was very successfully and achieved its objectives by:

° Providing a comprehensive and objective 'snap-shot' view and analysis of the physical and ecological condition of the Maroochy River.

° Providing a solid database and method for integrated catchment management with links to other sources of data (hydrology and land use and other information about the catchment).

° Highlighting the seriousness of the river degradation in the catchment on a site by site basis, showing where the problems are occurring and providing an indication of the processes causing the problems.

° Establishing a baseline against which the trends and future rate of change in condition can be assessed by follow-up surveys at the carefully defined site locations (including the photographs).

° Providing an assessment of the Maroochy River which can contribute towards a state-wide assessment of the State of the Rivers in Queensland using the same objective methodology.

° Stimulating and directing action through integrated catchment management to find permanent solutions to the problems identified and to preserve, rehabilitate and re-establish the riverine condition throughout the catchment so that the potential values of streams and rivers can be realised.

Condition Assessment

In terms of the overall condition rating, about one third of the major stream length in good condition, another third in moderate to poor condition, and a further third in degraded to highly graded condition. These overall condition ratings were produced from the combination of the individual ratings shown in the table opposite.

° Only 14% of the total length of streams in the entire catchment was rated as being in very good condition, with virtually all ratings above 80%.

° 19% of the total length of streams in the entire catchment was rated as being in good condition, that is with moderate to poor environmental condition ratings but stable bed and banks.

° 32% of the total length of streams in the entire catchment was rated as being in moderate to poor condition, that is with poor to very poor environmental condition ratings but stable bed and banks.

° 29% of the total length of streams in the entire catchment was rated as being in very poor or degraded condition, that is with very poor environmental condition ratings but unstable bed and bars, and partially unstable banks.

° 4% of the total length of streams in the entire catchment was rated as being in highly degraded condition, that is with very poor environmental condition ratings and both the bed and banks being unstable.

Each of the major sub-catchments had sections classified in each of the overall condition categories. Most of these sections in better condition occurred in the State Forest areas in the headwaters of the catchment, which have been protected from the clearing for grazing, crops, orchards and sugar cane that characterises most of the catchment. Isolated sections of streams in good condition occurred in the wetland areas in the lower parts of Coolum, Doonan and Eudlo Creeks. Much of the estuarine areas were also given good condition ratings. Extensive mangrove and salt marsh flats have been retained along much of the estuary banks. The condition of the bed, and aquatic vegetation (e.g. sea-grasses, and bed stability) in these estuary sections were not considered in deriving the condition ratings for the estuary.

Most of the sections rated in highly degraded condition occurred in the upland areas of Petrie, Eudlo, Brown and Paynter Creeks and North Maroochy River. The lowland areas adjoining the extensively modified streams and drains in the sugar cane fields were also rated poorly.

The other major findings from the study in relation to the major components were:

Reach Environs - 50% of the length of major streams in the catchment was classified as being
in poor or very poor condition, with 70-75% of Paynter and Petrie Creeks being poorly rated. Only 16% of the length of the major streams were classified as being in very good condition. These poor ratings reflect the extent of clearing along the stream verges for sugar cane, grazing, orchards, crops and for residential developments.

**Riparian Vegetation** - Most of the riparian vegetation in the catchment was rated as in poor to very poor condition (83% of the major stream length). Only 8% of the stream length was rated as being in very good condition. This was mostly attributed to clearing of the riparian area.

Mean riparian zone widths were only 14m (after setting the maximum for any zone at 50m), and 80% of the stream length were less than 20m wide, 40% less than 10 m wide and 30% less than 5 m wide. Lower ratings were also produced because much of the remnant riparian vegetation is dominated by exotic species (Camphor laurel, exotic pines, para grass chinese elm, willows and other exotic grasses).

**Aquatic Vegetation** - There is very little aquatic vegetation in the catchment. 88% of the length of the major streams were rated as having very poor aquatic vegetation cover. Unlike the other components the poor aquatic habitat ratings does not necessarily imply that the condition of the aquatic vegetation has deteriorated from a pristine state where aquatic vegetation covers were higher in the undisturbed streams. The natural attributes of the streams would have meant that aquatic vegetation cover would have been naturally low. These attributes include the narrow width and steep banks of the streams, rocky substrates and closed canopy cover over the stream by rainforest and *Eucalyptus* forest over most of the rivers and streams.

**Bank Stability** - Over 80% of the bank length in the entire catchment was rated as being stable (81 - 100% stable) or quite stable (61-80% stable).

Only 6% of the bank length was rated as unstable or very unstable (0-40% stable). Most of the instability in the bank appeared to be related to flow wave action, stock damage and clearing of the bank vegetation. The dominant process was erosion (95%) rather than aggradation (5%). Most of the erosion and aggradation occurred irregularly or was found along almost the entire length of the bank. Significant bank erosion was also found on bends (linked to a meandering process) and associated with obstacles along the banks.

**Bed and Bar Stability** - 60% of the length of the streams in the catchment was rated as stable or quite stable (rating >61%). Only 17% of the bed length was rated as unstable or very unstable (rating < 40%). Most of the bed was rated as eroding (59%), but the dominant process for the unstable sites was aggradation. Subjectively, 54% of the sites were rated as stable, 16% as eroding and 30% of sites as aggrading.

**Aquatic Habitat** - 17% of the length of streams in the non-estuarine parts of the catchment were rated as being in very poor condition; with a further 19% in poor condition. The majority (35%) of the stream length was in moderate condition. Only 5% was rated as very good and about 24% as in good condition.

**Recreational Values** - There was a broad range of recreational opportunities throughout the catchment:

- 11% of the sites rated as pristine natural (remote sites with restricted access and isolation from human impact and contact).
- 73% were rated as undeveloped rural - that is with natural, but highly modified settings, with good road access and moderate human contact.
- 7% of the sites occurred at highly modified urban settings, but with no recorded resort developments along the streams.

There is therefore a wide range of recreational opportunities to cater for all tastes. The recreational potential of the streams and rivers was also subjectively recorded for a wide variety of activities, from passive nature appreciation and walking to active types such as picnicking to fishing, water skiing and canoeing. Clearly riverine areas are the focus for much of the recreation in the catchment, much of it related to the natural attributes and settings of these areas. This increases the value of the remnant areas and increases the need for conservation and rehabilitation.

Most of the more remote and natural settings occurred in the State Forest areas in the upper catchment. In a landscape that has been extensively cleared the stream verges provide readily accessible semi-natural areas for walking and nature appreciation. The value of these areas is difficult to assess because it is a matter of a sub-conscious appreciation of the presence of these.
areas and their availability even though the actual use of these areas may be small.

Scenic Values - Once again these was subjectively assessed with the recorder asked to rank the scenic value of the site from 1-10 and to list the various features which contributed to this value assessment. At most of the sites the scenic value was linked to inherent natural beauty, scenic rural settings and artistic values. About 60% of the sites were ranked poorly from 1-3, reflecting the rural setting and clearing of most of the catchment. About 15% of the sites ranked from 8-10. These higher ranking sites were located in the upland areas, in the State Forest and at the sites of falls, rapids and cascades. Scenic values could be improved by re-establishing riparian vegetation.

Conservation Values - The conservation values were again determined subjectively at each site by the recorder. The distribution of known rare or endangered species in the catchment was not taken into account although the methodology does allow for this. The conservation ratings therefore refer to the broad scale assessment based on the ranking of the sites as remnant and representative habitat for aquatic and riparian plants or animal species, and the value of the stream verges as wildlife corridors. The majority of sites (>50%) were given a very poor rating (rank <3). Mostly these sections occurred in the degraded areas associated with sugar cane, and in the cleared upper reaches of Petrie and Paynter Creeks, North Maroochy River. 19% of the stream length was rated as having good to very good condition. These sections occurred in the uncleared headwaters of the South Maroochy River, Brown & York Creeks, and in the estuary and scattered throughout the rest of the catchment. The conservation value ratings were strongly linked with the condition of the riparian vegetation and aquatic habitat.

### Prognosis

The prognosis is therefore that the streams and rivers are mostly in poor to moderate condition with a major loss of environmental values but without major bank or bed stability problems that would have produced a far worse report. Fortunately serious problems with gully erosion or with severe bank erosion appear to be isolated to the lowland reaches of Petrie, Paynter, Eudlo Creeks. In some respects the prognosis was not as bad as would have been expected given the extent of clearing in the lowland areas of the catchment and the population size. Several natural attributes of the streams have so far acted to reduce the extent of degradation that may have otherwise occurred. These attributes include the retention of a narrow riparian fringe of vegetation along the steep bank faces beside most streams. Also many of the streams have rocky beds and rock outcrops along the banks which act as controls resisting the erosion that may otherwise have occurred. Also, there is relatively little severe bank or gully erosion in the catchment. These aspects are discussed further in the following section, however their occurrence has provided a unique opportunity to act now before the streams deteriorate any further. Much can be achieved now using 'natural remedies' because of this situation. Once the streams have severely degraded much more serious action will be required to restore their values, ('major surgery'), and to overcome the problems they cause in terms of uncontrolled erosion and altered channel and flow patterns.

The message is therefore to take up the challenge and to seize this fortunate opportunity to prevent further deterioration in the rivers and streams and to re-habilitate them. The projected population growth, which will see the Maroochy Shire double its population size in the 20 years from 1980 to the year 2000, will put immense pressure on the streams and rivers in the near future.

### Natural Stream Attributes which have Prevented More Serious Deterioration in River Condition

Despite the moderate to poor condition rating assigned to most of the streams and rivers in catchment many sections retain some values and the condition is perhaps better than expected because of several fortuitous natural attributes. These are:-

- Remnant riparian vegetation on steep bank slopes

Despite the extensive clearing of the catchment and the loss of much of the riparian vegetation, with 83% of the stream length in poor to very poor condition, a narrow but very vital strip or trees and shrubs remains along most of the banks. In many areas this strip may only be 2-10m wide and is confined to the slope of the banks, but these remnants remain along most of the banks.

Very few banks were completely bare. It is true that much of this remnant vegetation dominated by Camphor laurel and other exotic species, but there were some trees, shrubs, herbs and grasses present. There were also pockets of remnant rainforest and other native trees and shrubs along

State of the Maroochy River, 1993
Conclusions

Upstream Site Highly Degraded by loss of Riparian Vegetation - Site 11 Petrie Creek, Menarys Rd.

Downstream Site protected from bank erosion by retention of Riparian Vegetation - Site 27 Petrie Creek, about 2 km downstream of Site 11

State of the Maroochy River, 1993
river sections despite the extensive clearing of the floodplain and valley flat areas.

Probably these vegetation remnants have been left, not because of a conscious decision to protect the streams, but simply because the banks were too steep and too difficult to clear. Or the vegetation on the banks has re-generated or been invaded by exotic species after originally being cleared.

Whatever their origin, the retention of these narrow, but highly valuable strips of shrubs and trees has protected the stream from the severe bank erosion and bed instability which would otherwise have occurred if this vegetation had been cleared. There are many dramatic demonstrations of this throughout the catchment. When moving downstream through the boundary of an area with a narrow riparian vegetation to a cleared area there are often dramatic changes in the stream. The stable banks and stable bed of the area with riparian vegetation quickly changes to steep, slumping and eroding banks, and to beds almost completely infilled with sediments. These changes are accompanied by an almost complete loss of ecological values, and the creation of stream problems that require on-going and often expensive and ineffective management, rather than streams which essentially 'look after themselves'.

- **High incidence of boulder and rock substrates provides controls restricting bed and bank erosion**

The boulder and rock substrates along much of the streams, particularly in the South Maroochy have also provided another de-facto control measure which has prevented the deterioration in stream condition which would have otherwise occurred.

Given the extent of clearing of vegetation in the catchments, and along the stream banks, many more areas would have eroded but for this natural protection. Once again the ecological values of these sections of stream may be very low but they can be restored by re-establishing riparian vegetation and other measures. The presence of these natural erosion controls can be used for advantage in accomplishing this restoration.

- **Severe headward gully erosion and other processes de-stabilising the bed and banks are not prevalent in the catchment.**

Fortunately channel avulsion (where a "perched" stream assumes a new course on the floodplain), and headward gully erosion (where the bed erodes and deepens and this progresses upstream) are not prevalent in the catchment. Similarly severe erosion in the catchment leading to excessive sediment dumping into the stream is also not prevalent, though soil erosion associated with horticulture is a concern. These processes can irrevocably damage streams.

**Remnant patches of streams and rivers sections in good condition are scattered throughout the catchment in both upland and lowland areas.**

The 14% of stream length in very good condition, and the further 19% in good condition are scattered throughout the catchment. Each of the major sub-catchments has a range of sections in various conditions including the very good and good categories. The streams in good condition occur in the State Forest areas in the headwaters, but there are also remnant patches on private land in the slopes and in the lowland areas including freshwater wetland and mangrove/salt marsh swamps. These remnants act as buffer strips enhancing the value of the surrounding areas and also provide the 'seeds' or foci for restoration initiatives. They also provide dramatic examples of what the all the streams once looked like, and 'working models' of how streams in good condition operate. They also provide goals and models of the direction and objectives for restoration of different areas.

**Major Initiatives and Objectives for Improving the State of the Maroochy River Catchment**

The overall classification and condition assessment clearly establishes that riparian vegetation management and re-establishment should be the major priority in the Maroochy catchment. The loss of the riparian vegetation is not only the reason for the poor rating of many of the stream sections, but is also a fundamental cause of the more serious problems with bank erosion and loss of ecological values. Despite the poor rating of the riparian vegetation condition (83% in poor to very poor condition), what remains is highly valuable and is saving the banks from erosion and preventing further degradation of the condition.

- **Protect Existing Riparian Vegetation**

The existing riparian vegetation should be
protected. This applies not only in the State Forest and other public land areas but also on private lands.

**Increase the Value of Existing Degraded Riparian Vegetation by Increasing its Width and Structural Diversity**

The value and effectiveness of riparian vegetation is related to its many roles in:

° stabilising banks,
° intercepting sediments and nutrients in runoff from the catchment,
° providing a corridor for terrestrial and amphibian wildlife (birds, mammals, frogs, reptiles and invertebrates), and
° providing shelter, shade, organic debris which feed and support the instream communities in many ways.

These roles depend on the width, structural diversity and species composition of the riparian vegetation zone. Enhancement programmes should therefore be directed at these objectives in staged exercises with practical and realistic aims. Ideally riparian vegetation strips of 25-50m are desired, but clearly this may be an unrealistic objective. The value to width relationship is probably not linear but increases rapidly at first and then tapers off. The first objective should be focused on the banks themselves, and then further out along a strip of the floodplain bordering the stream.

The structure of the riparian vegetation is also important. A diversity of structural types is required that is a mixture of tall trees, low trees, shrubs and other understorey species, herbs and grasses. Closing the canopy over the smaller streams is also important if the streams are to regain their original nature.

° **Replace Exotic Species with Endemic Native Species**

Strategies for replacing exotic species such as Camphor laurel and preventing their regeneration in the restoration areas should be investigated. The emphasis should be on effective replacement not simple removal which may leave the banks temporarily prone to erosion.

° **Restore Lost Riparian Vegetation**

Restoration of riparian vegetation in areas where it has been removed would provide the most effective means of improving the condition of the streams and rivers. This should be seen as a general programme and as an integral part of efforts to stabilise and overcome areas of severe bed and bank erosion and other forms of instability.

This is not an easy task as there are many problems and it involves the cooperation and assistance of many land holders and community groups. There a problems with financing, weed control, fire management, stock watering issues, fencing maintenance and all the difficulties inherent in undertaking works in areas where the beneficiaries may be remote from where the action need to be directed. However, there are case histories where rainforest has been successfully restored along streams in a cooperative ventures involving landowners, residents in nearby towns and various government agencies. Such activities are at the foundation of what integrated catchment management is really about. Such schemes also have the advantage that they can be initiated as pilot schemes building on the initial enthusiasm of local groups. If successful such pilot schemes will act as catalysts for future expansions of the programmes involving whole communities through schools and other community groups.

Turnbull and Olsen (1992) recognised the unique conservation values of the remnant riparian vegetation communities (rainforest, *Eucalyptus*, and exotic species dominated) and the merits of re-establishing this vegetation. Most areas would be fertile enough to allow for rainforest regeneration. They also recommended the replacement of the exotic species with natives.

**5.2 Recommendations**

The major recommendations from the study are:-

1. **Re-establish and Protect Riparian Vegetation**

The major focus for action should be directed at re-establishing riparian vegetation:

a) Protect existing remnant pockets of riparian vegetation in State Forest areas, other remnants on public and private land, remnant freshwater wetland and mangrove/saltmarsh areas.

b) Enhance existing riparian vegetation by increasing its width and encouraging the fencing of stream verges and the establishment of defined...
hardened stock watering points to reduce stock damage. Efforts should also be made to increase the structural diversity of remnant zones and the replacement of exotic species.

c) Restore lost riparian vegetation through appropriate integrated programmes.

2. Establish the Need for Temporary Bed and Bank Stabilisation Measures in Highly Degraded Areas and Investigate Long-term Solutions through Integrated Catchment Management.

The stream sections in degraded and high-degraded condition with severe bank erosion and/or bed erosion or excessive build-up of instream sediments may require urgent rehabilitation measures. This may involve well designed artificial bank protection techniques as interim, temporary measures. Further more detailed study of these areas, including the resourcing, would be required to identify the cause of the problem and the appropriate long term solution using an integrated catchment approach. Such bed and bank stabilisation measures should be seen only as stop-gaps to arrest the degradation until the long term cause can be identified and solved permanently.

3. Follow-up Survey in 3-5 years to establish trends and rates of degradation in condition and the effectiveness of rehabilitation and protection measures.

It is suggested that this condition assessment be repeated in 3-5 years dependent on the availability of the required resources and the perceived need for such a follow-up. Repeat surveys are required to determining the trends in the changes in condition in different parts of the catchments. The projected increase in population in the catchment will put extra pressure on the streams and rivers. Establishing the trends and the time-frame for degradation are important for setting priorities and establishing the seriousness of the problem. Follow-up surveys would also be very useful for establishing the effectiveness of re-habitation or riparian vegetation and various other management initiative stimulated by this report. The methodology has been designed to allow for this replication as the survey sites have been carefully described and located.

6. References


Appendix 1. Outline of the State of the Rivers Methodology

The State of the Rivers Project was initiated in 1992 with the development and validation of a methodology (Anderson 1993a) and an implementation strategy (Anderson 1993b). The project originated from a clear need for detailed and comprehensive information on the physical and environmental condition of rivers and streams throughout Queensland. The major focus was on collecting information on the instream habitats, and the physical and ecological condition of rivers and streams for integrated catchment management.

The Integrated Catchment Working Committee of the Department of Primary Industries (DPI) had previously prepared a discussion paper on the "State of the Catchments" which highlighted the current knowledge of catchment issued and established a clear need for comprehensive comparative information on instream condition. The existing information was inconsistent and only available in a qualitative form which was inadequate for developing a comprehensive assessment of the State of the Rivers throughout Queensland which was the first step to developing action plans to rectify problems which had been identified in a general way. Various assessments of the condition of some river sections have been undertaken in the past, but these assessments have generally focused only on one particular aspect of the condition or value such as flooding, fisheries, gravel extraction or water quality.

What was needed was a more comprehensive approach to assessing the physical and ecological condition of all of Queensland’s Rivers using a consistent and objective methodology and including all relevant aspects. The project was to be undertaken on a catchment by catchment basis focusing initially on the needs of each catchment as a management unit, but with the results also being compiled to form a complete picture of the State of the Rivers throughout Queensland.

The methodology which has been developed includes an implementation strategy, catchment sub-division and sampling procedures, survey methods and datasheets, a database system (Dbase IV) for storing the survey data and data derived from other sources, analysis and classification programs and a series of programs to generate reports and linkage with the GIS system and other databases (HYDSYS).

There are a number of features of the methodology which establish its focus, scope and limitations (see Anderson 1993a):

Specific Purpose Instream Surveys

Specific purpose instream surveys were seen as being required for assessing the physical and ecological health of the streams. Whilst it was recognised that various bits of relevant information may already exist in various catchments, no consistent information is available across the state especially in terms of the instream parameters. Also while some valuable information about catchments such as vegetation cover, land use, etc. can be obtained directly, or indirectly, by remote sensing, the instream data can only be collected by manually ground surveys. Information on pool depths, bed sediment particle sizes, the distribution and abundance of logs and branches in the pools and aquatic vegetative cover are not without their own limitations.
can only be assessed by specific purpose survey. The instream data can not be properly assessed by other means. The development of a consistent classification of streams according to their physical and ecological condition therefore depends on such a consistent and comprehensive specific purpose survey.

Snap-Shot Approach

It is a 'snap-shot' approach seeking to establish the condition of the streams now in comparison with local representative catchment or regional standards (i.e. remnant streams sections in pristine or desirable condition). The method does not seek to establish trends in stream condition either currently or historically. While historical records provide an important frame of reference, the method does not seek to establish when the deterioration in condition occurred nor how quickly such changes are now occurring. It is akin to the periodic annual or 5 year 'health check or condition audit rather than trying to establish a full medical history. It was recognised that such historical records are either not available or not consistent enough to establish such trends. Such trends or rate of change in condition, or indeed the outcome of future remedial measures, can be assessed by follow-up replicate surveys. The methods have been specifically designed for such follow-up health checks.

Inbuilt Interfaces with GIS and other Data Sources

The methods are designed to interface with Geographic Information Systems (GIS) and with other data sources such as geology, soils, hydrology, water quality, land use, and land system classifications. The site identification codes and the database have been designed to be compatible with the HYDSYS system which is used by DPI to analyse water flow records at the set of gauging stations throughout Queensland, and will also be used to link to water quality information. The gauging stations are incorporated as special sites and summaries of the flow regimes are incorporated into the database for comparative purposes. There is also facilities for incorporating water quality summaries into the database in a similar way. The basic survey unit is the stream section and its associated land parcel (local sub-catchment). The way the sites and these sub-sections are described is directly compatible with the DPI's GIS system. This means that the GIS can be used to output the data summaries and also as a source of land use and other catchment information which can be used to analyse the links between catchment activities, management practices and processes and instream condition (e.g. nutrient loads, sediment yield and passage, slopes, soils, geology, and climate).

Features of the Method

- Specific purpose surveys focused on instream features.
- 'Snap-shot' approach designed to assess the relative physical and ecological condition of sites compared with a regional or catchment standard.
- Simple techniques for use by inexperienced staff after a short training programme.
- Interfaces with GIS and other sources of data.
- Minimal requirements for equipment and resources.
- Rapid surveys requiring less than 1 hour per site.
- Designed to provide data and analysis and classification systems for Integrated Catchment Management.
- Site locations are precisely designed to allow follow-up surveys to be conducted to establish trends, rates of change and effectiveness of remedial measures.
- Objective and comprehensive with all steps involved in deriving the ratings being explicitly defined.
- Scaling system is used to allow the relative condition of different habitat types to be compared using the same method.

State of the Maroochy River, 1993
Simple Methods Designed to be Undertaken by Non-Expert Staff after a Short Training Programme

The methodology has been designed to be undertaken by regional technical officers of the DPI and other local people without extensive background or experience in stream survey techniques. The implementation package (Anderson 1993b) includes a short training programme to introduce the general concepts and methods. Nevertheless the methods had to be designed to be simply and easily understood by inexperienced staff. A simple design had obvious advantages in implementing the method quickly and also provided local ownership and involvement in the surveys which was important for ensuring that the data was locally relevant and would be used locally. Graphics were used extensively in the design of the datasheets, with emphasis on a multiple choice between discrete options portrayed as diagrams. The need for coding sheets to support the datasheets was eliminated. The surveys were also designed to be conducted by teams of 2 people, each with their own vehicle and equipment. No specialised equipment requiring training or prior experience was required.

Service the Data Needs of Integrated Catchment and Provide an Integration System Linking Instream Condition with Catchment Processes

The methodology was designed specifically to provide detailed and comprehensive data and analysis tools for Integrated Catchment Management. It includes a sub-section numbering system which uses the drainage network to enable an explicit link between the instream data and catchment information. This enables one to identify all the sub-sections upstream from any point in the drainage network and their order in the drainage hierarchy. This enables the source of particular problems to be traced upstream. The system is designed to be used with both the instream data and catchment and land use information which can be incorporated into the database. The concept is to be able to identify an excessive sediment load in the stream, to trace it up successive sub-sections to locate the source sub-catchments and then to examine processes using slopes, soil characteristics, vegetative cover, land use practices, and run-off features to identify the source and cause of the excess sediment loads in the stream. The methodology therefore provides an essential tool for integrated catchment management by enabling not only the problems to be identified, but also the size and relative severity of the problem in different areas, as well as making the first steps towards understanding the processes, causes and sources of the problems to be identified. A crucial first step to stream management is the identification of the size, location and severity of a problem, and some understanding of why it is happening. Only then can the limited resources available be directed where they can be most effectively used.

Pragmatic Consideration of the Resources Required

The methodology was designed with a careful consideration of the resources required. A 'rapid-survey' approach was adopted to enable a large number of sites to be surveyed by small teams in a short period of time. Past experience had shown that the emphasis should be on surveying a large number of sites because of the variability in the natural and disturbed condition of streams throughout a catchment. Pragmatic issues of the availability of staff, the large number of streams in Queensland, and the need to ensure that the whole state could be surveyed in a reasonable time period of about 5 years meant that compromises had to be made in terms of the level of detail of the information collected at each site. It was decided that the surveys should be able to be completed in 45-60 minutes at each site allowing each team of two persons to complete between 8-10 sites each day, including travelling time between sites.

Establish a Base-Line for Follow-Up Surveys to Determine the Trends and rate of Change of Condition (precise definition of site locations)

The survey methods were designed to be used as a baseline against which future trends can be establish through follow-up surveys. The site locations are defined using grid references and portable satellite based position location equipment. These units are now widely available and are simple to use. Location based site descriptions are also used as a guide to help precisely locate the sites during follow-up surveys.

Focused on Aquatic and Riparian Habitat - No Terrestrial or Aquatic Fauna Surveys

The ecological condition assessment is based on
assessing the condition of the habitat and the vegetation community structure rather than on actual plant or animal surveys, which require multiple surveys throughout the year and highly qualified personnel. The 'snap-shot' approach can only be directed at habitat. Standard habitat assessment techniques habitat been used.

**Estuaries Included- Survey extends from the Mouth to the Upstream Limits of Streams with Permanent Defined Channels**

The boundaries of the survey are the catchments defined by the Australian Water Resources Council. The survey is continued downstream to the mouth of the estuary. Although the survey was designed for freshwater habitats, the survey was extended into the estuaries.

The upstream limit was more difficult to define as it depends on the climate and other features for the catchment. However, the major focus of the survey is on perennial streams, or seasonal streams with a defined channel and a channel depth > 0.3m. Clearly the upstream limits will vary in different areas.

**Independent Teams of Two**

The survey is designed to be conducted by teams of two people with each team having its own set of equipment. Two such teams, completing an average of 10 sites per day should be able to complete an average size catchment in 2-3 weeks, allowing a coverage of 100-200 sites. The larger catchments may require more time or more teams, but the site density required will be lower (see summary provided).

**Sampling Strategy Based on a Stratified Sampling Approach to define Homogeneous Stream Sections**

A stratified systematic procedure is used as the basis of the sampling. All relevant pre-existing information is used to successively sub-divide the streams and rivers in the catchment into smaller and smaller sections, using key attributes such as natural and artificial barriers, stream gradient, geology, etc. The initial sub-division is made using the major sub-catchments and tributaries. This process is continued initially as a mapping exercise and then during a pre-survey reconnaissance of the catchment. The aim of this exercise is to divide the streams and rivers into 'homogeneous' stream sections which share common natural general attributes and common current condition.

The survey sites are then allocated to these subsections. The sites are selected to be representative of the natural habitats and condition within the

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sub-section. The survey sites are reaches - i.e. lengths of a stream about 50m long which contain a representative selection of pools, runs, riffles and other habitat types present in the sub-section. Ideally the reach contains 2 complete meander wave lengths and contains a sample of the diversity of habitat conditions in the area. Sites are generally chosen to include the deepest pool in the general area. One or more sites are surveyed in each sub-section.

The site data is then compiled and analysed. Summaries can be produced which refer to the sites or to the combined data fore each of the sub-sections. The immediate catchment area associated with each sub-section is then defined to form the stream-section and sub-catchment elements which are the basic units within the system for analysis and for linkage with a GIS (see summary).

Explicit Objective Formulae for Producing the Condition Ratings that can be Modified, but are Applied Universally to all Catchments once Finalised

Condition assessment ratings are produced objectively from the raw data using a set of rating formulae (see Anderson 1993b). The process of generating these ratings is explicit at every stage and there is scope for changing the rating formulae and the weightings applied to each of the parameters included in the formulae. However, it is important that once these formulae and whinnies have been finalised that they are applied universally and consistently throughout Queensland. Generally the ratings are expressed as percentages with 100% representing a stream section in pristine or presumed pristine condition, or a section with a full set of values or uses. Low values or zero percentage ratings represent highly degraded conditions or severe loss of values or uses.

Condition is Assessed Relative to Local Catchment of Regional Remnants - Ratings are Scaled for Different Regions to enable Different Habitat Types to be compared in terms of the extent of Degradation from their Presumed Pristine Condition

There is a tremendous diversity of stream and river types throughout Queensland from the tropical rainforest streams to the seasonal streams of the channel country and the western draining streams of the Murray-Darling Basin. This creates problems when you are trying to compare the relative condition of different streams in different climatic regions. For example a pristine rainforest stream may have a dense, complex and wide riparian zone, whereas a western draining stream may have a narrow and incomplete riparian zone even in its natural and undisturbed state. It is clearly inappropriate to rate the rainforest stream as being in better 'condition' than the other stream even in their pristine condition. This has been dealt with by using catchment of regional standards, based on remnant stream sections in pristine or virtually pristine conditions as a standard against which the changes in condition of other sites are established on a relative scale. The ratings for these catchment or regional standards are then used to derive scaling factors for comparing different catchments. For example, in a rainforest catchment the maximum rating for the riparian vegetation may be 100%, and the condition of other sites in the area may be related to this standard. In a western draining stream the maximum rating may be only 70%. For comparisons between catchments and for producing a state-wide condition assessment, the ratings for the western draining stream would be scaled upward by a factor of 100/70 to enable a reasonable relative comparison. This means that only a single set of data sheets and assessment methods are applied throughout the state, rather than multiple methods. Both the unscaled and scaled ratings are maintained in the database and the weightings used for the various parameters and for scaling the results from different catchments are always made explicit.

Water Quality and Stream Flow Included as Options only for Cross-Catchment Comparisons - Long-term Summary Statistics of Hydrology included when Available

Water quality and stream flow measurements are not an obligatory part of the methods, but there is scope for undertaking these surveys as options. Separate assessments of these aspects are the subject of other programmes. The 'snap-shot' approach is only applicable for examining the variability of flows and water quality throughout the catchment at one point in time. This information is useful for classifying streams and for examining the representativeness of the permanent stations which are monitored monthly or at other regular intervals. However, analysis of long term records is required to establish the water quality and flow regime aspects of the stream condition. Again the database has been

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designed for incorporating hydrology and water quality summary or classification information into the database for analysis purposes, but the collection of this information is not seen as an obligatory part of the surveys.

Outline of the Maroochy River Survey Approach and Methodology

The Maroochy River was used as the pilot survey for the development and validation of the methodology (Anderson 1993 a,b). Its small size, close proximity to Brisbane, relatively complex range of river management issues and reasonably high population densities including rural residential developments and 'hobby farms' made it an ideal choice as a pilot. The methods worked beyond initial expectations enabling the pilot to be extended to a complete State of the Rivers Survey. The data was analysed as the first State of the Rivers Report.

The methods used were essentially those described in Anderson (1993 a,b). The survey was conducted over a three week period from 11 September to 2 October 1992. Two staff were involved in the pre-survey planning exercise and recognoitre survey during the first week. A meeting was held with Local Government representatives, members of the local Integrated Catchment Management group and Regional staff of the DPI to undertake the initial sub-division of the catchment into 'homogeneous' sub-sections using maps, previous studies and local knowledge of the stream types, vegetative cover and land use. An extensive recognoitre of the whole catchment was then undertaken over three days to further sub-divide the streams into sections and to select the location of representative sites (=reaches) for the subsequent survey. A one-day training workshop was held to train the 3 regional staff in the survey techniques and the use of the datasheets. This training consisted of a short seminar followed by a field trial. The emphasis was on a 'learn by doing' approach at several selected sites. The full survey of the catchment was then conducted by two teams of two staff over with each team being supplied with a vehicle and all the equipment required.

A copy of the datasheets is provided in Appendix 3.

A total of 192 sites were surveyed during 11 days, of which 185 were full survey sites and 7 were only partially surveyed.

Following the survey the stream sub-section boundaries and definitions were finalised and the
local catchment area for each was defined and entered into the GIS system. These stream sections and their associated local catchment land parcels are the basic units for linking the surveys with the GIS and for compiling land use and other information throughout the catchment. The location of the sites is defined by a site description, a grid reference and a latitude and longitude (derived from the GPS units). One or more sites are used to establish the condition of the stream within each stream sub-section, which is defined by its sub-catchment boundary, its local major and minor stream network, and a centroid.
Appendix 2. Case History Example of Re-Habilitation of Riparian Rainforest

Experiments conducted on the Atherton Tablelands in the Johnson River catchment (Davies Creek near Milanda) about 6 years ago, by various agencies (G. Tracey, CSIRO, Nigel Tucker, National Parks and Wildlife Service, Greening Australia) in cooperation with the landholder, have shown how rainforest can be successfully re-established along riparian zones.

The need for the re-habilitation arose because the land owner had a problem. In a section of his paddock where the rainforest had been completely cleared along the stream verges, the stream had become a bog, denying water to his cattle, and occasionally requiring the stock to be dug or dragged out of the swamp created by the action of the cattle themselves in an area fed by springs. He sought the help of local authorities in finding a way of re-establishing the vegetation and so recovering the stream as a safe watering point for his stock. He was willing to assist in fencing off the area and providing fencing and ongoing maintenance.

The first requirement for successful riparian vegetation re-habilitation was therefore present. The landowner had a problem; he had a stake and vested interest in re-establishing the streamside vegetation, and he was willing to contribute both in the short and long term to finding a permanent solution. Few if any attempts to improve riparian vegetation values will be successful without the involvement and sense of ownership by the landholder.

The National Parks and Wildlife Service became involved and a strategy for re-establishing the rainforest was developed using ideas developed by CSIRO.

How can you re-establish rainforest in a pasture area and hope to achieve the species diversity which characterises this type of vegetation?

The following methods were applied:-

1. The area was fenced-off to exclude stock which had probably damaged the banks in the first place, and would have grazed on the small trees.

2. Defined stock watering points were established between the fenced-off riparian zones and hardened using gravel and rock materials.

3. The areas to be replanted was treated with herbicides to kill off the grass which was left unslashed to reduce soil erosion.

4. A carefully selected range of tree species was planted as very mature plants (1-1.5m high). The size of the trees and their spacing was chosen to quickly close the canopy, within 2 years after planting, and thereby to reduce the competition from grass and weed species.

5. The trees planted were selected using the following list of desirable characteristics:-
   - Fast growing and hardy species,
   - Species which produced fruits and berries to attract birds,

   Some Acacia and other non-rainforest species were included to help to quickly close the canopy.

Only about 6 different rainforest species were originally planted. The Acacias were included because they are hardy and quick growing. These species would eventually be shaded-out by the rainforest trees. The choice of bird attracting species was very important. Six years after the original planting of about 6 species, this has increased to about 20 species. The bird attracted to the area to feed have brought in the additional species from local remnant pockets of rainforest nearby.

Greening Australia was also involved in the project and the local townspeople assisted in planting the trees.

Six years after the planting the results have been very successful. The rainforest has been established along the stream bank in a strip about 15-30m wide. The dense closed canopy now almost completely covers the stream.

The stream itself has incised back into the bed, re-exposing the springs and providing a pronounced "V" shaped channel of flowing water, maintaining water for the stock. The complete canopy cover has eliminated major weed problems.

This case history provides an excellent example of what can be done involving the whole community in the exercise.

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Some key aspects of its success were:

The ownership and vested interest by the land owner who had a long term commitment to the outcome of the project.

The involvement of Greening Australia and local authorities to provide expertise and personnel for the project. Other groups such as Land Care and the local Integrated Catchment Management Groups could also be involved. This provided a community ownership for the project.

The area was sited not in the headwaters of the stream which would have been preferred, but beside the main road, about 1 km outside of the town. This meant that everyone including the towns people and the local land owners who were initially sceptical of the project, could not avoid seeing and reviewing its progress.

Re-establishing rainforest or other riparian vegetation is not an easy task. There are many problems to be overcome. Fences have to be built, paid for, and maintained in flood prone areas. Defined hardened watering points for stock have to be established. There may also be on-going problems with weeds, vermin and fire hazards associated with fenced-off stream verges. There may be merit in using temporary electric fencing which can be installed until the trees are large enough not to be damaged by cattle and then moved to other areas. Specially designed collapsible fencing may be required to reduce flood damage. Allowing or encouraging the local land owner to periodically graze the area to control weeds and understorey species during the initial stages may also have merit. Nevertheless, despite the problems, community projects to re-habilitate riparian vegetation, which involve sympathetic and motivated land owners, townspeople and various community groups will be successful.

One of the important prerequisites for the success of such schemes is the willingness and ownership of the landowners. Even if the landowners do not own the stream bed and banks, they are the only ones who really have the equipment, knowledge and local vested interest to provide the on-going maintenance which is crucial for the success of such ventures. Some sort of incentive may be required to encourage their initial and on-going involvement. This may simply mean explaining how the action will provide immediate benefits to them as land owners along the stream banks.

It is unrealistic to believe that all land owners and all other members of the community will initially be willing to be involved in the project and see it as worthwhile. The strategy is therefore to start off with small groups of committed and interested individuals and use the successful outcome of the first pilot projects to encourage and convince more and more people to become involved.

Re-establishing riparian vegetation would appear to be an excellent activity for local schools. It would provide an excellent educational opportunity to teach students about the value of streams. On-going projects to initially re-establish the riparian vegetation, and then to maintain it and to monitor its success in terms of physical and ecological attributes would appear to be an excellent school project. Monitoring of the bird and wildlife usage of the area and the plants in the riparian zone could also be conducted by schools.

Re-establishing riparian vegetation would also appear to be an excellent project for integrated catchment management.
### State of the Maroochy River, 1993

#### Physical-Chemical Data

<table>
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<tr>
<th>Date (dd/mm/yy)</th>
<th>Receiver</th>
<th>Flow (m³/sec)</th>
<th>Water Depth (m)</th>
<th>Water Temperature (°C)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Conductivity (μS/cm)</th>
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**Notes:** Various parameters could be derived from these to provide an understanding of the river's state.
**State of the Maroochy River, 1993**

### Appendix 3. Data Sheets

#### Site Description

<table>
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<tr>
<th>Flow into</th>
<th>Site Description</th>
<th>Location Description (near n find key)</th>
<th>Flow into</th>
<th>Data (day/month)</th>
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#### Sketch

- Show location of survey access points, landmarks, and key features such as roads, houses, and other buildings.
- Also show the key features of the stream environs and its location.
- Mark the boundaries of the stream environs.

#### Notes

- Upstream
- Downstream
- Reach Environ
- Lateral Right
- Lateral Left
- Altitude (m)
- Average Photograph
- Film No.
- Shot
- Shot
- Shot
- Shot
- Shot
- Shot

#### Type of Site

- Full Survey Site
- Stream Gauge Site

#### Water Quality

- Other
- Other

#### Assistant

- Recorder

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The above data is for future follow-up surveys.
Appendix 3. Data Sheets

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Cross-section readings across the bed (datum at marlstone 15)

[Diagram showing cross-section readings with annotations and measurements]

sediment classification

and other relevant data
Appendix 3. Data Sheets 124

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State of the Maroochy River, 1993
State of the Maroochy River, 1993

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<th>Reclassification (RC)</th>
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<td>[ ] Not Noticeable</td>
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<tr>
<td>[ ] High</td>
<td>[ ] Medium</td>
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<tr>
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<tr>
<td>[ ] Increase in Value</td>
<td>Connectivity improvements, increased recreational opportunities</td>
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<td>[ ] Decrease in Value</td>
<td>Decreased water quality, reduced habitat diversity</td>
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<td>[ ] Implementation of Best Management Practices</td>
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<td>[ ] Habitat Recovery</td>
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<tr>
<td>[ ] Biennial</td>
<td>Annually</td>
</tr>
<tr>
<td>[ ] Quarterly</td>
<td>Annually</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Information</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Water Quality</td>
<td>Improved with enhanced treatment processes</td>
</tr>
<tr>
<td>[ ] Habitat Recovery</td>
<td>Increased with ongoing restoration efforts</td>
</tr>
<tr>
<td>[ ] Visitor Numbers</td>
<td>Stable with slight increases</td>
</tr>
</tbody>
</table>