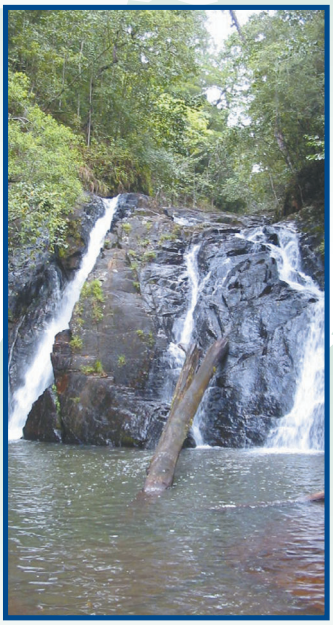

BEST PRACTICE MANUAL

Visitor Monitoring System for the Wet Tropics World Heritage Area

Volume 3
Case Studies - Biophysical Assessment

R. F. Wilson, S. M. Turton,
J. M. Bentrupperbäumer and J. P. Reser

Rainforest CRC
Cooperative Research Centre for Tropical Rainforest Ecology and Management

VISITOR MONITORING SYSTEM FOR THE WET TROPICS WORLD HERITAGE AREA

VOLUME 3
Case Studies – Biophysical Assessment

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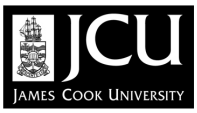

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PREFACE

Almost three million visitors cannot be wrong! The Wet Tropics World Heritage Area of North Queensland is not only a precious ecological asset, it has also become one of Australia's most outstanding attractions for local, interstate and international visitors. Queensland's reputation and status as a tourism destination owes much to its natural environment, not least the wonders of our tropical forests and landscapes.

Tourism in the World Heritage Area alone is estimated to generate over A$750 million (Driml 1997) of economic benefit for local communities each year. The Wet Tropics region has experienced significant increases in domestic and international tourism over the past twenty years, with some two million visitors per year in 1995 and an estimated three million in 2003. Recent projections suggest that tourist numbers will reach four million per year by 2016, with an increase in international visitors being a major contributing factor.

The recent *Wet Tropics Visitor Survey* (Bentrupperbäumer and Reser, 2002) has estimated about 4.4 million visits per year to recognised Wet Tropics World Heritage Area sites, with sixty percent of these visits by domestic and international tourists. The remaining forty percent were local residents engaging in rainforest-based recreational activities. In addition, it is estimated that some 270,000 people will live in the Wet Tropics region by 2016, placing increasing pressure on the World Heritage Area.

The *Wet Tropics Nature Based Tourism Strategy* (Wet Tropics Management Authority 2000) and *Wet Tropics Walking Strategy* (Wet Tropics Management Authority 2000) both address tourism and recreation issues in the World Heritage Area, and both have identified the need to develop a Visitor Monitoring System for ongoing evaluation of the environmental condition of some 180 recognised visitor nodes and sites in the area. Successful strategies to address these needs requires sound scientific advice on environmental impacts of visitation and use on the World Heritage Area. Only on this basis can effective management tools and practices be implemented to achieve sustainable outcomes.

The initial proposal for the Visitor Monitoring System was discussed with the Rainforest CRC's Program 4 Support Group in 2001, the role of which is to ensure that researchers and research users collaborate at every stage of the project. With strong endorsement from the Support Group, the Visitor Monitoring System has been designed to provide advice to managers of the Wet Tropics World Heritage Area on the basis of a hierarchical monitoring system that engages tour operators, park rangers and researchers. Once operational, the Visitor Monitoring System will allow environmental agencies to base land-management decisions on sound scientific advice – a crucial requirement that has been identified by industry, conservation groups and management agencies.

While specifically designed for the Wet Tropics World Heritage Area, this 'gold-standard' three-volume best practice manual is sufficiently generic to be of considerable value to protected area managers in other parts of Australia and overseas.

Tourism, research and conservation have a strong mutual interest. The Rainforest CRC has a long-term commitment to tourism research in tropical Australia, and the tourism industry has long been a major user of its research and a driver of the CRC's research agenda for the last ten years.

I congratulate the Rainforest CRC, the authors and the production team for the practical and highly valuable contribution they have made to sustainable tourism and conservation. I recommend the Visitor Monitoring System tools to all stakeholders in industry and in government agencies, and look forward to a continued tourism industry partnership with all stakeholders of the Wet Tropics World Heritage Area.

Daniel Gschwind
Chief Executive Officer
Queensland Tourism Industry Council

TERMS OF REFERENCE

DEVELOPMENT OF A VISITOR MONITORING SYSTEM FOR THE WET TROPICS WORLD HERITAGE AREA

The following Terms of Reference are quoted directly from the Wet Tropics Management Authority Contract (No. 658).

Purpose of the Contract

The *Wet Tropics Nature Based Tourism Strategy* (NBTS) and *Wet Tropics Walking Track Strategy* (WS) identify the need for a visitor monitoring system (VMS) associated with nature based tourism and recreation activities in the Wet Tropics World Heritage Area (WTWHA) and surrounding areas.

The proposed VMS aims to build on past and current research and monitoring of visitor management, coordinating the work of various researchers and land managers to provide a comprehensive and practical system for monitoring all aspects of visitor management. The project provides a necessary link between the research goals of Rainforest CRC Programs 3 and 4, which are essentially concerned with rainforest visitation and usage at regional and local level, respectively.

Aims of the Project

The aim of this project, essentially, is to design a robust, efficient, practical and cost-effective VMS for the WTWHA and environs, which assists management in identifying whether visitor management objectives are being met so that appropriate management responses can be made.

Key Attributes Required of the VMS Design

The VMS must be efficient, practical and cost-effective to implement.

The design should be recognised by both tourism interests and protected area managers as a robust, useful and worthwhile system for tourism and visitor management information and as a support for decision-making.

The site-monitoring component, which requires ongoing monitoring by field staff and/or tour operators, should be able to be readily incorporated into regular visitor management and tour operations. The benefits of conducting such monitoring must be readily demonstrable to field staff.

The VMS can be applied across the range of visitor site scenarios occurring in the study area (N.B. site monitoring elements are to be demonstrated at four pilot sites as part of this project).

The VMS design will also incorporate:

- Monitoring at other key regional locations (e.g. information centres, airports);
- Survey components and associated questionnaires to complement ongoing monitoring systems. (N.B. As part of a separate but complementary project, the Rainforest CRC will be designing and undertaking site visitor surveys to plug into this VMS. However, this VMS project will need to design more intensive and targeted survey components for the

four pilot sites, and ensure such surveys are completed as part of the 2001/2002 survey project);

- Elements associated with monitoring pre-destination marketing, promotions and trip planning information;
- Elements associated with monitoring suitability and appropriateness of information accessible to visitors on arrival to the Wet Tropics region, to assist in 'matching' visitor interests and expectations with available nature based tourism products; and
- A trends-based approach, which will assist management in identifying whether visitor management objectives are being met so that appropriate management responses can be made.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The input of several people from different stakeholder groups (the tourism industry, Wet Tropics Management Authority, Department of Natural Resources, Mines and Energy, and Queensland Parks and Wildlife Service) at different stages of this study is gratefully acknowledged.

Thanks to:

Tourism industry: John Courtenay; Gordon Dixon; members of the Tourism Alliance and Tourism Executive Committee; tour guides who conducted trials of the proforma (names withheld for privacy).

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Department of Natural Resources, Mines and Energy/Queensland Parks and Wildlife Service: Ritchie Carrigan; William Dorries; Lee Hess; Jeremy Little; Mike Murphy; Robin Smith; Andrew Spooner; and Tim Woods.

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Data entry and technical assistance: Ian Curtis.

EXECUTIVE SUMMARY

RESEARCH OBJECTIVES

1. To identify and collate existing expertise and data to develop a framework for a visitor monitoring system (VMS) for the Wet Tropics region that is recognised by tourism and protected area management.
2. To design a robust, efficient, practical and cost-effective system that incorporates both site and regional level components and to trial the system in the field.

INTRODUCTION

Australia's Wet Tropics World Heritage Area (WTWHA) is of international significance. It is the duty of the Australian community to ensure its special values are protected, conserved, presented and rehabilitated for future generations (WTMA 2000). In order to meet these obligations it has been recognised that the WTWHA requires a visitor monitoring system that incorporates regional and site level monitoring and involves all levels of users, commercial and free and independent travellers, and managers (WTMA 2000, 2001).

The Wet Tropics is an internationally acclaimed visitor destination (WTMA 2000). In 1998, there were over two hundred commercial tour operators with permits to operate within the Wet Tropics (QPWS 1998), most of whom were operating in far north Queensland within the WTWHA (TQ 1998). Visitors to the WTWHA sites also include domestic travellers and the local community. A survey, conducted in 1998 by Tourism Queensland, found domestic travellers account for more than eighty percent of visitors to Queensland (TQ 1998). Direct use of the WTWHA by tourists is estimated to generate over $179 million annually, which is a significant economic contribution to the local and regional economy (Driml 1997).

There are over 180 sites being used by visitors to the WTWHA, of which 94 have associated infrastructure (WTESSC 1996). This is a significant number of sites. Visitation is increasing to WTWHA sites and this requires careful management if it is to be sustainable. Human presence in any natural environment results in some level of disturbance (Hammitt and Cole 1998) and these impacts require monitoring.

Tour operators have reported that in the past their observations and comments to management regarding negative impacts associated with visitation were not always addressed. This highlights the need for a formalised monitoring system that ensures their concerns are recorded and, if necessary, acted upon. Therefore the first level of monitoring in the visitor monitoring system produced for the Wet Tropics Management Authority involves the tourism industry.

Sites with low levels of visitation are primarily visited by the local community and the more adventurous independent travellers. The types of impacts occurring at these sites are different than those at high use areas. Tour groups do not usually visit low use sites and thus land managers form the first level of monitoring at these sites.

Visitation and use of sites changes over time, so site managers require a monitoring system that will track these changes and respond as necessary.

There are three basic levels to the visitor monitoring system presented in this report: 1) tour operator rapid assessment; 2) land manager semi-rapid assessment; and 3) researcher semi-intensive assessment.

STRUCTURE OF THE VISITOR MONITORING SYSTEM BEST PRACTICE MANUAL

The Best Practice Manual consists of four sections, separated into three Volumes:

- Volume 1: Procedural Manual;
- Volume 2: Visitor Monitoring Process – From Pre-Destination to Post-Destination; and
- Volume 3: Case Studies – Biophysical Assessment.

Section 1 (Volume 1) details how the components of the VMS link to provide useful information for visitor management. It also shows how this VMS links with other VMS at a national, state and regional level and how it is complemented by other research and survey activities within the Rainforest CRC.

Section 2 (Volume 1) presents the protocols, proformas and methods used to monitor visitation and use, and directions for how the VMS might be enhanced with additional data from other sources in the future.

Section 3 (Volume 2) details how the VMS may be linked with pre- and post-destination planning and other components of the travel sequence.

Section 4 (Volume 3) comprises four case studies used to develop and trial the visitor monitoring system.

OVERVIEW OF SECTION 1: STRATEGIC LINKAGES (VOLUME 1)

In this section, we report on visitor monitoring conducted at a national, state and regional level. We discuss the work undertaken in Project 4.1 of the Rainforest CRC, which involved site and regional monitoring, and its links to Project 4.5 and pre-destination planning. Within Project 4.1 two types of surveys were conducted. The first was conducted during the wet and dry season at ten sites distributed throughout the Wet Tropics World Heritage Area (WTWHA); the second was a community attitudes survey. The site level work of Project 4.1 was developed further at four sites to provide a linkage to Project 4.5 (which addresses the biophysical impacts of visitation) by including an additional section in the visitor survey that addressed visitors' perceptions of biophysical impacts. Regional level monitoring conducted at gateways (Project 3.1, Rainforest CRC) to provide a link between site and regional level monitoring, was not completed. A genuine attempt to link site level monitoring and regional monitoring was undertaken by Project 4.1 by aggregating data collected at the ten survey sites.

Key Findings

There are few examples of visitor monitoring systems in Australia. Most visitor monitoring systems are being developed for protected areas by national park agencies. They range in complexity from general regional surveys of visitation and traffic counts to more detailed systems that include visitor surveys of peoples' experiences, expectations and satisfaction, and actual biophysical monitoring. However, they do not attempt to link components of visitor monitoring at a regional and site level.

To a large extent, existing systems and methods are serving very different objectives and addressing very different target populations and client/consumer audiences, as well as operating at different levels of analysis and spatial scales.

Our VMS has a more balanced approach, compared with others we have reviewed, as it includes not only biophysical impacts of visitation and use but also the impact of settings and experiences on visitors. Moreover, our system attempts to correct any adverse trends impacting on visitors and the environment.

Recommendations

Regional components of the VMS should include visitor pre-destination planning, arrival and departure information and community attitudes. A strategic framework is presented, examining how the VMS relates to other components of the travel sequence. We recommend the adoption of the visitor monitoring techniques developed for the various travel stages, although we acknowledge that further research will be required to operationalise these methods.

Site level components should include traffic counts, which are verified by on-site observations of vehicle occupancy, visitor surveys, observations of visitor behaviour on-site, and biophysical impact monitoring. These components should be supplemented by qualitative information from tour operators, land managers and the Aboriginal community that together provide the data to trigger responses by management.

Management Implications

With respect to a fully operational and satisfactory VMS, it is likely that two or more independent 'systems' will be adopted and implemented. The first will focus on site level and resident community management, and reporting needs relating to changes and impacts resulting from all human visitation and use. A second tourism planning and industry sponsored system will have a clearer focus on the monitoring of visitation patterns and profiles, destinations and decisions for those tourists visiting the WTWHA bioregion, and more generally, far north Queensland.

The more 'regional' tourism planning and industry sponsored system will in any case need to articulate with other state-wide and national tourism monitoring enterprises. It will serve rather different needs and requirements, though their findings are nonetheless of particular interest and relevance to protected area management, especially with respect to the assessment and quantification of changing 'pressures' and preferences, and both visitor satisfaction and tourism-related economic benefit.

Further Research

The relationship between the VMS and the full travel sequence has only been considered in general terms in this report. Recommendations are given on how different stages of travel might be monitored. A more detailed analysis of these recommendations is an area for further study.

OVERVIEW OF SECTION 2: PROCEDURES AND PROFORMAS FOR MONITORING BIOPHYSICAL IMPACTS OF VISITATION (VOLUME 1)

Section 2 of the report details the procedures and proformas for conducting a biophysical monitoring program at a site level in the WTWHA. Biophysical impacts in this context refer to impacts on the natural environment and visitor infrastructure. The methods and indicators chosen for this VMS allow basic visitor monitoring and use simple, robust, and cost-effective measures. This VMS was designed to identify positive, neutral and negative trends in the environment, infrastructure and services at a site. If negative trends were identified, then the

action to be implemented will depend on the nature, severity and source of impact, management intent and current management practices in place.

Procedures and proformas were designed for a tropical rainforest setting but may be applied to other natural settings. Types of monitoring are presented in order of increasing complexity, that is, from rapid assessment to detailed field-based measurements. We consider how the site monitoring components should be set up, and how the survey components should be applied.

Visitors to sites, whether on tours or as independent travellers, impact on the natural environment and have the potential to affect the quality of a site. The condition of the site also impacts on the visitor. Monitoring allows early detection of potential problems and thus assists in the preservation of a site and allows management to identify whether or not their objectives are being met.

Indicators included in the proformas were identified and collated from research and consultation with members of the tourist industry and protected area managers. Indicators used by researchers were adapted from methods used overseas and within Australia.

Key Findings

Tour operators represent the first level of visitor monitoring and are very important in the VMS for alerting land managers to problems, triggering immediate action and, if necessary, further intensive monitoring. We recognise that tour operators make more frequent visits than land managers to most sites and are in the position to give an early warning of any adverse impacts.

It is recognised that there are site-specific issues, which will be addressed for each site. Of the four VMS sites, only Marrdja Boardwalk is being used on a regular basis by tour groups. Particular issues at this site include the use of bus parking spaces by free and independent travellers and unauthorised tour groups, and visitors walking the wrong way around the boardwalk.

Protected area managers (rangers) represent the second level of visitor monitoring. The techniques employed are more intensive and comprehensive than those used by tour operators and so can be conducted less often. Specifically, we have developed and tested proformas for campsites and picnic sites, walking tracks and water features.

Recommendations

It is recommended that all tour guides conduct their VMS survey component once a week and incorporate it into their tour. This will allow a temporal overview of the site in a day. Benefits for tour guides include:

- involvement in management practices;
- opportunities to involve visitors in monitoring; and
- increased awareness of the environment by operators and their guests.

Monitoring techniques developed for rangers should be undertaken four times a year. Those developed for researchers should be conducted at least bi-annually.

Management Implications

The tour operator proforma was designed to:

- assist in monitoring site changes over time;
- increase awareness of changes in the environment;
- assist rangers in identifying problems;
- provide information to trigger land management actions; and
- provide an early warning to trigger intensive survey work.

Ranger-level proformas inform management on a range of human and environmental risks, including:

- inappropriate visitor behaviour;
- the need for greater ranger presence;
- the status of maintenance of infrastructure;
- the need for signs or fenced-off areas;
- information about visitor movements;
- tracking of maintenance needs;
- waste disposal problems;
- potential for human risk;
- disturbance to flora and fauna due to visitation;
- soil erosion; and
- decline in health of vegetation.

Further Research

Site-level survey instruments will be applied and tested at further visitor sites in the Wet Tropics to evaluate their utility across a range of settings.

OVERVIEW OF SECTION 3: VISITOR MONITORING PROCESS – FROM PRE-DESTINATION TO POST-DESTINATION (VOLUME 2)

Section 3 is presented in three sections:

- The visitation process;
- Methodologies used to monitor the visitation process; and
- An example illustrating the process.

The four stages of the visitation process under consideration include: planning the visit, access to the site; the onsite visit; and finally, the post site visit. The methodologies used to research the different stages of the visitation process are outlined and are those which have been used in the research reviewed (e.g. content analysis, surveys, impact assessments, infrastructure inventories etc.). The example provided illustrates how monitoring a particular issue, i.e., information flow, can be examined across each of the stages of the visitation process (e.g. brochures, signage etc.).

Marrdja Boardwalk, a key WTWHA site, is examined as a case study. The case study systematically addresses and presents research results for each component of the visitation process and current management policies. These together provide for an articulation of the management objectives and possible responses/actions.

Finally, a summary overview of the Marrdja case study is presented. This section identifies those aspects of the visitation process and VMS that need further research.

OVERVIEW OF SECTION 4: CASE STUDIES – BIOPHYSICAL ASSESSMENT (THIS VOLUME)

Case studies, including data for Marrdja Boardwalk, Davies Creek, Henrietta Creek/Nandroyan Falls and Murray Falls are contained in Volume 3.

Key Findings

A hierarchical system of monitoring visitation and use of Wet Tropics sites is feasible and operational but depends on the commitment of tour operators, land managers and researchers to make it successful.

A rapid assessment proforma developed for tour operator site monitoring allows for early detection of potential problems.

Intensive biophysical monitoring undertaken by researchers indicated high variability within sites, which negated the opportunity to compare amongst sites.

Common issues across sites included weed infestations along roads, walking tracks, camp and picnic areas, and evidence of feral pigs.

Intensive biophysical monitoring indicated people were keeping to walking tracks and not venturing into the forest, except where social (undesignated tracks) had developed. When this occurred, activity was confined to undesignated tracks and not widespread within the forest.

Human litter was an issue in habitats bordering camp and picnic areas.

A comparison of human perceptions of biophysical impacts and measured biophysical impacts using Land Manager Proformas indicated:

- water quality was the only indicator where reasonable agreement between peoples' perceptions and biophysical assessments occurred;
- biophysical measures suggested infrastructure damage was higher than that perceived by visitors;
- weeds and evidence of feral animals were more likely to be higher than visitor perceptions suggested;
- no clear correlation between perceptions and biophysical assessment were evident for soil erosion, vegetation damage or scavenging; and
- visitor responses were not providing appropriate information for managers.

Recommendations

- Develop a database that allows tour operators and land managers to enter data and receive an update on the condition of their sites.

- Hold workshops for tour operators and land managers on use of the proformas.
- Trial the Land Manager Proformas with rangers.
- Implement the Visitor Monitoring System.
- Take water samples for laboratory testing from sites used by visitors during intermediate assessments by land managers.

Management Implications

Social (undesignated) tracks pose potential human risk, as they may occur on steep sections of tracks or near waterholes and waterfalls. They may also cause environmental impacts such as erosion, and act as vectors for the spread of pathogens. Social tracks may also intrude on sensitive Aboriginal sites.

Weeds were dense along the edge of camp and picnic areas and water bodies, and need to be controlled to prevent further distribution.

Human litter within forest bordering camp and picnic areas needs attention, as poses a risk to wildlife and humans.

Future Research

Develop a weighting system, as attempted in this project with the modified Land Manager Proformas, that allows a condition score for natural and built environments to determine any human risk.

Identify potential indicators of visitation and wildlife interactions.

SECTION 4:
CASE STUDIES – BIOPHYSICAL ASSESSMENT

SECTION 4: CASE STUDIES – BIOPHYSICAL ASSESSMENT

GENERAL INTRODUCTION TO BIOPHYSICAL SURVEYS

This section outlines the process undertaken in developing the biophysical component of the Wet Tropics Visitor Monitoring System (VMS). It presents findings of both belt transects conducted across sites to identify litter and trampling impacts, and results of a trial with the tourism industry of a proforma developed for them to use in monitoring visitation and use of Wet Tropics sites. It also includes key findings and recommendations, management implications and future research.

A hierarchal system of data collection was developed (see Volume 1), which involved three levels:

- A rapid assessment to be undertaken by tour operators;
- An intermediate assessment to be undertaken by land managers; and
- An intensive assessment to be undertaken by researchers.

Similar indicators were used at each level of assessment. The system operates so that negative findings at the tour operator level trigger higher level monitoring at the land manager and researcher level, and a corresponding management response. The aim is to control environmental degradation associated with visitation at a particular site through early detection and management.

Results of a trial of these proformas are presented in four case studies. The trial was conducted at four sites within the Wet Tropics World Heritage Area: Marrdja Boardwalk, Davies Creek, Henrietta Creek/Nandroya Falls, and Murray Falls (Figure 1).

Distributed across the Wet Tropics, the four sites differ in elevation, geology, hydrology, rainfall, forest type, cultural significance and level and type of visitation. For these reasons, and because of the variability found among indicators within a site, the four sites are presented as case studies.

Each case study includes a general introduction to site and management issues. Findings from the trial of the Tour Operator Proforma, Land Manager Proforma and the Researcher Proforma are then presented with key findings and recommendations.

The final component of this section links findings from the biophysical questions addressed in a visitor survey conducted at the same time (Bentrupperbäumer and Reser 2002) with the biophysical measurements presented for each case study.

BIOPHYSICAL INDICATORS

Biophysical impacts result from natural stochastic events and direct and indirect anthropogenic activities. Direct anthropogenic effects resulting from visitation and recreation use of a site are numerous and include trampling of vegetation; soil erosion from vehicle traffic, mountain bikes and hikers; denuded vegetation in camp sites; scorched soil from irresponsible placement of fires; soil compaction; broken branches; ringbarked trees; littering; weeds imported via tyres and foot wear; gullying from off-road vehicle use; and removal of vegetation such as epiphytes, seedlings and seeds (Cole 1986, 1992; Buchanan 1987; Jim 1987). The sources of indirect impacts are harder to identify but may negatively impact on the natural environment, e.g. dieback.

In the tropics, stochastic events that impact on the forest are primarily associated with cyclones. These can be intense but most destruction is confined to the path taken by a cyclone. In contrast to anthropogenic effects, destructive climatic events such as drought occur less frequently.

In developing this set of indicators we have looked at impacts that result from visitor activity at a site, and those associated with management that are known to impact on visitors. Both are important in monitoring visitor behaviour if affected by the condition of a site (Bentrupperbäumer and Reser 2000).

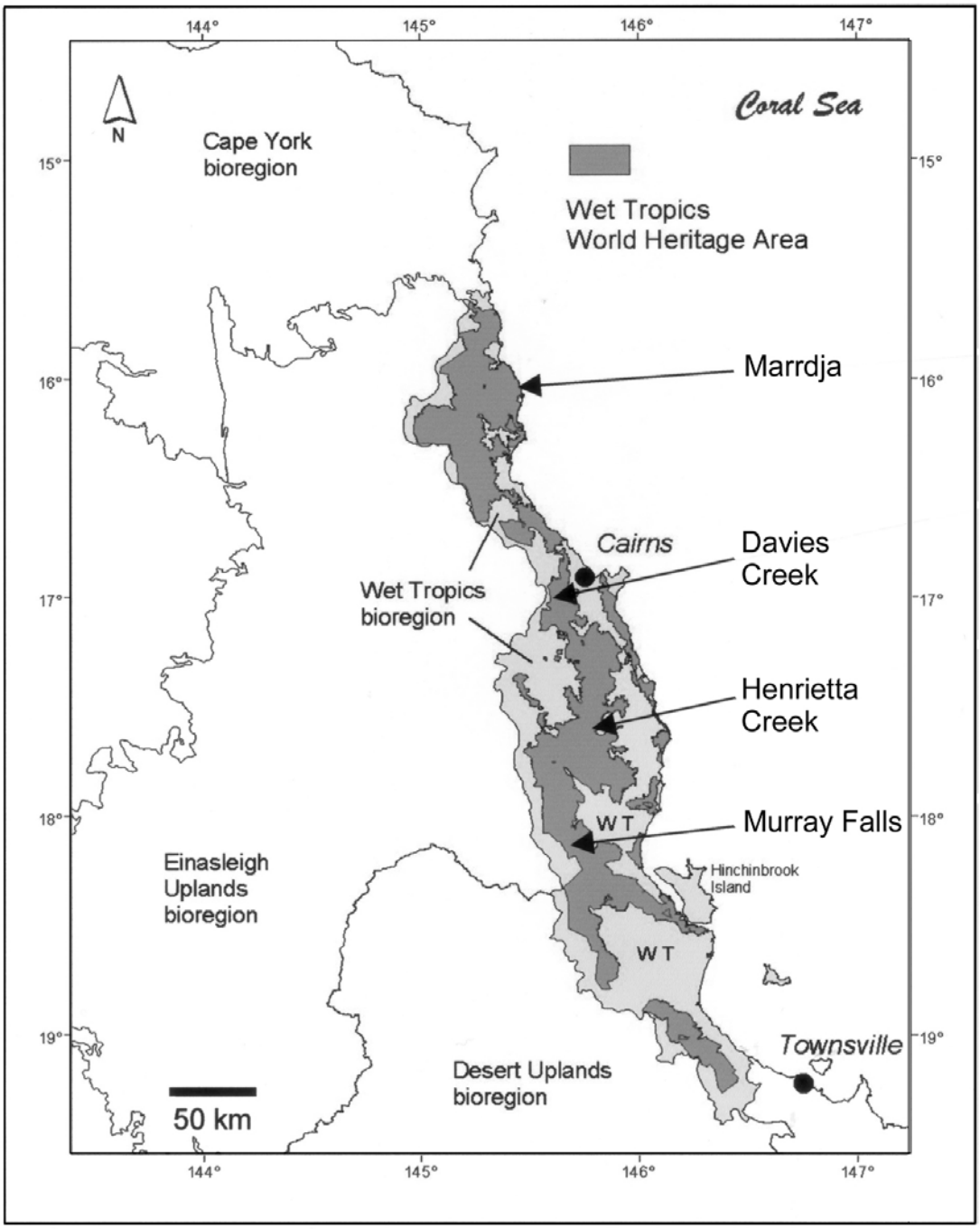


Figure 1: Location of Wet Tropics study sites (Map: G Wilson 2002).

STUDY SITES

Four study sites within the Wet Tropics – Marrdja Boardwalk (Daintree), Davies Creek (Atherton Tablelands), Henrietta Fall/Nandroya (Wooroonooran National Park), and Murray Falls (Murray Falls State Forest Park) – were used in this pilot study (Figure 1). Davies Creek is outside the Wet Tropics World Heritage Area, but is an adjacent National Park. These sites differ in their vegetation communities, elevation and level of visitation and are thus treated as case studies, not as replicates. Detailed site descriptions are presented in each case study.

The sites were selected in consultation with tour operators, land managers and the Aboriginal Community for the following reasons:

Site	Reason for Selection	Interested Party
Marrdja Boardwalk	High use interpretive boardwalk.	Tourism Queensland
Davies Creek	Local recreational site.	Queensland Parks and Wildlife Service
Henrietta Falls/Nandroya	Site in close proximity to major tourism development.	Wet Tropics Management Authority
Murray Falls	Site with Aboriginal community development opportunities.	Aboriginal Community

Vegetation at Marrdja Boardwalk and Murray Falls is lowland rainforest; Henrietta Falls/Nandroya is mid-elevation rainforest at around 550 metres above sea level. Davies Creek consists of dry/wet sclerophyll forest, also mid-elevation at around 594 metres. Level of visitor use, based on estimated amount of use per annum, was low at Davies Creek, Henrietta Creek and Murray Falls, and high at Marrdja Boardwalk. Low use sites receive less than forty thousand visitors per annum, while high use sites receive more than forty thousand visitors (Wet Tropics Management Authority 1994). A recent study of Murray Falls categorises this site as high use (Turton *et al.* 2000) but this was based on early data (Wet Tropics Management Authority 1994) where traffic counters were not considered to be reliable. Traffic counter data and estimates of visitor numbers collected during Rainforest CRC visitor surveys indicate that Murray Falls is a low use site with no visits by commercial tour operators.

Biophysical data were collected at the four sites in the dry (September to November 2001) and wet season (April to May 2002) to allow for seasonal variation in impacts. Seasonal differences are likely to influence environmental factors such as erosion, litter depth, and compaction. This was considered important, given the strong seasonal differences in rainfall across the Wet Tropics between seasons (Turton *et al.* 1999). However, the rainfall for the 2001-2002 wet season for the region was well below average and thus the results are unlikely to represent normal wet season conditions. Greater variation in biophysical impacts would be expected between the dry and wet season in normal years. In this study any differences in the dry and wet season data are not likely to be the result of seasonal effects. A further factor that influenced visitation to the region during this study was the collapse of Ansett and the ripple-on effects of the September 11, 2001 disaster in the United States on world travel.

LOCATION OF BIOPHYSICAL DATA COLLECTION WITHIN A SITE

Within each of the sites different use areas were identified – camp and picnic area, walking track and freshwater feature. The camp and picnic area was further divided into nodes. Five camp and picnic nodes were identified for Davies Creek and Henrietta Creek. Eight camp and picnic nodes were surveyed at Murray Falls, using the same locations used in Bentrupperbäumer and Reser (2002). It should be noted that Marrdja Boardwalk does not have camp or picnic facilities. For both the walking track and the camp and picnic area, samples were taken in the impact area, buffer and control, i.e. ten metres from the edge of the track or camp and picnic area (Figure 2).

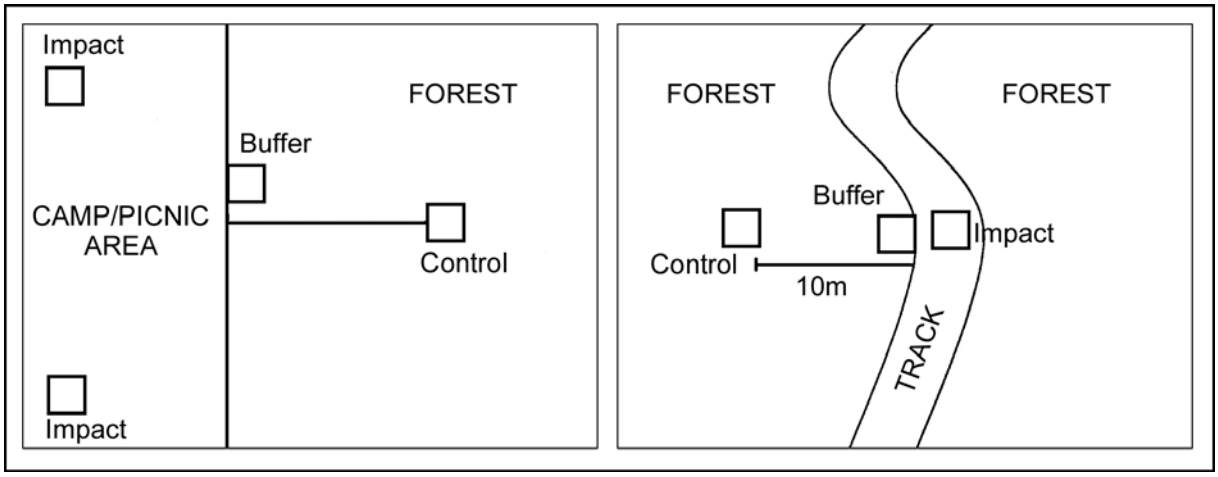


Figure 2: Sampling locations within a camp and picnic area and along walking tracks.

INDICATORS AND MEASUREMENTS USED IN THE SEMI-INTENSIVE BIOPHYSICAL ASSESSMENT

The methodology used in this study is referred to as semi-intensive because it does not use sophisticated equipment, however data collection takes time. It was based on recreational impact techniques that have been used in the Wet Tropics (Kluck 1998; Turton, Kluck and Day 2000) and in the United States (Hammit and Cole 1987) with some modifications to scaling, choices of indicators (Table 1), and collection techniques. For example, scaling was modified from a three point to a five point scale to increase sensitivity in identifying impacts. Additional indicators included canopy cover, presence of epiphytes, ferns, fungi and woody debris in quadrats.

Indicators were grouped to capture above ground and below ground processes and were chosen on the basis of being simple to measure, meaningful, reliable, sensitive to change and low cost. The use of belt transects for detecting litter and trampling was also included and time taken to conduct these surveys is shown in Table 2.

Measurements made using the belt transect were presence or absence of native plants, exotic plants, grass, broadleaf, woody plants, trees (first branch more than two metres above ground), vine, fern, leaf litter, mineral soil exposure, root exposure, rock, human litter, trampling, canopy, slope and height of tallest grass, broadleaf, and woody plant.

Table 1: Biophysical indicators used in the semi-intensive analyses.

BIOPHYSICAL INDICATOR	METHOD OF ANALYSIS	MEASUREMENT INSTRUMENT
a. ABOVE GROUND		
Canopy cover	Percentage cover	Cylinder with cross-hair to split area into quarters
Seedling density	Count of number of seedlings (<0.5m)	Ruler, 1 m^2 quadrat
Grass	Height of tallest grass	Ruler, 1 m^2 quadrat
Broadleaf	Height of tallest broadleaf	Ruler, 1 m^2 quadrat
Sapling	Height of tallest sapling	Ruler, 1 m^2 quadrat
Epiphytes	Scan of trees in camp/picnic area below 4 m; density on scale of 1-5	
Ferns	Scan of trees in camp/picnic are or along walking track in 15 m section; density on scale of 1-5	
b. SOIL LEVEL OR BELOW GROUND		
Mineral soil exposure	Percentage cover of exposed mineral soil (bare ground)	1 m^2 quadrat
Fungi	Percentage cover	1 m^2 quadrat
Woody debris	Percentage cover	1 m^2 quadrat
Exposed roots	Percentage cover	1 m^2 quadrat
Rock	Percentage cover	1 m^2 quadrat
Litter cover	Percentage cover	1 m^2 quadrat
Litter depth	An average of four measurements with the quadrat, recorded in cm	Ruler, 1 m^2 quadrat
Soil compaction	Measured in kilogram force per centimetre square. An average of four measurements per quadrat.	1 m^2 quadrat
c. OTHERS ASSOCIATED WITH VISITATION		
Trampling	Presence or absence of trampling	1 x 1 m belt transect (30 m long)
Human Litter	Number of items of different types, e.g. sharps	1 x 1 m belt transect (30 m long)
Track safety	Scalar: 1-5	
Track Slope	Degrees of slope	

Table 2: Time to conduct belt transect surveys where measurements consisting of fifteen presence/absence indicators and three measurements using a ruler to estimate heights.

Site	Season	Sampling	Total Time (mins) in each replicate					Mean Duration (mins)
			1	2	3	4	5	
Davies	Wet	Belt transect from campground	30	30	30	29	30	30
Henrietta	Wet		40	46	31	26	45	37.6
Murray Falls	Wet		30	20	25	32	30	27.5

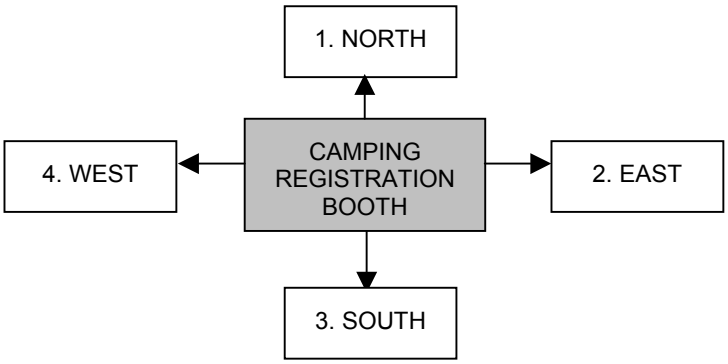
Belt transects fifteen metres long, sampling unit 0.5 metre length and 0.5 metres either side of transect line. Each level of monitoring required basic site level information of location, weather condition, date (season), and recorder.

PHOTOGRAPHIC MONITORING

Fixed points for photographic monitoring, to be taken during an intermediate assessment of the sites, were identified. These points were fixtures that are unlikely to move in the long term, e.g. registration booths, fork in road or commencement of track. Ideally GPS readings at these points should be taken if possible (see Section 2, Volume 1).

Considerations when setting up a photographic record at each site included:

1. Choosing locations within a site from which photographs can be taken on a repetitive basis, e.g. landscape features such as a large boulder, hill or permanent infrastructures such as ablution blocks, camping registration booths, shelters, designated car park or fork in a road;
2. Ensuring capture of areas sensitive to visitation and use; and
3. Taking four photographs at each location standardised in clockwise direction - north, east, south and west to assist in identifying and sorting images.



OVERVIEW OF DATA COLLECTED AT SITES

Data for items 1 to 4 in Table 3 are presented in Bentrupperbäumer and Reser (2002). The last page of the visitor survey administered at the pilot study sites was designed to investigate visitors perceptions of biophysical impacts and an analysis of these are included at the end of this report. Data for items 5 to 9 in Table 3 are presented in the following case studies.

As required by permits issued by Queensland Parks and Wildlife Service, rangers were contacted by phone the week prior to all visits so they could be present on site if convenient. Rangers attended all visits at Henrietta Creek and Murray Falls; two attended Marrdja Boardwalk; but no rangers visited Davies Creek. During these visits potential indicators, management issues and procedures were discussed and findings to date passed onto the Rangers.

Table 3: Timetable of data collection.

		Start May '01	Dry Aug-Dec '02	Wet Jan-May'02	6 week wet May-Jul '02	Two-monthly
1	Site Inventory	✔				
2	Traffic Counts					✔
3	Observations of people behaviour		✔	✔		
4	Visitor Survey		✔	✔		
5	Tour proforma		✔	✔	✔	
6	Ranger proforma		✔	✔		
7	Intensive Biophysical - quadrats		✔	✔		
8	Intensive Biophysical - transect			✔		
9	Photographic Record		✔	✔		

PROCESS IN DEVELOPING THE HIERARCHICAL MONITORING SYSTEM

Three levels of data collection were trialed ranging from a very rapid assessment (Tour Operator Proformas), an intermediate assessment (Land Manager Proformas) and an intensive assessment undertaken by researchers (Figure 3).

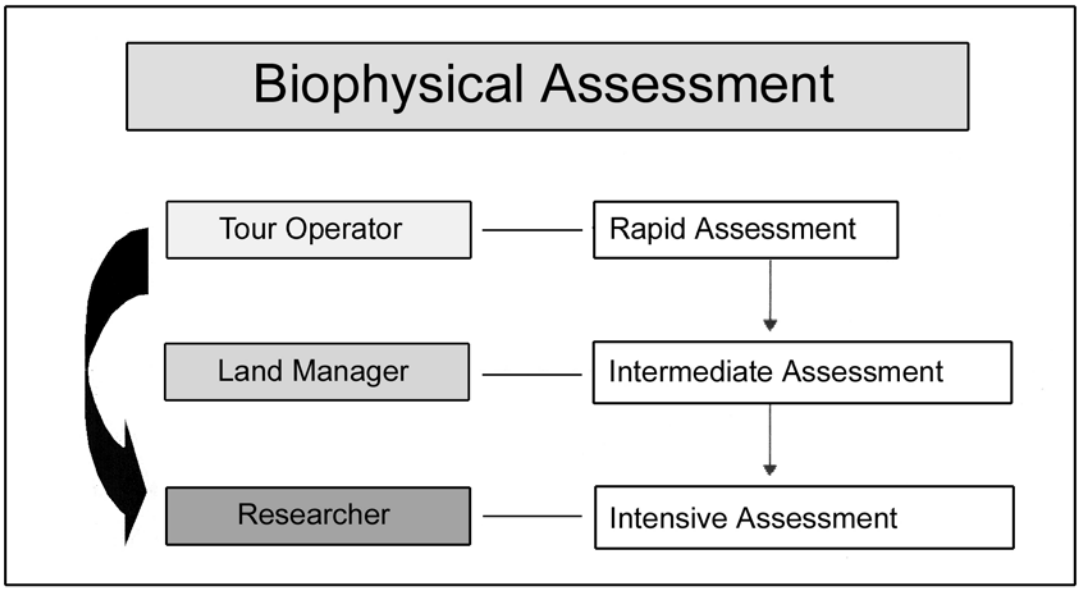


Figure 3: Three levels of data collection and their intended users (refer Volume 1 for details).

The indicators used for each level of monitoring were developed in consultation with research colleagues, Wet Tropics Management Authority, Department of Natural Resource, Mines and Energy, Queensland Parks and Wildlife Service and members of the tourism industry. Proformas were then developed by Rainforest CRC researchers and trialed in both the wet and dry seasons with some modifications between seasons. Indicators were chosen to reflect visitor related activities and management issues.

TOUR OPERATOR PROFORMAS

The Tour Operator Proformas represent the first level of visitor monitoring. This level of monitoring is important in:

- assisting and providing information to trigger land management actions;
- alerting land managers to problems;
- triggering immediate action;
- increasing awareness of changes in the environment; and
- providing an early warning to trigger more intensive survey work.

It is recognised that tour operators make more frequent visits than land managers to most sites and are thus in a position to give an early warning of adverse impacts.

Process in the Development of the Proforma

The Tour Operator Proforma was developed by researchers in close consultation with Wet Tropics Management Authority staff. The process used in its development involved:

- two field trips with representatives of all stakeholders involved in visitation and use of Wet Tropics sites;
- development of a proforma by researchers;
- Meetings with key stakeholders (Wet Tropics Management Authority, James Cook University and Tourism Queensland staff);
- field trip to trial proforma with researchers;
- additional fieldtrip with WTMA and researchers; and
- final production revision of the proforma by researchers.

Field trip with representatives of all stakeholder groups: field trips to Marrdja Boardwalk, Davies Creek and Henrietta Creek were conducted in a small bus to allow discussion *en route* with members of the Tourism Alliance Group and staff from Department of Natural Resources, Mines and Energy, Queensland Parks and Wildlife Service, Wet Tropics Management Authority and James Cook University. The objective of these trips was to seek agreement on goals and to explore how tour operators can assist with monitoring. During these field trips issues confronting tour operators visiting Wet Tropics sites were raised and discussed and were taken into account in the development of the Tour Operator Proforma.

Development of the proforma: following the field trips, Rainforest CRC researchers developed a proforma for use by tour operators that was considered relatively easy to complete; did not require any actual species identification; and monitored both changes in the environment and visitor behaviour.

Stakeholder meeting: a meeting was held with Max Chappell (Wet Tropics Management Authority), Robyn Wilson (Rainforest CRC researchers) and Emma Smith (Environmental

Tourism) to discuss the content of the proforma and an associated consultancy conducted for Tourism Queensland, i.e. Operator Impact Monitoring Guidelines, Tourism Queensland.

Workshop and field trip: a workshop and field trip including researchers and Wet Tropics Management Authority staff was then conducted to review the proforma and ensure that all information to be collected was relevant to management needs. This resulted in further refinement of the proforma prior to its trial by the tourism industry.

Arrangement of the proforma: the proforma is divided into sections to assist in isolating areas of impact. The first section provides broad generic information, the second provides information on the carpark and access road and the third contains information on the site. The latter is divided into a further three sections: 1) camp, picnic area and carpark, 2) walking track, and 3) freshwater.

Frequency of sampling: it is recommended that all tour operators conduct this survey once a week and incorporate it into their tour. This will allow a temporal overview of the use of a site in a day and where more than one tour operator is visiting at the same time, the opportunity to compare responses.

Tour operators who are interested in carrying out more intensive monitoring, e.g. bird or mammal lists or focusing on specific issues, e.g. use of the car park, feeding of wildlife, and dieback, are encouraged to do so and report changes to the appropriate land managers.

RESULTS OF TOUR OPERATOR PROFORMA TRIALS

At this stage only one of the four visitor monitoring sites (Marrdja Boardwalk) is being used on a regular basis by tour groups. To increase the sample size of the trial, tour operators visiting Mossman Gorge, a high use area used in the visitor survey (Bentrupperbäumer and Reser 2002), were included in the trial of the tour operator proformas by the industry. Particular issues at these sites include the use of bus parking by free and independent travellers and unauthorised tour groups, and visitors walking the wrong way around the boardwalk. These have been included in the proforma as they may be issues at other Wet Tropics sites where this proforma will be used in the future.

Eight companies were approached to participate in the trial of the Tour Operator Proforma. Six companies had permits to operate at Marrdja Boardwalk and Mossman respectively, and three had permits to both sites. The trial was conducted over a six-week period beginning on 27 May 2002. All companies participating in the trial were contacted on 9 July 2002 to thank them for their participation and to remind them to forward any returns they may have been accumulating.

One company, who did not return any completed forms, made the following comments:

"We have a permit to Marrdja Boardwalk but rarely use it. These proformas are unlikely to be done if they impinge on tour time. However, tours do have a stop at Hartleys Creek where the proformas could be completed."

"Different guides within the company visit a site each day, so recording would not be consistent as different operators would vary in their interpretation."

"Operators would have to refresh themselves with the proformas each time they use them, which takes time."

Only two companies returned completed proformas. Both conducted the trial over five weeks. Most operators said their guides were too busy to trial the proforma. One guide stated that he

was currently involved in a cassowary watch and was recording date, time and location of sightings, however that was the extent of time he could afford for monitoring. The employee also stated that the main problem with trips to Cape Tribulation was that their duties kept the guide busy and, with full loads, the guides are fully occupied with their visitors, leaving them no time to undertake extra monitoring. The company had added 'extras' to their tours to attract a better share of the market but this meant the guides had more to do. It may be possible for these proformas to work where tours were more relaxed and didn't cross the Daintree.

Other comments included:

"Consider simpler forms with fewer indicators."

"Completing proformas takes the guide away from the tourists and would be frowned upon by his employer."

"It takes time to become familiar with the task, and to read the instructions and purpose of the forms prior to starting a tour. This time is not given by the employer."

"Have participated with surveys in the past but they have involved an extra person doing the survey and not the tour guide."

"Concerned at the variation in education and skills of many guides and thus the consistency in quality of data collection, i.e. many of the guides do not recognise what constitutes a 'weed' species in the Wet Tropics."

LAND MANAGER PROFORMAS

The second level of monitoring, to be conducted by land managers, is more comprehensive than that conducted by the tour operators. It is anticipated that it will be conducted twice per season. The monitoring conducted by both tour operators and land managers is complementary in that similar indicators are incorporated in both. There are three proformas for this intermediate level of monitoring: camp and picnic area proforma, walking track proforma and water feature proforma.

Where no tour operators visit a site, additional factors need to be considered in the land manager monitoring, e.g. status of the road and carpark. These are not on the Land Manager Proformas.

Development of the Land Manager Proforma

Each indicator on the Land Manager Proformas is assessed on a five point scale, i.e. 1 = not apparent; 2 = low impact; 3 = moderate impact; 4 = high impact; and 5 = very high impact; along with the required management, i.e. 1 = no action required; 2 = watch; 3 = needs attention; 4 = immediate action needed; and 5 = being addressed. The approach to using the Land Manager Proformas is to walk around the site, then complete the proforma allocating a score and type of management required to each indicator. Where there is uncertainty in scoring an indicator, then a second walk around the site will be required to ensure reliability. It is recommended that the assessment is undertaken by two people, or by a person trained in the assessment that is not associated with the site.

The scoring of indicators was further developed in an attempt to overcome the subjectivity inherent in qualitative assessments of indicators and to allow a condition score to be developed for a site (Volume 1). This involved developing a quantitative measure for each level of each indicator based on researcher experience and intuition, and a workshop

conducted with fourth year Environmental Management students from The University of Queensland. A panel of twenty-four people including managers, planners and rangers were then asked to participate in assessing the measures attributed to each level of each indicator. Six people responded (Table 4).

Refinement to the Land Manager Proforma

A second round was then conducted to determine weightings for each indicator based on the importance of each indicator in the a) natural environment; b) built environment; and c) human risk. Weightings provided by those that responded were highly variable; it was decided to report the methodology for this but not the findings, as they could be misleading. The vision was that a condition score for the natural environment, built environment and human risk would be calculated for each area (camp and picnic area, walking track and water feature) and this would be used to monitor change at a site over time (N.B. measures attributed to each level of each indicator are given in the Volume 1).

Table 4: Number of respondents who assessed the scaling for each indicator and provided weightings for the indicators.

	Round 1 (Accessing Scaling)		**Round 2 (Weighting Indicators)**	
Respondent Group	Approached	Responded	Approached	Responded
Academics	5	4	7	5
Planners and Managers	6	1	6	1
District Rangers	5	0	5	0
Rangers	8	1	8	0

RESULTS OF LAND MANAGER PROFORMA TRIALS

Human Litter

All transects were taken from the edge of the camp and picnic area into the forest. No belt transects were conducted at Marrdja Boardwalk as it does not have a camp or picnic area. The type of human litter detected along the belt transects was similar across the sites (Table 5). Those common to all sites included sharp items such as glass bottles and jars, beer cans and tins and soft items such as plastic bottles and sweet wrappers. Site specific items included tent pegs, bottle tops, aluminium foil and potato chip bags at Davies Creek; metal bike patches, metal piping, thongs and flagging tape at Henrietta Creek; and cigarette packets at Murray Falls. The greatest number of litter items was recorded at Davies Creek, followed by Henrietta Creek and Murray Falls. Most items were small and associated with picnic tables, however other items such as broken bottles were recorded within the bush.

Table 5: Number of items of different types of human litter identified at three sites along five, thirty metre long by one metre wide belt transects taken from the edge of the camp and picnic site into the forest.

Litter		Site		
		Davies	***Henrietta***	***Murray Falls***
Sharp	Glass*	21	6	3
	Metal*	9	7	3
Soft	Plastic*	22	10	3
	Paper	1	14	1

*Glass and metal are risk factors; plastic is a problem to the environment and wildlife.

Trampling

There was negligible trampling recorded along the belt transects across the sites. Transects were conducted from the edge of the campground up to thirty metres into the forest. The exception being one transect conducted at Murray falls that linked the lower day use area to the upper camp area. Trampling did not appear to be a good indicator of human impact at sites with designated tracks.

KEY FINDINGS AND RECOMMENDATIONS

TOUR OPERATOR LEVEL

- Tour operator level of monitoring is feasible, i.e. two companies participated.
- The limited success of the trial may have been associated with how it was presented to the tour guides by the tour operator, i.e. guides need time to peruse instructions and may require demonstrations on what is required of them.
- Workloads vary between companies, possibly affecting the ability of tour guides to conduct monitoring.
- The number of companies completing the proformas was low, suggesting an independent surveyor may be required during the peak tourist season to undertake these surveys.
- Feedback would require a database that can be used by operators to allow them to enter data and receive immediate feedback.
- Presenting involvement in visitor monitoring to tour guides needs to highlight the following benefits:
  - it provides an avenue for involvement in management;
  - it provides an opportunity to involve visitors in monitoring;
  - it provides a point of interest for their tour; and
  - it assists in increasing visitor awareness of their surroundings.

LAND MANAGER LEVEL

- Monitoring needs to be considered under two categories, i.e. direct visitor impact and impact associated with management.
- Rangers should be encouraged to make observational comments on unusual activities in addition to other components.
- Standardised bird, reptile and mammal counts should be conducted at times when these animals are most active. Methodology for these counts is reported in most field technique texts and varies depending on the type of animals and vegetation being surveyed. Bird surveys conducted by Birds Australia and New South Wales National Parks and Wildlife Service (NPWS 1996; Tierney and Morris 2002) use a standard design that consists of a survey of a two hectare site over a twenty minute period within three hours of sunrise.
- Feedback would require a database that can be used by land managers to allow them to enter data and receive immediate feedback.
- Two people need to be involved in the assessment, or a trained independent person to conduct surveys of all sites and take responsibility for providing feedback.
- Epiphytes and ferns were not obvious in camp and picnic areas, which may mean they have already been removed; epiphytes have died due to edge effects; or they were never prevalent in that area. If this is to be used as an indicator then a comparison of epiphytes in the forest with those in the camp and picnic area needs to be undertaken.

MANAGEMENT IMPLICATIONS

IMPLEMENTATION OF THIS VMS

The results of the Tour Operator Proforma trial with the tourism industry showed work needs to be done to engage the tour operators and their guides in this monitoring. Some tour guides had no difficulty in completing the proformas over a six-week trial. The reasons some may have coped better than others include:

- they are more experienced guides;
- they received strong support from their operators to undertake this monitoring;
- they could see the value of participating in a Visitor Monitoring System;
- they had already undertaken similar monitoring as part of their normal duties; or
- they added value to their tour by letting visitors be involved in the process, and informed visitors they were assisting management, which enhanced their awareness.

Members of Tourism Alliance and Far North Tour Operators were very supportive of the Visitor Monitoring System, however feedback from the initial trial indicated the guides were struggling under increasing demands to offer more within their tours, and thus viewed the monitoring as another task.

DATABASE

The Visitor Monitoring System will generate a large amount of data, which needs to be contained within a database for analysis. Feedback needs to be given to those people who collect the data, and to management. It is important that data collection and input is kept up-to-date so that problems in data collection and problems at a site level are identified early.

FURTHER RESEARCH

Intensive Monitoring

The type of visitor to a site changes over time causing changes to the site itself. This will be identified through the Visitor Monitoring System and allow management to respond accordingly. It will be necessary to conduct intensive biophysical surveys to monitor environmental changes, in concert with visitor surveys to monitor visitor profiles so that sites are managed appropriately. A three-year cycle of monitoring at this intensive level, in line with government elections, is suggested unless the condition scores from ranger monitoring indicate that earlier biophysical monitoring is required. Further work needs to be done in developing composite scores of environmental indicators that identify certain types of impacts.

Wildlife-Human Interactions

There has been little research on the impact of humans on wildlife. This is primarily because most of our mammals are nocturnal, cryptic in colour and difficult to study. However, growing sectors of visitors are looking for tours that enable them to see wildlife. Research is needed on the impact of tourists on all forms of wildlife, e.g. birds, mammals, reptiles, amphibians and invertebrates.

MARRDJA BOARDWALK

LOCATION AND SITE DESCRIPTION

Marrdja Boardwalk is located at sea level in the Daintree National Park (Cape Tribulation 16°01'S, 145°26'E) within the Wet Tropics World Heritage Area. It is accessed from the main road and is ca. 140 km north of Cairns. The access road to the site is sealed throughout its length but the car park is not. Parking is provided for nine cars and five buses. The site contains a circuit track that is hardened throughout its length, with a concrete path through the rainforest and a wooden boardwalk through the mangroves (Figure 4). The elevated area through the mangroves has a wooden railing at waist height; sections of this are also fenced.

Annual average rainfall is approximately 3500mm, strongly seasonal with seventy percent falling between the months of December to April. January's mean daily temperature is near 28°C and July's mean daily temperature is around 22°C. However, temperatures up to 36° are not unusual during the summer months.

The forest ranges from lowland tropical rainforest consisting of complex mesophyll vine forest (Type 1a, Tracey 1982) to mature mangrove forest towards the sea. There are a variety of robust woody lianas, vascular epiphytes, palms (both feather and fan), zingibers and aroids on the site and a high diversity of mangrove species. The canopy is irregular, varying from twenty-five to thirty-three metres in height. The dominant rainforest canopy trees belong to the Proteaceae, Meliaceae, Sapindaceae, Apocynaceae, Lauraceae and Myrtaceae families.

Day visitors frequently sight dove species, honeyeaters, Victoria's riflebird, orange footed scrubfowl, spotted catbirds, and parrots. Also sighted are several frog species, a variety of reptiles including Boyd's forest dragons, carpet and amethystine pythons, two colubrid snakes, spectacled flying foxes and pigs.

SITE MANAGEMENT AND ACTIVITIES

The land manager for the Marrdja Boardwalk site is Queensland Parks and Wildlife Service. The track was recently extended to form a circuit track to address issues of overcrowding experienced by some tour operators.

An inventory of infrastructure at the site is detailed in Bentrupperbäumer and Reser (2002). The desired Track Class for this boardwalk is 'Pathway 1' (Wet Tropics Walking Strategy 2001). The track is hardened and consists of concrete sections connected by wooden boardwalk over wet areas. Although the majority of use is restricted to the concrete and wooden boardwalk, there is a tendency for some users to step off the track, especially in the case of large parties and where people pass.

Nature Based Tourism Strategy: I1 (Icon 1) Opportunity to experience outstanding World Heritage Area features and values in small to medium groups.

Strategies: Maximum vehicle capacity 35 persons; well-developed infrastructure; high on-site static and active interpretation.

Priority: Nil.

Wet Tropics Walking Track Strategy: Boardwalk; Pathway 1.

Visitation: Thirty-nine commercial Tour Operators have access to this site (pers. comm. Mike Prociv Queensland Parks and Wildlife Service, 2001). The main activities conducted at this site are walking and nature viewing. Main source of visitors are interstate and

international visitors on tours operating from Port Douglas and Cairns. There are no picnic or camping facilities at the site, but there are rest rooms.

Management Issues

- The car park has limited parking and deteriorates rapidly in wet weather.
- Visitors do not follow path directions.
- This site does not have bins or picnic facilities so visitors do not tend to stay after they have walked the track. Rangers blow the leaves off the boardwalk on a regular basis so little natural litter gathers on the track.

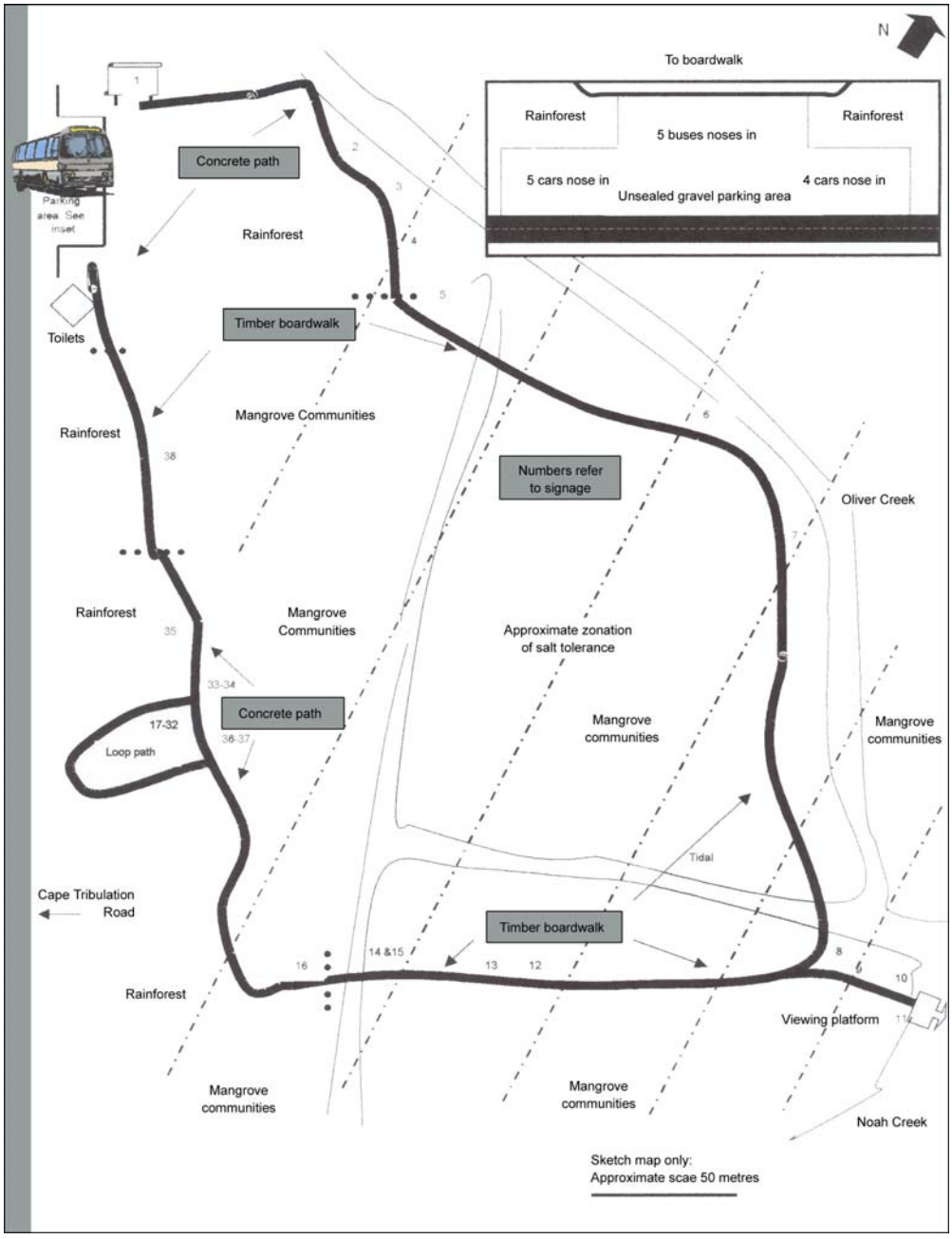


Figure 4: Schematic stylised diagram of Marrdja Boardwalk showing distribution of mangroves, rainforest and signage. Insert shows car and bus parking available at the site.

TOUR OPERATOR PROFORMA TRIAL

A pilot study trialing the Tour Operator Proforma was conducted firstly by researchers in the dry season on 12 December 2001, and in the wet season on 19 April 2002 (Appendix A1), and secondly in a six-week trial during June-July 2002 by the tourism industry (Appendix A2). Thirty-five indicators were trialed.

Key Findings of the Tour Operator Trial

- The car park requires maintenance, which has not been addressed.
- Litter was recorded in the car park area on all trips, and three of the five trips on the boardwalk. Although in all cases it was rated as 'sparse', research has shown that the presence of any litter encourages others to litter and requires immediate attention.
- Canopy death needs investigating, being recorded as sparse on four consecutive visits. It is probably due to the very dry conditions in the region or deciduous trees, but may be an early indicator of dieback. It may also be due to cyclone damage.
- Inappropriate visitor behaviour, i.e. visitors walking the wrong way around the track.

Problems Recorded by Researchers, and not Tour Operator Trial

- Extensive evidence of feral pigs along the track.
- Railing vandalised; this was addressed between surveys.

Similarity in Findings between Five Week Trial by Industry, and Research Trial

- Maintenance of the car cark is needed and not being addressed.
- Litter, although sparse, is a persistent problem.

LAND MANAGER PROFORMA TRIAL

Visitors were present during both surveys. During the wet season survey, a spectacled flying fox colony was present in the mangrove area beside the boardwalk. Results of the trial of the Land Manager Proforma are presented in Appendix B1.

Key Findings from Ranger Proforma - Continuing Problems

- Potholes and bog adjacent to track due to feral pig damage, which requires attention.
- Visitors stepping off the track to photograph a fig tree has led to mineral soil exposure. Need to fence off or provide platform to access tree.
- Weeds adjacent to road section of the track require attention.
- Railings require painting.

Human Related Activity

- Commercial tour groups and independent travellers walk the wrong way around the circuit track - this needs to be added as an indicator to the Land Manager Proforma.
- Visitors were stepping off the track to approach forest dragons indicating the need for education on the impact of such behaviour on wildlife.
- Visitors were stepping off the track to photograph a strangler fig.

Management Issues

- Potholes, gully erosion and boggy areas in the car park following rain.
- Visitors stepping off the track to view wildlife and vegetation.
- Railings splintering.
- Pig activity widespread close to the track.
- Exposed roots are common but considered to be natural, except in areas with pig damage.
- Weeds adjacent to the track and bordering the car park. Mainly introduced grasses, requiring attention.
- Traffic noise near the road.
- Ferns/orchids below four metres were abundant with no sign of pilfering.

Recommendations

- Provide information for visitors and guides on the impacts on fauna if they approach too closely.
- Provide information for visitors and guides on the problems they create by stepping off the designated track, e.g. mineral soil exposure, soil compaction, weed dispersal.
- Fence areas where people are stepping off track, or provide a platform to allow them access to interesting items such as curtain figs.
- Seal the car park.
- Provide clear signage to direct people or install turnstiles to control movement in one direction.
- Rangers need to remove the weeds or map where the weeds are to monitor spreading.
- Vehicle speed needs to be kept down in the vicinity of the walkway for safety and to lower the impact of traffic noise.

SEMI-INTENSIVE BIOPHYSICAL RESULTS

Tests were conducted on the length of the boardwalk excluding the mangrove area. Samples of the tread, buffer and control were taken at twenty metre intervals. Statistical findings are summarised in Table 6. Note the tread area is concreted, so only one indicator, canopy cover, was appropriate to measure (Table 6).

Key Findings

Buffer and Control

- Two indicators were significantly different between the buffer and control, i.e. root exposure and woody debris.
- Root exposure was greater in the control (mean rank 49.38) than the buffer (mean rank 31.63) indicating a high level of natural disturbance in the area.
- Woody debris was greater in the control (mean rank 47.95) than the buffer (mean rank 33.05).
- Mineral soil exposure and seedling density were approaching significance and indicated negative trends.

- Mineral soil exposure was greater in the buffer (mean rank 45.30) than the control (mean rank 35.70) and seedling density was greater in the control (mean rank 45.45) than the buffer (mean rank 35.55).

Seasonal Differences

- Two indicators were significantly different between seasons, i.e. organic litter depth and compaction.
- Organic litter was greater in the wet (mean rank 65.10) than in the dry (55.90).
- Compaction was greater in the dry (mean rank 61.41) than in the wet ((mean rank 34.14).
- There were no interactions between season and location of sample, i.e. tread, buffer and control.

Table 6: Summary of indicator responses between seasons and between sampling location, i.e. tread zone, buffer and control.

INDICATOR-BOARDWALK	Wet cf dry	Buffer cf. control	Tread/ buffer/ control	Season *sample location	Test
Canopy cover	0.18 N.S.	-	0.26 N.S.	-	Mann Whitney and Kruskal Wallis
ABOVE GROUND HEALTH – IMPACT ON SURROUNDING HABITAT					
Vegetation cover (%)	0.30 N.S.	0.66 N.S.	-	0.69 N.S.	ANOVA
Mineral soil exposure (%)	0.14 N.S.	0.053	-	0.99 N.S.	ANOVA
Root exposure (%)	0.25 N.S.	0.000***	-	-	Mann Whitney
Seedling density	0.38 N.S.	0.055	-	--	Mann Whitney
GROUND LEVEL HEALTH REFLECTING STATE OF THE TRACK AND SURROUNDING HABITAT					
Mineral soil exposure (%)	0.14 N.S.	0.053	-	0.99 N.S.	ANOVA
Organic litter (mm)	0.013*	0.93	-	0.55 N.S.	ANOVA
Root exposure (%)	0.25 N.S.	0.000***	-	-	Mann Whitney
Compaction (kgf cm^{-2})	0.03*	0.49 N.S.	-	0.822 N.S.	ANOVA
Erosion (%)	0.15	0.10	-	-	Mann Whitney
INDICATORS OF BIODIVERSITY					
Organic litter cover (mm)	0.01**	0.93	-	0.552 N.S.	ANOVA
Natural debris (%) e.g. logs	0.89 NS	0.006**	-	0.989 N.S.	ANOVA

* P<0.05, ** P<0.01, *** P<0.001, N.S. not significant. Note: an ANOVA was used where the assumption of normality and homogeneity of variance were not voided. Otherwise a non-parametric Mann Whitney was used.

SUMMARY

The Marrdja Boardwalk a hardened site that is well maintained, however, the use of the proformas has shown that systematic monitoring will identify positive trends, trends in negative human related activities, and the need for maintenance. Human related activities include approaching wildlife too closely, and stepping off the track to view and take photographs of wildlife and plants, and littering. Management issues include maintenance of the car park, infrastructure (boardwalk and railing) and signs.

The Tour Operator Proformas indicate that signs require maintenance, however this was not noticed at higher levels of monitoring. Semi-intensive biophysical surveys indicated that high levels of root exposure were natural at this site, i.e. they were higher in the control than the buffer. However, mineral soil exposure and a decrease in seedling density on the edge of the track suggested visitors were stepping off the track.

DAVIES CREEK

LOCATION AND SITE DESCRIPTION

This study site is located in the Davies Creek National Park (17°00'S, 145°34'E; area 486 ha), on the northeast border of the Atherton Tablelands. The site is accessed from the Kennedy Highway, between Mareeba and Kuranda by six kilometres of gravel road. This road becomes very corrugated between maintenance, prohibiting two-wheel drive access. There are numerous large woboys to divert water along the length of the road and on the steep five kilometre stretch of road between the camp/picnic area and the waterfall. The property on the approach to the site is being used for grazing cattle. The road-side vegetation is dominated by grass and weeds and is coated in dust. This site borders the Wet Tropics World Heritage Area but it was included in the study because of management issues related to local use that may also occur in the future at Wet Tropics sites.

Average annual rainfall at this site is 1469 mm, considerably less than that at the other three sites (Turton *et al.* 1999). In concert with the other sites, precipitation is seasonal with most rain falling in the wet season. The elevation at the site ranges between ca. 450 m at the camp and picnic area to ca. 594 m elevation at the waterfall. Davies Creek, a perennial watercourse traverses the study site. The bedrock at this site is predominately granite and due to the geology and dry climate, the area is dominated by medium and low woodland. Vegetation in the park is predominantly dry sclerophyll. There is a short section, ca. 200 m, of wet sclerophyll bordering the creek near the waterfall.

SITE MANAGEMENT AND ACTIVITIES

The Davies Creek site is managed by Queensland Parks and Wildlife Service. Its classification according to the Nature Based Tourism Strategy (Wet Tropics Management Authority 2000) is **R1 –** Recreation 1: Opportunities for small groups to experience the World Heritage Area and environs and recreate in a natural setting.

Strategies: Maximum vehicle capacity twelve persons; limited infrastructure; on-site basic interpretation.

Action required: Site management review.

Priority: Three site (actions that would expand the range of visitor opportunities but are not required in the short term; sites have not been subject to a preliminary overview by Rainforest Aboriginal people).

An inventory of the signage and facilities recorded during this study are reported in Bentrupperbäumer and Reser (2002). At the entrance to the park there is a fire risk sign and at the first pull-off bay a non-camping sign was erected during this study. At the main camping area is a registration booth with information on the park, whilst the carpark has regulatory and directional signage. The walking track circuit to the waterfall has limited signage, which is restricted to directional information and safety.

This site is primarily used by locals for picnics (Bentrupperbäumer and Reser 2002). It has low visitation, e.g. approximately 24,415 people per annum (Bentrupperbäumer and Reser 2002). There are two main activity nodes, a camp and picnic area and a waterfall circuit-track. Locals primarily use the camp and picnic area, whereas the waterfall circuit-track attracts other independent travellers. There are three camp and picnic areas; 1) a small pull off area that accommodates two to three vehicles; 2) main carpark area (ten vehicles); and 3) a third pull-off area that accommodates up to three vehicles. The main activity at the camp and picnic area is picnicking and swimming. Camping is allowed near the main car park but

there are no defined campsites. The bedrock is granite with little soil making it difficult for campers to find locations to erect tents. The picnic tables are not fixed and were moved by visitors between our visits. Most tables were positioned under trees. The creek was fast flowing but shallow with a few waist high water holes near the high use area and the substrate in this area was slippery.

DAVIES CREEK FALLS CIRCUIT

This is self-guided graded track (WTWS 2001) 850 m long located on the ridge above the camp/picnic area. The track leads to a lookout that provides excellent views of the gorge. The lookout is fenced but a section of the track that leads to the waterfall through some boulders is not, and is a potential risk to visitors. This section of the track is not as well defined as the rest of the track.

It is relatively easy to walk this track but the granite surface can be slippery on the steeper sections where there are no steps. It is not suitable for wheelchairs. The steeper section of the track (left branch from the car park to the falls) has some minor gully erosion caused by runoff. Between surveys an undesignated track appeared on a steeper section linking two points of the main track. The location of social (undesignated) tracks associated with the main track was mapped by Jenny Butler during this survey period and are illustrated in Figure 5 below.

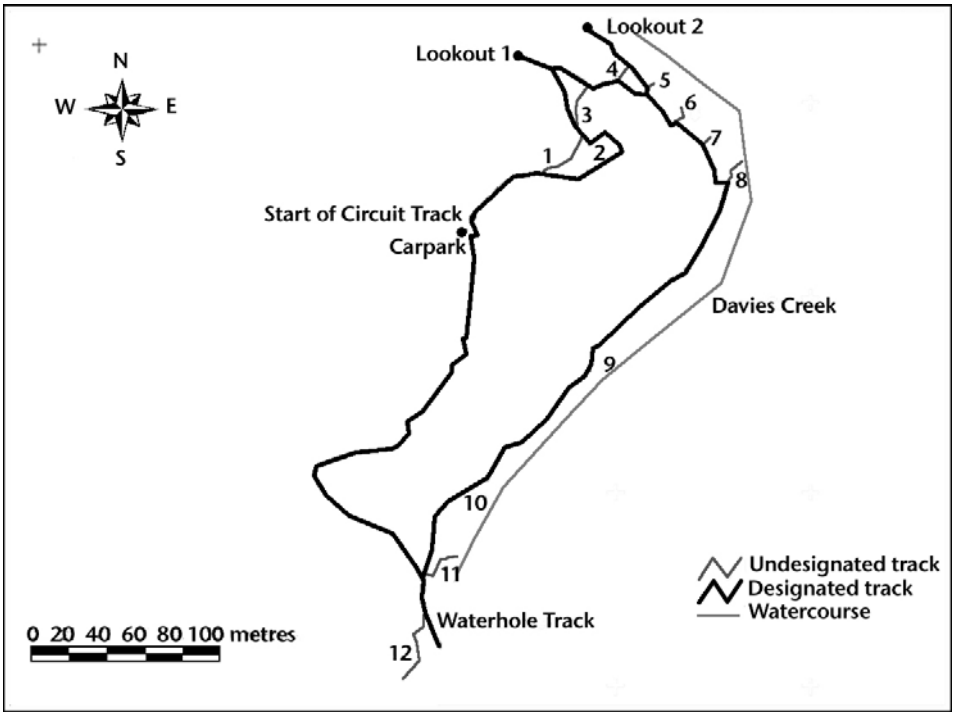


Figure 5: Location of undesignated walking tracks at Davies Creek.

There is obvious root erosion along the flat section of the track that borders the river. A swimming hole, at the base of the right branch of the track from the carpark, has no facilities; undesignated camp fireplaces were noted at this site.

Rangers were contacted prior to all visits to this site but no rangers were present on any of the survey trips (six in the dry season and five in the wet season).

Management Issues

- Domestic dogs visiting the park with campers and day visitors.
- Vandalism of trees and infrastructure.
- Camping in non-camping areas.
- Rubbish (drums of spent oil).
- Access to the waterfall via the circuit track.

RESULTS OF TOUR OPERATOR PROFORMA TRIAL

A pilot study trialing the Tour Operator Proforma was conducted in the dry season on 6 December 2001 and in the wet season on 18 April 2002 (Appendix A3). A field trip to this site with members of the tourism industry, and Wet Tropics Management Authority, Queensland Parks and Wildlife Service staff and researchers was conducted on 27 February 2002 to refine elements of the sampling. Key findings from the pilot study are presented below. Impacts were greater in the wet season than the dry. No commercial tour operators are operating at this site.

Key Findings of the Tour Operator Trial

- The access road to this site requires constant grading to enable the movements of two-wheel drive vehicles. During the first survey the road was corrugated, dusty and slippery, and dangerous even for a four-wheel drive vehicle. It had been freshly graded during our second survey and was accessible to two-wheel drive vehicles.
- There is adequate parking for vehicles and all vehicles were parked in designated areas.
- Trees were being vandalised within the camp/picnic area.
- Weeds were widespread throughout the site and along the road.
- Signs along the walking track required attention in both surveys.
- Litter in the camp and picnic ground consisted of small items such as cigarette butts, plastic bread ties, tea bags and bottle tops.
- Toilet block required attention, i.e. toilet seat not attached, missing glass in toilet window and graffiti recorded on both trips.

RESULTS OF LAND MANAGER PROFORMA TRIAL

Visitors were present during the first survey but not the second survey. Key findings and recommendations are presented for each of the activity nodes, e.g. the camp and picnic area, the walking track and freshwater feature, under two sub-headings – human related activities and management issues.

KEY FINDINGS FROM RANGER PROFORMAS

Camp and Picnic Area

Human Related Activity

- Undesignated tracks were recorded between the car park and camp and picnic area, camp and picnic area and creek, and car park to toilet. Campers commented that the tracks were being made as there was no easy access to camping areas.

- Litter was obvious during both surveys, consisting of cigarette butts, plastic wrappers detrimental to wildlife, and broken glass, tent pegs and bottle caps, which are potential risk factors to visitors. In general it consisted of a lot of small pieces.
- Numerous instances of campfires in undesignated areas were recorded during both surveys. Undesignated campfires pose a risk to surrounding vegetation, which should be addressed. This suggests more barbeques should be provided at this site. Some maintenance of the barbeques had occurred between the first and second survey.
- Evidence of infrastructure being vandalised was recorded during both surveys but was worse on the second survey. This was mainly due to the railings leading to the camp and picnic area being damaged (evidence of axe use).
- In the main camp ground most of the trees adjacent to picnic tables and barbeques have been vandalized, i.e. initials carved into the trunk, trunks chopped with axe, top section of numerous trees cut.
- A small dog not on a leash, with campers, was present during the first survey. The campers had been on site for four days. No domestic animals were observed during the second survey.
- Greater ranger presence during public holidays is required at this site to lessen the risk of vandalism, monitor camping and visitors releasing dogs in the park.

Management Issues

- There is a dense stand of weeds along the edge of Davies Creek watercourse and in the camp and picnic area. The camp and picnic area had been whipper-snipped between surveys, however weeds were seeding and needed attention.
- The carpark had erosion channels during the first survey and its condition had deteriorated by the second survey. Erosion gullies had deepened and extended the length of the carpark and were an obstacle to two-wheel drive vehicles, requiring attention.
- There was a non-active wasp nest on the roof of the registration booth, which was not a risk but required attention.
- A forty gallon drum discarded near the toilet block and left there for some time is aesthetically and environmentally unsatisfactory.
- Problems identified at the toilet block during the first survey, which had not been addressed by the second survey, included missing louvres in both male and female toilets, toilet seat not attached in the female toilet and graffiti on the wall in male toilets.
- Exposed roots around the camp and picnic area were due to local hydrology but may be aggravated by visitor activity. Recommend that access points be monitored for root exposure and erosion.

Graded Walk

Human Related Activity

- Infrastructure damage - damage to the railing in the car park, perspex over sign at waterfall was broken, requiring attention.
- Undesignated track - a new track approximately fifteen metres long and 0.5 metres wide on a steep slope between the main track appeared between our two sampling periods. This was receiving attention.
- Fire scars from undesignated fires near creek but close to vegetation. These will be washed away in rains but these are a problem in the dry as they damage the trees and may cause wild fires.

- Litter, although minor, needs attention as it encourages others to leave litter.

Management Issues

- A short star-picket used to secure a fence bordering the track. This is a potential hazard to walkers and needs covering.
- Gully erosion along track, resulting from local hydrology, was present on both surveys and needs attention as it is a human risk factor.
- Mineral soil exposure needs watching.
- Weeds were widespread throughout the area. These are difficult to control but recommend they are kept under control along the edge of the track which is the current practice.
- Exposed roots prevalent along the bank bordering the river appear to be the result of local hydrology, i.e. associated with flooding but the increase suggests that it is being compounded by visitation. May need to move the track away from edge of the bank.

Other Points of Interest

A currawong was observed carrying nesting material during first survey in December 2001. Reptiles sighted included freshwater turtles and skinks. A platypus was observed between the waterfall and waterhole during one visit but not during the survey.

Freshwater Feature

The impact area refers to the five metres of non-wetted area either side of the creek. This section of water was associated with the camp and picnic area. Visitor related activity, such as undesignated campfires and tracks, and litter, reported here are additional to those recorded in the camp/picnic area.

Human Related Activity

- An undesignated short track on the bank opposite the picnic area to the base of a tree with a rope-swing attached.
- Litter included cigarette butts.
- Remnant of a campfire at base of tree bordering creek during both surveys and fires scars on trees.
- Vegetation damage to lower branches of eucalypts.
- Rope attached to a tree, on opposite bank from the picnic area, hanging over very shallow water and slippery rocks. This was hanging down during the first trip but looped over a branch during the second visit and should be removed.

Management Issues

- Weeds were dense along the edge of Davies Creek watercourse during both surveys. During the second survey, a fifty metre stretch of bank bordering the picnic camp area was scored for the presence or absence of weeds at one metre intervals. Weeds occurred in 37 of the 50 one-square-metre samples in a punctuated pattern. The bank on the opposite side consisted of a solid stretch of tall, dense grass. Surveys need to monitor a fifty metre long by one metre wide stretch of bank for weeds on a regular basis.
- Algae on rocks in creek were a danger to people paddling and swimming.

Continuing Problems

- Undesignated campfires by water hole.
- Trees being vandalised.
- Maintenance of infrastructure not being attended to.

SEMI-INTENSIVE BIOPHYSICAL RESULTS

Camp and Picnic Area

Seven indicators were trialed at four camp and picnic nodes in the dry season, and five in the wet season (see Table 7). Management intent at the day-use and camp and picnic area is to keep the vegetation mown and free of debris, therefore the impacts of human activity on the surrounding habitat is of particular interest. Significant differences between the buffer and control, then between the tread, buffer and control were examined (see Table 7).

The data voided assumptions of normality and homogeneity required for parametric analysis, with the exception of percentage vegetation cover and canopy cover, so non-parametric tests have been used unless stated which did not allow for testing for interactions between season and zone.

Table 7: Summary of indicator responses between seasons (wet and dry) and zone (tread, buffer and control; n = 20) measured at four camp/picnic nodes in the dry season and five in the wet season at Davies Creek.

Indicator	Buffer and Control	Season (buffer and control data only)	Tread/buffer/ control	Season (tread, buffer and control data)
Bare soil (%)	*	*	**	*
Vegetation cover (%)	**	NS	***	NS Interaction NS
Litter cover (%)	NS	NS	***	NS
Litter depth (mm)	NS	*	***	NS
Seedlings	**	NS	**	NS
Compaction (kg cm-2)	*	NS	**	*
Canopy cover (%)	NS	NS	NS	NS Interaction NS

* P<0.05, ** P<0.01, *** P<0.001, N.S. = not significant. Non-parametric Mann Whitney and Kruskal Wallis tests were used as the data voided the assumptions of homogeneity of variance.

Key Findings for Camp and Picnic Nodes

- Four of the seven indicators were significantly different between the buffer and control.
- Vegetation cover was significantly different in the control than in the buffer and tread, indicating the impact was encroaching on the buffer.
- Mineral soil exposure was higher in the tread zone than in the buffer and control, associated with visitor use.
- Vegetation cover was correlated with mineral soil exposure, litter depth, seedling density and compaction (Spearman's Rho -0.544, 0.553, 0.527, -0.552).

- Canopy cover was not significantly different across zone (tread, buffer or control) or between seasons.
- Significant changes occurred between mineral soil exposure and litter depth between seasons, which were both greater in the wet.

Walking Track

- Ten indicators were trialed in the dry season and thirteen in the wet season. Additional indicators measured in the wet season were height of grass, broadleaf and woody plants.
- Three indicators were found to vary significantly between the buffer and the control (Table 8). Fungi were not recorded in either the wet or dry season in any of the quadrats (n= 120) and no vines were recorded across the track in either season.

Tread, buffer and control

- No significant difference in human litter among the tread, buffer and control.
- No significant difference in leaf tip death among the tread, buffer and control.
- Ten indicators were significantly different between the tread, buffer and control. Those that are important to management are bare ground, root exposure, litter cover, litter depth and erosion.

Table 8: Summary of indicator responses between seasons (wet and dry) and zone (tread, buffer and control; n = 20) measured at 22 metre intervals along the graded track.

INDICATORS - WALKING TRACK	Buffer cf. Control	Season (buffer and control)	Tread/ Buffer/ Control	Season (based on all data)	Season * Zone Interaction
INDICATORS OF ABOVE GROUND HEALTH					
vegetation cover (%)	NS	NS	***	*	-
bare ground (%)	**	NS	***	NS	-
root exposure (%)	NS	NS	*	*	-
seedling density	NS	NS	***	NS	-
canopy cover (%)	NS	**	NS	***	-
INDICATORS OF GROUND LEVEL HEALTH					
bare ground (%)	**	NS	***	NS	-
litter cover (%)	NS	***	***	NS	-
organic litter (mm)	NS	***	***	*	-
root exposure (%)	NS	NS	*	*	-
compaction (kgf cm^{-2})	**	NS	***	NS	*
Erosion (scale/%)	**/*	NS/NS	*/*	NS/NS	-
woody debris	NS	NS	***	NS	-
INDICATORS OF INVERTEBRATE DIVERSITY					
litter cover (%)	NS	***	***	NS	-
organic litter (mm)	NS	***	***	*	-
woody debris	NS	NS	***	NS	-

* P<0.05, ** P<0.01, *** P<0.001, N.S. = not significant. Note: an ANOVA was used where the assumption of normality and homogeneity of variance were not voided. In other cases, non-parametric Mann Whitney and Kruskal Wallis were used.

Buffer and Control

Significant indicators were those associated with soil, e.g. mineral soil exposure (bare ground), compaction, erosion and broadleaf weeds.

There was no significant difference in the height of the grass or woody plants between the buffer and control. However, there was a significant difference in the height of the broadleaf in the buffer compared to the control (Chi sq. 3.90, d.f. 1, P=0.05). This was primarily due to snake week (*Verbena*).

Mineral soil exposure (bare ground), compaction, erosion and broadleaf weeds were all significantly greater in the buffer than the control:

Indicator	Buffer Mean Rank	Control Mean Rank
mineral soil exposure	46.67	34.33
compaction	47.31	33.69
erosion	44.84	36.16
broadleaf weeds	23.67	17.33

Season

- Based on all data, four indicators were significantly different between season, i.e. ground cover, exposed roots, depth of litter and canopy cover.
- Based on buffer and control data, seasonal differences occurred in natural litter cover and depth, and canopy cover.
- Litter depth was greater in the wet (mean rank 50.71) than in the dry (mean rank 30.29).
- Litter cover was greater in the wet (mean rank 49.00) than in the dry (mean rank 32.00).
- Canopy cover was greater in the dry (mean rank 48.59) than in the wet (mean rank 32.91) which was counter-intuitive.

Key Findings for Walking Track

- Activity within the tread zone is impacting on soil properties bordering the walking track and resulting in an increase in broadleaf weeds.
- Track widening (range 22-430 cm) was recorded at seven of twenty sampling sites along the track in the dry but only one of the twenty in the wet season.
- Loose stones under foot were recorded on the steeper section of the track in eight of twenty samples along the track in the dry (Table 9).
- There are sections of the track that are difficult to negotiate due to loose substrate and gullying.

Table 9: Ease of walking on Davies Creek track in the dry season determined from twenty quadrats taken along the track. Scale: 1 = very easy; to 5 = very difficult.

Ease of Walking	Number of Quadrats	Percent
very easy	12	60
easy	2	10
moderate gradient/some loose stones	1	5
difficult -loose substrate, slippery	4	20
very difficult - loose substrate, gullying, steep	1	5
Total	**20**	**100**

Management intent is to keep the tread zone graded and free of vegetation, i.e. grass, broadleaves or woody plants. Therefore height of vegetation on graded tracks or leaf litter, bare ground and vegetation on board walks between the tread zone and the buffer and control were not compared as they do not relate to visitor impacts. However, the number of quadrats on the tread zone with vegetation present, and the height of the vegetation in the tread zone, indicate quality of management (Table 10). Where tall (more than 0.5 metres) vegetation occurs frequently it may impact on visitors forcing them to step off the track into the buffer zone. Thus where the tread zone has tall vegetation occurring in several quadrats it will be necessary to compare the height of vegetation between it and the buffer zone.

Table 10: Frequency of occurrence (range of heights) of different types of vegetation in quadrats measured along the walking track.

	Control (n=20)	Buffer (n=20)	Tread (n=20)
Grass	18 (450-110mm)	18 (105-1600 m)	9 (100-470 mm)
Broad leaf	4 (85-390 mm)	11 (50-500 mm)	1 (80 mm)
Woody	10 (50-1200 mm)	7 (100-1320mm)	2 (50-120 mm)

A range is reported rather than mean and SE, and as in most cases, there is a uniform spread of heights across all the categories. The exception was height of grass in the control, where seven quadrats contained grass of 570-600 mm in height; and the height of woody plants in the control, where seven quadrats had plants was more than 340 mm high.

Table 11: Number of quadrats with litter or leaf tip death along the walking track at Davies Creek.

	Control (n=20)	Buffer (n=20)	Tread (n=20)	Total (n=60 quads)
Human litter	1	1	1	3
Leaf tip death	11	7	4	22

Few litter items were recorded within the quadrats with no evidence that visitors were throwing their rubbish into the forest along the walking track.

Leaf tip death was higher in the control than the buffer and tread primarily due to greater tree density of foliage in the control. This was not due to human activity but to dry conditions.

SUMMARY

- Weeds are a problem in the camp and picnic area, along the watercourse and track but are receiving attention. Surveys need to monitor a fifty metre long by one metre wide stretch of bank for weeds on a regular basis.
- Numerous undesignated fire scars in the camp and picnic area suggest more barbeques need to be provided at this site or that the barbeques that are available are not suitable. Some maintenance of the barbeques had occurred between the first and second survey.
- Vandalism to native vegetation requires addressing, e.g. initials carved into the trunk, trunks chopped with axe, top section of numerous trees cut.
- A greater ranger presence is required during public holidays at this site to lessen the risk of vandalism, monitor camping and visitors releasing dogs in the park.
- Semi-intensive biophysical monitoring indicated the impacts of visitation were encroaching into the tread zone.

Continuing Problems

- Undesignated campfires by water hole.
- Trees being vandalised.
- Maintenance of infrastructure not being addressed.

HENRIETTA CREEK AND NANDROYA FALLS TRACK

LOCATION AND SITE DESCRIPTION

Henrietta Creek and Nandroya Falls (17°36'S 145°47'E) are located between Innisfail and Millaa Millaa. Nandroya Falls track commences approximately one hundred metres north of Henrietta Creek camp and picnic ground. The site is accessed from the Palmerston Highway.

Average annual rainfall for Millaa Millaa, approximately twenty kilometres north west of Henrietta Creek, is 2708 mm. The wettest months are December to May (range 208-464 mm) with monthly rainfall of less than 145 mm during the rest of the year (Wilson 2000). Mean annual temperature is 20.5°C. This data was collected at the Post Office in Millaa Millaa (altitude 831 m). Henrietta/Nandroya Falls is a mid-elevation site (ca. 550 m) and much wetter (>3,500 mm). Soil is basalt and it supports a complex mesophyll vine forest with trees 25-30 metres tall.

SITE MANAGEMENT AND ACTIVITIES

This site is managed by Queesnland Parks and Wildlife Service, and is within the Wet Tropics World Heritage Area. Two rangers service this site; one of whom is an Aboriginal ranger not from this area.

An inventory of the signage and facilities recorded during this study is included in Bentrupperbäumer and Reser (2002). At the entrance to the park are signs indicating the management agencies. In the camp and picnic area there is a registration booth for campers and a notice board with regulatory and educative information. Along the track from the eastern end of the campground following Henrietta creek are informative signs on wildlife. There are few sign on the Nandroya track and those that exist are directional.

Nandroya Falls circuit is a graded track. It is rated as 'high priority' for addressing actions in the Wet Tropics Walking Strategy (WTWS) (2001). The WTWS also identified the need to provide a footbridge across Henrietta Creek to link Henrietta camp and picnic area to the start of the track so as to insulate walkers from the highway. During this study access to the start of the walk required crossing either Henrietta creek or the Palmerston Highway. Management intent is to keep the tread zone of the track free of vegetation, i.e. grass, broadleaves or woody plants, and hardened to prevent erosion.

Nature Based Tourism Strategy: R2 (Recreation 2) Providing opportunities for large numbers of people and groups to experience outstanding World Heritage Area features and values.

Strategies: Highly developed infrastructure; high on-site and off-site static and active interpretation. Review facilities.

Priority: 2.

Action required: Master planning for Palmerston Area.

Visitation: The main activities conducted here are walking, picnicking, camping, and Aboriginal visitors occasionally fish at the site. March flies were present during both surveys and were deterring visitors. Observations of people using this site indicated that most visitors were stopping to use the toilet facilities only and did not venture into the rest of the park (Bentrupperbäumer and Reser 2002).

An Aboriginal concern, relating to the proposed canopy walkway in close proximity to this park, is that people will wander into the forest and interfere with culturally sensitive areas. Biophysical findings indicate that people are not venturing into the forest but remaining on the tracks.

Management Issues

- Domestic dogs.
- Access to Nandroya walking track from Henrietta camp and picnic area. The access is via a busy highway used by large trucks or via a creek crossing that subject to flooding in the wet season.

TOUR OPERATOR PROFORMA TRIAL

A pilot study trialing the Tour Operator Proforma was conducted in the dry season (11 December 2001) and wet season (13 April 2002). A field trip to this site with members of the tourism industry, and Wet Tropics Management Authority and Queensland Parks and Wildlife Service staff and researchers was conducted 27 February 2002 to refine elements of the sampling. The ranger responsible for Henrietta/Nandroya joined us on site. Key findings from the pilot study are presented in Appendix A4.

Key Findings from Tour Operator Trial

- Access and car parking requires attention.
- There was evidence of feral pigs along the track during both surveys but not in the camp and day-use area.
- Weeds were common bordering the access and the camp and day-use area on both surveys but more noticeable in the wet season.
- The track was well maintained but vines and branches had fallen across the track on both trips.
- No commercial tour operators are operating at this site.

RESULTS OF LAND MANAGER PROFORMA TRIALS

Scores and required actions for visitor related activities and management issues recorded during the wet and dry season using the ranger proformas are presented in Appendix B3, and key findings are reported below.

Camp and Picnic Area

- Campers were present during both surveys. Five camp and picnic nodes were used for conducting biophysical measurements (Figure 6).

Human Related Activity

- Undesignated tracks associated with campsites were observed during both surveys, but were few in numbers. These were short (less than five metres long) and did not lead to anything, suggesting they may have been used as toilet stops. However, no toilet paper was found in the vicinity.
- Litter, consisting of small items such as plastic ties and cigarette butts, was present on both visits.

- During the second survey evidence of animals scavenging was recorded, e.g. a bag of food scraps was recorded adjacent to a camping site. A musky rat kangaroo was observed feeding on the contents, and the remnants of a take-away meal were scattered in the female toilets. It appeared that this has been left for the ranger to take away but an animal had opened and dispersed the contents before the rangers visit.
- Fire scars from an undesignated fire were recorded at one campsite on the first survey but not during the second survey.
- Infrastructure damage included a broken seat at the picnic table at the first camping bay recorded on the second survey.

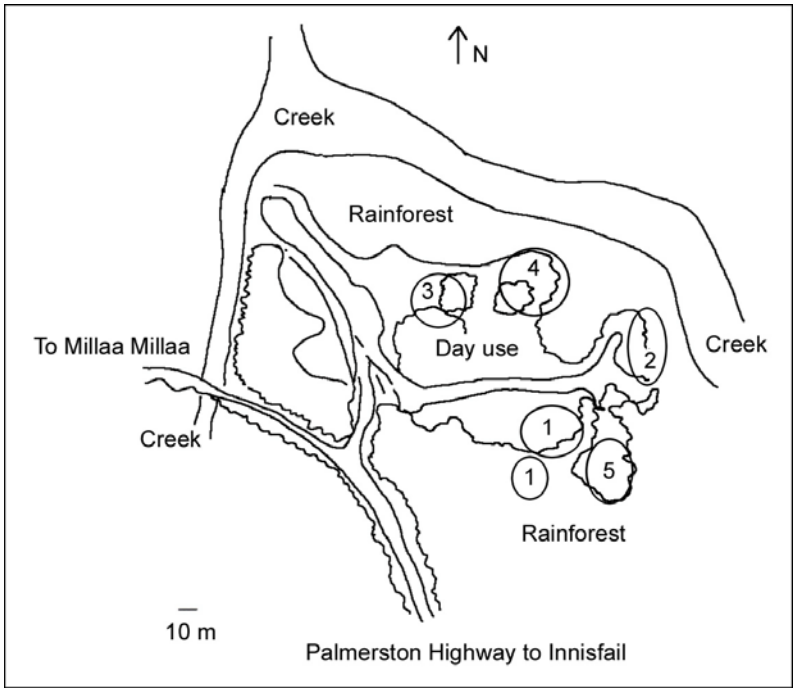


Figure 6: Location of map and nodes at Henrietta Creek.

Management Issues

- Potholes and bogs associated with the road were recorded on both surveys but had increased in extent and number by the second survey.
- Road noise associated with the movement of heavy transport vehicles on the Palmerston Highway was obvious within the camp and picnic area on both surveys.
- Mineral soil exposure was minor but occurring around high use areas such as the picnic shelter and the water tap.
- Weeds were obvious around the edge of the forest bordering the camp and picnic area on both surveys.
- A pied butcher-bird was observed scavenging at the main picnic shelter on the first survey.
- Picnic tables need cleaning of a build-up of grime on the seats and tabletops, and barbeque facilities were broken and needed replacing.

Nandroyan Falls Track

Human Related Activity

No impacts associated with human activities were recorded in either survey along the track.

Management Issues

- Storm damage was recorded during the second survey. This resulted in a mudslide, fallen debris and hazardous plants across the track. Debris was recorded in culverts on the first survey; fresh debris associated with the storm was recorded obstructing the culverts on the second survey. Loose stones and track structure damage was associated with the storm. The loose stones were located at creek crossings and not the main section of the track and were a greater problem on the second survey following the rain than the first.
- Weeds were recorded along the edge of the track during both surveys and were very obvious at the falls during both surveys.
- Pig activity was obvious during both surveys along the edge of the track.

Fresh Water Feature

Human Related Activity

- A shortcut (undesignated track) between the main track and Henrietta Creek was created between the two surveys. This was approximately three metres long and 0.3 metres wide.

Management Issues

- During both surveys, weeds were very obvious on the banks, islands within the creek near the camp and picnic area and the access points on both sides of the creek.
- Bank erosion due to hydrological factors was apparent on both surveys.

KEY FINDINGS FROM RANGER PROFORMA

- Weeds were common bordering the camp and picnic ground, Nandroya Creek and Falls, and along the track but did not appear to be penetrating far into the forest. They were more prevalent during the wet season survey.
- The site road had deteriorated between the surveys and car parking needed attention.
- There was evidence of pigs along the track during both surveys but not in the camp and day-use areas.
- The track was well maintained but vines and branches had fallen across the track on both trips.

SEMI-INTENSIVE BIOPHYSICAL RESULTS

Camp and Picnic Area

Seven indicators were measured across five camp/day-use areas in the dry and wet seasons (Table 12). Results and interpretations are presented for analyses on the tread, buffer and control; and buffer and control and season. Three sets of indicators were highly correlated:

- litter and vegetation cover (Spearman's rho = -0.734);

- litter depth and seedlings (Spearman's rho = 0.685); and
- litter depth and compaction (Spearman's rho = -0.589).

Tread, Buffer and Control

- All seven indicators were significantly different between the tread, buffer and control.
- Litter depth, seedling and compaction were significantly different.
- There were fewer seedlings in the tread as the area is mown.
- Compaction in the picnic and day-use area was double that in the buffer and control.
- Litter depth in the picnic and day-use area was approximately quarter that in the buffer and control.
- Litter cover was much higher in the control than the tread and buffer.
- Surprisingly, mineral soil exposure was much greater in the buffer than the tread or control.

Buffer and Control

- Four of the seven indicators were significantly different between the buffer and control.
- Vegetation cover was significantly greater in the buffer than control suggesting an edge effect, but litter cover was significantly greater in the control than the buffer.
- Canopy cover and bare soil were also greater in the control than the buffer suggesting some openness in the forest near the camp and picnic area.

Season

None of the seven indicators varied significantly between seasons using all data, however, compaction varied significantly between season based on buffer and control data. It was greater in the dry (mean rank 13.55) than the wet (mean rank 7.45).

Table 12: Summary of indicator responses between seasons (wet and dry) and zone (tread, buffer and control; n =20) measured at five camp/picnic nodes in the dry and wet at Henrietta Creek.

Indicator	Buffer and Control	Season (buffer and control data only)	Tread/buffer/ control	Season (tread, buffer and control data)
Bare soil (%)	*	NS	*	NS
Vegetation cover (%)	***	NS	*	NS
Litter cover (%)	**	NS	*	NS
Litter depth (mm)	NS	NS	***	NS Interaction NS
Seedlings	NS	NS	***	NS
Compaction (kg cm-2)	NS	*	***	NS
Canopy cover (%)	*	NS	**	NS

* P<0.05, ** P<0.01, *** P<0.001, N.S. = not significant. Non-parametric Mann Whitney and Kruskal Wallis tests were used on all data, except litter depth, as the data voided the assumptions of homogeneity of variance. An ANOVA was used to test for differences in litter depth across zone and season.

Nandroya Falls Track

Ten indicators were trialed in the dry season and thirteen in the wet (Table 13). The additional indicators measured in the wet season were height of grass, broadleaf and woody plants.

Table 13: Summary of response of indicators between seasons (wet and dry) and zone (tread, buffer and control; n = 20) measured at 110 m intervals along the graded track (see Appendix D for tables of statistical analyses).

INDICATORS - WALKING TRACK	Buffer cf. Control	Season (buffer and control)	Tread/ Buffer/ Control	Season based on all data	Season * zone Interaction
INDICATORS OF ABOVE GROUND HEALTH					
vegetation cover (%)	NS	-	NS	-	-
bare ground (%)	NS	NS	**	*	-
root exposure (%)	NS	NS	***	NS	-
seedling density	NS	NS	***	NS	-
canopy cover (%)	NS	NS	NS	NS	-
INDICATORS OF GROUND LEVEL HEALTH					
bare ground (%)	NS	NS	**	*	-
litter cover (%)	NS	NS	NS	NS	-
organic litter (mm)	*	***	***	***	-
root exposure (%)	NS	NS	***	NS	-
compaction (kgf cm^{-2})	*	**	***	***	***
Erosion (scale/%)	NS	NS	**/***	**/NS	-
woody debris	NS	*	***	**	-
INDICATORS OF INVERTEBRATE DIVERSITY					
litter cover (%)	NS	NS	NS	NS	-
organic litter (mm)	*	***	***	***	-
woody debris	NS	*	***	**	-

* P<0.05, ** P<0.01, *** P<0.001, N.S. = not significant. Note an ANOVA was used where the assumption of normality and homogeneity of variance were not voided. In other cases, non-parametric Mann Whitney and Kruskal Wallis were used.

Tread, Buffer and Control

- Eight of the ten variables were significantly different (Table 14) across the tread, buffer and control with this difference being primarily between the tread and the buffer/control.
- Mineral soil exposure, root exposure and erosion were less in the tread than the buffer and control, suggesting adequate management, i.e. surfacing the track, was in place.
- Woody debris, litter depth, and seedling density were less in the tread than buffer and control, in line with management intent.
- Compaction was much higher in the tread than the other two zones in line with management intent.

Table 14: Significant differences across tread, buffer and control at Nandroya Falls track.

	Mean Rank		
Indicator	**Tread**	**Buffer**	**Control**
% mineral soil exposure	47.27	69.79	62.63
% root exposure	37.50	66.5	77.95
% woody debris	44.24	62.14	75.13
% erosion	47.46	72.34	61.70
Compaction	91.49	49.19	37.00
Litter depth	33.72	65.20	82.57
Seedling density	32.41	76.59	72.50

Buffer and Control

- Three indicators were significantly different between the buffer and the control, i.e. litter depth, compaction and height of grass.
- Litter depth and compaction were correlated (Spearman's rho -0.642, P<0.01).
- Compaction was greater in the buffer than the control indicating a negative effect.
- Litter depth was greater in the control than buffer suggesting an edge effect.
- Grass was significantly higher in the buffer (mean rank 22.50) than the control (mean rank 18.50; Chi-sq. 4.31, d.f.=1, P=0.04), suggesting an edge effect.
- There was no significant difference between the height of the broadleaf and woody plants between the control and buffer.

Season

- Track widening was observed in the dry season (five of the twenty sample points had track widening ranging from fifty to five hundred centimetres) but not in the wet season.
- No fungi was recorded in the wet season and only two of 120 quadrats had fungi in the dry, i.e. one in the buffer and one in the control.
- Woody debris, litter depth and erosion were greater in the wet than the dry season.
- Compaction was greater in the dry than the wet season.
- No vines were recorded across the track in either season.

SUMMARY

- The road within the park was identified as needing attention at all levels of monitoring but this was not being addressed.
- Weeds were identified as a problem bordering the camp and picnic area in both Tour Operator and Land Manager Proformas.
- Infrastructure, i.e. picnic tables need maintenance, identified at all levels of monitoring.
- Food scraps were attracting animals resulting in scavenging around the camp and picnic area.
- There was a build-up of litter in the forest bordering the camp and picnic with many items of risk to wildlife and humans; identified in intensive monitoring but not during monitoring with Tour Operator and Land Manager Proformas.

MURRAY FALLS

LOCATION AND SITE DESCRIPTION

Murray Falls State Forest Park (18°09'S, 145°49'E; elevation ca. 116 m) is at the foothills of the Kirrama Range between Cardwell and Tully, Queensland, in the southern section of the WTWHA. It is approximately forty-two kilomtres north of Cardwell and is reached via the Bilyana turn off, a sealed road branching off the Bruce Highway. This road passes through the Jumbun community and leads to the park. The last four kilometres are gravel road and may not be passable to two-wheel drive vehicles following heavy extended periods of rain.

This site receives an average annual rainfall of approximately 2118 mm (Turton et al., 1999) with most of the rain falling in the wet season (ca. 1351 mm). Geology at the site is comprised of granite. Vegetation at Murray Falls is primarily lowland tropical rainforest consisting of mesophyll/ notophyll vine forest. This vegetation surrounds the camp/picnic area and is found along the first section of walking track and bordering the water course. The last section of the walking track, leading to the falls, is dominated by dry sclerophyll woodland. Hydrological features of this site are Murray River and Murray Falls.

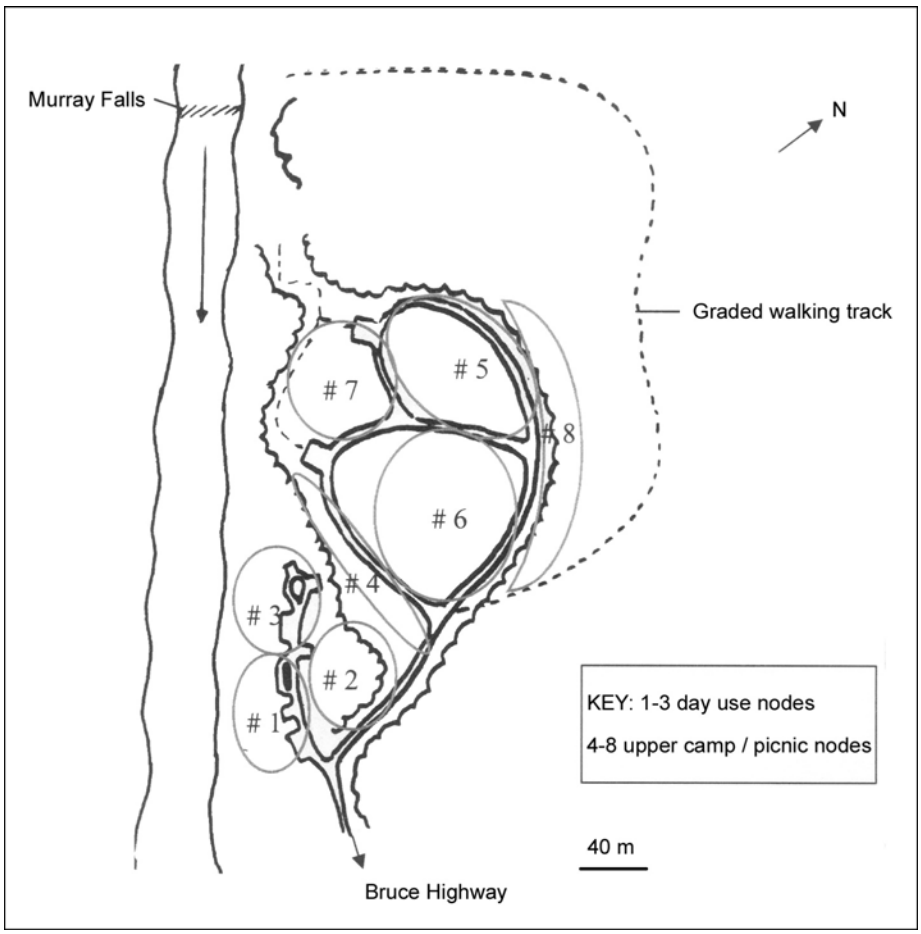


Figure 7: Site at Murray Falls showing location of sampling nodes for semi-intensive biophysical assessment.

INDIGENOUS COMMUNITY

This site is in Jumbun country, the home of the Girrmay, Jirrbal and Gulngay people. At the commencement of this study the local community centre was contacted and a meeting organised with the chairperson, Ms Marcia Jerry, to discuss the project and their involvement in monitoring visitation to this site. Of particular interest to Marcia was the signage that the community developed. A photographic record of the signs was taken during the study and is presented in Bentrupperbäumer and Reser (2002). At the meeting we discussed the areas that we were interested in working in within the park and asked if any of these were sensitive to the community and should not be entered, or recorded in our report. The areas we worked in were part of the public area.

Dr Dermont Smyth is currently developing the cultural indicators with the Girrmay, Jirrbal and Gulngay people in a separate project that will provide valuable information for future visitor monitoring.

SITE MANAGEMENT AND ACTIVITIES

The Department of Natural Resources, Mines and Energy managed this site up to eighteen months ago but it is now managed by Queensland Parks and Wildlife Service. Two rangers, one of whom is an Aboriginal ranger from Cardwell, service this site twice a week.

This site has an extensive picnic (day-use area) and camping area, a board walk to the base of the waterfall and a longer graded walk to the top of the waterfall. Approximately 15,950 people per year walk the longer Murray Falls Rainforest Walk (Dorrie pers. comm. 2001). There are three parking bays in the lower picnic area with a total of nine parking spots. The upper picnic camp area does not have designated parking areas and visitors are allowed to park on the grass beside tents and tables. An inventory of infrastructure at the site is detailed in Bentrupperbäumer and Reser (2002).

Nature Based Tourism Strategy (WTMA 2000): **R2** (Recreation 2) Recognised as a site of interest to Aboriginal people with potential for cultural tourism and management by Aboriginal people and of a traditional walking track to Kirrama Range.

Visitation: The main activities conducted at this site are camping, picnicking, swimming and walking. Visitors to the site are mainly from Tully. Visitation at this site dropped dramatically following the introduction of GST and it is now almost half pre-GST. Two of twelve regular seasonal visitors from south visited in 2001 and 2002 (pers. comm. Mike, Ranger). A second reason for a decline in visitation is young people moving away from the region. March flies are present in large numbers for many months of the year and do deter visitors.

Management Issues

- Inappropriate swimming at the waterfall, visitors clambering over rocks, and a lack of understanding of the consequences of their actions, e.g. this is a sensitive area to the Aboriginal community, and people are at risk of falling and dying (five people have been killed at this site).
- Visitors leaving trail, i.e. jumping over rail at the end of both trails to access water holes.
- People swimming at waterfall.
- Vandalism has also been a problem, e.g. shooting, rubbish, taking guide posts and graffiti. Other problems have been campers changing car oil in the park and leaving oil drums, cutting saplings for tee-pees, and taking orchids. On the track, the main management issues are drainage and erosion (pers. comm. W. Dorrie, Forest Officer, 2001).

- Brush turkeys and goannas have been observed scavenging at this site but neither have been observed scavenging in bins. The bins are elevated, lined with plastic inserts and have a flip lid to prevent scavenging by animals.
- Three days were spent at the site on each visit - one day conducting tours and ranger surveys and talking to rangers and the community, one day conducting the biophysical survey of the walking track and one day conducting the biophysical survey of the picnic ground and water body feature.

TOUR OPERATOR PROFORMA TRIAL

A pilot study trialing the Tour Operator Proforma was conducted in the dry season on 6 December 2001 and in the wet season on 8 May 2002. Results are presented in Appendix A5. Impacts were greater in the wet season than the dry. There had been some heavy rain prior to the wet season survey and the access road was churned up with a three to four metre long and seven metre wide muddy area. It was passable in a two-wheel drive with care. There was ample parking for vehicles and all vehicles were parked in designated areas. During the wet season survey, bark was stripped from trees and people were observed using undesignated tracks between the upper camp and picnic area and lower day-use area.

Weeds were recorded around the camp and picnic area and walking track in both seasons. Signs along the walking track needed attention in both surveys. Litter was not recorded along the walking track or the camp and picnic ground on either of the surveys.

No commercial tour operators are operating at this site. Indigenous horsetrail and bush tucker tours have been conducted at this site in the past but these are no longer operating.

Key Findings from Tour Operator Proforma

- Access to the site is a problem in the wet season; sections of the access road need work.
- Weeds are extensive throughout the campground and need attention.
- Signs need maintenance.
- Human litter was minimal but present where people were accessing the water.

RESULTS FROM LAND MANAGER PROFORMA TRIAL

Currently there is no tour operation at this site, therefore the land manager proformas represent the first level of monitoring until this situation changes. Data was collected during the dry season on 6 December 2001 and in the wet on 9 May 2002 at three nodes. These comprised the camp and picnic area, the walking track and a water body near the picnic ground that is used for swimming. Data is presented in Appendix B4.

Photographic locations and aspects for monitoring of the camp and picnic area are shown in Figure 8.

Camp and Picnic Area

- Visitors were present at the site during both surveys.

Human Related Activity

- A new track had appeared between the upper camp and picnic area and the lower day-use area in the time between the two surveys. This was down a steep bank.

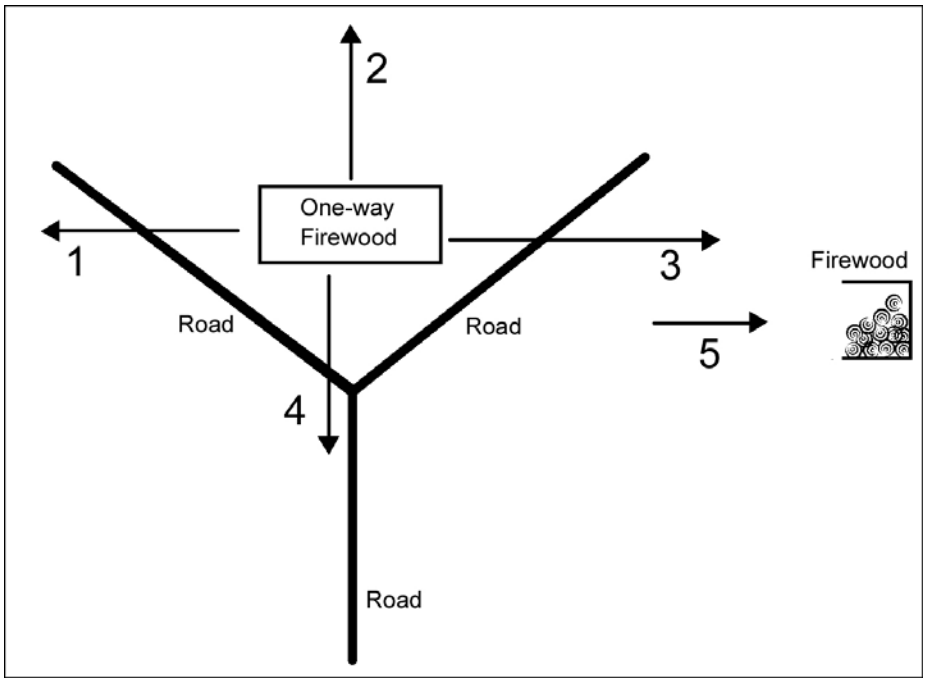


Figure 8: Photographic location and aspects for monitoring of the camp and picnic area at Murray Falls.

- Several of the trees in the campground had their bark stripped off during the wet. The rangers were aware of this and said it happens during the wet season as campers are looking for material to start fires (N.B. firewood is provided at this site).
- Litter was minor during both surveys, i.e. two cigarette butts and a plastic bag. Rangers were present and cleaning the area during both surveys.
- Sharp objects, e.g. tins and bottles (no broken glass) were recorded on the edge of the camp area.
- During the second survey, a kookaburra was scavenging at the picnic table while people were eating and banging its beak on the roof of the shelter.
- Graffiti (initials) was found on a table.

Management Issues

- Root exposure was not apparent in the camp and picnic area proper, but an ungraded track on the lower level leading from the day-use area to steps that lead to the upper camp and picnic area has very high exposure of minor roots.
- The camp and picnic area was mown and tidy, however bordering greater than fifty percent of both picnic and camp area during both surveys were paw paw, pineapple, non-native ginger, and passionfruit, lantana, introduced grasses, bamboo and snake weed (*Stachytarpheta cayennensis*). Paw paw were fruiting during the first survey and being eaten by wildlife. Passionfruit was wide spread, fruiting and being distributed by wildlife during the second survey. Lantana was fruiting during the second survey.

- There was minor mineral soil exposure around picnic areas, but very obvious around some barbeques. This was being addressed with paving.
- Pig digging was recorded on the edge of the forest at the entrance to the walking track and firewood stack during the second survey. This was not apparent during the first survey.
- Stripping trees of bark during the wet season needs attention.

Walking Track

Human Related Activity

- There had been an increase in size and use of undesignated tracks near the lookout/waterfall, but all of these were being attended to, i.e. prohibited entry signs. Such tracks are an on-going problem at this site. There are clear, visible signs warning people of the danger of serious injury if people venture off the track at the top of the waterfall. Present on both surveys was a short track from the upper camp and picnic area to the graded track near the start of the rainforest track that needs revegetating.
- The increase in litter between surveys was due to three cans near start of track.
- Weeds were occurring along the edge of the track and some patches of lantana were observed in the forest. The edge of the track had been sprayed prior to our second survey.
- Graffiti was recorded on the railing at the observation platform during the second survey

Management Issues

- Exposed roots were more apparent during the second than first survey in the rainforest area. It was not an issue on the dry sclerophyll section of the track but rangers were re-surfacing the track during our second surface to address this.
- Loose stones on the track were recorded on the dry sclerophyll section of the track only, during both surveys.

Other Issues and Observations

- There was minor leaf tip death observed in the dry sclerophyll section of the track during the second but not the first survey, which was most probably related to the extended dry period.
- Bracket fungi was observed on live trees during the second survey but not noted during the first survey.
- A monitor lizard and skinks were sighted along the rainforest track.

Freshwater Feature

Human Related Activity

- There were new short cuts (undesignated tracks) between the picnic area and water hole between the two surveys. These need watching as they have the potential to result in bank erosion.
- Cigarette butts were recorded on the bank at the main entry point during both surveys.
- A campfire had been built at the base of a tree causing a fire scar in the tree.
- Initials carved on one tree.

- Weeds were very obvious on the picnic-side of the bank near the visitor use section.

Management Issues

- Exposed roots were recorded where visitors were accessing the water, primarily hydrological but exacerbated by human use.

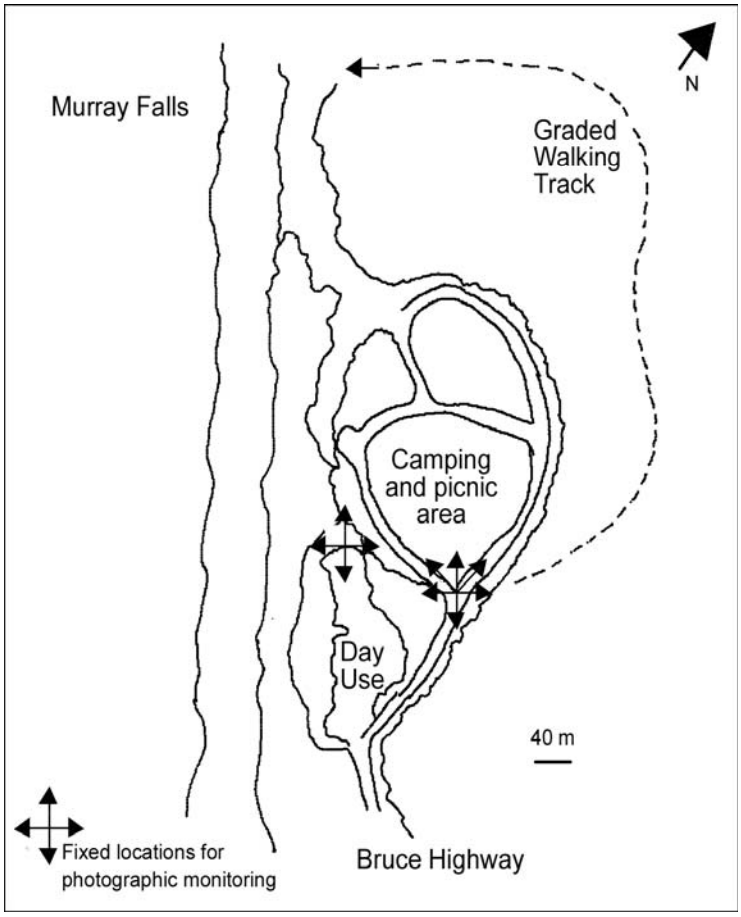


Figure 9: Location of camp and picnic area, day-use area and graded rainforest walk at Murray Falls.

SEMI-INTENSIVE BIOPHYSICAL RESULTS

Fixed points were identified for photographic monitoring as shown in Figure 9.

Camping and Picnic Area

Seven indicators were trialed at eight camp and picnic nodes in the dry and wet season (Table 15). Management intent at the day-use and camping and picnic area is to keep the vegetation mown and free of debris. Significant differences between the buffer and control, and between the tread, buffer and control were investigated to determine whether human activity is impacting on the surrounding habitat.

Data did not meet the required criteria for parametric analysis so non-parametric tests were used. These did not allow testing for interactions between season and zone. There were significant seasonal effects demonstrated with all indicators based on data collected in the buffer and control.

Table 15: Summary of indicator responses between seasons (wet and dry) and zone (tread, buffer and control). Three replicates were taken at each of the eight camp/picnic nodes (n = 72 one-square-metre quadrats).

INDICATOR Camp and Picnic Area	Buffer and Control	Season (buffer and control data only)	Tread/buffer/ control	Season (tread, buffer and control data)
Bare soil (%)	*	***	***	**
Vegetation cover (%)	***	***	***	***
Litter cover (%)	NS	***	***	NS
Litter depth (mm)	***	**	***	NS
Seedlings	***	*	***	***
Compaction (kg cm-2)	***	***	***	***
Canopy cover (%)	***	***	***	***

* P<0.05, ** P<0.01, ***P<0.001, N.S. = not significant. Non-parametric Mann Whitney and Kruskal Wallis tests were used as the data voided the assumptions of homogeneity of variance.

Key Findings

- Six of the seven indicators were significantly different between the buffer and control.
- All indicators were significantly different across the three zones.
- Bare soil was greater in the control than the buffer. This is counter-intuitive and would be expected to be greater at the edge if associated with human impact. Bare soil was significantly greater in the tread than the buffer and control.
- Vegetation cover was higher in the buffer than control but this was due to dense weedy species which graded to more open vegetation in the control.
- Litter was higher in the control than the buffer.
- Canopy cover was highest in the control (higher canopy cover would reduce the light level in the understorey and possibly vegetative growth resulting in the greater extent of bare ground in the control compared to the buffer.
- Seedlings were highest in the control than in the buffer.
- Compaction was higher in the buffer than control, and higher in the tread than buffer.
- Significant differences were demon-strated between all the wet and dry season indicators when using buffer and control data only. When including the tread, five of the seven indicators showed significant seasonal effects.

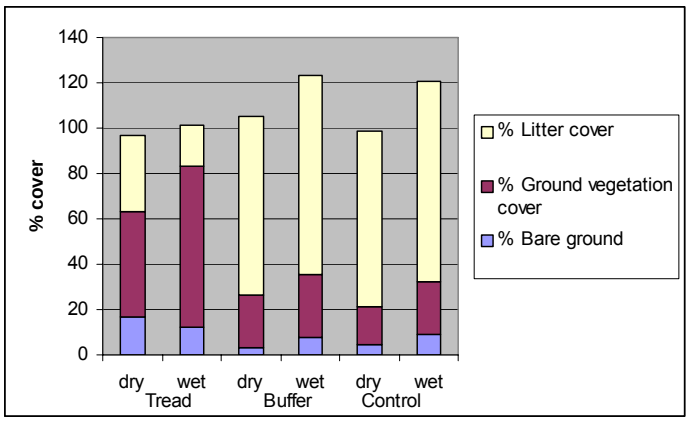


Figure 10: Mean percentage of cover of bare ground, vegetation and leaf litter within the eight camp/picnic areas, buffer (edge of the camp/picnic area) and control (ten metres from edge).

Seasonal Differences

- Ground vegetation cover increased in the wet.
- Leaf litter decreased in the wet.
- Bare ground decreased in the tread during the wet and increased in both the buffer and control (Figure 10).

Walking Track

- The location of the graded rainforest walk and the associated social trails were mapped in the dry season during this study (Figure 11). Note that social trail three is a track used by the Jumbun community.
- Ten indicators were trialed of which only one, bare ground, was found to vary significantly between the buffer and the control (Table 16).
- There was no interaction between season and zone but significant variation was apparent between seasons in the case of several indicators.

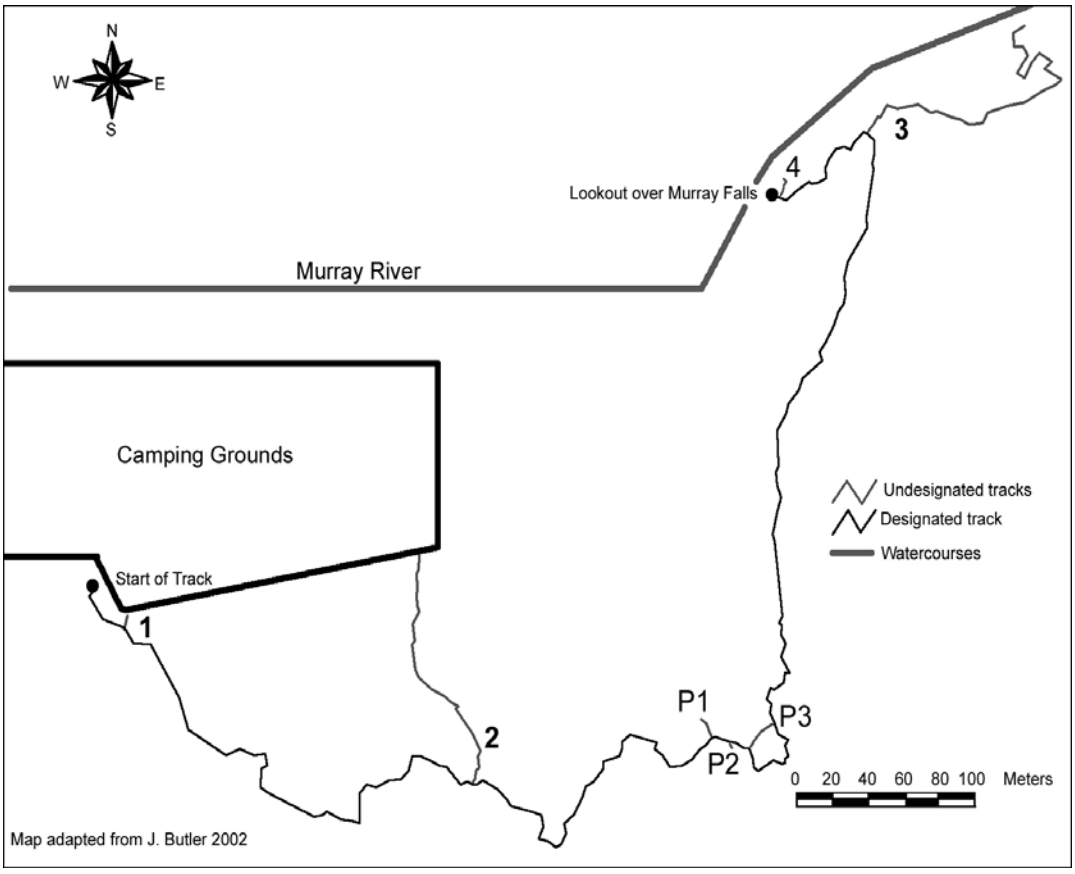


Figure 11: Location of undesignated tracks at Murray Falls.

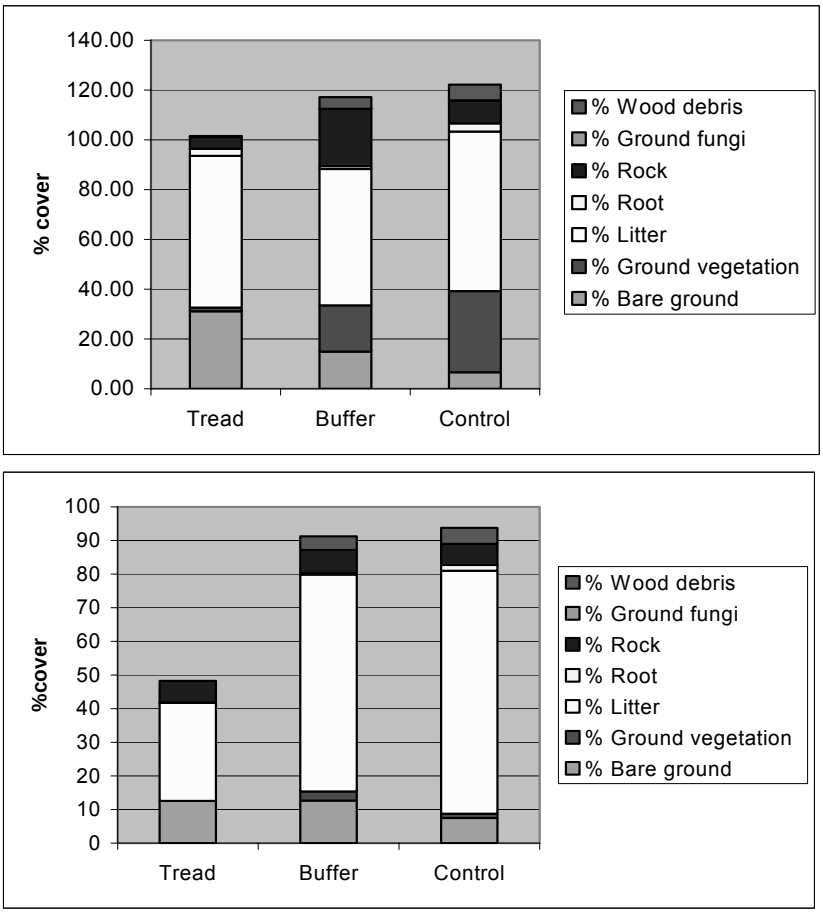
Table 16: Summary of indicator responses between seasons (wet and dry) and zone (tread, buffer and control; n = 20) measured at 47 metre intervals along the graded track at Murray Falls.

INDICATORS Walking Tracks	Season (buffer and control)	Buffer cf. Control	Tread/ Buffer/ Control	Season * zone	Test
INDICATORS OF ABOVE GROUND HEALTH					
vegetation cover (%)	***	NS	-	-	Mann Whitney
bare ground (%)	NS	*	-	NS	ANOVA
root exposure (%)	** (b/c) *** (t/b/c)	NS	NS	-	Mann Whitney & Kruskal Wallis
seedling density	*	NS	-	-	Mann Whitney
canopy cover (%)	NS	-	NS	NS	ANOVA
INDICATORS OF GROUND LEVEL HEALTH					
bare ground (%)	NS	*	-	NS	ANOVA
litter cover (%)	NS	NS	-	NS	ANOVA
organic litter (mm)	NS	NS	-	NS	ANOVA
root exposure (%)	** (b/c) *** (t/b/c)	NS	NS	-	Mann Whitney & Kruskal Wallis
compaction (kgf cm^{-2})	NS	NS	-	NS	ANOVA
erosion	***	NS	-	-	Mann Whitney
woody debris	NS	NS	-	-	Mann Whitney
INDICATORS OF INVERTEBRATE DIVERSITY					
litter cover (%)	NS	NS	-	NS	ANOVA
organic litter (mm)	NS	NS	-	NS	ANOVA
woody debris	NS	NS	-	-	Mann Whitney

* P<0.05, ** P<0.01, *** P<0.001, N.S. = not significant. Note: an ANOVA was used where the assumption of normality and homogeneity of variance were not voided. In other cases, non-parametric Mann Whitney and Kruskal Wallis were used. b/c = buffer, control; t/b/c = tread, buffer, control.

Key Findings

- There were no significant interactions between sampling location and season with any of the indicators.
- Percentage cover of bare ground was the only indicator that varied significantly between the buffer and control.
- Significant change in other indicators was associated with season.
- Percentage root exposure was significantly higher in the dry than the wet season.
- Seedling density was higher in the dry than the wet season.
- Percentage ground vegetation cover was significantly higher in the dry than the wet season.
- Percent erosion was significantly higher in the dry than the wet season.



Above: Dry Season

Figure 12: Mean percentage of cover of seven quantitative factors recorded in the tread, buffer (edge of track) and control (ten metres into the forest) zones along the graded track at Murray Falls (n = 20, one-square-metre quadrats per set).

Below: Wet Season

Management Impacts at Murray Falls

- The first three hundred metres of the track to the top lookout has been recently resurfaced with decomposed granite.
- The border of both the camp and picnic area and the walking track had been sprayed. Grass and seedlings were dead up to a metre from the edge. The ranger was spraying the edge of the camp ground whilst we were monitoring. The border along the section of the track in the dry sclerophyll had died back as a result of the spray. No seedlings were observed in the quadrats bordering the track.

Litter not in quadrat but visible from track:

- Beer can three metres from track (250 metres from start at camp ground).
- Bag of set concrete ten metres in (550 metres along track).
- Yoghurt container (600 metres).
- Bandaid (600 metres along track).
- Beer can metres from track (750 metres from start).

SUMMARY

No commercial tours visit this site, therefore the monitoring undertaken by rangers is the first level of monitoring. At sites where this occurs, the land manager level of monitoring will need to include additional factors, e.g. status of the road and carpark, and status of signage. It would be advisable to have an independent person(s) make an assessment of the site. The importance of the tour operator level of assessment in identifying and triggering an assessment of level of concern and trends in condition is demonstrated in the following examples.

Weeds were identified as a management issue at the tour operator level of assessment and shown to be at the higher level of concern and in need of immediate attention using the Land Manager Proforma. Inappropriate visitor behaviour (use of undesignated tracks) was identified at the tour operator level and shown to increase from low level of concern to intermediate level of concern by the second survey using the Land Manager Proforma. A strong negative trend in vegetation damage was also recorded with the Land Manager Proforma. Evidence of feral animals was identified in the Tour Operator Proforma. The level of concern, discerned from the Land Manager Proforma, was low in the dry season but increased to intermediate between surveys suggesting a negative trend.

The semi-intensive biophysical assessment was able to address how visitation is impacting on the surrounding forest and whether there are negative environmental impacts taking place. For example, measurements demonstrated that exposed mineral soil (bare ground) was greater in the tread than the buffer and control in the camp and picnic areas in both seasons suggesting a negative impact from visitation. This was primarily associated with picnic tables and barbeques. Compaction was also greater in the tread and buffer than the control suggesting the impacts from visitation were encroaching into the forest.

A positive trend in the camp and picnic areas, in line with management intent, was greater vegetative growth, a decrease in leaf litter and bare ground in the tread zone between surveys and little change in these indicators in the buffer and control between seasons.

Differences in seasonal trends between the camp and picnic area and the walking track were associated with wet season management e.g. spraying of border vegetation. Rangers had sprayed the edge of the walking track prior to our wet season survey reducing the vegetation cover and killing the seedlings in the buffer zone. This impact was recorded at the researcher level of monitoring but not at the tour operator or ranger levels. Spraying of the habitat bordering the camp and picnic ground was in progress while we were conducting our wet season sampling and had not yet taken effect.

The greater percentage of bare soil recorded in the buffer compared to the control along the walking track in both seasons is a negative response and suggests either animals using the edge of the track (edge effect), visitors stepping off the tread zone or hydrological effects related to the track and its location. This needs further investigation.

LINKS BETWEEN VISITOR PERCEPTIONS AND MEASURED BIOPHYSICAL IMPACTS

INTRODUCTION

Most studies of visitation and use of sites rely on findings from visitor surveys (questionnaires) and traffic counts to estimate visitor numbers for setting management actions (see Volume 1). In this research project we have taken a holistic approach to sampling by incorporating data on visitor surveys, visitor numbers (traffic counts), observations of peoples behaviours, and biophysical analyses (see reports Bentrupperbäumer and Reser 2002). In this section, we attempt to combine results from visitor surveys with those obtained from biophysical monitoring undertaken during the same period at the same sites.

METHOD

Visitors' perceptions of the status of the soil condition, water quality, presence of weeds, condition of vegetation, wildlife scavenging, deliberate human impacts on infrastructure, and presence or evidence of feral and domestic animals were obtained during a visitor survey conducted at the camp ground or entrance to four study site, i.e. Marrdja Boardwalk, Davies Creek, Henrietta Creek and Murray Falls (see attached for section of survey instrument investigating visitors perceptions of environmental impacts). The modal score of visitors responses (see Bentrupperbäumer and Reser 2002, for raw data) were compared with biophysical scores recorded and reported in this report. Note that a 1-6 point scale was used in the visitor survey, whereas a 1-5 point score was used in the biophysical assessment.

RESULTS

Separate tables comparing perceptions and biophysical measurements have been created for each site (Table 17). A combined table to show responses across sites demonstrates that visitor perceptions of environmental impacts is dependent on site (Table 18).

Table 17: Modal scores of visitor perceptions and biophysical measurements at a) Marrdja Boardwalk; b) Davies Creek; c) Henrietta Creek; and d) Murray Falls in the wet season (April 2002). Key: 1 = low impact to 6 = high impact; ↓ = biophysical measurement less than perceived impact; ↑ = biophysical measurements higher than perceived impact; = agreement between biophysical measurements and perceived impact.

Marrdja Boardwalk	Visitor Perception. Visitor Survey Mode. Scale 1-6	Ranger's Biophysical Measurement. Scale 1-5	Agreement
Soil Condition – evidence of erosion	2	2	=
Water quality – evidence of pollution	2	NA (tidal)	
Presence of weeds	2	2	=
Condition of vegetation (eg. trampling, breakage, ring-barking, fire scars	2	1	↓
Deliberate human impacts on infrastructure – evidence of graffiti, vandalism	1	1	=
Presence or evidence of feral and/or domestic animals, cane toads, pigs or dogs etc.	1	5	↑

Native wildlife behaviour – evidence of scavenging, tameness	2	1	↓
Davies Creek	**Visitor Perception. Visitor Survey Mode. Scale 1-6**	**Ranger's Biophysical Measurement. Scale 1-5**	**Agreement**
Soil Condition – evidence of erosion	3	3,4	↑
Water quality – evidence of pollution	1	1	=
Presence of weeds	4	3	=
Condition of vegetation (eg. trampling, breakage, ring-barking, fire scars	1,4 (bimodal)	3	=
Deliberate human impacts on infrastructure – evidence of graffiti, vandalism	1	3	↑
Presence or evidence of feral and/or domestic animals, cane toads, pigs or dogs etc.	1	1	=
Native wildlife behaviour – evidence of scavenging, tameness	1	1	=
Henrietta Creek	**Visitor Perception. Visitor Survey Mode. Scale 1-6**	**Ranger's Biophysical Measurement. Scale 1-5**	**Agreement**
Soil Condition – evidence of erosion	4	2	↓
Water quality – evidence of pollution	5	2	↓
Presence of weeds	3,4 (bimodal)	5	↑
Condition of vegetation (eg. trampling, breakage, ring-barking, fire scars	3,6 (bimodal)	1	↓
Deliberate human impacts on infrastructure – evidence of graffiti, vandalism	1	3	↑
Presence or evidence of feral and/or domestic animals, cane toads, pigs or dogs etc.	1	1	=
Native wildlife behaviour – evidence of scavenging, tameness	1	1	=
Murray Falls	**Visitor Perception. Visitor Survey Mode. Scale 1-6**	**Ranger's Biophysical Measurement. Scale 1-5**	**Agreement**
Soil Condition – evidence of erosion	1	2	↑
Water quality – evidence of pollution	1	1	=
Presence of weeds	1	5	↑
Condition of vegetation (eg. trampling, breakage, ring-barking, fire scars	1	5	↑
Deliberate human impacts on infrastructure – evidence of graffiti, vandalism	1	2	↑
Presence or evidence of feral and/or domestic animals, cane toads, pigs or dogs etc.	1	3	↑
Native wildlife behaviour – evidence of scavenging, tameness	1	2	↑

Table 18: Comparison of visitor perceptions and biophysical measurements across sites. Key: ↓ = biophysical measurement indicate lower impact than that perceived by visitors; ↑ = biophysical measurements indicate higher impact than perceived by visitors; = agreement between biophysical measurements and visitor perception.

Indicator	Marrdja Boardwalk	Davies Creek	Henrietta Creek	Murray Falls
Soil Condition – evidence of erosion	=	↑	↓	↑
Water quality – evidence of pollution	=	=	↓	=
Presence of weeds	=	=	↑	↑
Condition of vegetation (eg. trampling, breakage, ring-barking, fire scars	↓	=	↓	↑
Deliberate human impacts on infrastructure – evidence of graffiti, vandalism	=	↑	↑	↑
Presence or evidence of feral and/or domestic animals, cane toads, pigs or dogs etc.	↑	=	=	↑
Native wildlife behaviour – evidence of scavenging, tameness	↓	=	=	↑

KEY FINDINGS

- Water quality was the only indicator where there was reasonable agreement across sites between peoples' perceptions and the biophysical assessments.
- Biophysical measures suggest infrastructure damage is higher than that perceived by visitors.
- Weeds and evidence of feral animals are more likely to be higher than peoples' perceptions suggest.
- Soil erosion, vegetation damage and scavenging show no clear trend between peoples' perceptions and biophysical assessments.

DISCUSSION

Several studies conducted on people's perceptions of environmental impacts suggest that they identify more direct impacts of visitation such as litter rather than the biophysical impacts (Manning 1986; Bentrupperbäumer and Reser 2000; Moscardo 1997). However, some research suggests there is a growing awareness amongst visitors of the impacts that they may cause to the environment (Bryden 2001; Hillery *et al.* 2001; Bentrupperbäumer and Reser 2000, 2002). The results of this research suggest that this may depend on the site, e.g. at Davies Creek and Marrdja Boardwalk there was general agreement between results of the visitor survey and estimates from ranger proformas, however, at Henrietta Creek visitors were more likely to overestimate impacts, and at Murray Falls visitors under estimated the biophysical impacts of the majority of indicators.

Murray Falls was until recently under the management of Department of Natural Resources, Mines and Energy. They have maintained the same staff who have a forestry recreation approach to park management. Bins are provided at this site in contrast to the other sites. This and the overall cleanliness of the camp/picnic area may have influenced visitors' perception of environmental impacts occurring at this site.

In this section we have compared visitors perceptions of environmental impacts with environmental assessments made using the ranger proformas developed in this study. Measurements conducted by the researchers need to be converted into a score and compared with those obtained using the ranger proformas. This was not undertaken due to time constraints. However, results indicate that visitors' perceptions of environmental impacts do not identify or accurately reflect levels of environmental impacts undertaken at a more intensive level. Thus management cannot rely on responses from visitor surveys in identifying environmental impacts when setting management actions. This study strongly supports the need for implementing a visitor monitoring system that incorporates biophysical assessments of sites if visitation is to be sustainable.

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APPENDIX A – TOUR OPERATOR PROFORMAS

A1 SUMMARY TRIAL BY RESEARCHERS AT MARRDJA BOARDWALK

TOUR OPERATOR PROFORMA				
Key: Absent = 0; Present = 1		0		1
Key: Three point scale (absent; minimal; extensive). NR = Not Recorded; NA = Not Applicable		0	1	2
	Date	12-Dec-01	11-Jan-02	19-Apr-02
	Time	1145-1430	1050	1050
	Weather	Sunny	Sunny	Sunny
INDICATORS				
Infrastructure	Car park – full?	0	0	0
	No. tour buses <21	3	1	2
	No. tour buses >21	0	0	0
	No. cars	1	2	1
	Access/maintained	0	0	0
	Car park/maintained	1	1	1
	Facilities/maintained	0	0	0
	Facilities/clean	0	0	0
	Hazards minor/major	0	0	0
Animals/Roadkill	Birds	0	0	0
	Reptiles	0	0	0
	Mammals	0	0	0
Animals/Sighted	Feral dog	0	0	0
	Feral pig	0	0	1
	Feral cat	0	0	0
	Feral (other)	0	0	0
Evidence	Pigs	1	1	1
Weeds	Access	1	1	1
	Picnic Area			
Visitor Behaviour/Picnic	Litter	1	1	1
	Vandalism	1	0	0
	Feeding animals	0	0	0
	Scavenging animals	0	0	0
	Inappropriate visitor behaviour	0	0	0
Visitor Behavior/Picnic (cont'd)	Pilfering	0	0	0
	Inappropriate tour operations	0	0	0

Track	Track condition	0	0	0
	Signs condition	0	0	0
	Track hazards	0	1	0
Track/Visitor Behaviour	Litter	1	0	0
	Vandalism	0	0	0
	Inappropriate visitor behaviour	0	0	0
Track/Sightings	Feral dog	0	0	0
	Feral pig	1	1	1
	Feral cat	0	0	0
	Feral (other)	0	0	0
Track/Evidence	Pigs	2	2	2
	Canopy death	NR	NR	NR
	Bracket fungi	0	0	0

A2 SUMMARY OF TRIAL BY THE TOURISM INDUSTRY AT MARRDJA BOARDWALK

(Data collected by same person)

TOUR OPERATOR PROFORMA							
Company: Commercial	Key: Absent = 0; Present = 1		0		1		
Key: Three point scale (Absent = 0; Minimal = 1; Extensive = 3)			0	1	2		
Date	Key: NR = Not Recorded; NA = Not Applicable		21 Jun 2002	28 Jun 2002	12 Jul 2002	19 Jul 2002	25 Jul 2002
		Time	1440	1445	1455	1440	1500
		Weather	2	1	1	2	1
		Survey	1	2	3	4	5
Indicators	**ID**						
Infrastructure	1	Car park/full?	0	0	0	1	0
	2a	No. tour bus <21	4	3	2	0	2
	2b	No. tourbus >21	0	0	0	0	0
	3	No. cars	6	4	7	12	7
	4	Access/maintained	0	0	0	0	0
	5	Car park/maintained	1	1	1	1	1
	6	Facilities/maintained	1	1	NR	0	0
	7	Facilities/clean	0	NR	NR	0	NR
	8	Hazards minor/major	0	0	0	0	1
Animals/roadkill	9a	Birds	0	0	0	0	0
	9b	Reptiles	0	0	0	0	0
	9c	Mammals	0	0	0	0	0
Animals sighted/Access	10a	Feral dog	0	0	0	0	0
	10b	Feral pig	0	0	0	0	0
	10c	Feral cat	0	0	0	0	0
	10d	Feral (other)	0	0	0	0	0
Animals/evidence	11	Pigs	NR	NR	NR	NR	NR
Weeds	12	Access	NR	NR	NR	NR	NR
	13	Picnic Area	NR	NR	NR	NR	NR
Visitor behaviour/picnic	14	Litter	1	1	1	1	1
	15	Vandalism	0	0	0	0	0
	16	Feeding animals	0	0	0	0	0
	17	Scavenging animals	0	0	0	0	0
	18	Inappropriate visitor behaviour	1	0	0	0	0
	19	Pilfering	0	0	0	0	0
	20	Inappropriate tour operations	0	0	0	0	0

Track	21	Track condition	0	0	0	0	0
	22	Signs condition	0	0	0	0	0
	23	Track hazards	0	0	0	0	0
Visitor behaviour/tracks	24	Litter	1	1	0	0	1
	25	Vandalism	0	0	0	0	0
	26	Inappropriate visitor behaviour	0	0	0	1	1
Animals sighted/Tracks	27a	Feral dog	0	0	0	0	0
	27b	Feral pig	0	0	0	0	0
	27c	Feral cat	0	0	0	0	0
	27d	Feral (other)	0	0	0	0	0
Evidence Animals	28	Pigs	NR	NR	NR	NR	NR
Vegetation	29	Canopy death	NR	1	1	1	1
	30	Bracket fungi	NR	0	1	1	1
Water	31	Film	NA	NA	NA	NA	NA
	32	Smell	NA	NA	NA	NA	NA
	33	Litter	NA	NA	NA	NA	NA
	34	Clarity	NA	NA	NA	NA	NA
	35	Flow	NA	NA	NA	NA	NA

A3 SUMMARY OF TRIAL BY RESEARCHERS AT DAVIES CREEK

TOUR OPERATOR PROFORMA				
Key: Absent = 0; Present = 1		0		1
Key: Three point scale (Absent, Minimal, Extensive)		0	1	2
	Date		17/12/01	18/04/02
	Time		1130-1145	1045
	Weather		Overcast	Sunny
INDICATORS				
Infrastructure	Carpark/full?		0	0
	No. tour bus <21		0	0
	No. tourbus >21		0	0
	No. cars		0	0
	Access/condition		1	0
	Carpark/condition		1	1
	Facilities/condition		1	1
	Facilities/cleanliness		0	0
	Hazards		1	1
Animals/roadkill	Birds		0	0
	Reptiles		0	0
	Mammals		0	0
Animals/sighted	Feral dog		0	0
	Feral pig		0	0
	Feral cat		0	0
	Feral (other)		0	0
Weeds	Access		2	2
	Picnic Area		1	2
Visitor behaviour/picnic	Litter		1	2
	Vandalism		1	1
	Feeding animals		0	0
	Scavenging animals		1	0
	Inappropriate visitor behaviour		0	0
	Pilfering		0	0
	Inappropriate tour operations		0	0
Track	Track condition		1	1
	Signs condition		1	1
	Track hazards		1	0
Visitor behaviour/on track	Litter		1	1
	Vandalism		0	1
	Inappropriate visitor behaviour		0	0

Animals/on tracks	Feral dog	0	0
	Feral pig	0	0
	Feral cat	0	0
	Feral (other)	0	0
Animal/ Evidence	Pigs	0	0
Vegetation	Canopy death	0	0
	Bracket fungi	0	0
Water	Film	0	0
	Smell	0	0
	Litter	0	1
	Clarity	0	0
	Flow	3	3

A4 SUMMARY OF TRIAL BY RESEARCHERS AT HENRIETTA CREEK

TOUR OPERATOR PROFORMA				
Key: Absent = 0; Present = 1		0		1
Key: Three point scale (Absent, Minimal, Extensive)		0	1	2
	Date		11/12/01	13/04/02
	Time		1050	0900
	Weather		Sunny	Sun/O'cast
INDICATORS				
Infrastructure	Carpark/full?		0	0
	No. tour bus <21		0	0
	No. tourbus >21		0	0
	No. cars		2	0
	Access/condition		1	1
	Carpark/condition		1	1
	Facilities/condition		0	0
	Facilities/cleanliness		0	0
	Hazards		0	0
Animals/roadkill	Birds		0	0
	Reptiles		0	0
	Mammals		1	0
Animals/sighted	Feral dog		0	0
	Feral pig		0	0
	Feral cat		0	0
	Feral (other)		0	0
Evidence	Pigs		0	0
Weeds	Access		1	2
	Picnic Area		2	2
Visitor behaviour/picnic	Litter		0	0
	Vandalism		0	0
	Feeding animals		0	0
	Scavenging animals		0	0
	Inappropriate visitor behaviour		0	0
	Pilfering		0	0
	Inappropriate tour operations		0	0
Track	Track condition		0	0
	Signs condition		0	0
	Track hazards		1	1

Visitor behaviour/tracks	Litter	0	0
	Vandalism	0	0
	Inappropriate visitor behaviour	0	0
Animals/tracks	Feral dog	0	0
	Feral pig	0	0
	Feral cat	0	0
	Feral (other)	0	0
Evidence	Pig	1	1
Vegetation	Canopy death	0	0
	Bracket fungi	0	0
Water	Film	0	0
	Smell	0	0
	Litter	0	0
	Clarity	0	0
	Flow	2	3

A5 SUMMARY OF TRIAL BY RESEARCHERS AT MURRAY FALLS

TOUR OPERATOR PROFORMA				
Key: Absent = 0; Present = 1		0		1
Key: Three point scale (Absent, Minimal, Extensive)		0	1	2
		Date	6/12/01	8/05/02
		Time	1110	1100
		Weather	Sunny	Sunny
INDICATORS				
Infrastructure	Carpark/full?		0	0
	No. cars		4	8
	Access/maintained		0	1
	Carpark/maintained		0	0
	Facilities/maintained		0	0
	Facilities/clean		0	0
	Hazards minor/major		0	1
Animals/roadkill	Birds		0	0
	Reptiles		0	0
	Mammals		0	0
Animals/sighted	Feral dog		0	0
	Feral pig		0	0
	Feral cat		0	0
	Feral (other)		0	0
Animal /evidence	Pigs		0	2
Weeds	Access		2	2
	Picnic Area		2	2
Visitor behaviour/picnic	Litter		0	0
	Vandalism		0	1
	Feeding animals		0	0
	Scavenging animals		0	1
	Inappropriate visitor behaviour		0	1
	Pilfering		0	0
	Inappropriate tour operations		0	0
Track	Track condition		0	0
	Signs condition		1	1
	Track hazards		0	0
Visitor behaviour/tracks	Litter		0	0
	Vandalism		0	0
	Inappropriate visitorbehaviour		0	1

Animals/tracks	Feral dog	0	0
	Feral pig	0	0
	Feral cat	0	0
	Feral (other)	0	0
Track/Evidence	Pigs	1	1
Vegetation	Canopy death	0	0
	Bracket fungi	0	1
Water	Film	0	0
	Smell	0	0
	Litter	0	1
	Clarity	0	0
	Flow	3	3

APPENDIX B – LAND MANAGER PROFORMAS

B1 RESULTS OF DRY AND WET SEASON TRIALS OF THE LAND MANAGERS PROFORMAS AT MARRDJA BOARDWALK

LAND MANAGER PROFORMA				
SITE	**MARRDJA BOARDWALK**			
DATE	6-Dec-01		19-Apr-02	
WEATHER	Sunny (and overcast)		Sunny	
TIME START	1350		1450	
TIME STOP	1435		1530	
SAMPLING TIME	45 mins		40 mins	
THEME	**Walk**		**Walk**	
SEASON	dry		wet	
	RAW SCORE: 1 = very low impact; to 5 = very high impact		**ACTION SCALE:** 1 = no action required; 2 = watch; 3 = needs attention; 4 = immediate action needed; 5 = being addressed	
SECTION: HUMAN RELATED ACTIVITY				
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**
Undesignated track (s)	1	1	1	1
Track widening (people stepping off track)	2	3	2	3
Mineral soil exposure (due to stepping off track)	1	1	2	1
Exposed roots (people stepping off track and trampling)	1	1	1	1
Litter	1	1	1	1
Sharp foreign objects	1	1	1	1
Fire scars on trees	1	1	1	1

Fires scars from undesignated camp	-	-	-	-
New fire scars - edge	1	1	1	1
Wood pile(s) undesignated clumps	-	-	-	-
Infrastructure damage, e.g. recent vandalism	1	1	1	1
Vegetation damage	1	1	1	1
SECTION: FACTORS RELATED TO HUMAN DISTURBANCE OF WILDLIFE				
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**
Feeding wildlife	1	1	1	1
Birds/animals scavenging	1	1	1	1
Disturbing wildlife	1	1	2	2
Domestic animals	1	1	1	1
SECTION: IMPACTS ON TRACK, AND 2.5 METRES ADJACENT TO TRACK (Management Issues)				
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**
Overhanging hazardous plants on track	1	1	1	1
Hazardous plants (adjacent to track)	2	1	2	1
Potholes/bogs on track	1	1	1	1
Potholes/bogs adjacent to track	2	2	2	2
Mineral soil exposure on track	1	1	1	1
Mineral soil exposure adjacent to track	3	2	3	2
Debris blocking culvert/drains	1	1	1	1
Loose stones on track	1	1	1	1
Track, e.g. rotten tread, railings, seats	3	3	2	3
Gully erosion on track	1	1	1	1
Storm damage on or adjacent to track	1	1	1	1
Road impact, e.g. noise, dust	2	1	2	1
Feral animals	3	4	5	4

SECTION: VEGETATION – 2.5 METRES EITHER SIDE OF TRACK				
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**
Ferns/orchids below four metres	1	1	1	1
Weeds adjacent to track	3	3	2	3
Condition of surrounding plants eg patch death	1	1	1	1
Native seedlings on edge	2	1	1	1
Bracket fungi on live trees	1	1	1	1
SECTION: OTHER WIDLIFE This section tells if animals were present. It is not a good indicator of visitor impact as animal sightings and activity is related to time of day, need to feed, etc.				
Native birds	Obvious/not common		Common	
Reptiles	Not seen		Not seen	
Mammals	Not seen		Very common*	
Comment on unusual activity	None observed		None observed	

B2 RESULTS OF DRY AND WET SEASON TRIALS OF THE LAND MANAGERS PROFORMA AT DAVIES CREEK

LAND MANAGER PROFORMA						
SITE	**DAVIES CREEK**					
DATE	10-Dec-01	18-Apr-02	10-Dec-01	18-Apr-02	10-Dec-01	18-Apr-02
WEATHER	Sunny (and overcast)	Sunny	Sunny (and overcast)		Sunny (and overcast)	Sunny
TIMESTAR	1145		1330	1345	1200	1125
TIMESTOP	1200		1400	1520	1215	1150
SAMPLING TIME	15 mins		30 mins	135 mins	15 mins	25 mins
THEME	**Camp and Picnic**		**Walk**		**Freshwater Feature**	
SEASON	dry	wet	dry	wet	dry	wet
	RAW SCORE: 1 = very low impact; to 5 = very high impact			**ACTION SCALE:** 1 = no action required; 2 = watch; 3 = needs attention; 4 = immediate action needed; 5 = being addressed		

SECTION: HUMAN RELATED ACTIVITY												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Undesignated track (s)	3	2	2	2	3	3	5	5	3	1	3	2
Track widening					2	2	2	2				
Litter	3	3	4	4	2	3	2	3	3	3	3	3
Sharp foreign objects	2	3	3	3	3	3	1	1	5	3	3	4
Fire scars on trees	1	1	1	1	1	1	1	1			2	1
Fires Scars from undesignated camp	5	3	5	3	2	1	2	1	5	3	2	2
New fire scars - trees on edge	1	1	1	1	1	1	1	1	5	3	2	2
Wood pile(s) undesignated clumps	3	2	2	2	1	1	1	1	1	1	1	1

Infrastructure damage, e.g. recent vandalism	2	3	3	2	2	3	2	3	-	-	-	-
Vegetation damage	5	3	3	3	1	1	2	2	4	3	3	3
SECTION: FACTORS RELATED TO HUMAN DISTURBANCE OF WILDLIFE												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Feeding wildlife	1	1	1	1	1	1	1	1	1	1	1	1
Birds/animals scavenging	1	1	1	1	1	1	1	1	1	1	1	1
Disturbing wildlife	1	1	1	1	1	1	1	1	1	1	1	1
Domestic animals	2	3	1	1	1	1	1	1	1	1	1	1
SECTION: MANAGEMENT ISSUES (Walking track refers to impacts on the track)												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Hazardous plants (overhanging track)	1	1	1	1	1	1	1	1	1	1	1	1
Weeds (water proforma refers to weeds on bank)	4	3	3	3	4	3	4	3	4	2	5	2
Exposed roots	5	2	2		3	2	5	3	-	-	-	-
Potholes/bogs	2	1	5	3.5	2	1	1	1	-	-	-	-
Mineral soil exposure	2	1	3	1	2	1	2	2	-	-	-	-
Gully erosion	3	2	4	2	5	3	5	3	-	-	-	-
Storm damage	1	1	1	1	1	1	2	1	1	1	1	1
Road damage/carpark	4	3	4	3	1	1	1		1	1	1	1
Feral animals	1	1	1	1	1	1	2	1	1	1	1	1
SECTION: CONDITION OF VEGETATION												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Condition of surrounding plants, e.g. patch death	1	1	1	1	1	1	2	1	-	-	2	2

Native seedlings on edge	3	1	1	1	common	1	common	1	-	-	2	2
Bracket fungi on live trees	1	1	1	1	1	1	1	1	1	1	1	1
SECTION: MANAGEMENT ISSUES RELATED TO WALKING TRACKS												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Debris blocking culvert/drains					1	1	1	1				
Loose stones on track					2	1	1	1				
Track structure					2	2	3	2				
Road impacts near track					1	1	1	1				
SECTION: WATER QUALITY												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Surface film									2	2	1	1
Water clarity/settling									1	1	1	1
Water odour									1	1	1	1
SECTION: WATER SYSTEM – BANK AND VEGETATION												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Bank erosion									1	1	1	1
Water weeds									1	1	1	1
Loose slippery stones									1	1	2	2
SECTION: OTHER WILDLIFE **To make a meaningful assessment, twenty minute observations need to be conducted during the period of greatest bird, mammal and reptile activity. This was not conducted during these surveys due to time constraints.**												
Native birds	common				sparse		sparse		sparse		common	
Reptiles	None observed				sparse		sparse		Not common		None observed	

Mammals	None observed				None observed		None observed		None observed		None observed	
Native water-fauna									3	1	1	1
Comment on unusual activity	None observed		None observed		None observed		None observed		None observed		None observed	

B3 RESULTS OF DRY AND WET SEASON TRIALS OF THE LAND MANAGERS PROFORMA AT HENRIETTA CREEK

LAND MANAGER PROFORMA												
SITE	**HENRIETTA FALLS**											
DATE	11-Dec-01		13-Apr-02		11-Dec-01		13-Apr-02		11-Dec-01		13-Apr-02	
WEATHER	Sunny		Sunny (and overcast)		Sunny (and overcast)		Sunny (and overcast)		Overcast		Sunny (and overcast)	
TIME START	1210		1600		1330		1645		1540		1510	
TIME STOP	1320				1400				1545		1720	
SAMPLING TIME	70mins				30 mins				5 mins		130 mins	
THEME	Camp and Picnic		Camp and Picnic		Walk		Walk		Water feature (creek, river, waterfall)			
SEASON	dry		wet		dry		wet		dry		wet	
	RAW SCORE: 1 = very low impact; to 5 = very high impact						**ACTION SCALE:** 1 = no action required; 2 = watch; 3 = needs attention; 4 = immediate action needed; 5 = being addressed					
SECTION: HUMAN RELATED ACTIVITY												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Undesignated track (s)	2	2	2	2	1	1	1	1	1	1	2	2
Track widening					1	1	1	1				
Litter	2	2	2	3	1	1	1	1	1	1	1	1
Sharp foreign objects	1	1	3	3	1	1	1	1	1	1	1	1
Fire scars on trees	1	1	1	1	1	1	1	1	1	1	1	1
Fires scars from undesignated camp	2	2	1	1	1	1	1	1	1	1	1	1
New fire scars - edge	1	1	1	1	1	1	1	1	1	1	1	1
Wood pile(s) undesignated clumps	1	1	1	1	1	1	1	1	1	1	1	1

Infrastructure damage, e.g.new vandalism	1	1	3	3	1	1	1	1	1	1	1	1
Vegetation damage	1	1	1	1	1	1	1	1	1	1	1	1
SECTION: FACTORS RELATED TO HUMAN DISTURBANCE OF WILDLIFE												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Feeding wildlife	1	1	1	1	1	1	1	1	1	1	1	1
Birds/animals scavenging	1	1	1	1	1	1	1	1	1	1	1	1
Disturbing wildlife	1	1	1	1	1	1	1	1	1	1	1	1
Domestic animals	1	1	1	1	1	1	1	1	1	1	1	1
SECTION: MANAGEMENT ISSUES												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Hazardous plants (overhanging track)	1	1	1	1	1		2	3	1	1	1	1
Weeds. (water proforma refers to weeds on bank)	4	4	5	4	3	3	4	3	4	3	5	3
Exposed roots	2	2	1	1	1	1	1	1	1	1	1	1
Potholes/bogs	2	2	4	3	1	1	1	1	1	1	1	1
Mineral soil exposure	2	2	2	2	1	1	1	1	1	1	1	1
Gully/surface erosion	1	1	1	1	1	1	4	3	1	1	1	1
Storm damage	1	1	1	1	1	1	4	4	1	1	1	1
Road damage/carpark	2	2	3	3								
Feral animals	1	1	1	1	3	2	3	2	1	1	1	1
Road impacts , e.g. noise and dust	2	1	3	1	1	1	1	1	2	2	2	2

SECTION: VEGETATION												
	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale
Condition of surrounding plants	2	2	1	1	1		2	1	1	1	1	1
Native seedlings on edge			3	3	1	1	2	1				
Bracket fungi on live trees			1	1	2		2	1	1	1	1	1
SECTION: MANAGEMENT ISSUES SPECIFIC TO WALKING TRACKS												
	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale
Debris blocking culvert/drains					3	3	3	3				
Loose stones on track					2	2	4	3				
Track structure					2	2	4	3				
SECTION: WATER QUALITY												
	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale
Surface film									1	1	1	1
Water clarity/settling									1	1	2	1
Water odour									1	1	1	1
SECTION: WATER SYSTEM – BANK AND VEGETATION												
	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale	Raw Score	Action Scale
Bank erosion									2	2	2	2
Water weeds									1	1	1	1
Loose slippery stones									1	1	3	2

B4 RESULTS OF DRY AND WET SEASON TRIALS OF THE LAND MANAGERS PROFORMA AT MURRAY FALLS

LAND MANAGER PROFORMA												
SITE	**MURRAY FALLS**											
DATE	6-Dec-01		9-May-02		6-Dec-01		9-May-02		6-Dec-01		9-May-02	
WEATHER	Sunny		Sunny (and overcast)		Sunny (and overcast)		Sunny		Overcast		Overcast	
TIME START	1235		1640		1350		1000		1340		1525	
TIME STOP	1310				1435				1400		1545	
SAMPLING TIME	35 mins				45 mins				20 mins		20 mins	
THEME	Camp and Picnic		Camp and Picnic		Walk		Walk		Water feature (river)			
SEASON	dry		wet		dry		wet		dry		wet	
[redacted]	**RAW SCORE:** 1 = very low impact; to 5 = very high impact						**ACTION SCALE:** 1 = no action required; 2 = watch; 3 = needs attention; 4 = immediate action needed; 5 = being addressed					
SECTION: HUMAN RELATED ACTIVITY												
[redacted]	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Undesignated track (s)	2	2	3	5	2	5	3	5	2	2	3	2
Track widening					1	1	1	1				
Litter	1	1	2	2	1	1	3	3	2	3	2	3
Sharp foreign objects	1	1	2	3	1	1	1	1	1	1	1	1
Fire scars on trees on edge	1	1	1	1	1	1	1	1	5	3	4	2
Fires scars from undesignated camp	1	1	1	1	1	1	1	1	2	3	2	3
Wood pile(s) undesignated clumps	1	1	1	1					1	1	1	1

Infrastructure damage, e.g. recent vandalism	-	-	2	1	1	1	2	1	-	-	-	-
Vegetation damage	2	1	5	3	1	1	1	1	2	1	4	2
SECTION: FACTORS RELATED TO HUMAN DISTURBANCE OF WILDLIFE												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Feeding wildlife	1	1	1	1		1	1	1	1	1	1	1
Birds/animals scavenging	1	1	2	2		1	1	1	1	1	3	1
Disturbing wildlife	1	1	1	1		1	1	1	1	1	1	1
Domestic animals	1	1	1	1		1	1	1	1	1	1	1
SECTION: MANAGEMENT ISSUES												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Hazardous plants (overhanging track)	1	1	2	1	1	1	1	1	1	1	1	1
Weeds (water proforma refers to weeds on bank)	4	4	5	3	3	3	3	4	4	4	3	4
Exposed roots	2	2	2	3	2	1	4	5	3	2	3	2
Potholes/bogs	1	1	1	1	1	1	1	1	1	1	1	1
Mineral soil exposure	2	1	2	1	3	3	1	1	-	-	-	-
Gully erosion/surface erosion	1	1	1	1	2	2	1	5	2	2	2	2
Storm damage	1	1	1	1	1	1	1	1	2	1	2	1
Road damage/carpark	1	1	1	1	1	1	1	1	1	1	1	1
Feral animals	1	1	3	2	1	1	1	1	1	1	1	1
SECTION: CONDITION OF VEGETATION												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Condition of surrounding plants, e.g. patch death	1	1	1	1	1	1	2	2	1	1	1	1

Native seedlings on edge	common	1	common	1	common	1	common	1	common	1	common	1
Bracket fungi on live trees	1	1	1	1	1	1	3	2	1	1	1	1
SECTION: MANAGEMENT ISSUES SPECIFIC TO WALKING TRACKS												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Debris blocking culvert/drains					2	1	1	4				
Loose stones on track					4	3	1	4				
Track structure					2	1	1	1				
Road impacts near track					1	1	1	1				
SECTION: WATER QUALITY												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Surface film									1	1	1	1
Water clarity/settling									1	1	1	1
Water odour									1	1	2	1
SECTION: WATER SYSTEM – BANK AND VEGETATION												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Bank erosion									2		2	1
Water weeds									1	1	1	1
Loose slippery rocks									1	1	2	1
SECTION: OTHER WILDLIFE **To make a meaningful assessment, twenty minute observations need to be conducted during the period of greatest bird, mammal and reptile activity. This was not conducted during these surveys due to time constraints.**												
	Raw Score	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**	**Raw Score**	**Action Scale**
Native birds	1		2		4		4		-		-	

Reptiles	1		1		2		2		-		-	
Mammals	1		1		1		1		1		1	
Native water-fauna									2		2	

APPENDIX C – BIOPHYSICAL MEASUREMENTS

C1 MEASUREMENTS AT MARRDJA BOARDWALK

A. Dry season: Mean (±SE) and range for biophysical variables measured along the walking track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
% Bare ground	-	-	-	-	30.70	6.95	0-98.00	18	21.10	6.38	0-85.00	15
% Ground vegetation cover	-	-	-	-	11.65	4.84	0-90.00	11	12.90	5.46	0-99.00	12
% Litter cover	0.60	0.32	0-5	5	48.08	6.87	0-98.00	19	44.63	5.75	1-80	20
% Root cover	0.00	0.00	0	0	0.90	0.35	0-5.00	9	7.30	2.44	0-35.00	16
% Rock cover	0.00	0.00	0	0	0.10	0.07	0-1.00	1	1.10	1.00	0-20.00	3
% Ground fungi cover	0.00	0.00	0	0	0.03	0.03	0-0.50	1	0.53	0.26	0-5.00	5
% Wood debris cover	0.00	0.00	0	0	6.10	3.92	0-75.00	13	11.53	4.92	0-95.00	16
Erosion scale	0.00	0.00	0	0	0.60	0.23	0-3.00	6	0.35	0.17	2.00	4
% Erosion	0.00	0.00	0	0	7.50	2.84	0-40.00	6	6.00	2.94	40.00	4
Compaction	4.50	0.00	0	0	0.41	0.11	0-1.80	13	0.46	0.09	1.50	15
Litter depth (cm)	0.00	0.00	0	0	30.30	4.82	0-61.00	20	36.80	4.13	2-70.00	20
% Canopy cover	78.85	4.15	40-99	100	81.80	3.52	44-99.00	20	83.00	5.67	98.00	19
Seedling density	0.00	0.00	0	0	13.10	5.54	0-104.00	13	12.05	3.94	63.00	17
Slope	0.00	0.00	0	0	0.00	0.00	0.00	0	0.20	0.14	2.00	2
Weed/grass	-	-	-	-	-	-	-	-	-	-	-	-
Epiphyte	-	-	-	-	-	-	-	-	-	-	-	-

B. Wet season: Mean (±SE) and range for biophysical variables measured along the walking track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
% Bare ground	-	-	-	-	22.10	5.89	85.00	15	10.50	3.99	60.00	12
% Ground vegetation cover	0	0	0	0	12.20	6.17	99.00	5	9.50	3.93	65.00	9
% Litter cover	0.28	0.12	2.00	5	61.35	7.61	99.00	20	66.05	6.94	100.00	19
% Root cover	0.00	0.00	0.00	0	0.70	0.30	5.00	6	4.65	1.70	25.00	12
% Rock cover	0.00	0.00	0.00	0	0.08	0.05	1.00	2	0.60	0.31	5.00	4
% Ground fungi cover	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.05	0.05	1.00	1
% Wood debris cover	0.00	0.00	0.00	0	3.60	1.82	35.00	12	8.50	2.69	50.00	16
Erosion scale	0.00	0.00	0.00	0	0.55	0.28	4.00	4	0.20	0.20	4.00	1
% Erosion	0.00	0.00	0.00	0	8.60	4.65	60.00	4	2.00	2.00	40.00	1
Compaction	-	-	-	-	0.20	0.06	0.88	10	0.28	0.16	3.25	13
Litter depth (cm)	0.00	0.00	0.00	0	31.19	2.33	41.25	20	26.19	2.50	47.50	19
% Canopy cover	76.75	6.42	99.00	19	82.40	5.66	75.00	20	84.35	4.36	59.00	20
Seedling density	0.00	0.00	0.00	0	10.30	4.09	77.00	14	13.75	3.09	48.00	20
Slope	0	0	0	0	1.60	0.87	15.00	7	0.80	0.35	5.00	6
Weed/grass	0	0	0	0	-	-	-	8	0.30	0.11	1.00	6
Epiphyte	-	-	-	-	-	-	-	9	0.80	0.09	1.00	16

C2 MEASUREMENTS AT DAVIES CREEK CAMP AND PICNIC AREA

Percentage vegetation cover, canopy cover, bare soil, litter cover were measured in one-square-metre quadrats. Compaction was measured with a penetrometer. Litter depth (mm). Three measurements were taken in each zone and the mean is reported.

dry	Impact	1.00	1.70	5.00	13.00	12.00	5.00	0.00	1.20
dry	Buffer	1.00	10.00	20.00	12.00	78.00	8.00	0.00	3.10
dry	Control	1.00	50.00	12.00	5.70	44.30	16.00	0.70	0.00
dry	Impact	2.00	0.00	18.00	43.00	11.00	0.70	0.00	3.40
dry	Buffer	2.00	3.00	12.00	11.00	67.00	10.00	0.00	0.30
dry	Control	2.00	50.00	12.00	5.70	44.30	16.00	0.70	0.00
dry	Impact	3.00	13.00	0.00	0.00	21.70	0.70	0.00	0.60
dry	Buffer	3.00	6.70	1.70	5.00	28.00	12.00	0.00	0.70
dry	Control	3.00	48.00	1.70	2.70	49.70	1.20	0.00	0.40
dry	Impact	4.00	0.00	31.70	83.00	16.70	0.17	0.00	0.42
dry	Buffer	4.00	26.70	38.30	10.00	60.00	1.70	0.00	0.27
dry	Control	4.00	48.00	1.70	2.70	49.70	1.20	0.00	0.40
wet	Impact	1.00	17.00	8.33	83.00	0.00	0.00	0.00	2.71
wet	Buffer	1.00	16.00	25.00	47.33	36.67	14.33	0.33	1.11
wet	Control	1.00	37.00	13.33	46.00	13.67	18.33	1.00	1.23
wet	Impact	2.00	0.00	6.67	100.00	0.00	0.00	0.00	4.08
wet	Buffer	2.00	51.00	40.00	35.00	14.00	4.58	0.00	2.81
wet	Control	2.00	33.33	25.00	10.00	56.67	60.83	0.33	0.38
wet	Impact	3.00	19.00	23.33	71.67	0.00	0.00	0.00	3.06
wet	Buffer	3.00	11.67	6.00	31.67	56.67	8.35	0.00	2.56
wet	Control	3.00	61.67	0.00	5.67	32.67	49.60	1.00	0.44
wet	Impact	4.00	1.00	16.67	99.33	0.00	0.00	0.00	2.90
wet	Buffer	4.00	20.67	2.33	42.67	36.67	11.10	0.00	1.11
wet	Control	4.00	60.00	8.33	5.00	33.33	25.83	0.00	0.00
wet	Impact	5.00	0.00	15.00	50.00	16.67	4.17	0.00	4.42
wet	Buffer	5.00	17.33	21.67	10.00	76.00	20.87	0.00	6.02
wet	Control	5.00	48.00	11.67	16.67	34.08	38.65	0.58	0.51

C3 MEASUREMENTS AT DAVIES CREEK WALKING TRACK

A. Dry season: Mean, SE, range and number of quadrats indicators were recorded along the track, buffer and control sections of the Davies Creek Walking Track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
%Bare ground	13.3	4.20	1-70	19	6.43	3.14	0.5-50	11	0.5625	0.34	0.25-5	4
%Ground vegetation cover	0	0.00	0	0			0	0				0
%Litter cover	27.75	6.03	2-80	19	54.08	6.01	5-94	20	50.9	5.45	15-90	19
%Root cover	0.575	0.26	0.5-5	8	0.65	0.35	1-5	4	0.7	0.51	2-10	3
%Rock cover	8.625	4.37	0.5-80	9	10.75	4.60	1-85	11	14	5.96	5-100	8
%Ground fungi cover	0	0.00	0	0	0.00	0.00	0	0	0	0.00	0	0
%Wood debris cover	0.3	0.12	0.5-2	6	2.70	1.32	0.5-25	11	4.625	1.38	0.5-25	15
Erosion Scale												
%Erosion	4.5	2.61	5-50	6	6.00	2.28	5-30	9	0.5	0.34	5	2
Compaction	3.969	0.16	2.75-4.5	20	1.23	0.25	0.25-4.5	18	0.7075	0.24	0.25-4.5	13
Litter depth (cm)	6.4125	1.84	0.25-30	20	25.05	2.04	10-40	20	26.5	3.23	5-60	19
%Canopy cover	38.95	6.67	2-90	19	39.25	7.53	5-90	16	33.9	7.26	10-100	17
Seedling density	0	0.00	0	0	1.30	0.44	1-7	9	0.75	0.24	1-3	6
Slope	1.1		1-5	6	7.40	2.62	2-35	15	6.2	1.43	2-25	16
weed/grass	7.4			2	23.26	5.45	1-75	18	25.15	5.05	10-75	15
Epiphytes				0				4				0

B. Wet season: Mean, SE, range and number of quadrats indicators recorded in track, buffer and control sections of the Davies Creek Walking Track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
				n=20				n=20				n=20
%Bare ground	20.2	4.43	4-65	19	6.7	2.3	2-40	13	2.9	0.1	1-15	8
% Ground vegetation cover				0	11.9	6	2-85	8	2.8	1.38	20-25	6
%Litter cover	18.95	4.45	1-70	17	63.8	5.62	5-95	20	76.2	6.34	20-100	20
%Root cover	0.8	0.41	1-5	4	0.55	0.5	1-10	2	0	0	0	0
%Rock cover	1	1	20	1	13.95	3.1	2-45	14	16.55	6.2	2-100	12
%Ground fungi cover	0	0	0	0	0	0	0	0	0	0	0	0
%Wood debris cover	0.1	0.1	2	1	2.7	1.21	1-20	9	1.8	0.5	1-5	11
Erosion Scale												
%Erosion	6.5	2.18	5-30	6	3.5	1.63	5-20	5	0.75	0.55	5-10	2
Compaction	3.07	0.24	1.44-4.5	20	0.897	0.1	0.05-1.88	20	0.935	0.28	0-4.5	17
Litter depth (cm)	5.31	0.98	1.25-15	16	40.0625	4.81	8.75-85	20	55.125	6.45	20-100	20
%Canopy cover	11.5	3.28	1-50	16	11.5	3.5	5-60	16	18.35	4.47	2-70	18
Seedling density	0.15	0.11	1-2	2	0.85	0.3	1-4	7	1.2	0.38	1-5	10
Slope	0.8	0.35	1-5		8.1	2.55	2-45	15	10.15	2.18	1-35	17
weed/grass				15				9				10
Epiphytes				0				11				9

C4 MEASUREMENTS AT HENRIETTA CREEK CAMP AND PICNIC NODES

Percentage vegetation cover, canopy cover, bare soil, litter cover were measured in one-square-metre quadrats. Compaction was measured with a penetrometer. Litter depth (mm). Three measurements were taken in each zone and the mean is reported.

Henrietta	dry	Impact	1.00	0.00	69.30	16.70	83.30	13.30	1.70	0.00
Henrietta	dry	Buffer	1.00	15.00	55.00	1.50	83.50	16.00	5.00	0.17
Henrietta	dry	Control	1.00	28.30	94.30	0.70	71.00	17.30	2.30	0.30
Henrietta	dry	Impact	2.00	0.00	61.70	23.70	49.30	5.70	0.00	3.90
Henrietta	dry	Buffer	2.00	31.70	78.30	1.00	67.30	21.70	8.30	0.90
Henrietta	dry	Control	2.00	11.00	71.70	5.00	83.30	20.00	4.70	0.30
Henrietta	dry	Impact	3.00	59.00	0.00	41.00	0.00	0.00	0.00	3.30
Henrietta	dry	Buffer	3.00	45.00	81.70	1.70	53.30	19.00	1.70	0.50
Henrietta	dry	Control	3.00	1.70	97.00	5.00	93.00	19.00	1.30	.00
Henrietta	dry	Impact	4.00	81.70	28.30	1.70	0.00	0.00	0.00	1.80
Henrietta	dry	Buffer	4.00	45.00	81.70	1.70	53.30	19.00	1.70	0.50
Henrietta	dry	Control	4.00	1.70	97.00	5.00	93.00	19.00	1.30	0.00
Henrietta	dry	Impact	5.00	0.30	93.00	14.30	85.30	15.00	0.00	0.85
Henrietta	dry	Buffer	5.00	17.00	92.30	0.70	82.70	43.30	4.30	0.20
Henrietta	dry	Control	5.00	28.30	94.30	0.70	71.00	17.30	2.30	0.30
Henrietta	wet	Impact	1.00	0.00	55.00	3.33	96.67	11.67	0.00	0.79
Henrietta	wet	Buffer	1.00	43.33	68.33	0.00	56.67	40.00	8.33	0.02
Henrietta	wet	Control	1.00	6.67	95.33	10.00	83.33	30.00	1.00	0.13
Henrietta	wet	Impact	2.00	0.17	43.33	88.33	11.67	3.92	0.00	3.60
Henrietta	wet	Buffer	2.00	60.00	98.33	6.67	33.33	28.25	2.00	0.21
Henrietta	wet	Control	2.00	1.67	96.00	4.67	93.67	27.08	0.33	0.15
Henrietta	wet	Impact	3.00	97.00	78.33	3.00	0.00	0.00	0.00	2.23
Henrietta	wet	Buffer	3.00	55.00	88.00	0.00	45.00	19.58	2.33	0.17
Henrietta	wet	Control	3.00	13.33	92.67	7.00	79.67	45.83	13.67	0.00
Henrietta	wet	Impact	4.00	100.00	0.00	0.00	0.00	0.00	0.00	0.77
Henrietta	wet	Buffer	4.00	66.67	65.00	0.00	51.67	21.58	0.00	0.00
Henrietta	wet	Control	4.00	2.00	75.00	20.00	78.00	6.67	2.33	0.00
Henrietta	wet	Impact	5.00	0.00	95.67	0.00	100.00	14.17	.33	0.52
Henrietta	wet	Buffer	5.00	20.67	88.00	0.00	79.33	25.42	3.00	0.13
Henrietta	wet	Control	5.00	5.67	98.00	1.67	93.33	35.83	6.67	0.06

C5 MEASUREMENTS ALONG NANDROYA WALKING TRACK

A. Dry season: Mean (±SE), and range for biophysical variables measured during the dry season in five camp and picnic areas.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
% Bare ground	2.63	1.23	5-20	5	16.65	4.03	1-60	17	14.13	4.09	2-60	15
% Ground vegetation cover												0
% Litter cover	55.65	7.46	1-100	20	37.53	5.62	10-89	17	53.10	6.07	5-92	19
% Root cover				0	3.15	1.21	1-20	8	7.78	2.89	1-50	12
% Rock cover	27.20	6.84	5-84	14	12.38	5.38	0.5-100	9	10.00	4.66	2-90	9
% Ground fungi cover	0.05	0.05	0-1	1	0.05	0.05	0-1	1	0.05	0.05	0-1	1
% Wood debris cover	3.15	2.99	1-60	3	2.05	0.73	1-10	9	7.83	4.16	0.5-80	14
Erosion scale					1.50	0.41	2-5	9	0.40	0.18	1-3	5
% Erosion					13.50	3.93	10-50	9	3.50	1.71	5-30	5
Compaction	4.23	0.25	1-4.75	20	1.17	0.19	0.3-2.6	16	0.82	0.25	0.3-4.5	13
Litter depth (cm)	6.40	2.02	2-30	11	17.70	3.22	5-50	16	28.35	3.20	11-70	19
% Canopy cover	88.90	2.50	55-99	20	83.15	3.22	50-99	20	87.70	4.06	25-99	20
Seedling density	0.05	0.05	0-1	1	5.15	1.54	1-19	15	5.05	1.90	1-36	13
Slope	0.90	0.30	0-50	8	31.50	7.77	2-90	16	21.05	4.93	2-70	17
Weed/grass				0	27.75	5.54	2-98	18	8.18	2.38	0.5-40	18
Epiphyte	0	0	0	0	0	0	0	0	0	0	0	0

B. Wet season: Mean (±SE), and range for biophysical variables measured during the wet season in five camp and picnic areas.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
% Bare ground	26.6	7.85	1-90	17	20.50	4.48	1-60	18	4.26	15.70	1-73	18
% Ground vegetation cover			0	0	12.55	4.31	2-60	11	2.38	7.40	2-30	10
% Litter cover	57.9	7.50	7-100	20	46.15	6.82	2-99	20	6.08	54.15	2-99	20
% Root cover	0	0	0	0	7.00	3.96	1-80	11	1.19	4.85	1-15	15
% Rock cover	12.7	4.82	1-65	12	11.60	5.67	1-98	11	6.52	13.68	1-92	18
% Ground fungi cover	0	0	0	0	0	0	0	0	0	0	0	0
% Wood debris cover	1.3	0.50	1-10	11	2.65	0.76	1-15	15	1.18	5.35	1-15	17
Erosion scale	0.6	0.15	1-2	10	0.90	0.18	1-3	14	0.14	0.75	1-2	13
% Erosion	2.25	2.00	5-40	2	5.75	1.59	10-20	9	2.30	5.75	5-40	7
Compaction	2.16	0.28	0.20-4.50	19	0.46	0.11	0.05-1.75	16	0.06	0.24	0.05-0.90	13
Litter depth (cm)	19.03	1.85	4.5-37.5	20	41.19	3.55	15-80	20	6.10	58.11	25-137.5	20
% Canopy cover	77.55	4.85	20-100	20	76.95	5.89	15-99	20	3.83	83.90	40-98	20
Seedling density	0.2	0.20	1-4	1	5.25	1.39	1-20	16	2.24	5.70	1-44	15
Slope	0.85	0.32	1-5	7	25.35	7.94	1-85	18	5.70	23.75	2-70	15
Weed/grass	0.17	0.11		2	0.25	0.13		3	0.08	0.08		1
Epiphyte	0	0		0	0.20	0.09		4	0.11	0.60		12

C6 MEASUREMENTS AT MURRRAY FALLS CAMP AND PICNIC AREA

A. Dry season: Mean (±SE), and range for biophysical variables measured during the dry season in eight camp and picnic areas.

INDICATOR	Tread			Buffer			Control		
	Mean	Standard Error of Mean	Range	Mean	Standard Error of Mean	Range	Mean	Standard Error of Mean	Range
% Bare ground	16.93	7.78	0 - 64	3.35	1.13	0-9	4.44	1.5545	0.7-11
% Ground vegetation cover	46.31	8.9343	1.8 -75.5	23.10	6.90	3.5-57.7	17.00	4.88	1.8-33.3
% Litter cover	33.76	5.43	39.70	78.53	7.65	42.3-99.3	76.99	4.28	66-93.3
Compaction	2.61	0.41	3.30	0.61	0.10	0.3-1.2	0.22	7.035E-02	0-0.5
Litter depth (mm)	9.39	1.69	11.70	30.51	1.79	20-36.7	45.8	4.37	28.3-56.7
% Canopy cover	34.79	8.03	76.70	55.82	7.66	5.3-71.7	71.88	3.82	46.7-83.3
Seedling density	0	0	0	1.60	0.6071	0-5	2.63	0.67	0.7-5.7

B. Wet season: Mean (±SE), and range for biophysical variables measured during the wet season in eight camp/picnic areas.

INDICATOR	Tread			Buffer			Control		
	Mean	Standard Error of Mean	Range	Mean	Standard Error of Mean	Range	Mean	Standard Error of Mean	Range
% Bare ground	12.5	4.55	39.34	7.67	2.78	21.67	8.88	3.18	26.00
% Ground vegetation cover	70.79	5.51	43.33	27.58	6.16	46.66	23.33	10.18	79.33
% Litter cover	17.87	4.08	35.33	88.08	3.03	22.00	88.75	4.11	27.00
Compaction	2.27	0.51	4.39	0.51	9.3E-02		0.3125	9.6E-02	0.75
Litter depth (mm)	6.96	0.5	3.92	33.28	3.59	27.92	39.74	3.49	34.59
% Canopy cover	48.33	6.3	60	72.50	1.75	13.33	70.83	6.56	58.33
Seedling density	0	0	0	0.79	0.2881	2.33	4.13	1.49	10.67
HTGRASS	46.88	5.87	45	227.00	63.15	450.00	398.75	93.45	663.33
HTBROAD	27.71	3.64	26.66	335.42	66.65	506.66	23.33	17.49	143.33
HTWOODY	1.25	1.25	10	168.33	56.87	476.67	435.62	97.84	696.67

C7 MEASUREMENTS AT MURRAY FALLS WALKING TRACK

A. Dry season: Mean, SE, range and number of quadrats in which indicators were recorded in the track, buffer and control sections of the Murray Falls Walking Track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
% Bare ground	31.08	6.90	1-95	19	14.85	4.13	1-60	17	6.65	2.89	1-55	12
% Ground vegetation cover	1.53	1.33	1-20	3	18.60	4.65	1-50	14	32.60	8.78	4-100	14
% Litter cover	60.93	6.39	15-95	19	54.85	6.60	5-100	20	64.15	7.69	5-100	19
% Root cover	2.93	1.02	0.5-15	11	1.14	0.54	25-100	9	3.20	1.14	1-15	9
% Rock cover	4.86	2.58	0.25-50	11	23.00	5.54	5-80	12	9.20	3.39	2-50	9
% Ground fungi cover				0	0.10	0.10	1-2	1	0.10	0.10	1-2	1
% Wood debris cover	0.19	0.08	0.25-1	5	4.63	3.46	0.5-70	12	6.31	2.91	0.25-50	11
Erosion scale	0.25	0.10	0-1	5	0.45	0.18	1-3	6	0.10	0.07	0-1	2
% Erosion	1.80	1.10	1-20	4	6.10	3.02	1-50	6	1.30	1.02	1-20	3
Compaction	2.50	0.26	1-4.5	20	0.89	0.29	0.2-4.5	16	0.70	0.30	0.2-4.5	12
Litter depth (cm)	15.98	2.11	0.5-40	20	38.75	4.35	10-90	20	41.70	6.23	10-110	20
% Canopy cover	74.50	5.90	20-100	20	76.20	5.49	20-98	20	72.80	6.04	40-98	19
Seedling density	0.40	0.17	1-2	5	16.40	4.51	1-55	16	34.80	9.17	1-140	15
Slope	1.18	0.40	0.5-5	10	19.64	7.71	1-85	18	13.55	3.41	2-45	17
Weed/grass												
Epiphyte												

B. Wet season: Mean, SE, range and number of quadrats in which indicators were recorded in the track, buffer and control sections of the Murray Falls Walking Track.

INDICATOR	Tread				Buffer				Control			
	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present	Mean	Standard Error of Mean	Range	No. of Quad. Present
				n=20				n=20				n=20
% Bare ground	12.6	3.75	1-50	11	12.65	4.57	2-70	14	7.50	7.50	5-60	9
% Ground vegetation cover	0			0	2.75	2.50	5-50	2	1.25	1.25	5-20	2
% Litter cover	29.15	5.86	5-83	18	64.45	7.73	10-100	19	72.25	72.25	25-100	19
% Root cover	0.15	0.11	1-2	2	0.35	0.26	2-5	2	1.75	1.75	5-20	3
% Rock cover	6.35	4.13	2-75	5	7.00	4.59	10-80	3	6.25	6.25	50-75	2
% Ground fungi cover	0			0				0				0
% Wood debris cover	0			0	4.05	2.63	1-50	5	4.75	4.75	1-50	9
Erosion scale				0				0				0
% Erosion				0				0				0
Compaction	3.96	0.14	2.44-4.50	20	0.90	0.22	0.13-4.50	20	0.84	0.84	0.06-4.50	18
Litter depth (cm)	8.21	1.74	0.50-26.25	18	41.19	3.55	15-80	20	68.61	68.61	15-330	20
% Canopy cover	72.25	4.14	25-95	20	72.25	4.85	25-95	20	72.65	72.65	10-98	20
Seedling density	0.15	0.11	1-2	2	10.25	3.13	1-51	13	5.50	5.50	1-15	16
Slope	0.85	0.22	1-2	9	6.30	2.12	1-35	14	12.60	12.60	2-30	15
Weed/grass				0	0.40	0.11		8	0.30	0.30		6
Epiphyte				0	0.25	0.10		5	0.40	0.40		8

APPENDIX D – SUMMARY TABLES OF STATISTICS

D1 MARRDJA BOARDWALK BUFFER AND CONTROL

Comparing buffer and control in the wet and dry season

D1(A): Results of Kruskal Wallis tests to examine differences in indicators between the buffer and control.

Test Statistics[a,b]

	BAREGROU	GDVEGECO	LITTERCO	ROOTPERC	WOODDEBR	EROPERCE	COMPACTI	LITDEPTH	CANOPYCO
Chi-Square	3.477	.577	.001	13.019	8.471	2.643	.491	.001	.138
df	1	1	1	1	1	1	1	1	1
Asymp. Sig.	.062	.448	.973	.000	.004	.104	.484	.969	.710

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D1(B): Results of Kruskal Wallis tests to examine differences in indicators between the buffer and control.

Test Statistics[a,b]

	BAREGROU	GDVEGECO	LITTERCO	ROOTPERC	WOODDEBR	EROPERCE	COMPACTI	LITDEPTH	CANOPYCO
Chi-Square	4.562	2.150	2.140	1.249	.040	2.149	21.932	.378	1.832
df	1	1	1	1	1	1	1	1	1
Asymp. Sig.	.033	.143	.144	.264	.842	.143	.000	.539	.176

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

Ranks

	SEASON	N	Mean Rank
BAREGROU	dry	40	57.99
	wet	60	45.51
	Total	100	
GDVEGECO	dry	40	44.00
	wet	40	37.00
	Total	80	
LITTERCO	dry	60	55.90
	wet	60	65.10
	Total	120	
ROOTPERC	dry	60	63.54
	wet	60	57.46
	Total	120	
WOODDEBR	dry	60	59.92
	wet	60	61.08
	Total	120	
EROPERCE	dry	60	63.25
	wet	60	57.75
	Total	120	
COMPACTI	dry	60	61.41
	wet	40	34.14
	Total	100	
LITDEPTH	dry	60	62.41
	wet	60	58.59
	Total	120	
CANOPYCO	dry	60	56.22
	wet	60	64.78
	Total	120	

Ranks

	LOCATION	N	Mean Rank
BAREGROU	Buffer	40	45.30
	Control forest	40	35.70
	Total	80	
GDVEGECO	Buffer	40	38.69
	Control forest	40	42.31
	Total	80	
LITTERCO	Buffer	40	40.41
	Control forest	40	40.59
	Total	80	
ROOTPERC	Buffer	40	31.63
	Control forest	40	49.38
	Total	80	
WOODDEBR	Buffer	40	33.05
	Control forest	40	47.95
	Total	80	
EROPERCE	Buffer	40	43.45
	Control forest	40	37.55
	Total	80	
COMPACTI	Buffer	40	38.72
	Control forest	40	42.28
	Total	80	
LITDEPTH	Buffer	40	40.60
	Control forest	40	40.40
	Total	80	
CANOPYCO	Buffer	40	39.54
	Control forest	40	41.46
	Total	80	

D2 DAVIES CREEK CAMP AND PICNIC AREAS

Statistical analyses of data collected at four camp and picnic nodes in the dry season, and five camp and picnic nodes in the wet season at Davies Creek.

D2(A) and D2(D) calculated on all data, i.e. includes tread, buffer and control.
D2(E) to D2(G) calculated on buffer and control only.

D2(A): Results of Kruskal Wallis test to examine differences in indicators across the tread, buffer and control.

Test Statistics[a,b]

	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO
Chi-Square	17.534	2.236	9.893	15.639
df	2	2	2	2
Asymp. Sig.	.000	.327	.007	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	LITTERMM	SEEDLING	COMPACTI
Chi-Square	15.823	12.241	10.944
df	2	2	2
Asymp. Sig.	.000	.002	.004

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

D2(B): Results of an ANOVA to test for variation in canopy cover across the tread, buffer and control.

Tests of Between-Subjects Effects

Dependent Variable: CANOPYCO

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	421.138[a]	5	84.228	.616	.689
Intercept	5126.476	1	5126.476	37.516	.000
SEASON	27.935	1	27.935	.204	.656
ZONE	379.630	2	189.815	1.389	.271
SEASON * ZONE	26.064	2	13.032	.095	.909
Error	2869.600	21	136.648		
Total	8566.790	27			
Corrected Total	3290.738	26			

a. R Squared = .128 (Adjusted R Squared = -.080)

D2(C): Results of an ANOVA to test for variation in percentage vegetation cover across the tread, buffer and control.

Tests of Between-Subjects Effects

Dependent Variable: VEGECOVE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9027.196[a]	5	1805.439	15.208	.000
Intercept	15149.314	1	15149.314	127.608	.000
SEASON	154.861	1	154.861	1.304	.266
ZONE	8744.108	2	4372.054	36.827	.000
SEASON * ZONE	184.166	2	92.083	.776	.473
Error	2493.074	21	118.718		
Total	27205.515	27			
Corrected Total	11520.270	26			

a. R Squared = .784 (Adjusted R Squared = .732)

VEGECOVE

Tukey HSD[a,b]

ZONE	N	Subset 1	Subset 2
Impact	9	5.7444	
buffer	9	18.1189	
control	9		48.4444
Sig.		.063	1.000

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 118.718.

a. Uses Harmonic Mean Sample Size = 9.000.

b. Alpha = .05.

D2(D): Results of Kruskal Wallis test to examine differences in indicators between the dry and wet season.

Test Statistics[a,b]

	LITTERMM	SEEDLING	COMPACTI	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO
Chi-Square	1.054	.787	4.410	.612	.574	5.967	2.152
df	1	1	1	1	1	1	1
Asymp. Sig.	.305	.375	.036	.434	.449	.015	.142

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D2(E): Results of Kruskal Wallis test to examine differences in indicators between the buffer and control.

Test Statistics[a,b]

	LITTERMM	SEEDLING	COMPACTI	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO
Chi-Square	2.971	6.330	5.102	8.796	2.015	3.801	1.535
df	1	1	1	1	1	1	1
Asymp. Sig.	.085	.012	.024	.003	.156	.051	.215

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

D2(F): Results of Kruskal Wallis test to examine differences in indicators between the season using only buffer and control.

Test Statistics[a,b]

	LITTERMM	SEEDLING	COMPACTI	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO
Chi-Square	5.348	.831	3.178	.643	.390	4.773	2.568
df	1	1	1	1	1	1	1
Asymp. Sig.	.021	.362	.075	.423	.532	.029	.109

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D2(G): Results of an ANOVA to test for variation in percentage mineral soil exposure across the buffer and control.

Tests of Between-Subjects Effects

Dependent Variable: ARCBARE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	.396[b]	3	.132	5.898	.008	17.695	.879
Intercept	2.527	1	2.527	112.988	.000	112.988	1.000
SEASON	.259	1	.259	11.564	.004	11.564	.885
ZONE	.114	1	.114	5.105	.040	5.105	.557
SEASON * ZONE	1.277E-02	1	1.277E-02	.571	.463	.571	.109
Error	.313	14	2.237E-02				
Total	3.453	18					
Corrected Total	.709	17					

a. Computed using alpha = .05

b. R Squared = .558 (Adjusted R Squared = .464)

Correlations

			CANOPYCO	BARESOIL	LITTERCO	LITTERMM	SEEDLING	COMPACTI	VEGECOVE
Spearman's rho	CANOPYCO	Correlation Coefficient	1.000	.462*	.045	-.047	.013	.189	-.125
		Sig. (2-tailed)	.	.015	.824	.818	.950	.344	.533
		N	27	27	27	27	27	27	27
	BARESOIL	Correlation Coefficient	.462*	1.000	-.583**	-.448*	-.134	.616**	-.544**
		Sig. (2-tailed)	.015	.	.001	.019	.506	.001	.003
		N	27	27	27	27	27	27	27
	LITTERCO	Correlation Coefficient	.045	-.583**	1.000	.516**	.104	-.429*	.298
		Sig. (2-tailed)	.824	.001	.	.006	.604	.026	.132
		N	27	27	27	27	27	27	27
	LITTERMM	Correlation Coefficient	-.047	-.448*	.516**	1.000	.665**	-.394*	.553**
		Sig. (2-tailed)	.818	.019	.006	.	.000	.042	.003
		N	27	27	27	27	27	27	27
	SEEDLING	Correlation Coefficient	.013	-.134	.104	.665**	1.000	-.375	.527**
		Sig. (2-tailed)	.950	.506	.604	.000	.	.054	.005
		N	27	27	27	27	27	27	27
	COMPACTI	Correlation Coefficient	.189	.616**	-.429*	-.394*	-.375	1.000	-.552**
		Sig. (2-tailed)	.344	.001	.026	.042	.054	.	.003
		N	27	27	27	27	27	27	27
	VEGECOVE	Correlation Coefficient	-.125	-.544**	.298	.553**	.527**	-.552**	1.000
		Sig. (2-tailed)	.533	.003	.132	.003	.005	.003	.
		N	27	27	27	27	27	27	27

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

D3 DAVIES CREEK WALKING TRACK

D3(A): Kruskal Wallis tests to examine differences in indicators across zones (tread, buffer and control).

Test Statistics[a,b]

	AREGROU	DVEGECO	ITTERCO	OOTPERC	OCKPERC	OODDEBR	ROSCALE	ROPERCE	OMPACT	ITDEPTH	ANOPYCO	EEDENS	SLOPE	EEDGRAS	PIPHYTE	ITGRASS	Height roadleaf	TWOODY
Chi-Squa	40.300	17.269	36.814	6.223	11.610	22.439	8.984	8.278	66.389	62.895	.846	17.770	31.225	9.860	2.349	25.460	12.461	8.483
df	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2
Asymp. S	.000	.000	.000	.045	.003	.000	.011	.016	.000	.000	.655	.000	.000	.007	.125	.000	.002	.014

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D3(B): Kruskal Wallis tests to examine differences in indicators between season (wet and dry) using all data. Table D3(H) provides Mean Rank values.

Test Statistics[a,b]

	AREGROU	DVEGECO	ITTERCO	OOTPERC	OCKPERC	OODDEBR	ROSCALE	ROPERCE	OMPACT	ITDEPTH	ANOPYCO	EEDENS	SLOPE	EEDGRAS	PIPHYTE
Chi-Squa	3.518	5.520	2.509	4.024	.004	2.976	.663	.008	.365	4.843	17.995	.130	.158	40.397	14.561
df	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Asymp. S	.061	.019	.113	.045	.948	.084	.416	.928	.546	.028	.000	.719	.691	.000	.000

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D3(C): Kruskal Wallis tests to examine differences in indicators across zones (buffer and control only). Table D3(G) provides Mean Rank values.

Test Statistics[a,b]

	AREGROU	DVEGECO	ITTERCO	OOTPERC	OCKPERC	OODDEBR	ROSCALE	ROPERCE	OMPACT	ITDEPTH	ANOPYCO	EEDENS	SLOPE	EEDGRAS	PIPHYTE	ITGRASS	Height roadleaf	TWOODY
Chi-Squa	6.822	.445	.947	1.053	.447	2.232	7.096	5.720	6.894	1.651	.922	.012	1.804	.006	2.349	1.659	3.903	.708
df	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Asymp. S	.009	.505	.331	.305	.504	.135	.008	.017	.009	.199	.337	.915	.179	.939	.125	.198	.048	.400

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D3(D): Spearman Rank Correlations of all variables measured in the tread/buffer and control.

Correlations

		BAREGR	LITTERC	ROOTPER	ROCKPER	WOODDE	EROSCAL	EROPERC	COMPACT	DEPTH	CANOPY	SEEDENS	SLOPE	WEEDGR	EPIPHYT	HTGRASS	Height broadleaf	HTWOOD	HMNLITT	leaf tip dea
Spearman	BAREGR(Correlation C	1.000	-.233*	.143	-.207*	-.381*	.334*	.366*	.345*	-.300*	-.104	-.126	-.308*	-.297*	.169	-.305*	-.079	-.054	-.273*	-.152
	Sig. (2-tailed	.	.010	.120	.024	.000	.000	.000	.000	.001	.259	.172	.001	.002	.136	.018	.547	.680	.035	.245
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	LITTERC(Correlation C	-.233*	1.000	-.264*	-.004	.270*	-.225*	-.230*	-.538*	.620*	.156	.177	.116	.055	.248*	.610*	.086	.238	-.148	.465*
	Sig. (2-tailed	.010	.	.004	.966	.003	.014	.011	.000	.000	.089	.053	.205	.581	.027	.000	.515	.067	.259	.000
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	ROOTPEI Correlation C	.143	-.264*	1.000	-.029	-.116	.229*	.230*	.183*	-.241*	.061	.031	.020	.012	.026	-.243	-.084	.036	-.076	-.253
	Sig. (2-tailed	.120	.004	.	.756	.206	.012	.012	.045	.008	.511	.736	.826	.904	.818	.061	.524	.782	.562	.051
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	ROCKPEI Correlation C	-.207*	-.004	-.029	1.000	.060	-.168	-.147	-.053	.203*	-.180*	.002	.347*	-.050	.091	.143	.218	-.024	.172	-.025
	Sig. (2-tailed	.024	.966	.756	.	.514	.067	.110	.565	.026	.050	.984	.000	.611	.424	.274	.095	.855	.189	.849
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	WOODDE Correlation C	-.381*	.270*	-.116	.060	1.000	-.114	-.155	-.459*	.365*	.045	.163	.139	.268*	-.171	.316*	.249	.155	-.164	.261*
	Sig. (2-tailed	.000	.003	.206	.514	.	.215	.092	.000	.000	.623	.075	.131	.006	.131	.014	.055	.238	.211	.044
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	EROSCAI Correlation C	.334*	-.225*	.229*	-.168	-.114	1.000	.959*	.164	-.065	-.051	-.098	.116	-.083	-.224*	-.396*	-.192	-.056	-.131	-.037
	Sig. (2-tailed	.000	.014	.012	.067	.215	.	.000	.073	.478	.582	.287	.207	.405	.048	.002	.142	.671	.318	.780
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	EROPER(Correlation C	.366*	-.230*	.230*	-.147	-.155	.959*	1.000	.158	-.056	-.121	-.080	.136	-.161	-.182	-.401*	-.180	-.023	-.131	-.024
	Sig. (2-tailed	.000	.011	.012	.110	.092	.000	.	.085	.544	.188	.384	.140	.102	.109	.002	.168	.859	.319	.858
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	COMPAC Correlation C	.345*	-.538*	.183*	-.053	-.459*	.164	.158	1.000	-.657*	-.031	-.316*	-.271*	-.311*	.018	-.543*	-.277*	-.471*	.214	-.258*
	Sig. (2-tailed	.000	.000	.045	.565	.000	.073	.085	.	.000	.738	.000	.003	.001	.874	.000	.032	.000	.100	.047
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	LITDEPTI Correlation C	-.300*	.620*	-.241*	.203*	.365*	-.065	-.056	-.657*	1.000	-.018	.323*	.437*	.127	.293*	.552*	.252	.357*	-.148	.405*
	Sig. (2-tailed	.001	.000	.008	.026	.000	.478	.544	.000	.	.849	.000	.000	.198	.009	.000	.052	.005	.259	.001
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	CANOPY(Correlation C	-.104	.156	.061	-.180*	.045	-.051	-.121	-.031	-.018	1.000	.084	-.080	.147	-.080	.269*	.127	.186	-.216	-.015
	Sig. (2-tailed	.259	.089	.511	.050	.623	.582	.188	.738	.849	.	.363	.383	.138	.485	.038	.334	.154	.098	.908
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	SEEDENS Correlation C	-.126	.177	.031	.002	.163	-.098	-.080	-.316*	.323*	.084	1.000	.322*	.034	.086	.237	.177	.980*	-.153	.073
	Sig. (2-tailed	.172	.053	.736	.984	.075	.287	.384	.000	.000	.363	.	.000	.729	.452	.068	.175	.000	.244	.581
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	SLOPE Correlation C	-.308*	.116	.020	.347*	.139	.116	.136	-.271*	.437*	-.080	.322*	1.000	-.048	-.046	.146	-.048	.242	-.045	.133
	Sig. (2-tailed	.001	.205	.826	.000	.131	.207	.140	.003	.000	.383	.000	.	.627	.688	.266	.716	.062	.730	.312
	N	120	120	120	120	120	120	120	120	120	120	120	120	104	79	60	60	60	60	60
	WEEDGR Correlation C	-.297*	.055	.012	-.050	.268*	-.083	-.161	-.311*	.127	.147	.034	-.048	1.000	-.123	.204	.247	.112	-.031	.297*
	Sig. (2-tailed	.002	.581	.904	.611	.006	.405	.102	.001	.198	.138	.729	.627	.	.285	.118	.057	.395	.813	.021
	N	104	104	104	104	104	104	104	104	104	104	104	104	104	78	60	60	60	60	60
	EPIPHYTI Correlation C	.169	.248*	.026	.091	-.171	-.224*	-.182	.018	.293*	-.080	.086	-.046	-.123	1.000	-.243	.314*	.248	-.229	-.101
	Sig. (2-tailed	.136	.027	.818	.424	.131	.048	.109	.874	.009	.485	.452	.688	.285	.	.131	.049	.123	.154	.537
	N	79	79	79	79	79	79	79	79	79	79	79	79	78	79	40	40	40	40	40
	HTGRASS Correlation C	-.305*	.610*	-.243	.143	.316*	-.396*	-.401*	-.543*	.552*	.269*	.237	.146	.204	-.243	1.000	.363*	.246	-.071	.216
	Sig. (2-tailed	.018	.000	.061	.274	.014	.002	.002	.000	.000	.038	.068	.266	.118	.131	.	.004	.058	.588	.098
	N	60	60	60	60	60	60	60	60	60	60	60	60	60	40	60	60	60	60	60
	Height brc Correlation C	-.079	.086	-.084	.218	.249	-.192	-.180	-.277*	.252	.127	.177	-.048	.247	.314*	.363*	1.000	.193	-.136	-.073
	Sig. (2-tailed	.547	.515	.524	.095	.055	.142	.168	.032	.052	.334	.175	.716	.057	.049	.004	.	.141	.300	.579
	N	60	60	60	60	60	60	60	60	60	60	60	60	60	40	60	60	60	60	60
	HTWOOD Correlation C	-.054	.238	.036	-.024	.155	-.056	-.023	-.471*	.357*	.186	.980*	.242	.112	.248	.246	.193	1.000	-.153	.096
	Sig. (2-tailed	.680	.067	.782	.855	.238	.671	.859	.000	.005	.154	.000	.062	.395	.123	.058	.141	.	.245	.467
	N	60	60	60	60	60	60	60	60	60	60	60	60	60	40	60	60	60	60	60
	HMNLITTI Correlation C	-.273*	-.148	-.076	.172	-.164	-.131	-.131	.214	-.148	-.216	-.153	-.045	-.031	-.229	-.071	-.136	-.153	1.000	-.175
	Sig. (2-tailed	.035	.259	.562	.189	.211	.318	.319	.100	.259	.098	.244	.730	.813	.154	.588	.300	.245	.	.182
	N	60	60	60	60	60	60	60	60	60	60	60	60	60	40	60	60	60	60	60
	leaf tip de: Correlation C	-.152	.465*	-.253	-.025	.261*	-.037	-.024	-.258*	.405*	-.015	.073	.133	.297*	-.101	.216	-.073	.096	-.175	1.000
	Sig. (2-tailed	.245	.000	.051	.849	.044	.780	.858	.047	.001	.908	.581	.312	.021	.537	.098	.579	.467	.182	.
	N	60	60	60	60	60	60	60	60	60	60	60	60	60	40	60	60	60	60	60

*Correlation is significant at the .05 level (2-tailed).

**Correlation is significant at the .01 level (2-tailed).

D3(E): ANOVA to test for differences in compaction across zone (buffer and control) and season (dry and wet).

Tests of Between-Subjects Effects

Dependent Variable: COMPACTI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	2.771[b]	3	.924	.862	.465	2.586	.230
Intercept	70.951	1	70.951	66.212	.000	66.212	1.000
SEASON	5.304E-02	1	5.304E-02	.050	.825	.050	.056
LOCATION	1.162	1	1.162	1.084	.301	1.084	.177
SEASON * LOCATION	1.557	1	1.557	1.453	.232	1.453	.222
Error	81.439	76	1.072				
Total	155.162	80					
Corrected Total	84.211	79					

a. Computed using alpha = .05

b. R Squared = .033 (Adjusted R Squared = -.005)

D3(F): Wet season only - height of vegetation in buffer and control.

Ranks

	LOCATION	N	Mean Rank
HTGRASS	Buffer	20	18.13
	Control forest	20	22.88
	Total	40	
Height broadleaf	Buffer	20	23.67
	Control forest	20	17.33
	Total	40	
HTWOODY	Buffer	20	19.10
	Control forest	20	21.90
	Total	40	

Test Statistics[a,b]

	HTGRASS	Height broadleaf	HTWOODY
Chi-Square	1.659	3.903	.708
df	1	1	1
Asymp. Sig.	.198	.048	.400

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D3(G): Mean Rank values of data collected in buffer and control data collected in wet and dry season (see D3(E) and D3(F) for Kruskal Wallis analyses).

Ranks

	LOCATION	N	Mean Rank
BAREGROU	Buffer	40	46.67
	Control forest	40	34.33
	Total	80	
GDVEGECO	Buffer	20	21.55
	Control forest	20	19.45
	Total	40	
LITTERCO	Buffer	40	37.97
	Control forest	40	43.03
	Total	80	
ROOTPERC	Buffer	40	41.96
	Control forest	40	39.04
	Total	80	
ROCKPERC	Buffer	40	42.16
	Control forest	40	38.84
	Total	80	
WOODDEBR	Buffer	40	36.79
	Control forest	40	44.21
	Total	80	
EROSCALE	Buffer	40	45.55
	Control forest	40	35.45
	Total	80	
EROPERCE	Buffer	40	44.84
	Control forest	40	36.16
	Total	80	
COMPACTI	Buffer	40	47.31
	Control forest	40	33.69
	Total	80	
LITDEPTH	Buffer	40	37.17
	Control forest	40	43.83
	Total	80	
CANOPYCO	Buffer	40	38.03
	Control forest	40	42.97
	Total	80	
SEEDENSI	Buffer	40	40.25
	Control forest	40	40.75
	Total	80	
SLOPE	Buffer	40	37.06
	Control forest	40	43.94
	Total	80	
WEEDGRAS	Buffer	39	40.19
	Control forest	40	39.81
	Total	79	
EPIPHYTE	Buffer	39	43.19
	Control forest	40	36.89
	Total	79	
HTGRASS	Buffer	20	18.13
	Control forest	20	22.88
	Total	40	
Height broadleaf	Buffer	20	23.67
	Control forest	20	17.33
	Total	40	
HTWOODY	Buffer	20	19.10
	Control forest	20	21.90
	Total	40	

D3(H): Mean Rank values of data collected in wet and dry season.

Ranks

	SEASON	N	Mean Rank
BAREGROU	dry	40	36.04
	wet	40	44.96
	Total	80	
GDVEGECO	wet	40	20.50
	Total	40[a]	
LITTERCO	dry	40	32.00
	wet	40	49.00
	Total	80	
ROOTPERC	dry	40	43.00
	wet	40	38.00
	Total	80	
ROCKPERC	dry	40	36.83
	wet	40	44.17
	Total	80	
WOODDEBR	dry	40	43.71
	wet	40	37.29
	Total	80	
EROSCALE	dry	40	43.03
	wet	40	37.97
	Total	80	
EROPERCE	dry	40	41.61
	wet	40	39.39
	Total	80	
COMPACTI	dry	40	39.92
	wet	40	41.08
	Total	80	
LITDEPTH	dry	40	30.29
	wet	40	50.71
	Total	80	
CANOPYCO	dry	40	48.59
	wet	40	32.41
	Total	80	
SEEDENSI	dry	40	40.45
	wet	40	40.55
	Total	80	
SLOPE	dry	40	37.95
	wet	40	43.05
	Total	80	
WEEDGRAS	dry	39	54.22
	wet	40	26.14
	Total	79	
EPIPHYTE	dry	39	32.05
	wet	40	47.75
	Total	79	
HTGRASS	wet	40	20.50
	Total	40[a]	
Height broadleaf	wet	40	20.50
	Total	40[a]	
HTWOODY	wet	40	20.50
	Total	40[a]	

a. There is only one non-empty group.
Kruskal-Wallis Test cannot be performed.

D4 HENRIETTA CREEK CAMP AND PICNIC AREAS

D4(A): Wet Season only including tread/buffer and control.

Correlations

			HTGRASS	HTBROAD	HTWOODY
Spearman's rho	HTGRASS	Correlation Coefficient	1.000	.725**	-.004
		Sig. (2-tailed)	.	.002	.989
		N	15	15	15
	HTBROAD	Correlation Coefficient	.725**	1.000	.226
		Sig. (2-tailed)	.002	.	.417
		N	15	15	15
	HTWOODY	Correlation Coefficient	-.004	.226	1.000
		Sig. (2-tailed)	.989	.417	.
		N	15	15	15

**. Correlation is significant at the .01 level (2-tailed).

D4(B): Litter depth – the only factor that meet the assumptions of ANOVA. ANOVA to test for differences in tread/buffer/control and season.

Tests of Between-Subjects Effects

Dependent Variable: LITTERMM

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power [a]
Corrected Model	2530.411[b]	5	506.082	6.177	.001	30.886	.983
Intercept	10289.712	1	10289.712	125.595	.000	125.595	1.000
SEASON	138.245	1	138.245	1.687	.206	1.687	.239
ZONE	2224.665	2	1112.332	13.577	.000	27.154	.995
SEASON * ZONE	167.501	2	83.750	1.022	.375	2.044	.207
Error	1966.266	24	81.928				
Total	14786.389	30					
Corrected Total	4496.677	29					

a. Computed using alpha = .05

b. R Squared = .563 (Adjusted R Squared = .472)

D4(C): Wallis tests to examine differences between season using data from tread/buffer and control

Ranks	Season	N	Mean Rank
VEGECOVE	dry	15	15.13
	wet	15	15.87
	Total	30	
CANOPYCO	dry	15	14.80
	wet	15	16.20
	Total	30	
BARESOIL	dry	15	17.00
	wet	15	14.00
	Total	30	
LITTERCO	dry	15	15.60
	wet	15	15.40
	Total	30	
SEEDLING	dry	15	15.80
	wet	15	15.20
	Total	30	
COMPACTI	dry	15	17.33
	wet	15	13.67
	Total	30	

Test Statistics[a,b]

	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO	SEEDLING	COMPACTI
Chi-Square	.052	.190	.880	.004	.036	1.313
df	1	1	1	1	1	1
Asymp. Sig	.819	.663	.348	.950	.850	.252

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D4(D): Spearman Rank correlations of indicators measured in one-square-metre quadrats.

Correlations

			VEGECOVE	CANOPYCO	BARESOIL	LITTERCO	LITTERMM	SEEDLING	COMPACTI
Spearman's rh	VEGECOVI	Correlation Coefficie	1.000	-.219	-.446*	-.734**	.014	.044	.135
		Sig. (2-tailed)	.	.244	.014	.000	.941	.818	.478
		N	30	30	30	30	30	30	30
	CANOPYC(	Correlation Coefficie	-.219	1.000	-.061	.522**	.575**	.306	-.433*
		Sig. (2-tailed)	.244	.	.749	.003	.001	.100	.017
		N	30	30	30	30	30	30	30
	BARESOIL	Correlation Coefficie	-.446*	-.061	1.000	.016	-.271	-.291	.126
		Sig. (2-tailed)	.014	.749	.	.932	.148	.118	.506
		N	30	30	30	30	30	30	30
	LITTERCO	Correlation Coefficie	-.734**	.522**	.016	1.000	.356	.248	-.450*
		Sig. (2-tailed)	.000	.003	.932	.	.053	.186	.013
		N	30	30	30	30	30	30	30
	LITTERMM	Correlation Coefficie	.014	.575**	-.271	.356	1.000	.685**	-.589*
		Sig. (2-tailed)	.941	.001	.148	.053	.	.000	.001
		N	30	30	30	30	30	30	30
	SEEDLING	Correlation Coefficie	.044	.306	-.291	.248	.685**	1.000	-.506*
		Sig. (2-tailed)	.818	.100	.118	.186	.000	.	.004
		N	30	30	30	30	30	30	30
	COMPACTI	Correlation Coefficie	.135	-.433*	.126	-.450*	-.589**	-.506**	1.000
		Sig. (2-tailed)	.478	.017	.506	.013	.001	.004	.
		N	30	30	30	30	30	30	30

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

D4(E): Kruskal Wallis tests to examine differences in indicators between season using data from tread/buffer and control.

Ranks

	ZONE	N	Mean Rank
VEGECOVE	Impact	10	13.30
	buffer	10	21.10
	control	10	12.10
	Total	30	
CANOPYCO	Impact	10	9.25
	buffer	10	15.05
	control	10	22.20
	Total	30	
BARESOIL	Impact	10	19.20
	buffer	10	9.30
	control	10	18.00
	Total	30	
LITTERCO	Impact	10	12.65
	buffer	10	12.70
	control	10	21.15
	Total	30	
SEEDLING	Impact	10	6.65
	buffer	10	20.65
	control	10	19.20
	Total	30	
COMPACTI	Impact	10	23.35
	buffer	10	13.80
	control	10	9.35
	Total	30	

Test Statistics[a,b]

	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO	SEEDLING	COMPACTI
Chi-Square	6.180	10.873	7.613	6.198	15.743	13.329
df	2	2	2	2	2	2
Asymp. Sig	.045	.004	.022	.045	.000	.001

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

D4(F): Kruskal Wallis tests to examine differences in indicators between buffer and control at five camp and picnic areas.

Test Statistics[a,b]

	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO	SEEDLING	COMPACTI
Chi-Square	11.088	4.494	5.936	7.841	.414	2.218
df	1	1	1	1	1	1
Asymp. Sig	.001	.034	.015	.005	.520	.136

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Ranks

	ZONE	N	Mean Rank
VEGECOVE	buffer	10	14.90
	control	10	6.10
	Total	20	
CANOPYCO	buffer	10	7.70
	control	10	13.30
	Total	20	
BARESOIL	buffer	10	7.30
	control	10	13.70
	Total	20	
LITTERCO	buffer	10	6.80
	control	10	14.20
	Total	20	
SEEDLING	buffer	10	11.35
	control	10	9.65
	Total	20	
COMPACTI	buffer	10	12.45
	control	10	8.55
	Total	20	

D4(G): Kruskal Wallis tests to examine differences in indicators between season (wet and dry) using data collected in buffer and control only.

Test Statistics[a,b]

	VEGECOVE	CANOPYCO	BARESOIL	LITTERCO	SEEDLING	COMPACTI
Chi-Square	.023	.206	.023	.206	.006	5.426
df	1	1	1	1	1	1
Asymp. Sig.	.880	.650	.879	.650	.940	.020

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D5 NANDROYA WALKING TRACK

D5(A): ANOVA to test for differences in compaction across zone (tread, buffer and control) and between season (dry and wet).

Tests of Between-Subjects Effects

Dependent Variable: COMPACTI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	219.428[b]	5	43.886	51.424	.000	257.120	1.000
Intercept	269.496	1	269.496	315.789	.000	315.789	1.000
SEASON	36.870	1	36.870	43.204	.000	43.204	1.000
LOCATION	169.415	2	84.708	99.258	.000	198.517	1.000
SEASON * LOCATIO	13.623	2	6.812	7.982	.001	15.963	.951
Error	95.581	112	.853				
Total	591.725	118					
Corrected Total	315.009	117					

a. Computed using alpha = .05

b. R Squared = .697 (Adjusted R Squared = .683)

D5(B): Kruskal Wallis tests to examine differences in indicators across zones (tread, buffer and control) with associated table of mean rank values.

Test Statistics[a,b]

	BAREGROU	GDVEGECO	LITTERCO	ROOTPERC	ROCKPERC	WOODDEBR	EROPERCE
Chi-Square	8.922	.223	5.389	37.401	3.420	17.389	17.032
df	2	1	2	2	2	2	2
Asymp. Sig.	.012	.637	.068	.000	.181	.000	.000

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

Ranks

	LOCATION	N	Mean Rank
BAREGROU	Tread	39	47.27
	Buffer	40	69.79
	Control forest	40	62.63
	Total	119	
GDVEGECO	Buffer	20	21.33
	Control forest	20	19.67
	Total	40	
LITTERCO	Tread	40	67.35
	Buffer	40	50.28
	Control forest	40	63.88
	Total	120	
ROOTPERC	Tread	40	37.50
	Buffer	40	66.05
	Control forest	40	77.95
	Total	120	
ROCKPERC	Tread	40	67.76
	Buffer	40	56.71
	Control forest	39	55.41
	Total	119	
WOODDEBR	Tread	40	44.24
	Buffer	40	62.14
	Control forest	40	75.13
	Total	120	
EROPERCE	Tread	40	47.46
	Buffer	40	72.34
	Control forest	40	61.70
	Total	120	

Ranks

	LOCATION	N	Mean Rank
EROSCALE	Tread	40	48.80
	Buffer	40	72.47
	Control forest	40	60.22
	Total	120	
COMPACTI	Tread	40	91.49
	Buffer	39	49.19
	Control forest	39	37.00
	Total	118	
LITDEPTH	Tread	40	33.72
	Buffer	40	65.20
	Control forest	40	82.57
	Total	120	
CANOPYCO	Tread	40	59.76
	Buffer	40	55.50
	Control forest	40	66.24
	Total	120	
SEEDENSI	Tread	40	32.41
	Buffer	40	76.59
	Control forest	40	72.50
	Total	120	

Test Statistics[a,b]

	EROSCALE	COMPACTI	LITDEPTH	CANOPYCO	SEEDENSI
Chi-Square	11.752	55.874	40.750	1.957	44.854
df	2	2	2	2	2
Asymp. Sig.	.003	.000	.000	.376	.000

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D5(C): Kruskal Wallis tests to examine differences in indicators across seasons, with associated table of mean rank values (* based on Tread/Buffer/Control data).

Ranks

	SEASON	N	Mean Rank
EROSCALE	dry	60	51.98
	wet	60	69.02
	Total	120	
COMPACTI	dry	60	69.42
	wet	58	49.24
	Total	118	
LITDEPTH	dry	60	43.43
	wet	60	77.57
	Total	120	
CANOPYCO	dry	60	64.75
	wet	60	56.25
	Total	120	
SEEDENSI	dry	60	59.10
	wet	60	61.90
	Total	120	

Test Statistics[a,b]

	EROSCALE	COMPACTI	LITDEPTH	CANOPYCO	SEEDENSI
Chi-Square	9.121	10.348	29.037	1.814	.221
df	1	1	1	1	1
Asymp. Sig.	.003	.001	.000	.178	.638

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

Ranks

	SEASON	N	Mean Rank
BAREGROU	dry	59	52.21
	wet	60	67.66
	Total	119	
GDVEGECO	wet	40	20.50
	Total	40[a]	
LITTERCO	dry	60	58.28
	wet	60	62.72
	Total	120	
ROOTPERC	dry	60	58.19
	wet	60	62.81
	Total	120	
ROCKPERC	dry	60	61.99
	wet	59	57.97
	Total	119	
WOODDEBR	dry	60	52.27
	wet	60	68.73
	Total	120	
EROPERCE	dry	60	59.33
	wet	60	61.67
	Total	120	

a. There is only one non-empty group.
Kruskal-Wallis Test cannot be performed.

Test Statistics[a,b]

	BAREGROU	LITTERCO	ROOTPERC	ROCKPERC	WOODDEBR	EROPERCE
Chi-Square	6.073	.488	.692	.448	7.351	.226
df	1	1	1	1	1	1
Asymp. Sig.	.014	.485	.406	.503	.007	.634

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D5(D): Kruskal Wallis tests to examine differences in indicators across seasons with associated table of mean rank values (* based on Buffer/Control data only).

Ranks

	SEASON	N	Mean Rank
BAREGROU	dry	40	38.56
	wet	40	42.44
	Total	80	
GDVEGECO	wet	40	20.50
	Total	40[a]	
LITTERCO	dry	40	38.46
	wet	40	42.54
	Total	80	
ROOTPERC	dry	40	38.54
	wet	40	42.46
	Total	80	
ROCKPERC	dry	40	39.56
	wet	39	40.45
	Total	79	
WOODDEBR	dry	40	35.51
	wet	40	45.49
	Total	80	
EROPERCE	dry	40	40.70
	wet	40	40.30
	Total	80	

a. There is only one non-empty group.
Kruskal-Wallis Test cannot be performed.

Test Statistics[a,b]

	BAREGROU	LITTERCO	ROOTPERC	ROCKPERC	WOODDEBR	EROPERCE
Chi-Square	.561	.616	.622	.034	3.843	.008
df	1	1	1	1	1	1
Asymp. Sig.	.454	.433	.430	.853	.050	.929

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

Ranks

	SEASON	N	Mean Rank
COMPACTI	dry	40	46.49
	wet	38	32.14
	Total	78	
LITDEPTH	dry	40	26.35
	wet	40	54.65
	Total	80	
CANOPYCO	dry	40	42.17
	wet	40	38.83
	Total	80	
SEEDENSI	dry	40	39.40
	wet	40	41.60
	Total	80	

Test Statistics[a,b]

	COMPACTI	LITDEPTH	CANOPYCO	SEEDENSI
Chi-Square	7.958	29.773	.421	.184
df	1	1	1	1
Asymp. Sig.	.005	.000	.516	.668

a. Kruskal Wallis Test

b. Grouping Variable: SEASON

D5(E): Kruskal Wallis tests to examine differences in indicators across zones (buffer and control), with associated table of mean rank values (* based on Buffer/Control data only).

Ranks

	LOCATION	N	Mean Rank
COMPACTI	Buffer	39	44.92
	Control forest	39	34.08
	Total	78	
LITDEPTH	Buffer	40	34.50
	Control forest	40	46.50
	Total	80	
CANOPYCO	Buffer	40	36.94
	Control forest	40	44.06
	Total	80	
SEEDENSI	Buffer	40	41.79
	Control forest	40	39.21
	Total	80	

Test Statistics[a,b]

	COMPACTI	LITDEPTH	CANOPYCO	SEEDENSI
Chi-Square	4.554	5.353	1.904	.252
df	1	1	1	1
Asymp. Sig.	.033	.021	.168	.616

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

Ranks

	LOCATION	N	Mean Rank
BAREGROU	Buffer	40	43.24
	Control forest	40	37.76
	Total	80	
GDVEGECO	Buffer	20	21.33
	Control forest	20	19.67
	Total	40	
LITTERCO	Buffer	40	35.55
	Control forest	40	45.45
	Total	80	
ROOTPERC	Buffer	40	36.55
	Control forest	40	44.45
	Total	80	
ROCKPERC	Buffer	40	40.54
	Control forest	39	39.45
	Total	79	
WOODDEBR	Buffer	40	35.89
	Control forest	40	45.11
	Total	80	
EROPERCE	Buffer	40	44.29
	Control forest	40	36.71
	Total	80	

Test Statistics[a,b]

	BAREGROU	GDVEGECO	LITTERCO	ROOTPERC	ROCKPERC	WOODDEBR	EROPERCE
Chi-Squar	1.120	.223	3.634	2.518	.052	3.287	2.823
df	1	1	1	1	1	1	1
Asymp. Si	.290	.637	.057	.113	.820	.070	.093

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D5(F): Table of spearman rank correlations for indicators measured along the Nandroya walking track.

Correlations

			BAREGROU	GDVEGECC	LITTERCO	ROOTPERC	WOODDEBR	EROPERCE	COMPACTI	LITDEPTH	CANOPYCC	SEEDENSI
Spearman's rh	BAREGROU	Correlation Coeffic	1.000	-.151	-.250**	.301**	.193*	.527**	-.215*	.163	-.134	.256**
		Sig. (2-tailed)	.	.353	.006	.001	.035	.000	.020	.077	.146	.005
		N	119	40	119	119	119	119	117	119	119	119
	GDVEGECC	Correlation Coeffic	-.151	1.000	-.239	.071	.093	-.176	.027	-.295	.114	.189
		Sig. (2-tailed)	.353	.	.137	.661	.569	.278	.874	.064	.484	.242
		N	40	40	40	40	40	40	38	40	40	40
	LITTERCO	Correlation Coeffic	-.250**	-.239	1.000	-.105	-.012	-.152	.057	.188*	.119	-.027
		Sig. (2-tailed)	.006	.137	.	.254	.893	.098	.542	.040	.195	.770
		N	119	40	120	120	120	120	118	120	120	120
	ROOTPERC	Correlation Coeffic	.301**	.071	-.105	1.000	.244**	.261**	-.465**	.363**	.078	.447**
		Sig. (2-tailed)	.001	.661	.254	.	.007	.004	.000	.000	.399	.000
		N	119	40	120	120	120	120	118	120	120	120
	WOODDEB	Correlation Coeffic	.193*	.093	-.012	.244**	1.000	.089	-.379**	.433**	.164	.295**
		Sig. (2-tailed)	.035	.569	.893	.007	.	.334	.000	.000	.074	.001
		N	119	40	120	120	120	120	118	120	120	120
	EROPERCE	Correlation Coeffic	.527**	-.176	-.152	.261**	.089	1.000	-.203*	.156	-.118	.259**
		Sig. (2-tailed)	.000	.278	.098	.004	.334	.	.027	.090	.200	.004
		N	119	40	120	120	120	120	118	120	120	120
	COMPACTI	Correlation Coeffic	-.215*	.027	.057	-.465**	-.379**	-.203*	1.000	-.642**	-.021	-.304**
		Sig. (2-tailed)	.020	.874	.542	.000	.000	.027	.	.000	.825	.001
		N	117	38	118	118	118	118	118	118	118	118
	LITDEPTH	Correlation Coeffic	.163	-.295	.188*	.363**	.433**	.156	-.642**	1.000	.034	.292**
		Sig. (2-tailed)	.077	.064	.040	.000	.000	.090	.000	.	.710	.001
		N	119	40	120	120	120	120	118	120	120	120
	CANOPYCC	Correlation Coeffic	-.134	.114	.119	.078	.164	-.118	-.021	.034	1.000	.091
		Sig. (2-tailed)	.146	.484	.195	.399	.074	.200	.825	.710	.	.321
		N	119	40	120	120	120	120	118	120	120	120
	SEEDENSI	Correlation Coeffic	.256**	.189	-.027	.447**	.295**	.259**	-.304**	.292**	.091	1.000
		Sig. (2-tailed)	.005	.242	.770	.000	.001	.004	.001	.001	.321	.
		N	119	40	120	120	120	120	118	120	120	120

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

D5(G): Height of vegetation Tread/Buffer and control.

Test Statistics[a,b]

	HTGRASS	Height broadleaf	HTWOODY
Chi-Square	4.164	14.734	25.447
df	2	2	2
Asymp. Sig.	.125	.001	.000

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

Ranks

	LOCATION	N	Mean Rank
HTGRASS	Tread	20	31.42
	Buffer	20	33.08
	Control forest	20	27.00
	Total	60	
Height broadleaf	Tread	20	19.40
	Buffer	20	37.75
	Control forest	20	34.35
	Total	60	
HTWOODY	Tread	20	15.32
	Buffer	20	39.35
	Control forest	20	36.83
	Total	60	

D5(H): Height of vegetation Buffer/control.

Ranks

	LOCATION	N	Mean Rank
HTGRASS	Buffer	20	22.50
	Control forest	20	18.50
	Total	40	
Height broadleaf	Buffer	20	21.77
	Control forest	20	19.23
	Total	40	
HTWOODY	Buffer	20	21.50
	Control forest	20	19.50
	Total	40	

Test Statistics[a,b]

	HTGRASS	Height broadleaf	HTWOODY
Chi-Square	4.318	.502	.296
df	1	1	1
Asymp. Sig.	.038	.478	.586

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

D6 MURRAY FALLS CAMP AND PICNIC AREAS

D6(A): Comparison among tread, buffer and control.

Test Statistics[a,b]

	BARESOIL
Chi-Square	99.042
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	VEGECOVE
Chi-Square	106.139
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	LITTERCO
Chi-Square	501.427
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	LITTERMM
Chi-Square	518.725
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	CANOPYCO
Chi-Square	375.636
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	SEEDLING
Chi-Square	541.993
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

Test Statistics[a,b]

	COMPACTI
Chi-Square	504.846
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: ZONE

D6(B): Comparison of buffer and control.

Test Statistics[a]

	BARESOIL
Mann-Whitney U	11636.000
Wilcoxon W	22811.000
Z	-2.161
Asymp. Sig. (2-tailed)	.031

a. Grouping Variable: ZONE

Test Statistics[a]

	VEGECOVE
Mann-Whitney U	7007.000
Wilcoxon W	23478.000
Z	-7.716
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: ZONE

Test Statistics[a]

	LITTERCO
Mann-Whitney U	11505.000
Wilcoxon W	26905.000
Z	-1.744
Asymp. Sig. (2-tailed)	.081

a. Grouping Variable: ZONE

Test Statistics[a]

	LITTERMM
Mann-Whitney U	5800.000
Wilcoxon W	17125.000
Z	-8.938
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: ZONE

Test Statistics[a]

	SEEDLING
Mann-Whitney U	4122.500
Wilcoxon W	15750.500
Z	-11.047
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: ZONE

Test Statistics[a]

	COMPACTI
Mann-Whitney U	7816.500
Wilcoxon W	23926.500
Z	-6.632
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: ZONE

Test Statistics[a]

	CANOPYCO
Mann-Whitney U	8859.500
Wilcoxon W	20640.500
Z	-5.514
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: ZONE

D6(C): Comparison between season using buffer and control only.

Test Statistics[a]

	BARESOIL
Mann-Whitney U	3118.000
Wilcoxon W	5134.000
Z	-7.690
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	VEGECOVE
Mann-Whitney U	4617.000
Wilcoxon W	6570.000
Z	-5.521
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	LITTERCO
Mann-Whitney U	5215.000
Wilcoxon W	40460.000
Z	-4.675
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	LITTERMM
Mann-Whitney U	6597.000
Wilcoxon W	42912.000
Z	-2.407
Asymp. Sig. (2-tailed)	.016

a. Grouping Variable: SEASON

Test Statistics[a]

	SEEDLING
Mann-Whitney U	7121.000
Wilcoxon W	9137.000
Z	-1.906
Asymp. Sig. (2-tailed)	.057

a. Grouping Variable: SEASON

Test Statistics[a]

	COMPACTI
Mann-Whitney U	4369.500
Wilcoxon W	6385.500
Z	-5.828
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	CANOPYCO
Mann-Whitney U	4917.000
Wilcoxon W	6933.000
Z	-5.131
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

D6(D): Comparison between season using tread, buffer and control data.

Test Statistics[a]

	BARESOIL
Mann-Whitney U	39532.000
Wilcoxon W	148343.00
Z	-2.834
Asymp. Sig. (2-tailed)	.005

a. Grouping Variable: SEASON

Test Statistics[a]

	VEGECOVE
Mann-Whitney U	23891.000
Wilcoxon W	43394.000
Z	-9.791
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	LITTERCO
Mann-Whitney U	43801.000
Wilcoxon W	151681.00
Z	-1.149
Asymp. Sig. (2-tailed)	.250

a. Grouping Variable: SEASON

Test Statistics[a]

	LITTERMM
Mann-Whitney U	43290.000
Wilcoxon W	63190.000
Z	-1.277
Asymp. Sig. (2-tailed)	.202

a. Grouping Variable: SEASON

Test Statistics[a]

	SEEDLING
Mann-Whitney U	33794.000
Wilcoxon W	53694.000
Z	-6.126
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	COMPACTI
Mann-Whitney U	38178.500
Wilcoxon W	146989.500
Z	-3.526
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

Test Statistics[a]

	CANOPYCO
Mann-Whitney U	22890.000
Wilcoxon W	42196.000
Z	-10.093
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

D7 MURRAY FALLS GRADED WALKING TRACK

D7(A): ANOVA to test if the percentage canopy cover varied significantly between the buffer and control between season.

Dependent Variable: Percentage canopy cover (sqrt arc sin transformed).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9.235E-02	5	1.847E-02	0.229	0.949
Intercept	134.672	1	134.672	1670.731	0.000
LOCATION	1.417E-02	2	7.085E-03	0.088	0.916
SEASON	6.093E-02	1	6.093E-02	0.756	0.386
LOCATION * SEASON	1.725E-02	2	8.625E-03	0.107	0.899
Error	9.189	114	8.061E-02		
Total	143.954	120			
Corrected Total	9.282	119			

a R Squared = .010 (Adjusted R Squared = -.033)

D7(B): ANOVA to test if the percentage bare ground (mineral soil exposure) varied significantly between the buffer and control between season.

Dependent Variable: Percentage Bare Ground (sqrt arcsin transformed).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.291	3	9.714E-02	1.467	0.230
Intercept	4.474	1	4.474	67.545	0.000
SEASON	1.444E-02	1	1.444E-02	0.218	0.642
LOCATION	0.263	1	0.263	3.967	0.050
SEASON * LOCATION	1.423E-02	1	1.423E-02	0.215	0.644
Error	5.034	76	6.624E-02		
Total	9.800	80			
Corrected Total	5.326	79			

a R Squared = .055 (Adjusted R Squared = .017)

D7(C): ANOVA to test if the percentage litter cover varied significantly between the buffer and control between season.

Dependent Variable: Percentage cover of litter (sqrt arcsin transformed).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.493	3	0.164	0.887	0.452
Intercept	75.483	1	75.483	407.198	0.000
SEASON	0.312	1	0.312	1.686	0.198
LOCATION	0.179	1	0.179	0.967	0.329
SEASON * LOCATION	1.396E-03	1	1.396E-03	0.008	0.931
Error	14.088	76	0.185		
Total	90.064	80			
Corrected Total	14.581	79			

a R Squared = .034 (Adjusted R Squared = -.004)

D7(D): ANOVA to test if the depth of litter varied significantly between the buffer and control between season.

Dependent Variable: Litter depth (sqrt arcsin transformed).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.705E-02	3	5.684E-03	0.126	0.944
Intercept	33.211	1	33.211	735.911	0.000
SEASON	3.353E-03	1	3.353E-03	0.074	0.786
LOCATION	9.729E-03	1	9.729E-03	0.216	0.644
SEASON * LOCATION	3.425E-03	1	3.425E-03	0.076	0.784
Error	3.204	71	4.513E-02		
Total	36.789	75			
Corrected Total	3.221	74			

a R Squared = .005 (Adjusted R Squared = -.037)

D7(E): ANOVA to test for a difference in compaction between the buffer and control between season.

Dependent Variable: Soil compaction (sqrt transfromed).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.971	3	0.324	1.060	0.371
Intercept	42.299	1	42.299	138.507	0.000
SEASON	0.513	1	0.513	1.679	0.199
LOCATION	0.415	1	0.415	1.360	0.247
SEASON * LOCATION	4.268E-02	1	4.268E-02	0.140	0.710
Error	23.210	76	0.305		
Total	66.480	80			
Corrected Total	24.181	79			

a R Squared = .040 (Adjusted R Squared = .002)

D7(F): Comparison of ground vegetation cover between buffer and control; and wet and dry season using buffer and control data.

Test Statistics[a]

	GDVEGECO
Mann-Whitney U	584.000
Wilcoxon W	1214.000
Z	-.365
Asymp. Sig. (2-tailed)	.715

a. Grouping Variable: LOCATION

Test Statistics[a]

	GDVEGECO
Mann-Whitney U	96.500
Wilcoxon W	916.500
Z	-6.523
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

D7(G): Comparison of percentage root cover between buffer and control, and wet and dry season on using buffer and control data.

Test Statistics[a]

	ROOTPERC
Mann-Whitney U	740.500
Wilcoxon W	1560.500
Z	-.717
Asymp. Sig. (2-tailed)	.473

a. Grouping Variable: LOCATION

Test Statistics[a]

	ROOTPERC
Mann-Whitney U	559.000
Wilcoxon W	1379.000
Z	-2.904
Asymp. Sig. (2-tailed)	.004

a. Grouping Variable: SEASON

D7(H): Comparison of number of seedlings between buffer and control, and wet and dry season using buffer and control data.

Test Statistics[a]

	SEEDENSI
Mann-Whitney U	729.500
Wilcoxon W	1549.500
Z	-.684
Asymp. Sig. (2-tailed)	.494

a. Grouping Variable: LOCATION

Test Statistics[a]

	SEEDENSI
Mann-Whitney U	588.500
Wilcoxon W	1408.500
Z	-2.053
Asymp. Sig. (2-tailed)	.040

a. Grouping Variable: SEASON

D7(I): Comparison of percentage cover of woody debris between buffer and control, and wet and dry season using buffer and control data.

Test Statistics[a]

	WOODDEBR
Mann-Whitney U	714.500
Wilcoxon W	1534.500
Z	-.897
Asymp. Sig. (2-tailed)	.370

a. Grouping Variable: LOCATION

Test Statistics[a]

	WOODDEBR
Mann-Whitney U	652.000
Wilcoxon W	1472.000
Z	-1.553
Asymp. Sig. (2-tailed)	.121

a. Grouping Variable: SEASON

D7(J): Comparison of percentage erosion between buffer and control, and wet and dry season using buffer and control data.

Test Statistics[a]

	EROPERCE
Mann-Whitney U	737.000
Wilcoxon W	1557.000
Z	-1.105
Asymp. Sig. (2-tailed)	.269

a. Grouping Variable: LOCATION

Test Statistics[a]

	EROPERCE
Mann-Whitney U	620.000
Wilcoxon W	1440.000
Z	-3.158
Asymp. Sig. (2-tailed)	.002

a. Grouping Variable: SEASON

D7(K): Comparison of percentage root cover amongst zones (tread, buffer and control) and between season.

Test Statistics[a,b]

	ROOTPERC
Chi-Square	.649
df	2
Asymp. Sig.	.723

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

Test Statistics[a]

	ROOTPERC
Mann-Whitney U	1158.500
Wilcoxon W	2988.500
Z	-4.156
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SEASON

D7(L): Comparison of percentage woody debris cover amongst zones (tread, buffer and control) and between season.

Test Statistics[a,b]

	WOODDEBR
Chi-Square	16.866
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: LOCATION

Test Statistics[a]

	WOODDEBR
Mann-Whitney U	1441.000
Wilcoxon W	3271.000
Z	-2.215
Asymp. Sig. (2-tailed)	.027

a. Grouping Variable: SEASON

APPENDIX E – SECTION OF SURVEY INSTRUMENT TO INVESTIGATE VISITORS' PERCEPTIONS OF ENVIRONMENTAL IMPACTS

See Bentrupperbaumer and Reser 2002.

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1. Please indicate how **important** you consider each of the following **benefits** of this natural area are:

	SCALE				
	ot important		→		Important
(a) Conservation of plants and animals	2	3	4	5	6
(b) Education about Aboriginal cultural heritage	2	3	4	5	6
(c) Education about non-Indigenous cultural heritage	2	3	4	5	6
(d) Education about the environment	2	3	4	5	6
(e) Scenic beauty	2	3	4	5	6
(f) Places for recreation and relaxation	2	3	4	5	6
(g) Economic benefits from tourism	2	3	4	5	6
(h) Clean water	2	3	4	5	6
(i) Clean air	2	3	4	5	6

2. What do you consider to be the three most important **treats** to the well-being of the environment at this site?

   (a) .....

   (b) .....

   (c) .....

3. What **strategies** are you aware of that could reduce the impact of your visit to this area?

   .....

   .....

   .....

4. Please rate your perception of the quality/status of the following aspects (where applicable) at the site:

	SCALE				
	ɔw		→		High
(a) Soil condition (evidence of erosion, top-soil loss, removal of leaf litter)	2	3	4	5	6
(b) Water quality (evidence of pollution)	2	3	4	5	6
(c) Presence of weeds	2	3	4	5	6
(d) Condition of vegetation (e.g. trampling, breakage, ring-barking, fire scars)	2	3	4	5	6
(e) Native wildlife behaviour (e.g. evidence of scavenging, tameness)	2	3	4	5	6
(f) Deliberate human impacts on infrastructure (evidence of graffiti, vandalism)	2	3	4	5	6
(g) Presence of feral and/or domestic animals (evidence of cane toads, pigs, dogs)	2	3	4	5	6

Additional Comments:

.....

.....

5. How would you rate your level of physical comfort during your visit to this site today?

SCALE					
ncomfortable		➔			Comfortable
2	3		4	5	6

If you were **uncomfortable**, please provide details:

.....

.....

6. Which of the following items did you bring on your trip today?

- ☐ Hat
- ☐ Long sleeve shirt
- ☐ Long pants
- ☐ Sunglasses
- ☐ Rain coat/gear
- ☐ Backpack
- ☐ Insect repellent
- ☐ Water

7. How often do you visit a National Park or natural area like this one?

- ☐ This is my/our first time
- ☐ Less than once a year
- ☐ Once a year
- ☐ Two to five times a year
- ☐ More than five times a year