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Assessment, evaluation and a comparison of planned and unplanned walk trails in coastal south-western Australia

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ABSTRACT

Three walk trails, the 'Bibbulmun Track' in West Cape Howe National Park and The Bald Head and Peak Head trails, in Torndirrup National Park were compared and evaluated using a problem assessment method. Indicators used to categorise trail degradation in the problem-assessment-trail-census included trail depth, excessive width, root exposure and trail proliferation. Other environmental variables measured in the trail assessment were slope, soil type and trail-side vegetation. Maintenance features such as boardwalks, steps, water bars and signs were assigned a condition and effectiveness rating. The most prevalent degradation problems on the assessed trails were soil erosion, exposed roots and excessive width. Trail proliferation was problematic in sections of indistinct trail or where a view could be accessed. The Bald Head and Peak Head trails were highly degraded compared to the assessed section of the Bibbulmun Track, which has been subject to a higher level of planning and management intervention. An evaluation of past management actions in relation to present trail conditions for all three trails indicates that trail alignment following natural contours and the installation of maintenance features such as board-walks, water-bars and steps on sloped sections are crucial to sustainable trail management. The utility of a trail problem assessment method developed in mountainous areas of the US has worked well in the assessment of sandy coastal walking trails, with the monitoring of trail conditions recommended as part of a sustainable trail management program and made possible due to the data that has been generated during this trail assessment.

Keywords: Trail assessment, environmental characteristics, maintenance features, West Cape Howe and Torndirrup National Parks

INTRODUCTION

Walking trails are an important means of access into a wide range of environments, some more resistant to the impacts of recreation than others. Furthermore, increasing recreational pressure from walkers has meant that walk trails world wide have suffered accelerated degradation problems that diminish the natural, social and cultural values of an area and potentially make trail usage unsafe (Leung and Marion, 1996; Liddle, 1997; Newsome et al., 2002). Information on trail conditions is essential for the maintenance and sustainability of walking trails and should include descriptive variables, assessment of maintenance features and an analysis of temporal visitation data including user type and behaviour (Marion and Leung, 2004).

The majority of research into the recreation ecology of walking trails has traditionally focused on high use mountainous environments in Europe and the United States. Following on from this, a number of techniques for assessing walking trails have been developed by researchers in the US as a way of evaluating trail conditions and degradation problems (e.g. Bratton et al., 1977; Cole, 1983; Leung and Marion, 1999). The suitability of trail assessment techniques developed for mountainous environments, however, has not been tested in sandy coastal environments. In addition to this, the popularity and increasing use of fragile coastal environments in many parts of the world has meant that these areas have often required rehabilitation and careful planning at a local level due to degraded conditions (Oma et al., 1992; Harvey and Caton, 2003).

Coastal locations in south-western Australia such as West Cape Howe and Torndirrup National Park (hereafter referred to as WCHNP and TNP) are areas of significant biological diversity and attract a large number of recreational visitors each year (CALM, 2004). Walking trails within the two parks occur in stabilised (fixed) sand dune environments and have been subject to different levels of use and management actions over the last three decades (CALM, 1992; CALM, 1995). Western Australia's icon walking trail, the 'Bibbulmun Track' (964km) traverses both WCHNP and TNP. Conceived in 1972 and completed in 1998, a considerable amount of time and effort has gone into its planning and implementation. Unplanned trails, on the other hand, have received reactive management actions in response to degradation problems. Despite this, no formal assessment of trail conditions that occur along the Bibbulmun Track and for other trails in sandy coastal locations has been

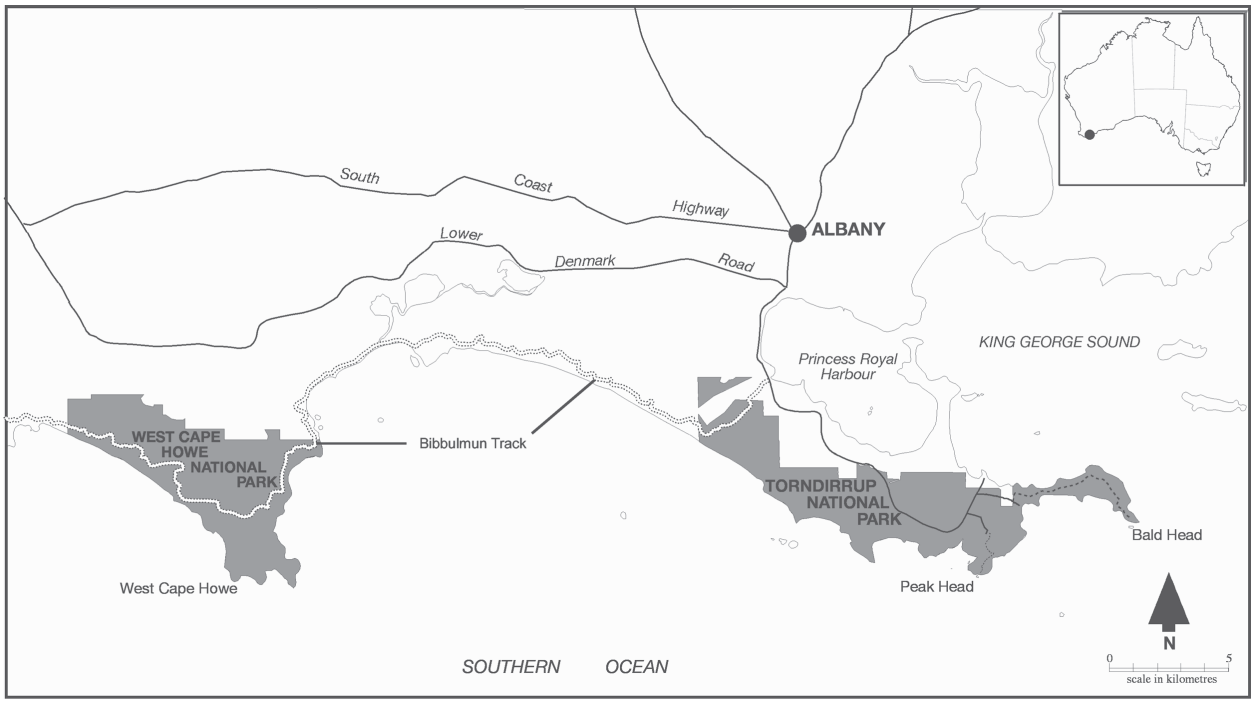

Figure 1. Study area, WCHNP and TNP on the South Coast of Western Australia

undertaken in Western Australia. Currently there are no baseline data that categorise trail conditions and there has been no assessment of the effectiveness of trail management actions in either WCHNP or TNP.

The objectives of this paper are therefore to:

- Assess, evaluate and compare a section of the planned Bibbulmun Track in the WCHNP with two unplanned but popular access trails, the Bald Head and Peak Head walk trails in TNP.
- Report on the suitability of current trail assessment techniques in sandy coastal environments in Australia.

Location of West Cape Howe and Torndirrup National Park

The study area focuses on two National Parks, WCHNP and TNP on the south coast of Western Australia (Figure 1). The two parks are located close to the regional centre of Albany and contain walking trails that meander through stabilised coastal sand dunes. WCHNP is located approximately 400km south east of Perth and 30 km south west of Albany (Figure 2). Western Australia's most southerly point, Torbay Head and West Cape Howe are contained within approximately 23 kilometres of rugged coastline on the park's southern border (CALM, 1995). The Bibbulmun Track traverses the park from east to west (Figure 1) and continues along the coast line terminating at Albany (Figure 2).

TNP is located approximately 400km south east of Perth and 10 km south of Albany. The area was set aside as a reserve in 1918 and elevated to National Park status in 1969 (Smith, 1991). Located on the Flinders Peninsula, Princess Royal Harbour is located to the north and the Southern Ocean forms the parks southern border. The Bibbulmun Track passes through the western corner of the park (Figure 1) with the Bald Head and Peak Head trails located at the eastern end of the park (Figures 3 and 4).

ENVIRONMENTAL CHARACTERISTICS

Climate

The study area is described as having a sub-Mediterranean climate with mild summers and cool wet winters. Air temperature is constantly moderated by the marine influence, ranging between a mean daily minimum and maximum air temperature of 10° and 20° C respectively. Annual mean rainfall is 1000mm with the majority of rainfall between May and August (Smith, 1991; CALM, 1995). Summer rainfall, however, is a common occurrence mostly as overnight drizzle in an easterly airstream but also as thunderstorms, the result of converging tropical cloud delivered to the region in a northerly airstream (Smith, 1991). The wind is a significant climatic factor that has the potential to erode exposed sandy soils and affect the behaviour of wild or prescribed fires in the parks (CALM, 1995). North westerly to southerly winds are commonly associated with cold fronts between May and August. Strong and gusty south easterly to northerly winds are experienced September to December, with persistent easterlies in January and February (Smith, 1991).

Geology and Soils

Both National Parks are underlain by a combination of pre-Cambrian granites, dolerite and banded gneisses that

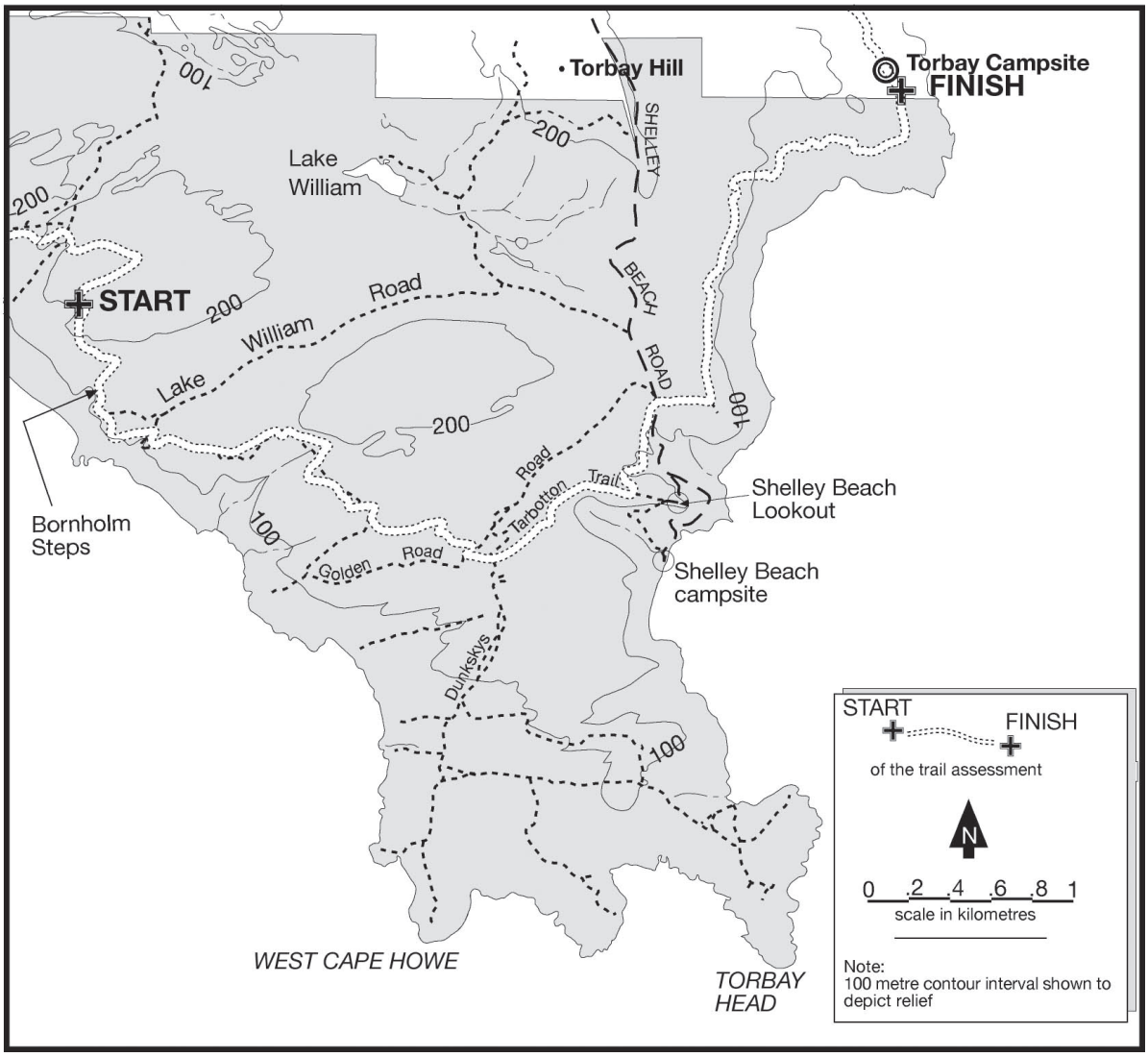

Figure 2. The assessed section of the Bibbulmun Track in WCHNP showing the Tarbotton Trail and historical vehicle trail network, trail length 11657.9 m

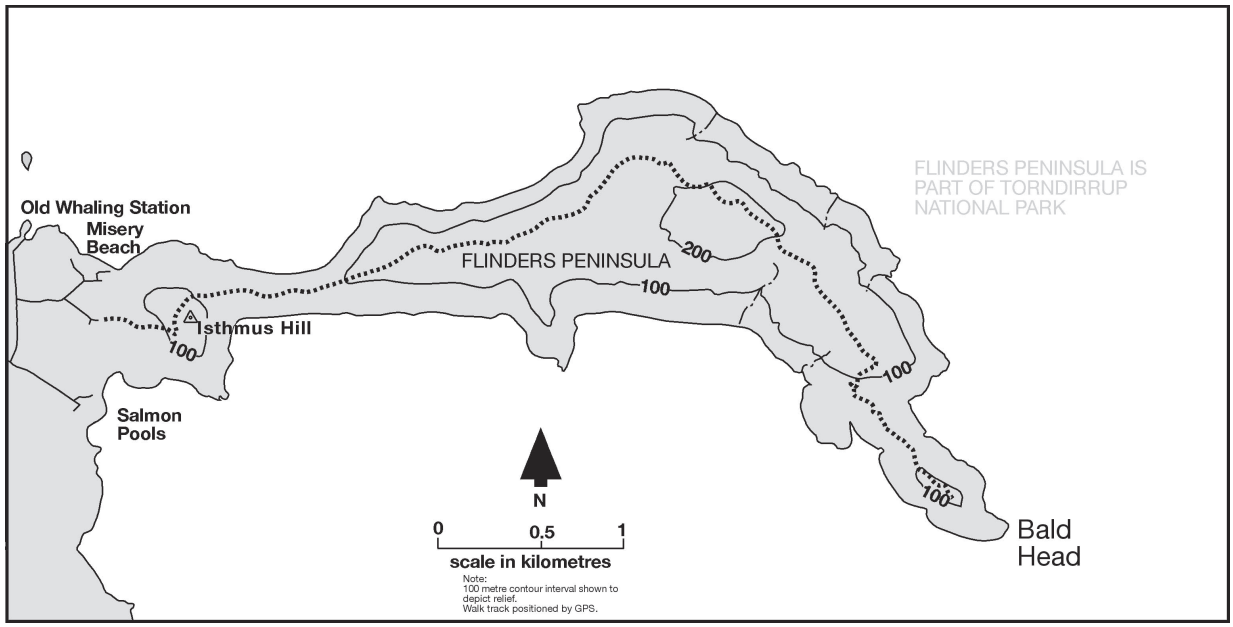

Figure 3. The Bald Head trail on the Flinders Peninsula in TNP, trail length 6552.8m

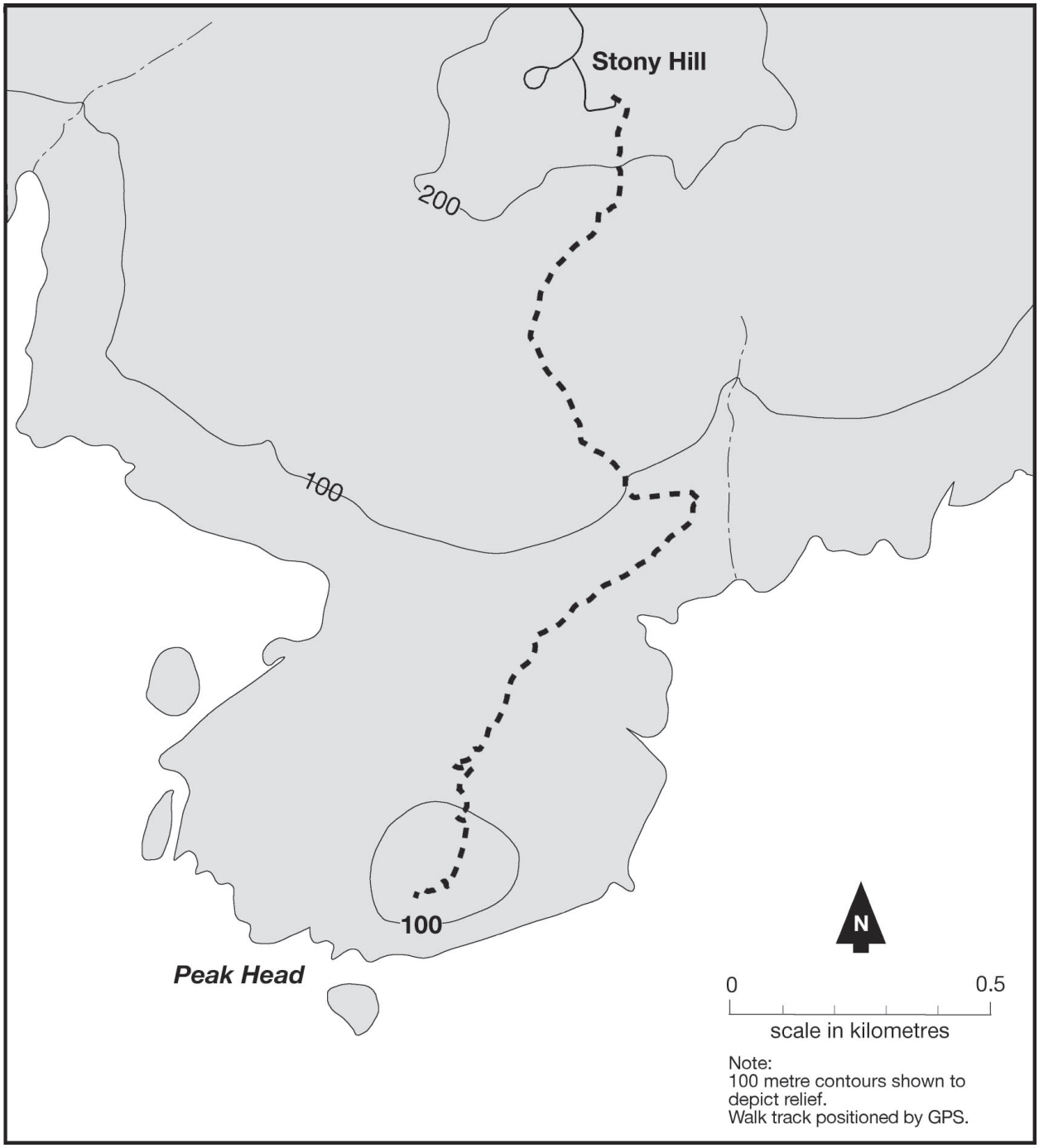

Figure 4. The Peak Head trail in TNP, trail length 2188.5m

form rock outcrops, coastal cliffs and monadnocks. Subjected to a long history of weathering, the physiography is expressed as variations in topography, soils and hydrology (Churchward et al., 1988). The weathering of basement rock has produced localised clay, gravel and a laterite profile more noticeable inland due to the dominance of a mantle of limestone sand along the coastline. Although there is some gravel or laterite development on the coastal strip occurring in association with exposed granite or gneiss monadnocks (CALM, 1995). The coastal mantle exhibits a largely continuous ridge of Tamala Limestone (karst) of Pleistocene age, overlain by younger sections of aeolian sands of Holocene age, now largely stabilised parabolic dunes. The surface soil in both parks is nutrient poor white to grey and yellow to brown fine to medium quartz sand with minor clay soils. Aeolian sands, distributed along the southern coastline, display a uniform grain size, lack cohesion and are generally poor in organic matter. (McArthur and Bettenay, 1960).

Coastal Dune Morphology

The granite and gneiss headlands that characterise the south coast are connected by shallow, curved sandy bays that have acted as the supply point for vast quantities of aeolian sand being moved inland during four major marine transgressions during the Pleistocene (Hodgkin and Hesp, 1998). Ancient parabolic dune fields have generally accreted in low-lying areas but wind blown sand has also covered granite peaks and Tamala Limestone along the coastline forming a belt some 2–3km in width (Churchward et al., 1988). The most recent marine transgression was during the Holocene, when sea levels reached about 1m higher than the present before receding approximately 4000 years ago. Coastal dunes are now mostly stabilised by vegetation but still vulnerable to erosion following disturbances such as fire, human activity and high winds associated with storm fronts (Beard, 1979).

Vegetation

Beard (1979) described the dominant plant communities that occur in the immediate study areas as being Low Forest, Shrubland and Rock Outcrop. Shrubland is further divided into two groups of heath found on the coastal strip in both parks (Table 1).

Recreational Use of Selected Walk Trails

TNP is the most visited park on the southern coastline. Visitation statistics for both WCHNP and TNP are displayed as percentage values and compared to the total numbers of visitors to 6 major National Parks in the Great Southern District which contains both WCHNP and TNP (Table 2).

Data on trail usage from electronic pedestrian counters placed at selected positions on the Bibbulmun Track, between Denmark and Albany between1996–2003 and at the beginning of the Bald Head and Peak Head trails between1996–1999 are indicated below (Figure 5).

TRAIL ASSESSMENT METHODOLOGY

General considerations

The total length of each assessed trail (see Figure 2 for the assessed section of the Bibbulmun Track) was established by pushing a measuring wheel from a designated start point to a designated finish point. Start points were also made easily identifiable and locatable with a photographic image and Global Positioning System (GPS) reading. Indicators measured during the trail assessment comprised environmental, degradation and maintenance features (Table 3). The assessed variables were measured concurrently and recorded directly onto a field proforma.

The trail-problem-assessment-method (Leung and Marion, 1999) was chosen because of the generated data's capacity to document the extent, location and frequency of the chosen indicators and would also prove useful to further identify problem sections of trail that could be assessed by point sampling techniques that measure changes in soil micro-topography (Randall, 2004). Environmental and degradation indicators as outlined in

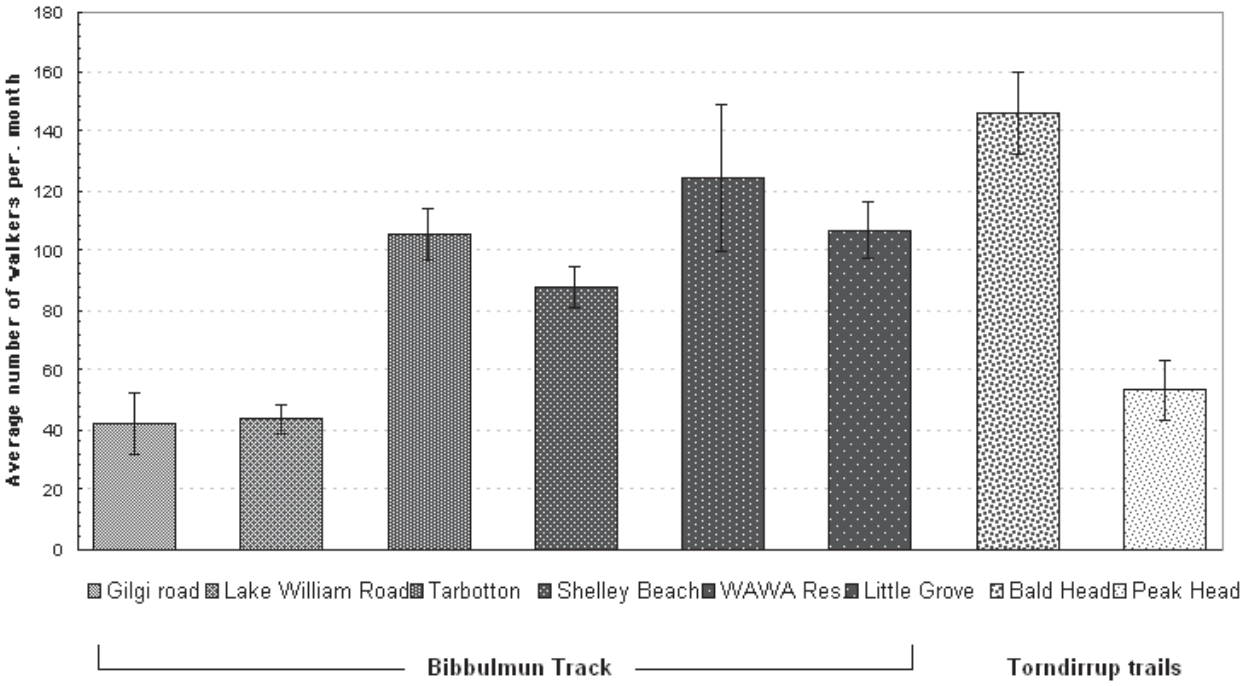

Figure 5. Average numbers of walkers per month on the Bibbulmun Track between Denmark and Albany, and the Bald Head and Peak Head trails in TNP

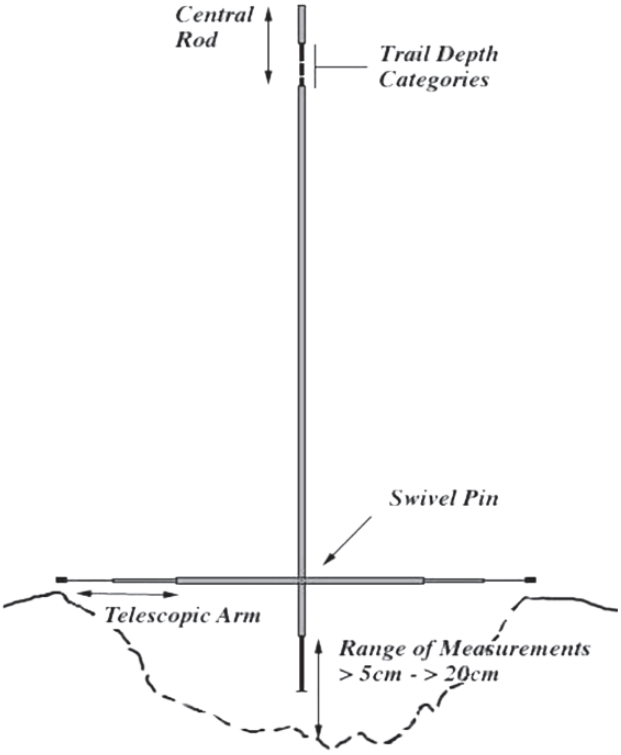

Figure 6. Trail depth and width measuring device, telescopic cross arms measure width, while central rod is calibrated to measure range of trail depth categories at a glance

Table 3 were recorded as the lineal extent of each segment occurring on the trail length. Exposed roots and trail proliferation were given a severity rating from 1–5 or low to high.

Trail erosion depth and excessive width

Trail erosion depth and width categories were standardised by measuring the minimum and maximum parameters during a preliminary field trip (Table 4). A trail-depth-measuring device was developed to facilitate measuring trail depth and width categories, which were recorded as the start and finish point of each linear section (Figure 6).

Maintenance features

Maintenance features are engineering or educational solutions (i.e. steps or signs) that help to counteract walk trail degradation or increase user comfort. Features are preferably made from locally available materials such as stone or wood but are also made from steel or geo-synthetic surfaces such as rubber. Maintenance features were divided into 2 categories defined by the system of measurement. Maintenance features that had a continuous occurrence described in metre length, such as a board-walk or wood chip surface were documented by recording the start and finish point. Single, non-continuous maintenance features such as water-bars or signs were recorded with a single data point, which was recorded at the centre of each feature. Maintenance features were also given a condition rating and an effectiveness rating (Table 5). The condition of a maintenance feature refers to the physical condition of the material used in construction e.g. wooden water bar in poor condition is suffering from dry rot or split along entire length. The effectiveness of a feature refers to the observational evidence that degradation is being counteracted e.g. a water bar is diverting the flow of water off a sloped trail tread. Observational evidence is confirmed by the presence of trail sediment adjacent to the water bar and lack of trail degradation below the water bar.

Results of trail assessment

Environmental attributes and indicators of erosion of the assessed section of the Bibbulmun Track and the Bald and Peak Head Trails are summarised in Table 6.

Indicators of trail degradation

The Bibbulmun track has 2.5% total erosion recorded along the assessed section of trail compared with 51% of Bald Head and 62% of Peak Head. Comparative results are similar for excessive width (2.3% on the Bibbulmun Track v 11% along Bald Head), trail proliferation (0.8% on the Bibbulmun Track v 6% along Bald Head) and root exposure (0.3% on the Bibbulmun Track v 29.7% along Peak Head). All indicators of trail degradation are low along the Bibbulmun Track as compared with the Bald and Peak Head trails (Figure 7; Table 6).

MAINTENANCE FEATURES

Assessed Section of the Bibbulmun Track (Total length 11.65 km)

Trail maintenance features were noticeably more numerous than the Bald or Peak Head trails. Continuous maintenance features included: 298.8m of board-walk (3 sections), 293.4m of soil retaining boards (45 sections), 150.9m of rubber belting (4 sections), 442.8m of stairs (28 sections) and 50.9m of wood chip surfacing (1 section). Non-continuous features included: 2 bridges, 2 boot cleaning stations, 6 excluding barriers, 6 seats, 18 single steps, 75 signs and 551 water bars (Table 7).

Continuous maintenance features described as being in excellent condition totalled 11.1%, while 49.8% of continuous maintenance features are described as having an excellent effectiveness. Overall the condition of continuous maintenance features is moderate to moderate-excellent and the comparative effectiveness is moderate-excellent to excellent. A total of 83.8% of non-continuous maintenance features are in moderate-excellent condition while only 59.5% of features have moderate-excellent effectiveness. A minor proportion (1.5%) of non-continuous maintenance features are placed between the moderate to poor condition categories, with 27.7% of non-continuous features located between the moderate to poor effectiveness categories.

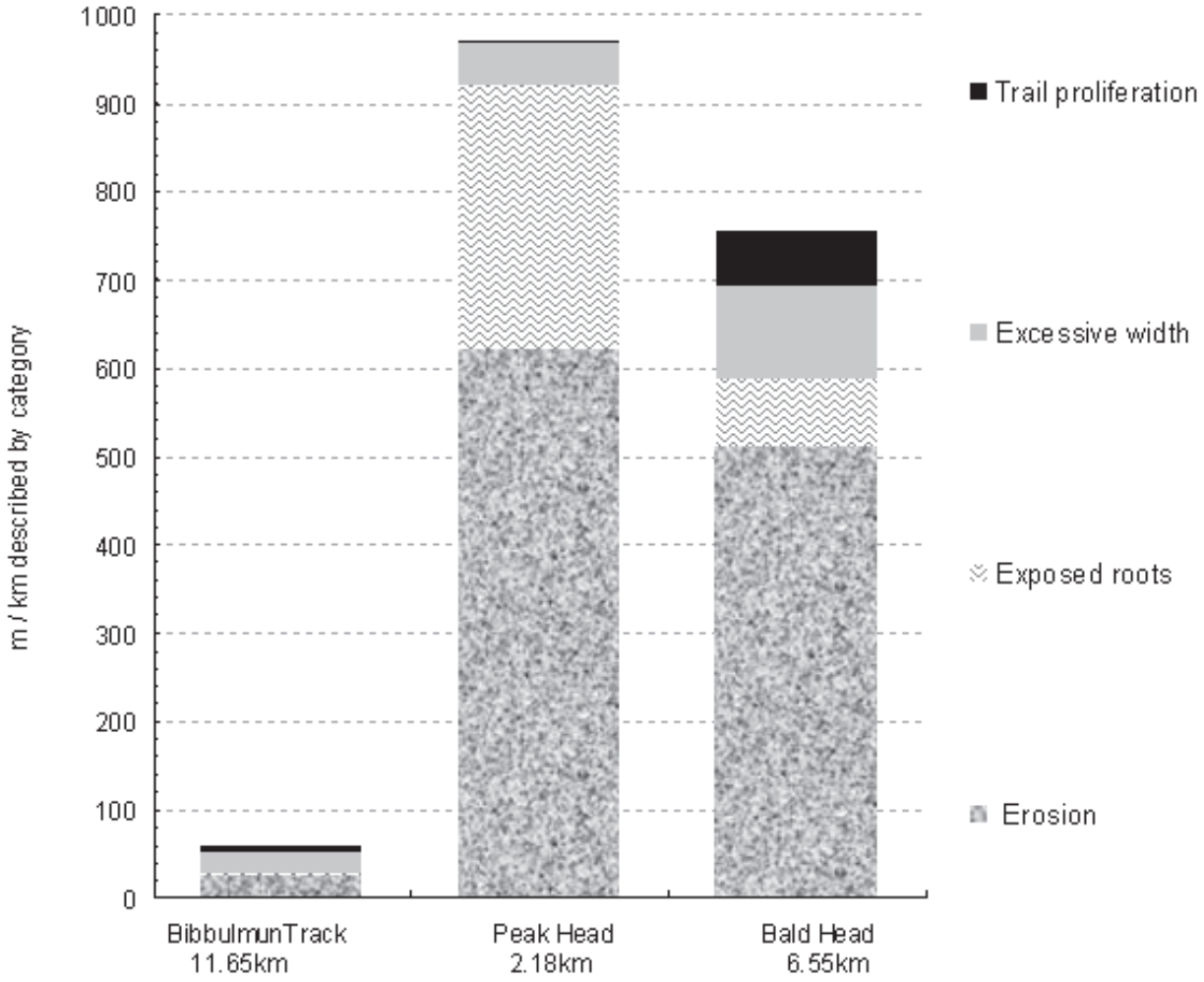

Figure 7. A comparison of degradation (m/km) between assessed trails in the study area

Bald Head trail (Total length 6.55 km)

Continuous maintenance features on the Bald Head trail were restricted to 7 sections of timber board-walk (552.2m), stairs (2.9m) and one fence (1.3m). Directional signs (75), and other non continuous maintenance features comprising 1 water bar. The majority of the 7 board-walks were in moderate to moderate-poor condition while still maintaining a 100% moderate-excellent effectiveness rating. The timber board–walk was 24.6% in moderate-poor condition, 66.9% in moderate condition and 8.6% in moderate-excellent condition. The effectiveness rating for the board-walk was 100% moderate-excellent, indicating that the features effectiveness was not reliant on its condition. The condition and effectiveness of directional signs on the trail were very similar. Of the 75 signs, 93.4% were in moderate to excellent condition with 53.9% classified as having a moderate-excellent effectiveness, but with only 10.5% attracting an excellent effectiveness rating (Table 8). Signs that were in need of re-painting were difficult to detect. Any moderate to moderate-poor effectiveness ratings were given to signs that were difficult to see from a distance and therefore potentially encouraged trail proliferation.

Peak Head trail (Total length 2.18 km)

Of the 89 water bars on the Peak Head trail, 48 were totally covered by displaced soil and 14 were between 70–90% covered by soil rendering them ineffective. All water bars were in moderate-excellent condition. However, the majority (48) were classified as being poor in effectiveness with 12 achieving moderate-excellent effectiveness (Table 9). Directional signs (24) were between the moderate to excellent classification in both condition and effectiveness with some general comments during assessment highlighting the need for repainting. A relatively minor number of steps (12) were all in moderate-excellent condition and of moderate to moderate-excellent effectiveness.

COMPARISON OF THE ASSESSED TRAILS

Overview

The trails selected for assessment in the study area have been subject to different use levels and management actions, while environmental conditions (soils, slope and climatic factors) that affect the rate of water and wind erosion, are very similar (see Table 6). Areas of exposed granite outcrop were not assessable in terms of erosion but contributed to the total length of the trail. The Bibbulmun Track in WCHNP is a carefully planned and implemented walk trail that has benefited from government and community funding, regular volunteer maintenance work and a higher level of management in relation to other walk trails. In contrast, the Bald Head and Peak Head trails have existed as unplanned access trails prior to the creation of the Bibbulmun Track in the study area. The closure of vehicle trails, partial upgrades and maintenance work in response to erosion problems on both the Bald Head and Peak Head trails in the mid 90's have improved the conditions of both trails. The levels of erosion evident along the Bald Head and Peak Head trails is a reflection of the unplanned nature of these trails and represents ongoing degradation that management has had to react to. In addition, park management is constrained by constantly shrinking land management budgets a situation seen in other protected areas worldwide (Leung and Monz, 2006).

Vegetation

The vegetation types occurring on all three assessed trails in the study area are very similar. Shrubland scrub-heath and heath communities are the dominant vegetation types on the assessed trails (see Table 1). The main differences being *Eucalyptus angulosa* as the dominant small tree/shrub on the Bald Head trail compared with *A. flexuosa* the dominant small tree/shrub on the Bibbulmun Track and Peak Head trail. Vegetation plays an important role in protecting exposed trail soil from the effects of raindrop splash erosion by dissipating the kinetic energy of falling raindrops (Brandt, 1989). Furthermore, in coastal areas the presence of high trail-side vegetation affords protection from the effects of deflation by providing a barrier that intercepts and accumulates wind blown sand particles (Harvey and Caton, 2003). Sections of high trail-side vegetation comprising *A. flexuosa*, E. *angulosa*, *Eucalyptus marginata, Acacia fraseriana* and *Melaleuca cuticularis* were present along the Bibbulmun Track in WCHNP and comprised 4.2% of the total trail length (Table 6). A further 30% of the Bibbulmun Track comprises myrtaceous heath (< 60cm in height) with occasional small trees of *E. marginata* and *A. fraseriana*. This shrubland scrub heath community exhibited a very dense organic rich under-trail root network which most likely contributes to trail resilience along the Bibbulmun Track (eg. Oma et al,. 1992).

On the Peak Head trail, shrubland scrub heath dominated by *A. flexuosa* comprises 28.6% of the total trail length. Trail erosion in excess of 10cm depth and root exposure was not evident in these sections (Table 6). In contrast, the Bald Head trail comprised 72.9% shrubland scrub heath with an almost continuous cover of *E. angulosa* and *A. flexuosa* (< 3m in height). These sections of trail, apparently sheltered from the effects of rain splash and wind erosion by the trailside trees, were badly eroded (see Table 6) and did not seem to benefit from the presence of high trailside vegetation.

Soils / substrate type

The assessed trails mostly traverse the fixed component of the coastal dune system comprising Tamala Limestone in association with unconsolidated nutrient poor medium to fine quartz sand, although 26% of the Bald Head Trail comprises exposed granite (Table 6). Exposed granite surfaces are not subject to measurable erosion but can influence the velocity of water running onto the adjoining trail, leading to root exposure, as was observed on the Bald Head trail (Table 6). Limestone karst features were noticeably vulnerable to compaction and deflation and occurred as exposed features on degraded sections of the Tarbotton trail (Bibbulmun Track) and the Bald Head trail.

Variable levels of organic matter were present in the surface soils. For example, 96% of the assessed portion of the Bibbulmun Track were classified Grey/Black soil indicating the presence of organic matter. The addition of organic matter and the development of soil horizons in coastal locations reflects stable surface conditions and is strongly influenced by vegetation type and the rate of water infiltration (Thompson, 1983; Jungerius and van der Meulen, 1988; Jungerius and Dekker, 1990). Organic matter also aids in reducing deflation by adding cohesion to sand particles (eg. Eldridge and Rosentreter, 1999) The role of organic matter, however, can be complex due to the development of water repellence from hydrophobic residues that coat sand grains at the soil surface (eg. Bridge and Ross, 1983; Thompson, 1983). Extreme dryness of surficial organic matter also contributes to water repellence (Jungerius and de Jong, 1989). This in turn reduces infiltration and where vegetation is sparse and ground is sloping increased run-off and erosion occurs as buoyant sand particles and organic matter are entrained in surface wash (Jungerius and van der Meulen, 1988). In contrast to the darker soils of the Bibbulmun Track, the Peak Head and Bald Head trails had a larger proportion of white sub-surface soil present on the trail tread and given the high levels of recorded degradation the colour reflects the creation of new surfaces as organic matter has been lost to lower-lying sections of the trail.

Slope and Degradation

Erosion categories have been combined to represent the total erosion from > 5cm. This is in order to simplify the comparison of trails and because each successive erosion category is also a contributor to the previous categories e.g. an erosion depth of 20cm also contributes to the lower

categories 5–9cm and 10–19cm. Figure 7 compares the extent of degradation (m/km) of the assessed trails in the study area.

Trail proliferation is most noticeable on the Bald Head trail occuring on sections of indistinct trail that are poorly signed and occur in the area of exposed granite outcrops. On both the Bald Head and Peak Head trails excessive width is generally the result of sections of trail being located on a dissused vehicle trail.

A comparative analysis of total erosion within slope categories for the assessed trails shows a proportional increase in erosion with increasing slope on the Bald Head and Peak Head trails. The Bibbulmun Track, in contrast to the Bald Head and Peak Head trails, shows minimal erosion with a noticeable lack of erosion for slope values >18° (Figure 8).

The Bibbulmun Track does not exhibit the same increase in total erosion with increasing trail slope that the Bald Head and Peak Head trails show, despite being the longest assessed trail (11.65 km). This is most likely due to: the way in which the trail is aligned on natural contours avoiding steep slopes; the type of vegetation communities (low forest and myrtaceous heath); presence of organic matter in the trail soil and the presence of effective maintenance features such as water bars, retaining boards and steps. Effective maintenance features help to inhibit erosion by slowing the velocity of surface water on the trail tread and stabilising the poorly consolidated sand on sloped sections of trail.

Maintenance Features

A comparison of non-continuous maintenance features that occur on the three assessed trails in the study area reveals that the Bibbulmun Track has the highest proportion (85%) of water bars, steps, signs, seats, bridges, and boot cleaning stations. Figure 9 represents a comparison of selected non-continuous maintenance features (water bars and steps) present in each slope category on the assessed trails in the study area. The presence of effective water bars and steps in sections of trail with a slope value of between 6–17° and >18° is the most likely reason that erosion is not evident on these sloped sections on the Bibbulmun Track in WCHNP (see Figure 8). It also appears that the installation of water bars in sections of slope 18° > has been abandoned in preference of the construction of steps and stairs. This represents a good management decision, as steps level the soil surface reducing the velocity of surface water on the trail, even if the steps are only in moderate condition. Average tread of steps designed for steep slopes should be less than 1m to enhance this attribute (Parks and Wildlife Service Tasmania, 1994). Moreover, water bars can become covered in sediment and no longer operate effectively to slow any surface water flow, they require regular maintenance to clear away debris and are probably not as effective as steps, on steep slopes.

Of the three assessed trails, the Bibbulmun Track has the highest percentage (58%) of continuous maintenance

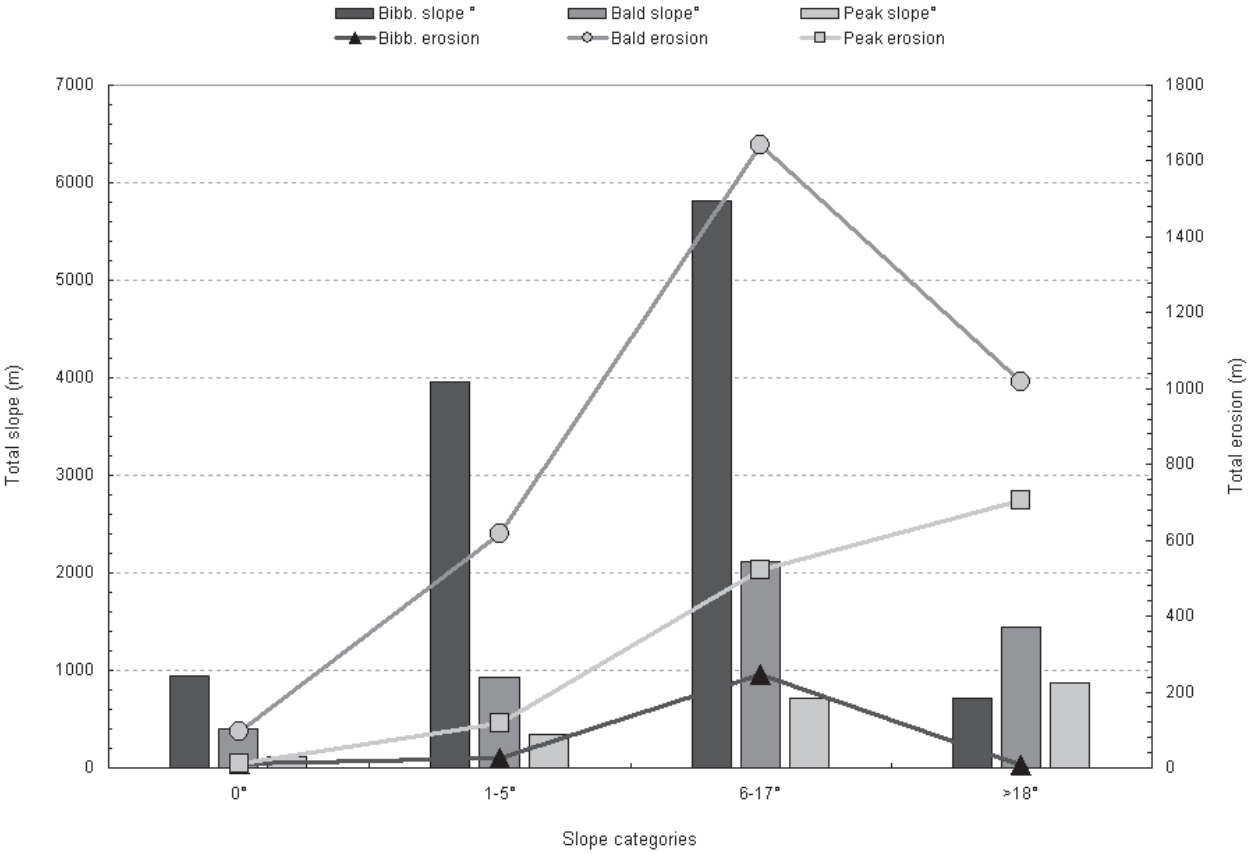

Figure 8. A comparison of slope categories and total erosion on the assessed trails in the study area

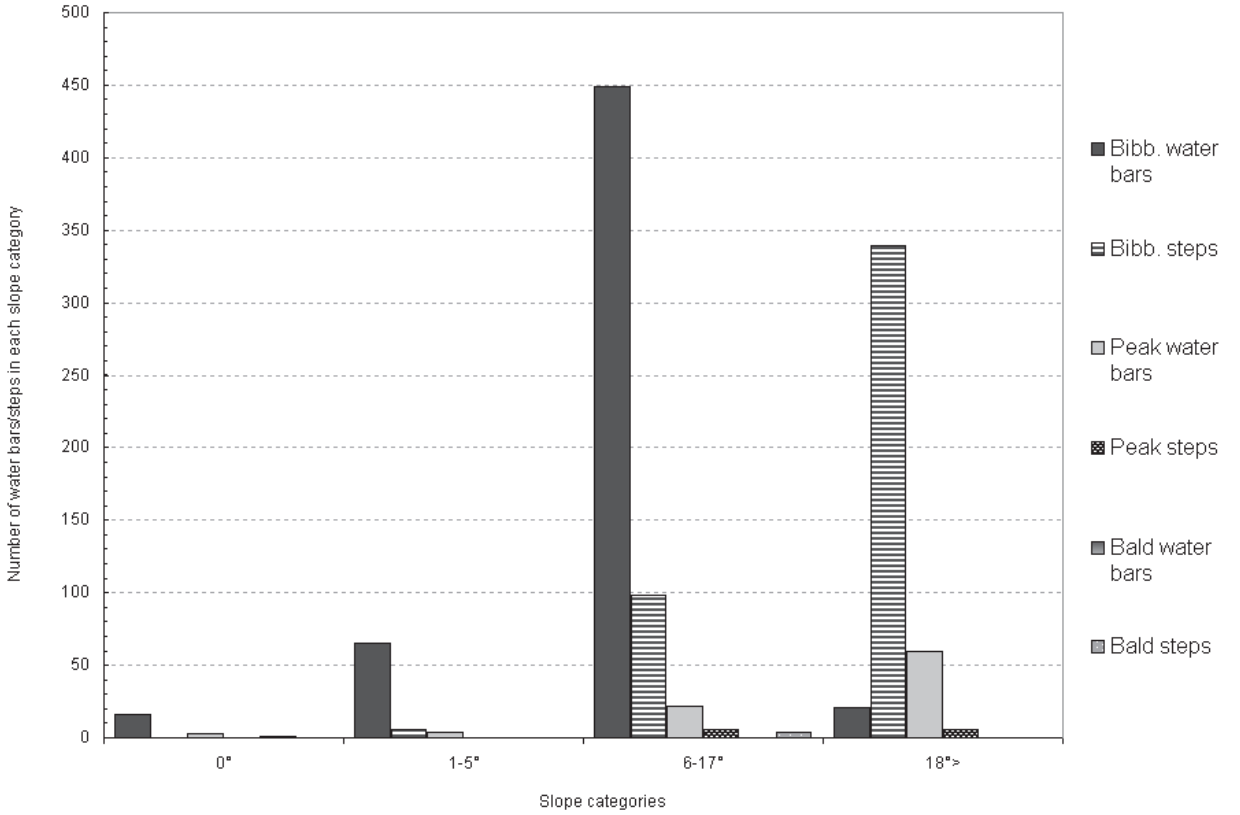

Figure 9. A comparison of the number of steps and water bars in each slope category on the assessed trails in the study area

features such as board-walks, zones of wood chip application, groups of steps (stairs), retaining boards and rubber belt surfacing. The remaining continuous maintenance features are the Bald Head board-walk (41%) and the Peak Head stairs (1%). The charring of sections of board-walk on the Tarbotton trail due to the damaging effects of wild fire (Figure 10) has not lowered the effectiveness rating which was moderate-excellent to excellent. The decline in the condition of these maintenance features is representative of their age (~ six yrs). Moreover, as long as the surface of the feature receives and disperses the weight of the walker, compaction and movement of the trail soil is averted. Because walkers are confined to a narrow board-walk, the trampling of trailside vegetation is averted.

Moderate–poorly effective maintenance features on the Bibbulmun Track such as water bars were mainly located on the Tarbotton trail. The shear number of water bars on the Bibbulmun Track (551) meant that some water bars had attracted a moderate-poor effectiveness rating because they had been undercut by deflation. The non-continuous maintenance features on the Bald Head trail were mainly directional signs on exposed granite and were sometimes difficult to detect from a distance, leading to disorientation that can ultimately lead to trail proliferation. Water bars on the Peak Head trail were mainly of poor

Figure 10. A charred board-walk with split cross tread and protruding nails, moderate-poor condition but moderate-excellent / excellent effectiveness rating for Bibbulmun Track in WCHNP

effectiveness and did not seem to be arresting erosion as well as the numerous exposed tree roots that were acting as surrogate water bars on severe sections of trail degradation. A water bar should be aligned on a 45–60° angle to the trail. Water bars that were positioned at 90° in relation to the trail and lacked the angle necessary for the diversion of surface water appeared to create a lip that surface water could fall over and erode the soil at the base of the water bar (Figure 11). In some cases it was difficult to establish whether or not the feature was meant to be a water bar or a step. Groups of steps on slopes > 10° with widely spaced treads were observed to be eroded at the stair base due to the effects of vertical water spillage over the step lip. The effectiveness rating of grouped steps on slopes > 10° was markedly increased if the tread space between each step was < 1m with 60cm treads being suggested as a standard for single lane walking trails in Tasmania (Parks and Wildlife Service Tasmania, 1994). Mende and Newsome (2006) in their assessment of walking trails in the Stirling Range National Park, south-western Australia, noted that the effectiveness of a maintenance feature was not necessarily dependant on its condition but related more to the proper placement of the feature and the number of such features along a given trail. This was also observed to be the case from the results of the assessment for the three assessed trails in this study.

SUSTAINABLE TRAIL MANAGEMENT ALONG THE COASTAL ZONE OF SOUTH-WEST WESTERN AUSTRALIA

Basis for a Monitoring Program

The collection of census data for the trails in the study area has provided a comprehensive profile of the present trail conditions for the Bald head and Peak Head Trails and for the assessed section of the Bibbulmun Track. By using the initial census as the baseline data to create a monitoring program, any subsequent census will be able to detect changes in trail conditions when compared to the baseline measurements. Census techniques, however, are not suitable for repeated measures of very long trails (>10km) such as extended sections of the Bibbulmun Track due to the constraints of time and money commonly faced by land management agencies. One option would be to undertake a preliminary observational assessment looking for a basic indicator of degradation such as trail erosion depth greater than 10cm e.g. Tarbotton trail (Figure 2). The start and finish of problem sections could be recorded by a GPS system to facilitate a more efficient and comprehensive census of the problem sections at a later date.

Trails such as the Bald Head and Peak Head trails are

Figure 11. Water bars (left) with a tread space > 1m showing water erosion at the base of each bar due to the on trail waterfall created during surface water flow. Grouped steps (right) on a steep slope with a tread space of < 1m, show no signs of water erosion or soil movement. Bibbulmun Track in WCHNP

relatively short and therefore census techniques can be applied to the whole trail at a rate of approximately 3km per day. Point sampling techniques were chosen for selected degraded sections on the Peak Head and Bald Head trails using Point Intercept Frame (PIN) measurements. This was done to collect a series of cross sectional trail profiles, repeated over time to establish changes in soil micro-topography on deeply incised sections of sloped trail that represent some of the most severe degradation on these two trails. A complete review of the PIN frame methods can be found in Phillips and Newsome, (2002) with the methods and results for this study in Randall (2004).

Suitability of Methods for Sandy Coastal Environments

The application of the trail problem assessment method (Leung and Marion, 1999) to sandy coastal environments therefore appears to work well. Leung and Marion (1999) suggest that changes can be made to the methods they developed to collect census data on trail conditions, such as including different types of indicators for different environments. Standards for indicators such as trail erosion depth and root exposure were chosen following preliminary field trips to establish the extent of these problems and therefore assign suitable categories that were representative of the host environment. Vegetation communities were largely specific to the sandy coastal environment. Soil type, although broadly uniform was categorised into two main groups, grey or white, aided by the inclusion of the general trail condition categories, firm or loose, which showed a strong relationship with the soil categories (i.e. grey-firm and white-loose) in preliminary strip graph interpretation analysis (Randall, 2004).

An analysis of the results has shown that the management and planning efforts responsible for the creation of the Bibbulmun Track in WCHNP have been very effective in designing a trail for a sandy coastal environment that will not easily degrade. The comparative analysis of the three assessed trails, made possible by the census data, has been a useful way of evaluating the suitability of the trail design techniques used on the Bibbulmun Track. Information produced as a result of census data can also help in anticipating the logistics of applying those techniques to the Bald Head and Peak Head trails for maintenance work or trail realignments.

The issue of increasing trail usage

The increasing popularity of outdoor recreation and hiking in natural areas points to increased usage of the Bibbulmun Track and other walk trails in the Great Southern District of Western Australia. In order to understand the relationships between usage and trail deterioration it is crucial to establish a database of visitation to trail networks. Electronic counters are probably the best way of recording data that is accurate, as end-of-trail log books can be notoriously unreliable. However, the location of a trail counter has an influence on the accuracy of the data gathered as a result. For example in the case of the Bald Head trail, the data logger that recorded trail usage between 1996–1999 (Figure 5), was positioned at the beginning section of the trail (car park end) and would not represent those walkers that did not complete the whole trail. A more reliable way of recording trail usage and exploring the relationships between use factors and degradation would be to position a trail counter on a known problem section. Temporal changes in erosion on and off the trail could then be recorded by point sampling techniques at the same location the counter is positioned and thus related to trail use with an increased level of confidence.

Limitations of the approach applied in this study

Leung and Marion (1999) suggest that when undertaking large scale trail surveys that involve multiple recorders, error arising from subjective decision making can be reduced by training staff with written and photographic descriptions and by constantly rotating multiple staff who record in teams. A series of photographs and written descriptions was included in this project and will aid in reducing this source of error should a future monitoring program evolve.

Some inaccuracies are possible if repeated as a monitoring program. This can be apparent when a subjective decision, made by the recorder as to the correct location of the start and finish points of degradation or environmental indicators and correctly allocating standardised variables such as percentage root exposure, the condition and effectiveness of maintenance features and the severity of trail proliferation. It is recommended that the original recorder repeats any subsequent survey, or that training of new staff is undertaken prior to the commencement of a subsequent survey program. Despite such limitations the approach has proved to be useful in validating the planning and management effort applied to the assessed section of Bibbulmun Track and in confirming that trail alignment following natural contours and the installation of maintenance features such as board-walks, water-bars and steps on sloped sections are crucial to sustainable trail management.

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Table 1

Vegetation communities of fixed dunes and granite monadnocks in the study area

	Vegetation Community	Characteristics
Low Forest		Stunted trees < 10m three different associations *Eucalyptus marginata, Allocasaurina fraseriana* and *Melaleuca cuticularis.* Other spp. include *Banksia* spp., *Dryandra* spp.
Shrubland	Scrub Heath	Occurs on inland coastal strip Dominant trees < 4m *Agonis flexuosa* and *Eucalyptus angulosa* in association with a Proteaceous upper layer of tall shrubs and a Myrtaceous lower layer. Other Spp. include *Adenanthos sericeus, Templetonia retusa* and *Hardenbergia comptoniana*
	Heath	Closed lower layer of dwarf shrubs < 60cm, Species diverse, often Myrtaceous dominant, independent or in association with scrub heath with scattered shrubs of *A. flexuosa* and *E. angulosa* occurring as stunted ecotypes. Other spp.include *Hakea prostrata, Scaveola crasifalia, Loxocarya cinerea* and *Adenanthos obovatus*
Rock Outcrop		Mosses, grasses and scattered shrubs *Anthocercis viscosae, Agonis marginata, Hakea elliptica* and *Dryandra formosa*

source: Beard (1979)

Table 2

Total visitors: Great Southern District 1993-2003 and percentage comparison, WCHNP and TNP

Great Southern District	TNP	WCHNP
4,338 606	1,749 199	297, 539
100%	40.3%	6.9%

source: CALM (2004)

Table 3

Indicators used to evaluate walk trails by the problem assessment method

Environmental	Degradation	Maintenance Features
Vegetation community	Erosion depth	Bridge, board-walk, boot cleaner, excluding devices, fences, retaining boards, seats, water-bars, steps, signs, woodchip and rubber belt surfacing
Rock type	Excessive trail width	
Soil texture	Exposed roots	
Slope°	Trail proliferation	

Table 4

Categories used to measure trail erosion depth and excessive width

Category		Description
< 5cm	(N)	normal level of soil compaction between trail-side berms
5 - 9cm	(E1)	trail depth between 5cm and 9cm
10 – 19cm	(E2)	trail depth between 10cm and 19cm
20cm >	(E3)	trail depth 20cm or greater
60 –120cm	(W1)	trail width between 60 –120cm
> 120cm	(W2)	trail width greater than 120cm

Table 5

Maintenance features and ratings description used during trail assessment

Continuous	Non-continuous	Condition/effectiveness rating
board-walk, wood chips and rubber belt surfacing, retaining boards, fence, stairs (multiple steps)	bridge, seat, water- bars, step (single) boot cleaning station (removes fungal pathogens from footwear)	1 excellent 2 moderate to excellent 3 moderate 4 moderate to poor 5 poor

Table 6

Combined results of the assessed section of the Bibbulmun Track WCHNP and the Bald and Peak Head trails in TNP

Bibbulmun Track 11.65 km	Bald Head Trail 6.55 km			Peak Head Trail 2.18 km					
	Occurrence (n)	Total (m)	% of trail	Occurrence (n)	Total (m)	% of trail	Occurrence (n)	Total (m)	% of trail
Trail impact indicator									
Excessive width (total)		265	2.3		698	11		104	4.8
Category									
Width 60-120cm	2	36	0.3	9	223	3.4	2	14	0.6
Width > 120cm	2	229	2.0	15	475	7.2	4	90	4.1
Erosion depth (total)		292	2.5		3341.4	51.0		1359.9	62.1
Category									
5-9cm	18	227	1.9	92	1680.9	25.7	17	852.3	38.9
10-19cm	6	59	0.5	59	768	11.7	8	394	18
> 20cm	1	7	0.1	32	892	13.6	37	113	5.2
Exposed roots (total)		32	0.3		504	7.7		649	29.7
Category									
3-5%	0	0	0	5	67	1	0	0	0
6-10%	1	8	0.07	12	148	2.3	19	427	19.5
11-20%	2	13	0.11	9	81	1.2	9	163	7.4
> 20%	2	11	0.09	5	209	3.2	5	60	2.7
Trail proliferation (total)	21	100	0.8	39	396	6		11.9	1
Severity 1-5									
1 low	8	75	0.6	3	98	1.5	0	0	0
2	4	14	0.1	10	63	1	3	11.9	0.5
3	3	11	0.1	6	192	2.9	0	0	0
4	0	0	0	1	7	0.1	0	0	0
5 high	0	0	0	2	36	0.5	0	0	0
Slope º									
Category									
0 º		942.3	8.1		406.5	6.2		107.3	4.9
1-5 º		3959.1	34.0		929.6	14.2		343	15.7
6-17 º		5816.1	49.9		2118.1	32.3		720.1	32.9
18 º >		711.2	6.1		1436.2	21.9		873.8	39.9
Vegetation Community									
Low Forest		486.9	4.2		0	0		0	0
Shrubland Scrub Heath		8247.2	70.7		4779.1	72.9		625.1	28.6
Shrubland Heath (limestone)		2655.9	22.8		9.2	0.1		1304.2	59.6
Shrubland Heath (granite)		18.9	0.2		166.9	2.5		134.9	6.2
Rock Outcrop		249	2.1		1597.6	24.4		124.3	5.7
source: Beard (1979)									
Soil Type (standardised)									
White (sand)		0	0		1805.5	27.6		156.4	7.1
Grey / black (+ organic matter)		11196.3	96.1		2506.3	38.3		1805	82.5
Conditions (underfoot)									
Loose		26.3	0.2		1808.8	27.6		367.4	16.8
Firm		11170	95.8		2225.8	34		1602.9	73.2
Rocky		461.5	3.9		1968.8	34.2		218.2	10.5
Rock Type									
Granite		309.3	2.6		1691.7	25.9		219.4	10.1
Limestone		152.2	1.3		549.3	8.3		7.7	0.4

Table 7

Maintenance features present on the Bibbulmun Track in WCHNP

Category	**Continuous =1236.8 m**		**Non-continuous n=661**	
Condition	Total (m)	% of total length (m)	Total (n)	% of total
excellent	136.9	11.1	97	14.7
moderate-excellent	611.9	49.5	554	83.8
moderate	486.3	39.3	7	1.1
moderate-poor	1.7	0.1	1	0.2
poor	0	0	1	0.2
Effectivness				
excellent	615.5	49.8	85	12.7
moderate-excellent	513.3	41.5	393	59.5
moderate	75.6	6.1	72	10.9
moderate-poor	32.4	2.6	104	15.7
poor	0	0	6	1.1

Table 8

Maintenance features present on the Bald Head Track

Category	**Continuous =556.4 m**		**Non-continuous n=76**	
Condition	Total (m)	% of total length (m)	Total (n)	% of total (n)
excellent	0	0	8	10.5
moderate-excellent	50.2	9	42	55.3
moderate	369.3	66.4	22	28.9
moderate-poor	136.9	24.6	4	5.3
poor	0	0	0	0.0
Effectivness				
excellent	0	0	8	10.5
moderate-excellent	556.4	100	36	47.4
moderate	0	0	29	38.2
moderate-poor	0	0	3	3.9
poor	0	0	0	0.0

Table 9

Maintenance features present on the Peak Head Track

Category	**Non-contiuous n= 124**
Condition	Total (n) % of total (n)
excellent	4 3.2
moderate-excellent	111 89.5
moderate	10 8.1
moderate-poor	0 0
poor	0 0
Effectivness	
excellent	4 3.2
moderate-excellent	33 26.6
moderate	27 21.8
moderate-poor	13 10.5
poor	48 38.7