AN INTEGRATED FRAMEWORK FOR DEVELOPING ECOLOGICAL INDICATORS OF VISITOR USE OF PROTECTED AREAS

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SUMMARY

Objectives

Protected area managers need to monitor the ecological impacts of visitor use and assess their performance in managing visitor use. To assist this process the Sustainable Tourism Corporative Research Centre (STCRC) has established a series of projects to develop indicators and protocols for assessing visitor use and its impacts that can be used as part of an integrated monitoring system for protected areas. The aim of this report was to evaluate existing information related to the development of impact indicators and how these might be applied to the management of visitor impacts in protected areas. The objective was to develop an integrated framework that would deliver a range of indicators appropriate at a variety of park management levels.

Report Overview

This report evaluated the tourism, biodiversity and environmental management literature to consolidate existing information and methods currently used, to monitor visitor use in protected areas. The report presents an integrated framework that has been developed to assist protected area managers to focus monitoring efforts that can be implemented at various scales tailored to meet the visitor management use requirements in individual protected areas. This report drew upon consultation with an industry reference group, scientific reference group and other organisations involved in evaluation and an extensive review of the international literature.

In the process of formulating this integrated framework the report presents a series of chapters that evaluated the role of specific facets, such as visitor impacts and the use of ecological indicators, before combining these into the proposed framework. The report then goes on to provide an example of how the framework can be applied in monitoring the ecological impacts of visitors to protected areas and also provides recommendations for adopting an adaptive management response to improve protected area management in the face of increasing visitation.

The report provides the evaluation in a series of individual chapters that enable the reader to follow the process of formulating the proposed new framework by evaluating past and current practices. Chapter 1 describes the objectives and methods used to develop this report.

Chapter 2 provides a general overview of visitor use of Australian protected areas and a literature review of visitor impacts. The need for monitoring and assessment of visitor use is also discussed.

Chapter 3 provides an evaluation of ecological indicators that can be used for monitoring visitor impacts including summarising criteria those indicators must meet. How protected area managers can select ecological indicators tailored to their park is then described. The chapter highlights how indicators can cover multiple spatiotemporal scales to allow visitor impacts on the composition, structure and function of ecological communities to be monitored.

Chapter 4 contains a review of the most commonly used visitor management frameworks, including an evaluation of their strengths and weaknesses and how they deal with ecological complexity. Current visitor management frameworks commonly use or adapt elements from general ecological monitoring frameworks but are not usually integrated into a general evaluation framework (such as the World Commission on Protected Areas management evaluation framework).

Chapter 5 introduces the IUCN WCPA protected area management evaluation framework and the recently expanded IUCN WCPA framework based on Worboys (2007) PhD research including the concept of core evaluation subjects and their relevance for visitor impact evaluation.

Based on the reviews in Chapters 2 to 5, Chapter 6 presents the proposal for an integrated framework (see overleaf) for selecting ecological indicators of visitor impacts and guidelines for how this might be applied in the field. The framework is a six stage process of evaluation and aims to facilitate the identification of a hierarchy of indicators (A through D in the figure) addressing site level through to park level requirements.

In the final chapter the next step in this project is described where the framework is tested, and clear user friendly monitoring protocols are developed to guide managers in implementing effective monitoring programs for walking tracks. Some of the requirements for implementing monitoring including the need for baseline values and thresholds for change are introduced. The utility of the framework for adaptive management and how it can be incorporated into wider performance reporting frameworks is also demonstrated. Finally the capacity of management agencies to monitor visitor impacts is discussed.

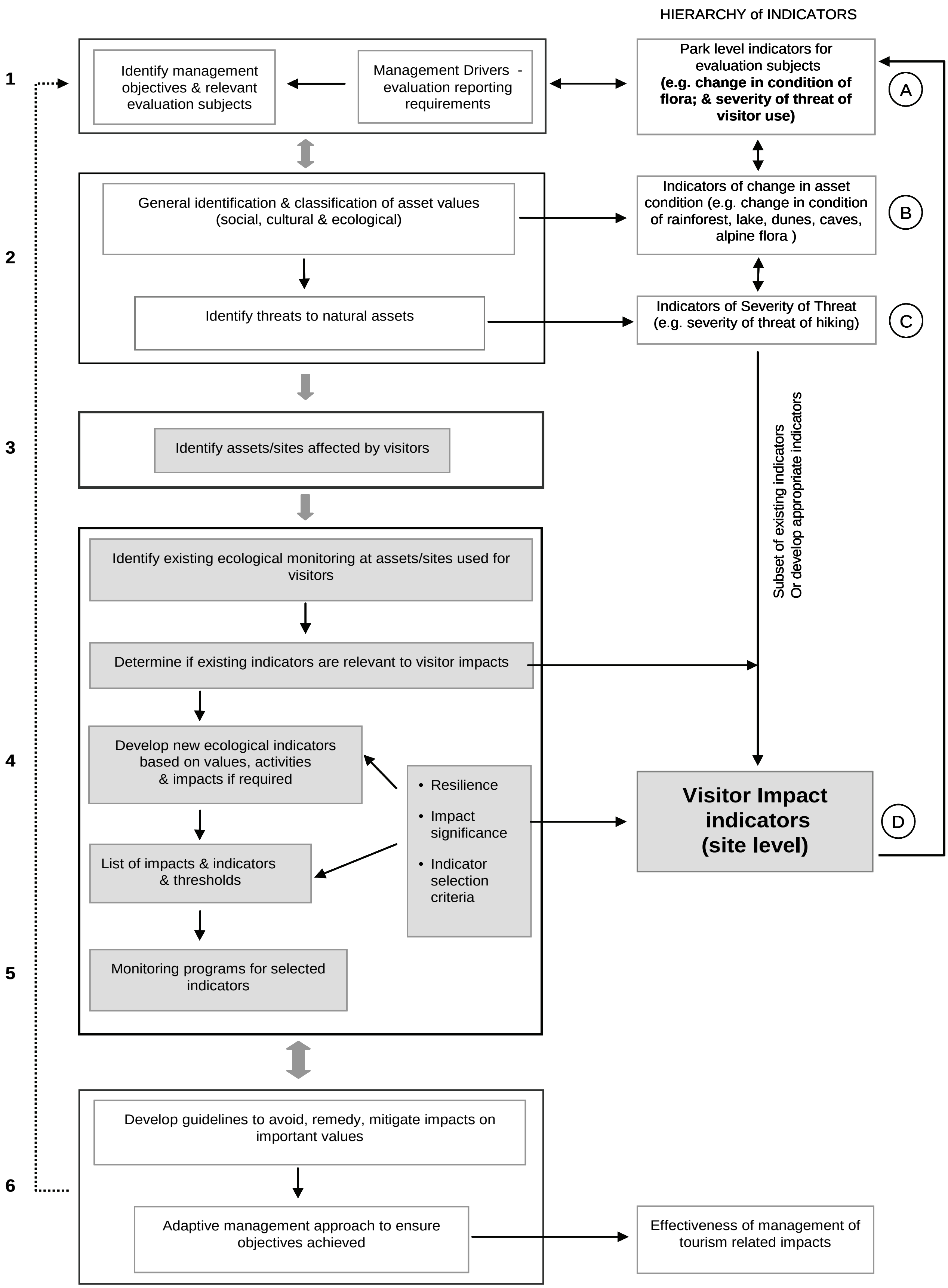

Figure 1 Integrated framework for developing ecological indicators of visitor impacts in protected areas

Key Findings

- Visitor monitoring needs to be integrated into a general framework for evaluating the effectiveness of management.
- There are numerous frameworks for managing visitors that have strengths and weaknesses, but are not widely used in Australia and do not effectively link visitor monitoring with overall management evaluation.
- The integrated framework does link visitor monitoring with overall management assessment. It is based on the expanded WCPA evaluation framework and clarifies how:
  - visitor monitoring fits into overall management evaluation of a park
  - monitoring findings can be used to improve management of visitors at sites.
- When using the integrated framework it is possible to:
  - prioritise sites for visitor monitoring
  - identify appropriate indicators that could be used by protected area agencies.

The framework consists of six steps:

- identifying management objectives and relevant evaluation subjects
- classifying natural assets and threats to those assets
- prioritising sites for visitor monitoring
- selecting ecological indicators of visitor impacts
- developing monitoring programs for indicators
- using results to improve future management (adaptive management).

At various stages in the framework the opportunity exists to identify a series of indicators in a hierarchical fashion ranging from site level indicators, to indicators of threats, indicators of change in asset condition and park level indicators for evaluation.

Future Action

The next stages of this project are to:

- review Australian best practice visitor monitoring and reporting in World Heritage areas
- develop monitoring protocols for an example activities/infrastructure, in this case walking tracks.

In order to do this the park manager must have information on:

- establishing baseline values for natural sites selected for visitor monitoring
- choosing appropriate monitoring protocols and techniques, including measurement techniques
- choosing appropriate techniques and procedures for data analysis and interpretation
- integrating monitoring data into an adaptive management framework.

Chapter 1

INTRODUCTION

Objectives

Protected area managers need to monitor the ecological impacts of visitor use and assess their performance in managing visitor use. To assist this process the Sustainable Tourism Corporative Research Centre (STCRC) has established a series of projects to develop indicators and protocols for assessing visitor use and its impacts that can be used as part of an integrated monitoring system for protected areas. The aim of this report was to evaluate existing information related to the development of impact indicators and how these might be applied to the management of visitor impacts in protected areas. The objective was to develop an integrated framework that would deliver a range of indicators appropriate at a variety of park management levels.

Methodology

This report presents an evaluation of international tourism, biodiversity and environmental management literature to consolidate existing information, and methods currently used, to monitor visitor use in protected areas. This approach was chosen in consultation with a scientific reference group (members from STCRC, International Centre for Ecotourism Research and Griffith University) given the breadth of the field and that individual protected areas will have site specific visitor impact monitoring requirements. The first part of the report was a detailed evaluation of i) visitor impacts in protected areas, ii) the use of ecological indicators and their potential for monitoring visitor impacts, iii) existing frameworks developed for monitoring and managing visitor use in protected areas and iv) frameworks for evaluating management effectiveness of protected areas.

The second part of the report used this detailed evaluation, outlined above, to develop an integrated framework that is based around the lessons learnt from previous research. The new framework aims to prioritise visitor impact monitoring by encouraging managers to i) identify critical park assets, ii) review the vulnerability of such assets and iii) specifically assess the pressure from visitors. In presenting the new framework the report provides detail of each of the six steps that are central to the use of the framework.

The final part of the report then provides an example of how the new framework can be applied using an example. The report presents a suggested integrated framework that can be implemented at various scales to meet the visitor management use requirements in protected areas.

Once completed the draft report was circulated to the scientific reference group (five members) as well as an industry reference group for comment. The industry reference included representatives from Parks Victoria, Conservation and Land Management, Western Australia, Tasmanian Parks and Wildlife Service and the New South Wales Department of National Parks and Wildlife Service. Feedback and comments received from these two groups were then incorporated into the final report.

Chapter 2

REVIEW OF VISITOR IMPACTS IN PROTECTED AREAS

Protected Areas

Protected areas are one of the main strategies by which Australia fulfils its national and international obligations to conserve biodiversity (Worboys *et al*. 2005). Ideally they allow for sustainable use of the landscape without compromising biodiversity or other intrinsic environmental or cultural values. A protected area is defined by the IUCN World Commission on Protected Areas (IUCN, now the World Commission on Protected Areas—WCPA) as 'an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources and managed through legal or other effective means' (IUCN 1994).

In Australia, over 80 895 000 ha (more than 10% of the land) is conserved in over 7720 protected areas (CAPAD 2004, Table 1). There are at least 50 categories of reserve types from specific-purpose areas such as scientific reserves to very large multi-zoned areas such as the Great Barrier Reef World Heritage Area (Worboys *et al.* 2005). The WCPA definition of protected areas and its six level system describing management intent was adopted by Australia in 1994 (Environment Australia 2003).

Australian protected areas are managed by nine separate jurisdictions; six state agencies, two self-governing territories and the Commonwealth in accordance with principles set out by the WCPA for protected areas and World Heritage legislation (Worboys *et al*. 2005).

Table 1 Extent of Australian terrestrial protected areas categorized by IUCN—World Conservation Union Protected area management categories (CAPAD 2004).

WCPA Category	Purpose	Number	Area (ha)
IA	Mainly for science	2090	18 212 695
IB	Mainly for wilderness protection	38	4 099 515
II	Mainly for ecosystem protection and recreation	644	29 678 100
III	Mainly for conservation of specific natural features	2019	970 517
IV	Mainly for conservation through management intervention	2060	2 818 936
V	Mainly for landscape/seascape conservation and recreation	139	919 746
VI	Mainly for sustainable use of natural ecosystems	730	24 195 591
Total		**7720**	**80 895 099**

Visitors and Protected Areas

Tourism is one of the world's fastest growing industries and nature-based tourism is one of its largest components (Newsome *et al.* 2002; UNEP 2003). Increases in the demand for nature based tourism and recreation are closely linked to supply and in many cases this is provided by protected areas (Carey *et al.* 2000). The challenge is for protected areas to provide these services in a sustainable fashion. These global trends are also found in Australia where much of the pressure for nature based tourism and recreation is focused in and around protected areas, which received over 108 million visitors during 2004–05 (Worboys 2007). The tourism industry contributes 4% to the national GDP (ABS 2006) a decline from about 5% in the early 1990s but still more than the entire agricultural sector (Preece *et al.* 1995).

Visitor Impacts in Protected Areas

Visitor use of protected areas needs to be managed, as overuse or inappropriate use can, and has caused adverse impacts (Tables 2 and 3 and references therein). Some of the key threats associated with visitor use include disturbance to wildlife, introduction and spread of exotic species, pollution of water, soil erosion, damage to vegetation and escaped fires that cause bushfires (Liddle 1997; Newsome *et al*. 2002; Buckley 2004). In addition to these environmental consequences, overuse or inappropriate use can also reduce the quality of the visitor experience (Belnap 1998, Manning 1999a, Leung & Marion 2000, Choi & Sirakaya 2006).

There are numerous frameworks and models, policies and plans that have been developed to manage visitors and minimise their ecological impacts. These usually recommend or stipulate monitoring of appropriate ecological indicators to provide information on changes in the condition of the environment. Protected area managers need to know about these frameworks and how to select appropriate indicators for monitoring. The most commonly used visitor management frameworks are reviewed in Chapter 3 of this report.

The ecological impacts of recreation activities in protected areas have been studied in Australia (Wilson *et al.* 2004, Turton 2005) and overseas. The following section summarises important impacts of specific recreational activities on components of the ecosystem as well as key Australian references on recreation impacts in a series of tables.

- Table 2 summarises direct and indirect ecological impacts of visitor use on soil, vegetation, wildlife, waterways and water bodies and landscape features. Specific causes and effects are identified.
- Table 3 summarises visitor activities affecting aquatic ecosystems.
- Table 4 provides references for general reviews of ecological impacts of visitor use with an emphasis on Australian research.
- Table 5 provides references for recent Australian studies of ecological impacts of specific visitor activities.
- Table 6 provides references for recent Australian studies of visitor use impacts on specific ecosystem components.
- Table 7 provides references for recent Australian studies of impacts of infrastructure on specific ecosystem components.

Summary of Key Findings

Recreation ecology research and research into the management of visitors in parks have highlighted that:

- visitor use of protected areas is rarely systematically monitored
- monitoring visitor use is increasingly considered a responsibility of protected area managers
- visitor use of protected areas has a range of impacts that need to be managed, minimised, monitored, reduced and rehabilitated
- activities vary in the amount and type of damage they cause
- some visitor impacts are intense and localised, like aquatic systems where this is almost always the case
- some visitor use impacts last decades or centuries and some are irreversible
- there is a range of secondary effects of visitor use, only some of which are recognised
- ecological communities vary in their resistance and resilience to visitor-mediated damage
- increasing use often results in increasing environmental damage
- monitoring programs need to be localised to detect visitor use impacts
- general ecological monitoring will not usually detect localised impacts of visitor use
- hardening of the habitat is a common response by managers, but is not necessarily always appropriate
- there is a clear need for more research in different ecosystems to identify/quantify/understand the range and intensity of impacts, both direct and indirect.

Table 2 Summary of direct and indirect ecological impacts of visitor use on components of terrestrial ecosystems

Ecosystem component	Impact	Cause (visitor use)
Soil		
Direct impact	Alteration to structure and composition through - compaction - loss of organic litter	• construction of infrastructure • camp fires • disposal of human waste • burying rubbish
	Physical erosion of soils and parent material - loss of soil	• track erosion • constant use of tracks impacts surrounding areas • damage to vegetation allows water and wind to remove soil • tracks redirect water flows
Indirect impact	Reduced soil moisture Reduced soil pore space Reduced microbial activity	• soil compaction with use • altered runoff patterns • change in soil chemistry/moisture/airspaces
Geological features (e.g. caves, lakes, hot pools, dunes, river margins, peri-glacial features, rock formations)		
Direct impact	Physical damage (e.g. breakage, graffiti)	• high impacts use (rock-climbing, mountain biking, horse-riding etc.)
Indirect impact	Reduced visual appeal Soil erosion & changes in hydrology in adjacent areas	• high impacts use (rock-climbing, mountain-biking, horse-riding etc.)
Landscape - general		
Direct impact	Alternation to vegetation structure Alteration to land shape/landscape	• camping, recreational trampling, off road vehicle use, mountain bikes, snow mobiles, snow groomers, quad bikes, collecting wood for fires, use of camp fires
Indirect impact	Reduced visual appeal	• camping, recreational trampling, off road vehicle use, mountain bikes, snow mobiles, snow groomers, quad bikes, collecting wood for fires, use of camp fires
Wildlife		
Direct impact	Disruption of activity - breeding patterns - feeding /foraging - parental behaviour - other behaviour	• visitor behaviour (photography, light, sound), visitor use intensity (crowding) • light sound etc. from adjacent areas where construction of visitor facilities
	Disruption of habitat	• physical disruption to vegetation and soils from infrastructure, and activities • physical change from introduction of weeds • disruption from feral animals • supplemented food • Inappropriate wildlife watching behaviour e.g. boats too close to marine birds, crocodiles, seals etc.
	Direct killing or injuring	• road accidents • hunting, fishing and collecting
Indirect impact	Reduced health Increased mortality Reduced reproductive rates Change in species Change in composition of communities	

Vegetation		
Direct impact	Loss of ground cover Reduced height, growth Reduced reproduction Reduced biomass Loss of species Tree trunk damage	Camping, recreational trampling, off road vehicle use, mountain bikes, snow mobiles, snow groomers, quad bikes, collecting wood for fires, use of camp fires
Indirect impact	Introduction and spread of exotic species	Introduction on visitor equipment and clothing
	Change in community species composition Change in community age structure composition Altered growth rates Altered microclimate	

Sources: Buckley (2004); Cole (1985); Green & Higginbottom (2001); Hadwen & Arthington (2003); Hadwen *et al.* (2003); Hadwen & Bunn (2004); Hadwen & Bunn (2005); Hadwen *et al.* (2005a); Hadwen *et al.* (2005b); Hall & McArthur (1993); Kuss *et al.* (1990); Leung & Marion (2000); Liddle (1997); Newsome *et al.* (2002, 2004); Parliamentary Commissioner for the Environment (1997); Sun & Walsh (1998); Ward & Beanland (1996).

Table 3 List of activities undertaken by visitors that may influence the health of aquatic ecosystems within protected areas

Activity	Spatial Extent	Temporal Extent	Potential Impact on Aquatic Ecosystems
Trampling—track erosion	Local and intense	Long lasting	Changed runoff characteristics; increased delivery of sediment and possibly nutrients and organic matter to water-bodies
Trampling—campsite compaction and runoff	Local and intense	Long lasting	Loss of buffer zone function Increased nutrient loads Increased sediment loads Reduced in-stream habitat
Trampling—riparian zone vegetation	Local and patchy	Long lasting, gradual changes over time	Loss of buffer zone function Increased nutrient loads Increased sediment loads Reduced in-stream habitat
Trampling—littoral zone vegetation	Local and intense	Long lasting	Loss of in-stream habitat Loss of sediment stability Increased nutrient availability due to sediment re-suspension
Trampling—bank stability	Local and intense, or dispersed and variable	Long lasting	Changed erosional processes Changed channel morphology Modified aquatic habitat
Trampling—sediment transport at access points	Local and intense	Long lasting with gradual changes over time	Sediment deposition can change in-stream habitat Increased nutrient loads
Terrestrial weed dispersal	Broad and patchy	Long lasting with gradual changes over time	Changed riparian zone structure and composition and associated OM subsidies Changed in-stream habitat due to loss of LWD Altered food webs due to modified OM inputs and rates
Aquatic weed dispersal	Broad and patchy	Long lasting with gradual changes over time	Changed in-stream habitat and resources Changed flow and hydraulic characteristics
Camping—compaction of soil	Local and intense	Long lasting	Increased runoff and nutrient delivery Loss of riparian zone habitat and structure
Camping—littering	Broad and patchy	Short term peaks, particularly around weekends and holiday periods	Physical entrapment and killing of biota Deposition zones can collect high loads of garbage Chemical pollutants associated with plastics can be toxic to organisms
Camping—human wastes	Local and intense	Short term peaks, but some capacity for long lasting effects	Increased nutrients and associated algal growth Human health concerns—E. coli and other microbial contaminants
Camping—microbial contamination	Local and intense	Short term peaks, but with some capacity for lasting effects	Human and wildlife health concerns
Camping—use of detergents and soaps	Local and patchy	Short term peaks—effects of residence times and bioaccumulation capacity is largely unknown	Changes in water surface tension Changes in DO dissolvability Addition of nutrients, particularly phosphates Toxicity to flora and fauna

Activity	Spatial Extent	Temporal Extent	Potential Impact on Aquatic Ecosystems
Campfires—delivery of ash to waterways	Local and patchy	Nightly contributions? Peaks possible during busy period	High POM—changes in in-stream microbial productivity Light attenuation due to increased turbidity—may influence algal production
Campfires—removal of wood and riparian vegetation	Local and intense	Constant, or peaks with increasing demand during busy periods	Increased light and nutrients, loss of buffer zone function, increased sediment delivery Changes in in-stream habitat and loss of riparian subsidies
Campfires—runoff from fire pits	Local and patchy, but possibly intense within patches	Intermittent delivery—peaks during storm events	Increased turbidity due to high particulate organic matter loads Reduced light penetration and algal production Increased microbial production
Campfires—litter and unburnt matter	Local and patchy	Intermittent	Potential change in in-stream habitat Delivery of contaminants and toxic pollutants
Swimming—sediment re-suspension	Local and patchy, but intense at access points	Constant (ramp or press) with peaks (pulses) during busy periods	May increase nutrient availability and algal production May decrease light penetration via increased turbidity and therefore reduce algal production
Swimming—nutrient addition	Local and patchy	Short term peaks (pulses) with short residence times	Localised increase in algal production Potential shift in food web resource base for consumers
Swimming—microbial contamination	Local and broader (contaminants may spread)	Short term peaks (pulses) with short residence times	Human and wildlife health concerns
Swimming—water level fluctuations and wave generation	Local	Daily fluctuations, with peaks in the middle of the day?	Change in littoral zone extent Change in littoral zone structure
Swimming access—trampling/scraping of littoral surfaces	Local and intense	Constant disturbance	Change in algae/lichen/moss cover and composition
Swimming—removal of LWD	Local and patchy	Long lasting	Loss of in-stream habitat
Swimming—modification of pool habitat (piling up rocks to create a weir)	Local	Variable—may be long lasting but can also be reset by human activities and high flow events	Water-level fluctuations, with littoral zone flooding and conversion of riffle and run habitats to that of pools Reduced downstream flows
Swimming—rope swings	Local and patchy	Long lasting but variable, depending on use patterns Likely to be daytime only, with peaks in busy periods	Associated de-snagging reduces in-stream habitat complexity and availability Riparian impacts on tree and surrounding vegetation Turbulence and wave effects from entry points Bank erosion and loss of littoral and riparian vegetation at exit points?
Picnicking—clearing of picnic spots	Local and patchy	Long lasting	Soil compaction Increased runoff and delivery of sediments and nutrients to receiving waters
Picnicking—compaction of soil	Local and intense	Long lasting	Increased runoff and nutrient delivery Loss of riparian zone habitat and structure
Picnicking—littering	Local and intense	Short term—rubbish likely to be cleared away intermittently	Pollutants and chemicals from plastics etc might be toxic Depositional zones can accumulate rubbish

Activity	Spatial Extent	Temporal Extent	Potential Impact on Aquatic Ecosystems
Picnicking—food wastes	j and patchy	Short term—low residence times—food wastes are likely to be quickly consumed by resident biota	Increased nutrients and potential algal growth responses Increased resources for aquatic consumers
Picnicking—interactions with wildlife	Local and patchy, but intense within patches	Short term peaks in activity levels, but with constant degree of interaction	Increased wildlife presence Reduced wildlife presence Wildlife reliance on human food
Boating—noise pollution	Local and intense	Short term—peaks on weekends and holiday periods when numbers of boats increases	Disturbance of wildlife—reduced feeding and fecundity
Boating—oil pollution	Local and intense (most likely at access points), but may be patchy	Short term in water column, long term in sediments	Toxicity of oil pollutants to aquatic biota Changes in surface tension, DO etc.
Boating—contaminants—TBTs etc.	Local and intense	Short term in water column, long term in sediments	Toxicity of oil pollutants to aquatic biota Changes in surface tension, DO etc.
Boating—anchor damage	Local, but patchy, with intense use in high use areas.	Long lasting	Habitat modification, loss of in-stream habitat complexity Reduced habitat quality
Boating—wake creation and effects	Broad with some intense local effects	Daytime peaks? Long lasting effects	Water level fluctuations and wave damage to littoral zone vegetation and habitat
Boating—shoreline mooring and access points	Local and intense use of access points	Constant heavy use in popular areas More peaks in less well used areas	Erosion, increased nutrient and sediment delivery to waterways Increased turbidity Loss of in-stream habitat Loss of shoreline habitat
Boating—injuries to wildlife	Broad and patchy	Short term peaks in busy periods and/or seasonal peaks based on migration and movement patterns of organisms	Mortality Reduced fertility
Boating—sediment re-suspension	Local and intense	Short term peaks in re-suspension	Re-suspension of nutrients may stimulate algal production Increased turbidity may reduce algal production
Boating—turbidity	Broad and patchy	Likely to be peaks during busy periods, but in high traffic areas, increased turbidity may persist	Reduced light penetration and algal production Increased microbial production
Hunting—trampling	Broad and patchy, but focussed along trails (if they exist)	Seasonal (for taxa with defined hunting seasons)	Increased sediment and nutrient delivery to receiving waters

Activity	Spatial Extent	Temporal Extent	Potential Impact on Aquatic Ecosystems
Hunting direct impacts	Local and intense	Seasonal (for taxa with defined hunting seasons)	Mortality Reduced standing stocks Reduced fecundity Food web implications?
Hunting—lead contamination	Broad and patchy	Bioaccumulation likely to be a long lasting effect	Toxicity of shot contaminants to aquatic biota Changes in invertebrate and vertebrate communities?
Fishing—recreational stocking of native fish	Local stocking, but may have broad extent over time.	Peaks during stocking events, but may stay high if stocking is successful	Food and resource implications for local populations Intense competition for resources Impacts due to predation Addition of top-predators may have food web implications
Fishing—recreational stocking of introduced fish	Local stocking effects, but may have broader extent over time	Peaks during stocking events, but may stay high if stocking is successful	Food and resource implications for local populations Intense competition for resources Introduced species may outcompete natives for resources Impacts due to predation Addition of top-predators may have food web implications
Fishing direct impacts	Local and intense	Short term peaks, but with lasting effects	Mortality Sub-lethal effects Removal of top-predators may have food web implications
Fishing—mortality from handling and capture	Local	Short term peaks during busy periods, but with lasting effects	Mortality Loss of top-predators may have food web implications
Fishing—site access and trampling	Local and intense	Constant use, but with peaks during busy periods	Increased delivery of nutrients and sediment Increased algal growth Changed riparian structure
Fishing—littering	Local and patchy	Short term peaks, may persist in depositional zones	Pollutants and chemicals from plastics may be toxic Entrapment of biota Depositional zones may have high concentrations of rubbish
Rubbish—site contamination and disease	Local and intense	Long term and lasting effects in refuse dumping areas	Pollutants and chemicals Nutrient delivery may stimulate algal production
Wildlife disturbance	Local and intense	Short term	Reduced wildlife survival and fecundity Disturbance may affect important distribution patterns and movements across the landscape
Wildlife feeding	Local and intense	Short term, but long lasting behaviours can be entrenched	Increased and reduced abundances of some taxa Reliance on human food sources Change in food web structure and function Increase threat of attacks on humans?

Source: (Data sourced from Hadwen & Arthington (2003); Hadwen *et al.* (2003); Hadwen & Bunn (2004); Hadwen & Bunn (2005); Hadwen *et al.* (2005a); Hadwen *et al.* (2005b).

Table 4 Recent general reviews of ecological impacts of visitor use in protected areas

General reviews
Buckley, R. 2002. Managing tourism in parks: research priorities of industry associations and protected area agencies in Australia. *Journal of Ecotourism* 1:162–172. Buckley, R., 2003. Ecological indicators of tourism impacts in parks. *Journal of Ecotourism* 2: 54–66. Buckley, R., 2004. Impacts positive and negative: Links between ecotourism and environment. In: Buckley, R. (Ed.) Environmental Impacts of Ecotourism. CABI Publishing, New York. pp. 1–14. Cater, C (Ed). In Press. High Impact Activities in Parks: Conservation Through Cooperation. Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast. Hadwen W. L., Arthington A. H., Boon P. I., Lepesteur M. & McComb A. J. (2005) *Rivers, Streams, Lakes And Estuaries: hot spots for cool recreation and tourism in Australia.* Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast. Liddle, M. 1997. Recreation Ecology. Chapman and Hall, London. Newsome, D. Moore, S.A. & Dowling, R. K. 2002. Natural Area Tourism: Ecology, Impacts and Management. Channel View Publications, Sydney. Sun, D. & Walsh, D. 1998. Review of studies on environmental impacts of recreation and tourism in Australia. *Journal of Environmental Management* 53: 323–338.

Table 5 Recent studies of ecological impacts of specific recreation activities in Australian protected areas

Impacts from specific recreation activity	
Hiking & camping	Cole, D.N. 2004. Impacts of hiking and camping on soils and vegetation: a review. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism* CABI Publishing, New York. pp. 41–60.
Mountain bike riding	Goeft, U., Alder, J. 2001. Sustainable mountain biking: a case study from the southwest of Western Australia. *Journal of Sustainable Tourism* 9: 193–211.
Horse riding	Landsberg, J., Logan, B. and Shorthouse, D. 2001 Horse riding in urban conservation areas: reviewing scientific evidence to guide management. *Ecological Management and Restoration* 2: 36–46. Newsome, D., Phillips, N, Milewskii, A. and Annear, R. 2002. Effects of horse riding on national parks and other natural ecosystems in Australia: implications for management. *Journal of Ecotourism* 1: 52–74. Newsome, D., Cole, D.N., Marion, J. 2004. Environmental impacts associated with recreational horse-riding. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism.* CABI Publishing, New York. pp. 61–82. Smith, A. and Newsome, D. In Press. Horse riding in protected areas. In: Cater, C. (Ed). High Impact Activities in Parks: Conservation Through Cooperation. Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast. pp. 1–17
Rock climbing	Cater, C. and Hales. R. In Press. Impacts and Management of Rock Climbing in Protected Areas. In: Cater, C. (Ed). High Impact Activities in Parks: Conservation Through Cooperation. Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast. pp. 24–36.
Skiing and other snow based activities	Pickering, C.M. and Hill, W. (2003). Ecological change as a result of winter tourism: snow manipulation in the Australian Alps. In: Buckley, R., Pickering, C.M. and Weaver, D. (Eds) *Nature-based Tourism, Environment and Land Management*. CABI Publishing, New York. pp 137–149.
Rafting/kayaking	Hadwen W. L., Arthington A. H., Boon P. I., Lepesteur M. & McComb A. J. (2005) *Rivers, Streams, Lakes And Estuaries: hot spots for cool recreation and tourism in Australia.* Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast.

Driving (off road)	Buckley, R. 2004. Environmental impacts of motorized off-highway vehicles. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York, pp. 83–93. Lonsdale, W.M. & Lane, A.M., 1994. Tourist vehicles as vectors of weed seeds in Kakadu National Park, northern Australia. *Biological Conservation* 69, 277–83. Buckley, R. In Press. Off-road vehicles in protected areas. In: Cater, C. (Ed). High Impact Activities in Parks: Conservation Through Cooperation. Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast. pp. 18–23.
Sailing/boating	Mosisch, T.D. and Arthington, A. H. 2004. Impacts of recreational power-boating on freshwater ecosystems. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing. New York, pp. 125–154. Warnken, J. and Byrnes, T. 2004. Impacts of tour boats in Marine Environments. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York. pp. 99–124.
Fishing	Hadwen W. L., Arthington A. H., Boon P. I., Lepesteur M. & McComb A. J. (2005) *Rivers, Streams, Lakes And Estuaries: hot spots for cool recreation and tourism in Australia.* Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast.
Swimming	Butler B., Birtles A., Pearson R. & Jones K. (1996) Ecotourism, water quality and wet tropics streams. pp. 79. Australian Centre for Tropical Freshwater Research, James Cook University, Townsville. Hadwen W. L. & Arthington A. H. (2003) The significance and management implications of perched dune lakes as swimming and recreation sites on Fraser Island, Australia. *The Journal of Tourism Studies* 14: 35–44. Hadwen W. L., Arthington A. H. & Mosisch T. D. (2003) The impact of tourism on dune lakes on Fraser Island, Australia. *Lakes and Reservoirs: Research and Management* 8: 15–26. Hadwen W. L. & Bunn S. E. (2004) Tourists increase the contribution of autochthonous carbon to littoral zone food webs in oligotrophic dune lakes. *Marine and Freshwater Research* 55: 701–708. Hadwen W. L. & Bunn S. E. (2005) Food web responses to low-level nutrient and ^{15}N-tracer additions in the littoral zone of an oligotrophic dune lake. *Limnology and Oceanography* 50: 1096–1105. Hadwen W. L., Bunn S. E., Arthington A. H. & Mosisch T. D. (2005) Within-lake detection of the effects of tourist activities in the littoral zone of oligotrophic dune lakes. *Aquatic Ecosystem Health and Management* 8: 159–173. Hadwen W. L., Arthington A. H., Boon P. I., Lepesteur M. & McComb A. J. (2005) *Rivers, streams, lakes and estuaries: hot spots for cool recreation and tourism in Australia*. Sustainable Tourism Cooperative Research Centre - CRCST Press, Gold Coast.

Table 6 Recent Australian studies of impacts of visitor use on ecosystem components

Impacts on specific ecosystem component	
Review of impacts on vegetation	Pickering, C.M. and Hill, W. (In Press). Impacts of tourism on plant biodiversity and vegetation in protected areas in Australia. *Journal of Environmental Management.*
Rare and threatened plants	Kelly, C., Pickering, C.M., Buckley, R.C. 2003. Impacts of tourism on threatened plants taxa and communities in Australia. *Ecological Restoration and Management* 4: 37–44.
Rainforest flora & soils	Talbot, L.M., Turton, S.M., Graham, A.W. 2003. Trampling resistance of tropical rainforest soils and vegetation in the wet tropics of north east Australia. *Journal of Environmental Management* 69: 63–69. Turton, S.M., 2005. Managing environmental impacts of recreation and tourism in rainforests at the Wet Tropics of Queensland World Heritage Area. *Geographical Research* 43: 140–151.
Alpine flora	Pickering, C.M., Johnston, S., Green, K. and Enders, G. (2003). Impacts of nature tourism on the Mount Kosciusko alpine area, Australia. In: Buckley, R., Pickering, C.M. and Weaver, D. (eds.), *Nature-based Tourism, Environment and Land Management*. CABI Publishing, New York. pp 123–135.
Reviews of impacts on wildlife	Buckley, R. 2004. Impacts of ecotourism on terrestrial wildlife. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York, pp. 211–228. Green, R. and Giese, M. 2004. Negative effects of wildlife tourism on wildlife. In: Higginbottom, K. (Ed.) *Wildlife Tourism: Impacts, Management and Planning.* Common Ground, Melbourne. pp. 81–98. Green, R. and Higginbotton, K 2001. *The Negative Effects of Wildlife Tourism on Wildlife*. CRC for Sustainable Tourism, Griffith University. Higginbottom, K. 2004. Wildlife Tourism: Impacts, Management and Planning. Common Ground, Melbourne. In: Higginbottom, K. (Ed.) *Wildlife Tourism: Impacts, Management and Planning.* Common Ground, Melbourne.
Birds	Buckley, R. 2004. Impacts of ecotourism on birds. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York. pp. 187–210.
Aquatic ecosystems	Butler B., Birtles A., Pearson R. & Jones K. (1996) Ecotourism, water quality and wet tropics streams. pp. 79. Australian Centre for Tropical Freshwater Research, James Cook University, Townsville. Hadwen W. L. & Arthington A. H. (2003) The significance and management implications of perched dune lakes as swimming and recreation sites on Fraser Island, Australia. *The Journal of Tourism Studies* 14: 35–44. Hadwen W. L., Arthington A. H. & Mosisch T. D. (2003) The impact of tourism on dune lakes on Fraser Island, Australia. *Lakes and Reservoirs: Research and Management* 8: 15–26. Hadwen W. L. & Bunn S. E. (2004) Tourists increase the contribution of autochthonous carbon to littoral zone food webs in oligotrophic dune lakes. *Marine and Freshwater Research* 55: 701–708. Hadwen W. L. & Bunn S. E. (2005) Food web responses to low-level nutrient and ^{15}N-tracer additions in the littoral zone of an oligotrophic dune lake. *Limnology and Oceanography* 50: 1096–1105. Hadwen W. L., Bunn S. E., Arthington A. H. & Mosisch T. D. (2005) Within-lake detection of the effects of tourist activities in the littoral zone of oligotrophic dune lakes. *Aquatic Ecosystem Health and Management* 8: 159–173. Hadwen W. L., Arthington A. H., Boon P. I., Lepesteur M. & McComb A. J. (2005) *Rivers, Streams, Lakes And Estuaries: hot spots for cool recreation and tourism in Australia.* Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast.

Table 7 Recent Australian studies of ecological impacts of infrastructure

Impacts from visitor infrastructure	
Impacts of resorts including ski resorts	Buckley, R.C., Pickering, C.M., Warnken, J. 2000. Environmental management for alpine tourism and resorts in Australia. In: Goode, P.M., Price, M.F., Zimmerman F.M. (Eds) *Tourism and Development in Mountain Regions*. CABI Publishing, New York, pp. 27–46. Pickering, C.M. and Hill, W. (2003). Ecological change as a result of winter tourism: snow manipulation in the Australian Alps. In: Buckley, R., Pickering, C.M. and Weaver, D. (Eds) *Nature-based Tourism, Environment and Land Management*. CABI Publishing, New York. pp 137–149.
Impacts of roads and tracks	Donaldson, A., Bennet, A. 2004. Ecological Effects of Roads: Implications for the Internal Fragmentation of Australian Parks and Reserves. Parks Victoria Technical Paper Series No. 12. Parks Victoria, Melbourne.
Impact Creep	Smith, A.J. Newsome, D. (2006) *An Investigation into the Concept of and Factors Leading to Impact Creep and its Management.* Sustainable Tourism Cooperative Research Centre Research Report, Griffith University, Gold Coast.

Chapter 3

SELECTING AND USING ECOLOGICAL INDICATORS

What Are Ecological Indicators?

Because of the complexity of biodiversity (ecosystems, habitat), information about it needs to be assembled and expressed using simplified variables, typically in the form of indicators (Noss 1990, 1999). Ecological indicators are defined as quantitative or qualitative variables that provide useful information about changes in the natural environment. They are used to help compile a picture of the status and trends in the condition of the environment and provide information that can be used to assess extent to which management has been effective (Hockings *et al.* 2000, 2006).

A number of authors have contributed to the debate about what constitutes a good ecological indicator (e.g. Noss 1990, Buckley 2003, Niemi & McDonald 2004) and many believe that that no single indicator is likely to satisfy all requirements, and that an ideal set of indicators can't be developed for implementation across a wide range of systems. However others agree that a strong justifiable set can certainly be developed for a particular system (and uses).

General Frameworks for Developing Ecological Indicators

A series of specific frameworks have been developed since the 1970s for managing the impacts of visitors within a park (Chapter 4). Because these involve assessing the ecological condition and change in condition of sites in response to visitors, they are often based on, and incorporate aspects of general frameworks for developing ecological indicators. General ecological indicator frameworks were developed to allow governments and other organisations to report on the state of the environment.

Two of the most widely used general frameworks for identifying ecological indicators are summarised in the following section as they are often incorporated into specific frameworks for managing visitor impacts in protected areas.

Pressure State Response framework (PSR)

The Pressure-State-Response (PSR) framework was proposed in the 1970s as a mechanism for developing environmental indicators of anthropogenic activities (Newton & Kapos 2002). It was subsequently adopted by the Organisation for Economic Cooperation and Developments (OECD) and a preliminary set of environmental indicators was proposed in 1991 (OECD 1993).

The PSR framework is not limited to protected areas but is used worldwide as a tool for reporting on environmental condition. It is a simplified model of how human interaction with the environment changes the environment, and is generally viewed as the best conceptual framework for indicators and state of the environment reporting.

The PSR framework states that human activities exert pressures on the environment, changing the state of natural resources (for example extent of forest cover). People respond to these changes with policies and programs to prevent, reduce or mitigate pressures and thereby reduce environmental damage. Indicators can clarify relationships between components, pressure, state and response (Newton & Kapos 2002).

Many countries and organisations have modified the basic PSR framework for their own specific purposes. Modifications were made for the 1996 Australian State of the Environment report in order to better describe the multi-dimensional relationship between pressure, state and response by firstly defining the condition of the environment before information about pressures and responses (Environment Australia 1996). This involved a change to a Condition-Pressure-Response model (CPR).

The PSR Framework has been widely applied to indicator development. For example, the Commission on Sustainable Development used a variation, the 'Driving force-State-Response' framework (DSR) (CSD 2001) where the term 'driving force' was used instead of 'pressure' to take into account social, economic and institutional factors. This also acknowledged that driving forces can impact sustainable development in either positive or negative ways.

The European Environment Agency further expanded the PSR framework forming the Driving force-Pressure-State-Impact-Response (DPSIR) framework with five indicator categories, with drivers as well as impacts described (EEA 1999; Watts *et al.* 2004). This provides mechanism for analysing and reporting on environmental problems.

Noss's framework for biodiversity indicators

Noss's (1990,1999) framework for selecting indicators of biodiversity was developed so that complex ecological systems could be monitored using simplified variables (indicators) that could be aggregated across different scales for evaluation and reporting. Biodiversity was separated into three components: (1) composition, (2) structure and (3) function and a nested hierarchy of 'attributes' was developed for each component at four levels of organisation: regional landscape, community-ecosystem, population-species and genetic.

Attributes of the three components of biodiversity were organised into these three levels as follows:

- *Composition*—Landscape Types, Communities, Ecosystems, Species, Populations, Genes
- *Structure*—Landscape Patterns, Physiognomy, Habitat Structure, Population Structure, Genetic Structure
- *Function*—Landscape Processes, Disturbances; Land-Use Trends, Site-specific Interactions, Ecosystem Processes, Demographic Processes, Life Histories, Genetic Processes.

Noss also identified indicators of each attribute in terrestrial ecosystems, but not in aquatic ecosystems, at the four levels of organisation for the purpose of environmental monitoring. These are listed in Chapter 2 of this report.

Selecting Ecological Indicators

Accurate, timely and cost effective evaluation of ecological integrity depends on using appropriate monitoring programs with suitable indicators (Noss 1990; Niemi & McDonald 2004). The selection of indicators for visitor monitoring depends on their ability to inform clearly defined objectives (Buckley 2003, Wiersma 2005) and there are a number of key issues that need to be taken into consideration when selecting indicators (Table 8).

1. It is difficult to select appropriate ecological indicators for diffuse, and difficult to detect impacts of visitors (Warnken & Buckley 2000), particularly across multiple spatiotemporal scales (Buckley 2003).
2. Impacts should be prioritised prior to selecting indicators (Jennings 2005) as failure to do so may result in unrealistic goals being set that cannot be achieved. This is the approach taken in the integrated framework (Chapter 5).
3. Indicators are designed to facilitate understanding of ecological condition and trends in condition. Setting condition thresholds around an acceptable range has increasingly been used as an approach to ecosystem management (Biggs & Rogers 2003) and is useful when dealing with dynamic ecosystems (Rogers 2003). As a result indicator values may not be static and should also be subject to revision and modification based on the best available information.
4. Selection of appropriate indicators is often hampered by poor objective setting (Dale & Beyeler 2001) as well as the failure to recognise the complexity of ecological systems (Yoccoz *et al.* 2001).
5. Ecosystems are complex and as a result monitoring programs should be rigorously designed and implemented (Wiersma 2005). Of concern is the scale at which indicators are selected. It has been suggested that long-term anthropogenic stress, including visitor impacts, is best monitored at a community level rather than at the level of a single species (Odum 1985—in Orfanidis *et al.* 2003). Furthermore, current trends in aquatic ecosystem assessment call for an increased focus on the application of functional or ecosystem process indicators, rather than structural (community composition) indicators.
6. Ensuring that potential indicators meet an array of selection criteria is a critical step in the development framework (Monz *et al.* 2003) and extensive lists of such criteria have been compiled previously (Belnap 1998, Dale & Beyeler 2001, Buckley 2003, Miller & Twining-Ward 2005, Wiersma 2005) (Table 9). This process is captured in our integrated framework (Chapter 5).

Table 8 Summary of criteria for selecting ecological indicators from recreation ecology literature and the frequency of reporting

Criteria	Authors
Essential criteria	
Easily measurable, reliable repeated measures, large sampling windows	1, 2, 3, 4, 6, 7, 8, 9, 11, 12
Have known responses to natural disturbance and anthropogenic stress, discriminatory	1, 2, 3, 6, 7, 9, 10, 12
Ecologically significant, credible	2, 3, 5, 6, 11, 12
Low impact to measure	3
Meaningful for management and other stakeholders (policy relevant)	3, 5, 7, 10, 11
Directly linked to visitor use and impact	2, 3, 13
Other criteria	
Sensitive to stress on ecosystems	1, 2, 6, 7, 9, 13, 14
Predictable stress response (quick response)	1, 3, 4, 13, 14, 15
Anticipatory	1, 6
Predict changes that can be averted by management action, actionable	1, 2, 3, 7, 9, 13, 14
Integrative across the full spectrum of spatiotemporal ecological gradients	1, 2, 6, 7
Low variability in responses, i.e. precise and accurate measures	1, 3, 9, 10, 12
Feasible, cost effective	2, 3, 4, 9, 10, 11, 12, 13, 14
Management capacity (ease of training)	3, 13, 14
Builds on available baseline data	3, 9, 11
Ease of identification (fauna and flora indicators)	4
Public interest, transparent, reflect social and political interests	4, 5, 11, 15
Independent of sample size	6
Addresses management objectives—outcome driven	5, 7, 11, 12
Report against as many evaluation components as possible for performance reporting	7, 11
Should report on *outputs* rather than *inputs*	8
Should be descriptive rather than evaluative	8

1) Dale & Beyeler (2001); 2) Buckley (2003); 3) Belnap (1998); 4) Niemi & McDonald (2004); 5) McCool & Stankey (2004); 6) Noss (1990); 7) Moore *et al.* (2003); 8) Eagles *et al.* (2002); 9) Rome (1999); 10) Ward *et al.* (2002); 11) Heinemann *et al.* (1998); 12) Kurtz *et al.* (2001), 13) Hadwen *et al.* (2003) 14) Hadwen *et al.* (2005a), 15) Hadwen & Arthington (2003)

Having presented a summary of the value of indicators and the potential pitfalls to consider in their application to monitoring programs, a number of indicators that can potentially be used to monitor visitor impacts in terrestrial ecosystems within protected areas can now be reviewed.

Potential Ecological Indicators for Monitoring Visitor Use

Since the 1970s numerous sets of indicators have been developed for monitoring ecological conditions and visitor impacts in terrestrial environments. This report does not develop a specific set of indicators for monitoring ecological condition for all Australian protected areas as this depends on the individual circumstances for each protected area (including the nature and extent of visited ecosystems), and some guidelines and indicators have previously been developed for Australia (Heinemann *et al.* 1998, ANZECC 2000). However, potential indicators were categorised based on their ability to provide information about vegetation, soil, wildlife, ecological processes, ecological integrity and secondary effects so that relevant indicators can be selected for any given park (Table 9).

The use of Noss's (1990) hierarchy that recognises three characteristics of diversity: structural, compositional and functional at various spatial scales is recommended as the use of this approach within our integrated framework will focus the manager's attention towards identification of ecological indicators.

Table 9 Types of indicators that could be used

Ecological component	Indicator	Spatial scale (Noss 1990)	Component of the ecological community (Noss 1990)
Vegetation	• % of area degraded/transformed (e.g. fire or other disturbance regimes)	Regional	Structure/Composition
	• Changes in species composition	Community	Composition
	• Changes in community structure	Community	Structure
	• % cover of introduced weeds and the severity of such infestations	Population	Composition
	• Damage to specific species	Population	Structure
	• Numbers of seedlings	Population	Composition
	• Changes in structural physiognomy	Community	Structure
	• Level of fragmentation and rate of vegetation loss	Regional	Structure
	• Extent of seed production	Population	Function
	• Extent of habitat revegetation[1]	Regional	Structure/Function
Soil	• Degree of compaction	Community	Structure
	• Changes in the soil A horizon	Community	Structure/Function
	• Extent of bare ground	Community	Function
	• Number of and trends in walking trails	Regional	Composition
	• Multiple trail formation	Regional	Composition
	• Extent of soil erosion	Regional	Structure/Function
Wildlife	• Behavioural shifts (vigilance monitoring)	Community	Function
	• Effects on productivity (reduced Fecundity or increased mortality)	Community/ Population	Function
	• Displacement (decline in observations of species at specific sites)	Community	Structure
	• Invasion	Regional	Structure
	• Shifts in community composition (e.g. influx of generalists)	Community	Composition
	• Degree of habituation (e.g. frequency of foraging for handouts)	Community/ Population	Function/Composition
	• Loss of species (decline in observations at specific sites)	Community/ Regional	Composition
Species diversity	• Biodiversity indices (richness, evenness)	Regional/ Community	Composition
	• Numbers of invasive species	Community	Composition

[1] Gray & Azuma (2005) suggest that a number of vegetation indicators can be combined into a single measure of vegetation integrity. This is possible but managers should be wary of the possible loss of identifying causal mechanism should indicators be combined (see Miller & Twining-Ward 2005).

Biodiversity Pattern	• Shifts in community structure (either floral or faunal, e.g. there are no significant changes in the guild structure and composition of bird communities)	Community	Structure
	• Extent of habitat types	Regional	Structure/Function
	• Extent of habitat fragmentation	Regional	Structure/Function
	• Connectivity indices among disjunct vegetation fragments	Regional	Structure/Function
	• Vegetation structural physiognomy maintained within certain limits (e.g. minimum numbers of hollow trees, vertical stratification etc.)	Community	Structure
Biodiversity Process	• Water runoff patterns	Regional	Function
	• Nutrient loads	Community	Function
	• Litter accumulation and decomposition	Community	Function
Knock-on effects (secondary)	• Weed dispersal	Regional/ Community	Composition
	• Edge effects and margin erosion	Regional	Structure
Ecological integrity	• It is possible to assess the ecological integrity of a site using a combination of indicators (e.g. % cover, number of tree hollows/km², ratio of edge to interior habitat); each assessed independently but then combined to provide an overall score for the integrity. Scoring systems have been proposed in some Australian regions (see Oliver 2004) and the use of these may facilitate comparisons among variable sites for improved reporting.		
Ecosystem functioning (see Sheil *et al.* 2004 for a review of a series of criteria and indicators for tropical forest management)	• No chemical contamination of the food chain and ecosystem	Regional/ Community	Function
	• Ecologically sensitive areas and buffer zones, particularly along watercourses, are protected[2]	Regional	Composition
	• Threatened species are protected[3]	Community/ Population	Composition
	• Erosion and soil degradation is minimised	Regional	Function
	• Landscape patterns maintained (variability within the patterns observed is within acceptable threshold limits)	Regional	Structure/Function

Adapted from ANZECC (2000), Ward *et al.* (2002), Oliver (2004), Sheil *et al.* (2004), Gray & Azuma (2005).

The key to identifying indicators is matching these with explicitly stated objectives and goals for the particular protected area in question, listing critical issues, and then identifying appropriate measures to collate the data from these indicators. This facilitates an understanding of the linkages between the indicators and visitor use (Reynolds & Braithewaite 2001). There are a number of working groups that have proposed a series of principles and approaches to developing indicators (Bellagio Principles, Balaton Group in Miller & Twining-Ward 2005) but the one weakness of these approaches is that there is no linkage between the development and the conversion into implementation, with subsequent review and evaluation. Our framework is designed to incorporate these broader approaches into indicator selection and implementation.

Although Sirakaya *et al.* (2001) suggest that indicators must be set to cover the socioeconomic, cultural, natural and political disciplines across multiple scales this may not be possible when attempting to refine

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[2] A cautionary note on the use of this particular indicator—this assumes that these areas have already been identified and agreed upon and that the features that make them sensitive continue to be monitored

[3] Another note here is that although there may be a need to ensure the ongoing protection of threatened species these may not be key species in the ecological functioning and managers should be aware that keystone species could also be those that are common and widespread

indicators and limit their number. Perhaps prioritisation of indicators can be based on how many of each of these facets is taken up by any single indicator, suggesting that prioritisation at an earlier stage (i.e. impact level) occur prior to determining appropriate indicators (Jennings 2005). This is likely to ensure that only the most appropriate indicators are selected for monitoring. There is also the opportunity to aggregate data from a suite of standardised indicators to permit comparative assessments of protected areas at variable spatial scales (Buckley 2003, Moore *et al.* 2003, Oliver 2004) but Miller and Twining-Ward (2005) caution that one does not lose the complexity of the situation through such processes and that any procedures for aggregation (weighting, scoring etc.) must be clearly conveyed. There may well be efforts to identify indicators from existing monitoring programs but care must be exercised that these are not selected or derived purely because monitoring is already being completed.

A key to the development of indicators (ecological, social, economic, environmental) that aim to provide information on sustainability targets is that these processes need to be undertaken in a participatory manner where the component parts are not viewed in isolation. This has commonly been the reductionist strategy adopted but advancement towards meeting sustainability goals requires that the complexity and interrelationships among all constituents are considered (McCool & Stankey 2004, Miller & Twining-Ward 2005).

The focus of this report was also partially constrained by the narrow focus on ecological indicators since complimentary reports dealing with social and economic issues are being completed in parallel. However, the integration of these individual reports will be critical to the success of the larger program to achieve a holistic view of indicators of visitor sustainability. Successful integration of the various components will hopefully address some of the concerns raised by numerous authors in sustainability science (Sirakaya *et al.* 2001, McCool & Stankey 2004) by ultimately considering ecological, social and economic issues within broader political contexts.

Chapter 4

FRAMEWORKS FOR MANAGING VISITOR USE OF PROTECTED AREAS

The development of specific frameworks to assist with the management of visitors in protected areas has been a sequential process with newer frameworks often incorporating aspects of previous frameworks as well as aspects of general ecological indicator frameworks (such as the Pressure State Response (PSR) framework and Noss's Biodiversity framework).

All frameworks have strengths and weaknesses and no single framework is dominantly used. Partly this is due to historical constraints with different systems developed in different countries for different parks/systems. In Australia for example, visitor management frameworks are used less than in North America. The frameworks that have been used most often in Australia are the Visitor Impact Management framework (VIM) and the Recreation Opportunity Spectrum (ROS) (McArthur & Sebastian 1998, Brown *et al.* 2006).

The most commonly used visitor management frameworks are reviewed (Tables 10 and 11) describing their origins, strengths and weaknesses, overriding objectives, processes involved and approaches taken, their rationale, application and purpose and finally the extent to which they involve stakeholder input.

These frameworks differ in the extent to which they:

- use behaviour regulation (carrying capacity)
- use site modification (ROS)
- determine standards, then monitor sites and adjust management accordingly (LAC)
- understand the relationships between ecological impacts and visitors (VIM, VERP)
- understand visitors (VAMP)
- consider visitor experience in planning and use of stakeholder involvement (TOMM)
- incorporate ecosystem condition in monitoring (TPC, VS & DSS/TNAC)
- fit into other aspects of evaluation of management (DSS/TNAC) (Table 10).

Six of these frameworks are based on the concept of carrying capacity (Table 10). The seventh is a general tourism planning framework developed in Australia (TOMM, Table 11), and the final three are more recent frameworks that incorporate, more clearly, concepts of ecological condition (Table 10).

Carrying Capacity

During the 1970s, recreational carrying capacity was developed in the U.S. as an approach to managing visitors in sensitive environments. Problems of visitor overuse could be solved by setting limits to numbers based upon a pre-determined level, derived from ecological, social and other analyses. This framework is comprised of a descriptive component—type and extent of visitor related impacts and a value judgment component—concerning acceptability of different levels of impact. However, this approach has serious limitations as it is restrictive, focused on limits and constraints, and can be seen as working against protected area objectives designed to encourage appropriate visitor enjoyment and valuation of the resource (Clarke & Stankey 1979, Stankey *et al.* 1985, Cole & Stankey 1998).

Frameworks based on carrying capacity

When the limitations of this approach were understood a number of more sophisticated frameworks based on carrying capacity were developed, to provide a structure for managing visitors in protected areas. Emphasis was shifted from fixed resource capabilities and amount of use to achieving desired conditions using a more structured approach (Farrell & Marion 2002). The Recreation Opportunity Spectrum system (ROS) was the first of these frameworks to be used and is still among the most widely used. Carrying capacity was incorporated into several other frameworks particularly Limits of Acceptable Change (LAC), with two other frameworks, Visitor Impact Management (VIM) and Visitor Experience and Resource Protection framework (VERP) conceptually related to LAC (McArthur & Sebastian 1998).

Core elements of these frameworks are: (1) defining recreation opportunities; (2) monitoring indicators to determine change in conditions as a result of human use and (3) implementing management action if predetermined resource and social standards were not met (Manning 1999b). It has been argued that ROS, VERP and VAMP are more suited to providing a broader perspective of the management requirements for visitors whereas VIM and LAC are more specific in their assessment of visitor impacts (Nilsen & Tayler 1998). Recreation Opportunity Spectrum and Visitor Impact Management systems are used by agencies in Australia (Brown *et al.*2006; McArthur & Sebastian 1998).

Carrying capacity is more widely used in Central and South America but less than 10% of developing countries use LAC and less than 20% use VIM, Visitor Activities Management Process or ROS. Because of this, the Protected Area Visitor Impact Management framework (PAVIM) was developed for Central and South America where staff and financial resources are often limited. It is based on carrying capacity in that it is simple and cost effective, but takes into account multiple underling causes of impacts, has defensible decisions and involves local communities. Decisions are made by experts such as managers and other stakeholders based on their expert knowledge rather than from monitoring indicators and developing standards (Farrell & Marion 2002).

Table 10 Comparative review of frameworks used to manage visitor impacts in protected areas: frameworks based on carrying capacity

	Frameworks Based on Carrying Capacity					
	ROS	**LAC**	**VIM**	**VERP**	**VAMP**	**PAVIM**
Source	Clark & Stankey (1979)	Stankey *et al*. (1985); Cole & Stankey (1998)	Graefe *et al.* (1990)	Graefe *et al.* (1990); Manning, *et al.* (1996), Hoff & Lime (1997), USDI (1997),	Payne & Graham (1993)	Farrell & Marion (2002)
Country	USA	USA	USA	USA	Canada	USA (for use in central and south America)
Strength	Links supply (resource) and demand (tourism) and maximises recreational opportunities. Identifies potential impacts.	Able to monitor both ecological and social conditions to provide strategic alternatives for management. Potential early warning system.	Includes possible indicators for structural and compositional aspects. Uses standards or acceptable change limits. Potential early warning system.	Builds in a degree of spatiotemporal monitoring and assesses indicators against benchmarks using a transparent process. Potential early warning system.	Strong focus on management requirements (but from a social aspect) to provide a contextual basis.	Builds on strong stakeholder involvement but requires high levels of local knowledge. Has the capacity to consider multi-disciplinary assessments.
Weakness	Overemphasis on recreational opportunity and limited focus towards ecological integrity. Focus on achieving a desired state.	No explicit linkages to overriding management objectives and is therefore reactive rather than proactive appears to address structural and compositional ecological components. Poor linkages to identifying root causes of impacts.	Lack of functional indicators. Poor linkages to identifying root causes of impacts. Indicators relate to desired condition.	Requires higher level of technical expertise to monitor ecological components, implies greater support from management agencies. Poor linkages to identifying root causes of impacts.	Strong focus on visitor opportunities and little attention to ecological integrity or condition. Deals primarily with service delivery for social component of PA management.	Uses an expert panel to replace explicit indicators, monitoring and standards increasing the risk of subjectivity and exposing potential bias.
Complementarity	VAMP	VIM / VERP	LAC / VERP	LAC / VIM / PAVIM	ROS	VERP
Overriding objective	Maximising recreational opportunities for visitors.	Natural resource conservation.	Natural resource conservation.	Resource conservation and protection.	Visitor opportunity planning.	Alternatives to standard carrying capacity frameworks such as LAC.
Process	Inventory physical, social and management 'settings', analyses settings and identify conflicts, design and monitoring.	Identifies acceptable conditions and actions required to meet conditions for resource and social aspects. Defines minimally acceptable conditions but within maximum acceptable deviations. Essentially defines compromises.	Addresses three main issues relating to impacts - problematic conditions, possible causal factors and potential management response.	Iterative process looking at the quality of resources and the visitor experience. Defines appropriate levels of use in space and time.	Hierarchy of decisions within management plan. Objectives drive the creation of visitor opportunities.	Flexible six-step process that considers zoning, acceptability of impacts and implications of management actions within these zones.

Approach	Use indicators and standards to report on settings. Strong linkages to social aspects looking at future opportunities.	Nine step cyclical process to identify resource and social indicators in existing recreational opportunity classes. Acceptable limits (standards) are set and alternative management strategies to minimise impacts are suggested.	Top down approach, reviewing objectives and selecting baselines for key indicators. Identifies probably causes of impacts. Includes physical, biological and social impacts.	Uses a multidisciplinary team that develop indicators and standards based upon the identification of existing resources and visitor activities. Uses zoning to partition activities for monitoring and management. Compare utilised areas to control areas.	Reviews PA objectives and potential visitor opportunities within constraints imposed by resource capacity. Highlights alternative visitor activities for inclusion in revised management plans.	Identifies area values, purpose and management zones with explicitly management objectives. Continues to identify and prioritise impact problems in a public process and then focuses an analysis of the problems using an expert panel prior to the selection of management actions and their evaluation.
Development rationale	Conflict between recreation and resource protection objectives.	Desire to improve management of recreational impacts.	Attempts to identify problems and causal factors to improve management strategies.	Attempts to link management and operational planning components.	Guidance for planning and management of existing, developing and new Parks.	Framework that replaces the need to use historical carrying capacity limits to defend management actions.
Application	Landscape planning, recreation opportunity management. Local and regional level.	Widely used in assessing natural and social condition. Large reserves. The environmental carrying capacity approach has been criticised due to its inability to minimise visitor impacts (Lindberg & McCool 1998).	Flexible and similar to LAC. Looks at single complex sites	Prescribes management zones with acceptable use limits and indicators measure visitor impacts and response to management.	Assessment of visitor opportunity.	Potential application in multiple land-use areas as well as single large reserves but has not yet been tested in the field.
Purpose		Address recreational carrying capacity.		Developing methods to identify biological indicators.	Provides a framework for the creation and management of visitor opportunities.	
Stakeholder input		Allows for input from various stakeholders.	Allows for input from various stakeholders.	Allows for input from various stakeholders.		Allows for input from various stakeholders.

Limits of Acceptable Change (LAC); Recreation Opportunity Spectrum (ROS); Visitor Impact Management (VIM); Visitor Activity Management Process (VAMP); Visitor Experience Resource Protection (VERP).

Table 11 Comparative review of selected frameworks used to manage visitor use of protected areas
Comprehensive tourism: Tourism Optimisation Management Model (TOMM)
More recent ecological condition frameworks: Thresholds of Potential Concern (TPC); Vital Signs (VS); Decision Support System/Tourism Natural Asset Classification (DSS/TNAC)

	Tourism opportunities framework	**Recent ecological condition frameworks**		
	TOMM	**TPC**	**VS**	**DSS /TNAC**
Source	Minidisc Roberts Consultants (1997)	Biggs & Rogers (2003)	Mons *et al.* (2003)	Ward *et al.* (2002); Hughes *et al.* (2004)
Country	Australia	South Africa	USA	New Zealand
Strength	Recognises the social and political contexts in addition to ecological concerns. Makes provision for involving stakeholders. Uses an acceptable range for indicators rather than a single state.	Potential early warning system. Uses an acceptable range for indicators rather than a single state.	Helpful to illustrate mechanisms of impact and ecosystem-level consequences. Allows one to visualise linkages that can possibly reduce the number of indicators selected.	Application across multiple management levels. Builds on previous visitor management models and incorporates an assessment of resource classification to guide indicator development. Adaptive approaches to ensure management objectives are met.
Weakness	Does not explicitly mention the management objectives and how these inform the monitoring process. Largely dealt with social and management issues.	The thresholds that are set are based on the best available information at the time and may need to be revised periodically as new research and monitoring improve understanding.	Does not explicitly link vital signs to management objectives even though the process is driven by management concerns. Limited focus on functional components of the ecosystems.	Uses a limited subset of stakeholders to develop indicators. Has no explicit linkage to effectiveness reporting systems (Ward *et al.* 2002) but included in revisions (Hughes *et al.* 2004).
Complementarity		DSS/TNAC	PSR/DSS	PSR/DPSIR/TPC
Overriding objective	Maximising tourism opportunity.	Maintaining the functional integrity of the system by maximising the habitat heterogeneity.	Developed conceptual models of interactions of *agents of change*, *stressors* and *ecosystem response*.	Integrates combinations of different natural attractions and associated visitor activity in these areas.
Process	Review objectives, select indicators and set standards, identify probable impacts and management strategies and implement actions.	Identify ecosystem components and establish thresholds of acceptable change/transformation. Thresholds act as upper and lower triggers that prompt management intervention but are not necessarily fixed.	Impacts occurring in sensitive areas of most concern given the dual interests (ecological, social) in these areas.	Identifies and classifies natural assets and then develops indicators within these zones based on significance of impacts and nature of activities.
Approach	Describes the management context and developed indicators using acceptable ranges and benchmarks. Cyclical process of adaptive management.	Uses a scientifically defensible approach to identify upper and lower threshold limits for a range of ecosystem components and services. Monitoring is undertaken to assess the trends in the thresholds and management triggers allow intervention or revision before system failure.	Selection of vital signs of resource condition. Uses conceptual models of interactions of agents of change (drivers), stressors (pressures) and ecosystem responses (state and response). Assessment of stressors is closely linked to visitor parameters (density, distribution etc.).	Asset classification framework identifies values associated with key asset types/classes. Tourism activities and significance of impacts inform indicator development. Management responses are advocated that remedy or mitigate impacts to maintain asset values.
Development rationale	Developed for the sustainable use of forests integrating visitor and resource management.	Desire to shift management and decision making processes from being reactive to proactive.	Created for monitoring the condition of natural resource variables indicative of ecosystem health and resource integrity.	A framework that integrates the needs of tourism operators and environmental managers.

	Tourism opportunities framework	**Recent ecological condition frameworks**		
Application		Adaptive protected area management approach that is currently being used as the preferred system in the Kruger National Park, South Africa.		Currently used at a number of local sites, has potential for wider application across similar asset types.
Purpose		Improvement of protected area management through a continual process of learning by doing (Strategic Adaptive Management).	Looks at mechanisms of impact and ecosystem-level consequences.	Management of biophysical effects of tourism in natural areas.
Stakeholder input	Allows for input from various stakeholders.	Allows for input from various stakeholders.		Allows for either limited of extensive stakeholder input but elicits effective involvement.

Overall Tourism Management Framework

The Tourism Optimisation Management Model (TOMM) was designed to assist in planning tourism opportunities for Kangaroo Island in South Australia by Minidisc Roberts Consultants (1997). While also based on Limits of Acceptable Change it has a wider scope including a regional application and can be used on public and private land and includes extensive stakeholder involvement (Table 11 and references therein).

Recent visitor impact management frameworks incorporating ecosystem condition

Earlier frameworks (Table 10), although potentially identifying impacts at an early stage, have two main limitations: firstly, they often did not link the impact with cause/s of impact and secondly, they often did not go beyond identifying site-specific impacts (Nilsen & Tayler 1998). Thresholds of Potential Concern (TPC) and Decision Support Systems/Tourism Natural Asset Classification (DSS/TNAC) take into account the dynamic nature of the environment and allow managers to assess changes along environmental gradients rather than defining specific end points (Table 11).

Although the Limits of Acceptable Change concept still forms the basis for more recent frameworks, adaptive management principles are used with feedback mechanisms for reviewing management objectives and reassessing priorities and actions. Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Adaptive approaches utilise a range of thresholds and rely heavily on the use of indicators to assess the significance of the impacts through monitoring (Belnap 1998, Biggs & Rogers 2003, Hughes *et al.* 2004, Miller & Twining-Ward 2005). Adopting adaptive management principles more recent frameworks e.g. DSS/TNAC provides a more integrated approach to visitor management.

Recent studies comparing various framework and models have also proposed refinements to address site-specific considerations (Nilsen & Tayler 1998, Farrell & Marion 2002, Moore *et al.* 2003). The underlying assumption of these reviews is that there are conflicting objectives facing managers and that frameworks can be developed for specific areas that highlight potential conflicts and prioritise objectives (Cole & Stankey 1998).

The recently proposed DSS/TNAC framework has built on the complex adaptive systems approach[4] (Miller & Twining-Ward 2005) while also drawing from research into the resilience of ecosystems (Walker *et al.* 2002) (Table 11). These frameworks based on the PSR framework address sustainable tourism through understanding the inherent instability in ecological systems and identify important components within these systems that are subject to continual change. Monitoring/management needs to be flexible (adaptive) to allow for such fluctuations while not reducing the resilience (ability to absorb stress) of the system in the long term. They also stress the need to select appropriate indicators at a range of spatial and temporal levels (Belnap 1998, Ward ***et al.*** 2002, Hughey *et al.* 2004, Watts *et al.* 2004, Hadwen *et al*. 2005a).

[4] Ecological systems are inherently unstable and are in continual states of flux. It is the diversity (structural, compositional and functional, *sensu* Noss 1990) associated with this heterogeneity that highlights the need for management systems to gain a better understanding of the complexity of systems (ecosystems components and relationships among these). Management is therefore required to be flexible to cater for such ecosystem flux and an adaptive approach is warranted. Improvements are made to monitoring and management systems by learning from outcomes.

Chapter 5

FRAMEWORKS FOR EVALUATING THE MANAGEMENT EFFECTIVENESS OF PROTECTED AREAS

Increasingly, protected area agencies are required to evaluate and report on their management performance (Hockings 2003, Tonge *et al.* 2004, Worboys *et al.* 2005) and management frameworks facilitate the linkage of planning, monitoring and evaluation (Hockings 1998). Evaluation reports include monthly and quarterly internal reports such as for finances and human resources and other administrative and management processes, yearly reports on the achievement of organisational goals and targets, such as annual reports, longer term reports identifying the change in condition of protected areas such as state of parks reporting and reporting required for external organisations such as World Heritage integrity reports (Worboys *et al.* 2005).

Broad scale assessment of the condition of the environment and severity of major threats is one component of state of parks and World Heritage reporting (Environment Australia 2003, DEC 2005). Evaluation of the condition of the environment for a single park is less common, and few Australian protected areas have systems in place to monitor and evaluate management outcomes (Hockings *et al.* 2000, 2006). Evaluation for a single park includes the process of developing plans of management which often require assessments of the values of the park, including condition and trend in condition of values, threats to values, management actions that can be taken to eliminate/ameliorate threats, and ways to evaluate the success of those actions (Worboys *et al.* 2005).

One of the threats to the values of a park is visitor use. For example, the Australian government's first report to the World Heritage Commission (Environment Australia 2003) found that visitor overuse or inappropriate visitor use was a threat for almost all of Australia's World Heritage Areas and recommended a 'greater investment in research on sustainable tourism development' (Environment Australia 2003). The need for visitor use of protected areas to be carefully managed and sustainable has been recognised at a global level in the International Convention on Biological Diversity (CBD) (SCBD 2001). The development of ongoing, integrated monitoring, evaluation and reporting systems and adaptive management are mechanisms which help facilitate sustainable visitor use of protected areas. However, systematic, ongoing monitoring of visitors is rarely conducted for Australia's protected areas and thus empirical information on the level of extent of the threat from visitor use is unknown and unacknowledged.

The WCPA Management Evaluation Framework

There is increasing recognition that protected area agencies need to assess the effectiveness of their management and use evaluation findings to improve conservation (Dudley *et al.* 1999, SCBD 2001, IUCN 2005, Hockings *et al.* 2006). In response to this need, IUCN (the World Conservation Union) and its World Commission on Protected Areas (WCPA) developed a framework for guiding the evaluation of management effectiveness. The framework is directly linked to the cycle of management for protected areas.

The WCPA framework classifies the cycle of management into six stages or 'elements' beginning with: (1) the context within which management takes place, through (2) management planning (3) inputs such as the allocation of staff and financial resources and (4) management processes. The final elements are (5) evaluation of the outputs and (6) outcomes that are produced as a result of management actions (Figure 1) (Hockings *et al.* 2000, 2006). For the six elements of the management cycle the WCPA framework identifies a total of ten 'criteria' to be assessed. Criteria are broad sub-groups of elements and provide guidance as to what should be assessed (Figure 1) (Hockings *et al.* 2000, 2006). The WCPA framework also identified a process for conducting evaluation and a checklist of issues managers should consider. Potential indicators are also suggested.

The WCPA framework is flexible and can be adapted to the needs and resources of management agencies. It is becoming more widely accepted and is the basis of a number of methods for assessment (Hockings *et al.* 2006). For example, it has been used to develop evaluation methods for systems of protected areas such as Enhancing our Heritage (Stolton *et al.* 2006), RAPPAM (Ervin 2003a,b) and the World Wildlife Fund World Bank Tracking Tool (Stolton *et al.* 2003). It has also been used as the basis for evaluation for single protected areas and for limited areas within a single protected area (Hocking *et al.* 2000, 2006).

Ideally, assessments of management effectiveness will incorporate aspects from all six elements of the WCPA framework. This is not always the case and the evaluation of outcomes of management, particularly conservation outcomes, is potentially difficult and costly as it involves assessment of management success relative to the objectives of management plans and national plans (Hockings *et al.* 2000, 2006). This information ideally should be provided by long term monitoring programs of appropriate ecological indicators (Worboys *et al.* 2005).

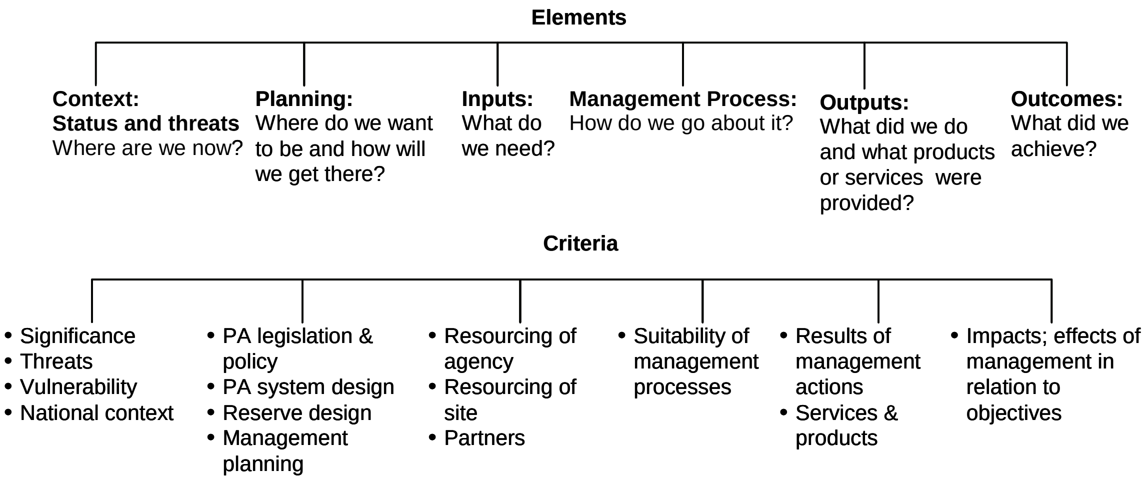

Figure 2 The WCPA framework for evaluating management effectiveness of protected areas (Hockings *et al.* 2000, 2006)

The Expanded-WCPA Management Evaluation Framework

The WCPA framework provides general guidance about what is evaluated for each stage of the management cycle (Figure 1). However, recent empirical research by Worboys (2007) on the evaluation needs of protected area practitioners worldwide further identified specific evaluation needs:

- firstly, people are undertaking too much evaluation relative to available management resources
- secondly, they want more specific guidance on what should be evaluated
- finally they are not satisfied with the current focus of evaluation, which is predominantly the assessment of management processes. Protected area mangers want more emphasis on assessing management outcomes, particularly conservation outcomes.

On this basis Worboys (2007) expanded the WCPA management evaluation framework to include three additional evaluation criteria: assessing baseline conditions of values, the change in condition of values and the severity of threats to protected areas (Figure 2) (Worboys (2007).

Based on the results of global and Australian surveys of 178 protected area professionals who were asked what their organisations were actually evaluating and what they considered were the key gaps in what was evaluated. That is—what should be evaluated that wasn't already being evaluated. He categorised responses relative to the ten criteria of the expanded-WCPA framework in three increasingly more specific categories (areas, subjects and topics). This extended categorisation comprised 251 evaluation subjects (Figure 2).

Core Evaluation Subjects

One of the key finding of Worboys' global and Australian surveys was that too much evaluation was required relative to available staff and financial resources. Therefore, guidance was needed for prioritising evaluation subjects. From 251 subjects identified by users, Worboys derived a core set of 31 priority subjects (Figure 2). Core evaluation subjects are defined for each of the six elements of the WCPA framework and provide focus for evaluating the primary purpose for which protected areas have been established—the conservation and effective management of biodiversity and of natural and associated cultural resources (Worboys 2007).

However, different management organisations will require different subsets of evaluation subjects from the core subjects and it is expected that they will identify their own priority subjects to suit their own evaluation information requirements. Other subjects (from the 251 subjects of the expanded-WCPA framework) may also be required depending on individual needs (Worboys 2007). Appendix A lists 111 subjects of evaluation with potential relevance to assessing the triple bottom line of visitor use of protected areas: ecological, social and economic.

Organisations will require different subsets of evaluation subjects and not all core subjects will be required by all users. Individual protected area management organisations will identify their own priority subjects to suit their own evaluation information requirements.

Appropriate ecological indicators should be developed for these evaluation subjects and monitoring programs implemented (Worboys 2007). A key aspect of the expanded evaluation framework is that indicators can be chosen to provide information for a variety of purposes and at several scales. For example, monitoring of indicators can provide information about evaluation subjects at a site/s, but can also be aggregated to provide information at the level of park or even region (several parks).

This approach has been used for evaluation of the Great Barrier Reef Marine Park. The Great Barrier Reef Marine Park Authority, the agency responsible for overall management of the Park, regularly reports on the condition of the reef. The park level indicator—'Healthy Reef' has been used to report overall condition of the coral reefs. Clearly this is a broad scale indicator but the information has been aggregated from a range of long term monitoring programs at a series of reefs (GBRMPA 2005).

Core Subjects and Evaluating Visitor Use of Protected Areas

Visitor use is seen as a major threat to protected areas by managers world wide (Worboys 2007), and is considered to be an integral part of any assessment of the effectiveness of protected area management (Worboys 2007). However, what aspects of visitor use are evaluated? Where is the line drawn between assessing the effectiveness of management for protected areas and for visitor use management? Does visitor use evaluation cover all aspects of the ecological integrity of a protected area for example, or should it have a more restricted approach?

The core evaluation subject for visitor use is identified as severity of threat from visit use (Worboys 2007). For most protected areas, monitoring and assessment would be applied to discrete areas within protected areas where there are substantial interactions between visitor use and important environmental resources. These could be (for example) key visitor destinations such as a scenic lookout or a wildlife observation area. The evaluation information collected would be used for the sustainable management of visitor use for these discrete areas.

Any evaluation information obtained for the discrete areas within protected areas could be used as input to the more generic whole of protected area management evaluations conducted for core evaluation subjects such as (1) baseline values of flora (2) baseline values of fauna (3) baseline values ecosystem, habitat, land types (4) change in condition of flora (5) change in condition of fauna (6) severity of threat from weeds and (8) severity of threat from pest animal (Figure 2). As well as core subjects there are a number of other evaluation subjects identified in the expanded-WCPA framework that may also be important when assessing other social and economic of visitor use (Figure 3).

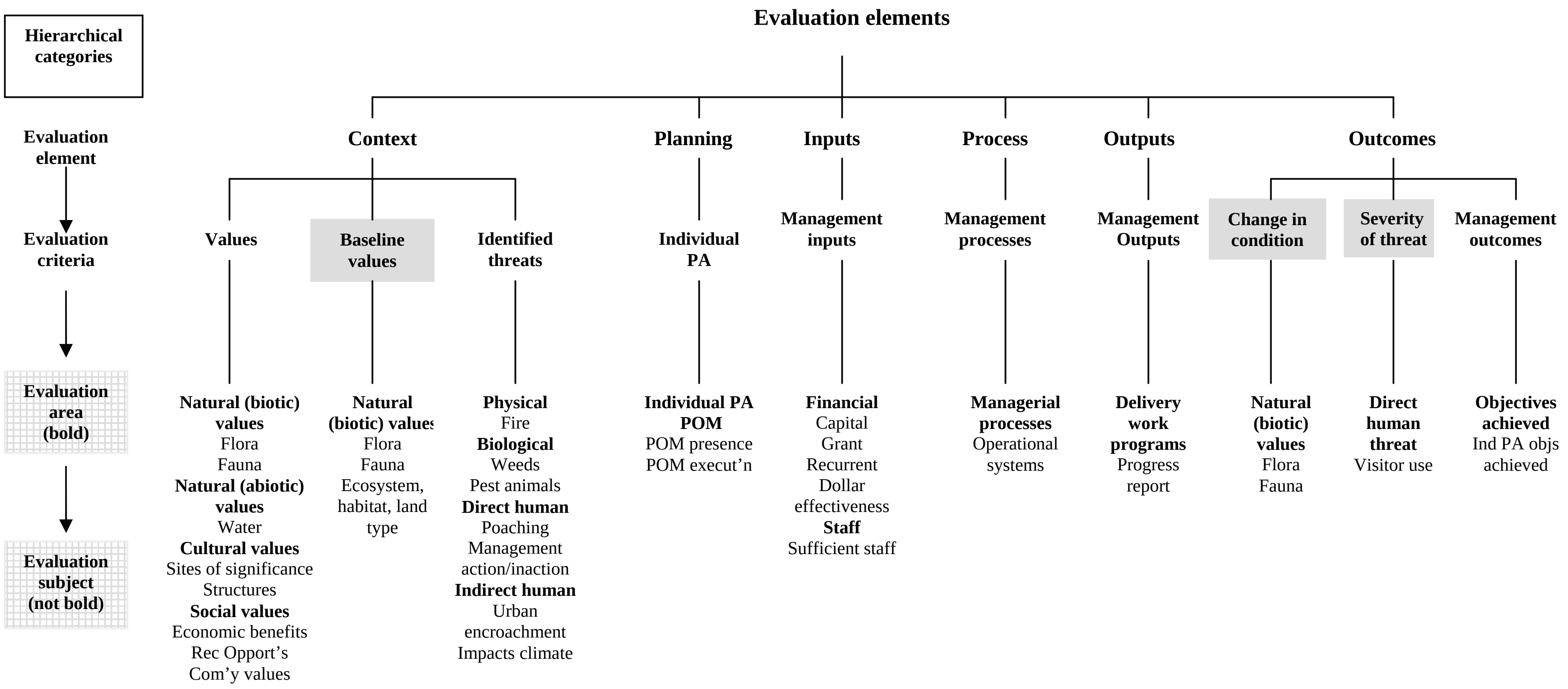

Figure 3 Thirty-one core evaluation subjects categorised relative to the draft expanded-WCPA evaluation framework.

Grey shaded boxes identify the three additional criteria added to the WCPA framework by Worboys (2007). Evaluation area and evaluation subject (grey hatched boxes are more specific categories within criteria.

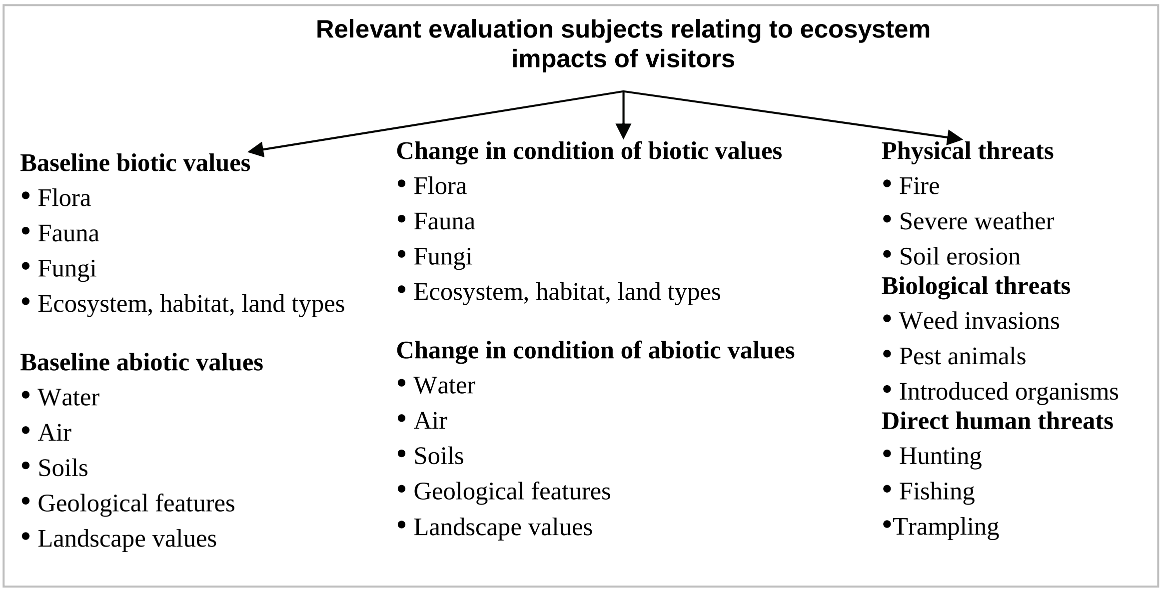

Figure 4 Evaluation subjects that relate to the ecological impacts of visitors (Worboys 2007)

Chapter 6

INTEGRATED FRAMEWORK FOR DEVELOPING ECOLOGICAL INDICATORS OF VISITOR USE

Rationale for the Framework

Sustainable tourism is considered an appropriate use of most Australian protected areas. However, visitor use needs to be managed and the effectiveness of management needs to be assessed. Overuse or inappropriate visitor use can adversely affect natural values. Despite the importance of Australia's natural assets, few have stand-alone management guidelines to ensure that visitor impacts are monitored and the values of assets are maintained. Although progress is currently being made there are few legislative requirements in Australia for monitoring visitor impacts and currently impacts are rarely adequately monitored (Buckley 2004, Hadwen *et al.* 2005a, Worboys *et al.* 2005). Significantly, even when there is visitor monitoring it is usually not integrated into overall management evaluation frameworks (McArthur and Sebastian 1998; Brown *et al.* 2006). In addition, the capacity of management agencies to develop and implement visitor monitoring is still being developed. In spite of limited staff and financial resources, agencies have many assessment and reporting requirements with many managers identifying that there are too many reporting systems and different methods for evaluation (Worboys 2007).

To overcome these issues a framework (and associated guidelines for its use) which integrates visitor impact monitoring and evaluation with the cycle of management for protected areas and produces feedback that enable managers to improve management has been developed. The integrated framework is linked to the expanded-WCPA management effectiveness evaluation framework (Chapter 4) and uses, as far as possible, existing management processes for focusing monitoring effort and selecting ecological indicators.

Focusing monitoring effort is achieved through a process of prioritising natural assets used by visitors or likely to be affected by visitor use. The prioritisation is based on value of natural assets, vulnerability of natural assets and the type and severity of visitor use. The report provides information on selecting appropriate ecological indicators (Chapter 2) that, if monitored systematically, will provide information on the change in condition of natural assets.

Specific monitoring protocols and guidelines for walking tracks are outlined in subsequent STCRC Reports which will include examples of protocols for visitor impact monitoring, how to set thresholds and how to interpret results.

Focusing and Prioritising Monitoring Effort

Although monitoring and assessment should be conducted at natural assets used by visitors or likely to be affected by visitor use, agencies commonly have insufficient funding to support such full and comprehensive evaluation. Therefore, our framework recommends prioritising visitor impact monitoring based on: (1) the importance/value/significance of assets (2) the vulnerability of assets and (3) the pressure/threat from visitor use.

A natural asset used by visitors or affected by visitor use could be a type of habitat or a type of ecosystem or a type of physical landscape. They can occur in just one location or in more than one location within a protected area. Natural assets used by visitors occupy area ranging in size from small discrete locations (e.g. visitor lookout, picnic areas, hardened campsite) to extensive areas (e.g. sand dune ecosystems used for camping accessed by off road vehicles which can extend for many kilometres). Assets can also be components of the physical environment (e.g. a cave, or a mountain top, snow bank, hot spring, waterfall) or they can be components of the flora (e.g. littoral rainforest, short alpine herb fields) or components of the fauna (e.g. terrestrial mammal, aquatic mammals, bird, reptile, insect, glow worms).

Methodologies for prioritising the value of natural assets are documented by relevant state or territory protected area management organisations and other organisations such as the Australian Heritage Commission, and organisations responsible for state of the environment reporting.

In general ecological concepts for determining the importance/value of natural phenomena include knowledge of rarity, diversity and habitat condition. Vulnerability of natural phenomena is also determined using ecological concepts such as resistance or resilience. Finally assets used by visitors should be prioritised based on the **severity of threat from visitor use.** This is achieved through understanding and identifying the types of activities and infrastructure at assets and the potential impacts of these at other assets (see Chapter 1).

For some protected areas, the value/importance and vulnerability of assets has been identified. In many instances, threats from visitor use have also been identified. Such assessments are often given in plans of management and other planning/policy documents. On this basis managers can prioritise assets used by visitors.

Site Level Indicators, Asset Level Indicators and Park Level Indicators

Indicators of change in condition from visitor use at discrete sites are selected through a process which considers characteristics of visitor use (what is the activity and what are its potential impacts?) and characteristics of the site (e.g. is the natural asset a component of the flora or fauna; an aquatic ecosystem; a geological feature such as a cave or other rock formation; or it is a landscape feature such as a waterfall or lookout?).

The design of the monitoring program depends on the characteristics of the natural asset and the type of visitor activity. Depending on the asset type (e.g. wildlife, flora or cave) monitoring may be implemented at a single site, several sites or numerous sites representing the asset, with the sites located where visitor use occurs and other sites that might be affected. The appropriateness of a site based approach is confirmed by recreational ecologist worldwide who point out that most visitor impacts are localised and severe and that general ecological monitoring cannot detect small scale but important site based impacts of visitors (Chapter 1).

Monitoring protocols and thresholds of concern are the subject of subsequent STCRC reports and hence will not be addressed here in detail. Both are dependent on the characteristics of the asset and the type of visitor activity.

Site based monitoring of ecological indicators to measure change in condition is current best practice approach in Australia and overseas. This approach was used by the Great Barrier Reef Marine Park Authority (GBRMPA) in assessing the overall condition of the Great Barrier Reef. For the park level indicator 'Healthy Reef'—the overall condition of reef was assessed based on data from long term monitoring programs measuring the extent/coverage of healthy coral on a series of reefs (GBRPMA 2005).

The Tasmanian Parks and Wildlife Service (TPWS) used a site based approach to monitoring in order to assess performance in managing visitor activities and use in Tasmanian wilderness. Biophysical indicators were monitored at 450 sites along the walking track system, and at 50 sites along the lower the Gordon River (TPWS 2004). Assessment of trends in condition based on these data were used as part of higher level assessment of performance in protecting the natural and cultural heritage of the Tasmanian wilderness.

Scalable evaluation information

Evaluation information obtained for a site may be suitable for use at other levels within an organisation. Typically, the information is less specific the higher the level within an organisation in which it is used (Worboys 2007). For example, detailed site specific evaluation information for the discrete areas within protected areas that are evaluated for severity of threat from visitor use, could be used as input to the more generic whole of protected area management evaluations conducted for core evaluation subjects such as change in condition of flora and fauna with a generic indicator such as 'healthy park' (Figure 4). However, when using site based data to report on park level indicators, care must be taken as aggregation of data can grossly understate visitor impacts.

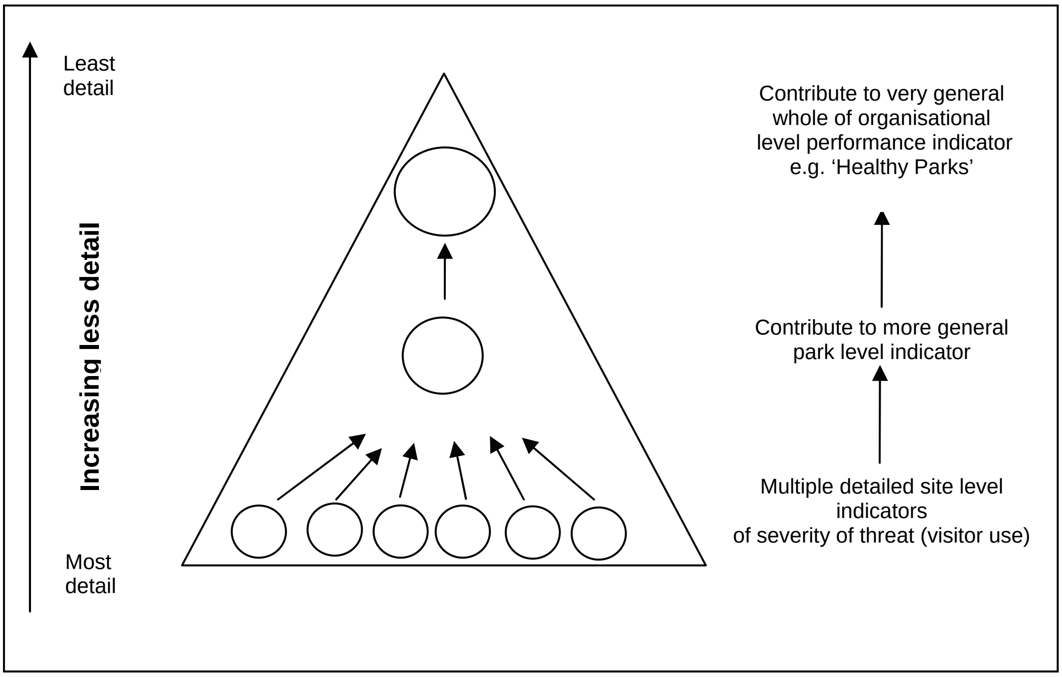

Figure 5 Conceptual diagram of use of data from site level monitoring of severity of threat from visitor use to inform system of park level performance indicator

The Key Strengths of the Integrated Framework

1. This framework integrates monitoring and evaluation into the cycle of management for a protected area and generates feedback that enables managers to learn from and progressively improve management.
2. It is linked to the expanded-WCPA evaluation framework (Hockings *et al.* 2000, Worboys 2007) (Chapter 4). Indicators are selected to provide information for relevant core evaluation subjects identified in the expanded- WCPA framework. Relevant evaluation subjects include severity of the threat from visitor use and baseline values and change in condition of flora/fauna/ecosystem/ habitat.
3. It is based on existing management systems and processes to limit additional workload and costs.
4. Managers select sites for visitor monitoring by prioritising their value and vulnerability and identifying the types of visitor activities.
5. Site based monitoring provides information on change in condition from visitor use. However, information from sites can be aggregated to provide information on change in condition of flora/fauna/habitat at the whole of park level (see example in Figure 6).

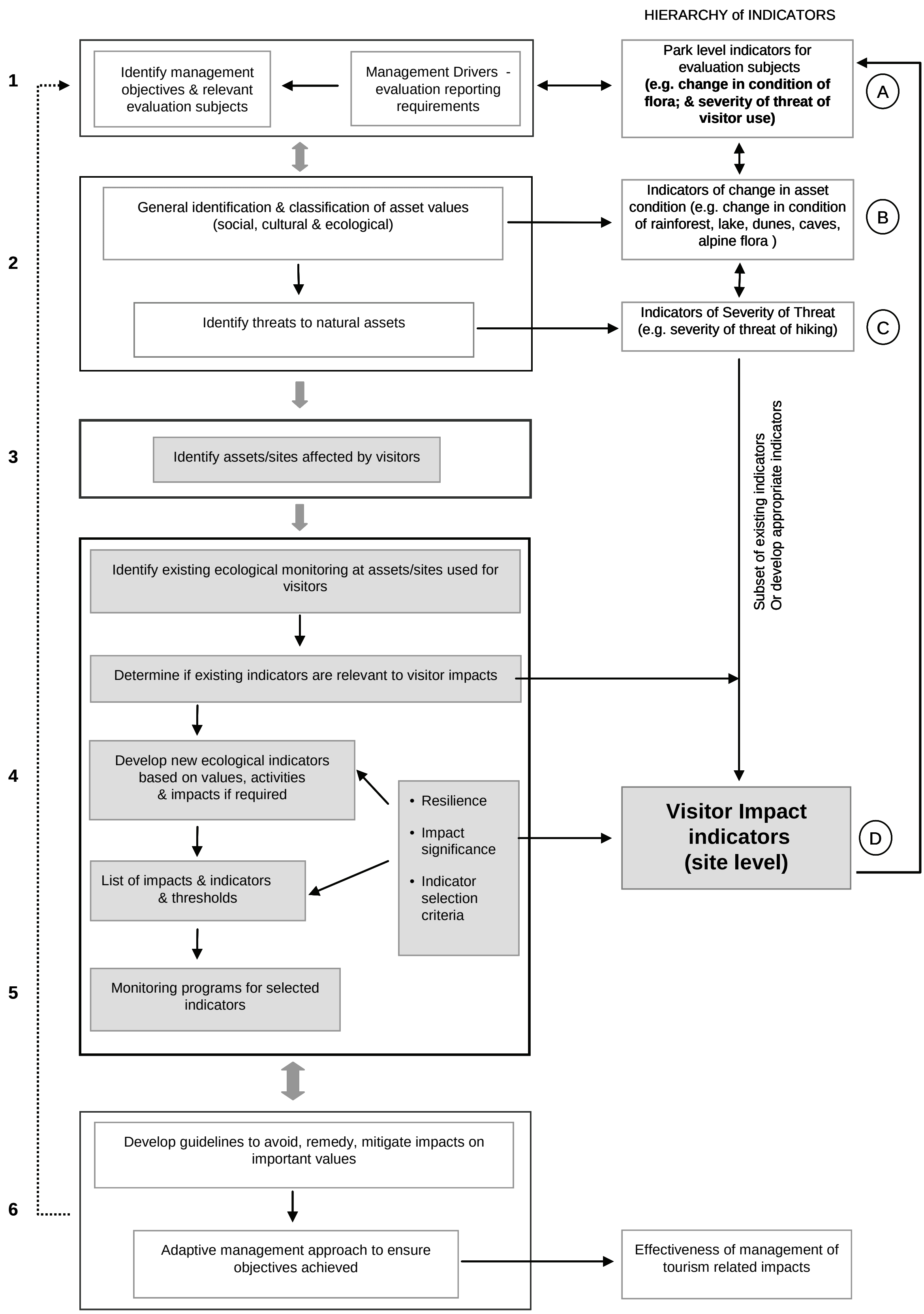

Figure 6 Integrated framework for developing ecological indicators of visitor impacts in protected areas

The framework consists of six steps: (1) identifying management objectives and relevant evaluation subjects, (2) classifying natural assets and threats to those assets, (3) prioritising sites for visitor monitoring, (4) selecting ecological indicators of visitor impacts, (5) developing monitoring programs for indicators and (6) using results to improve future management (adaptive management). Guidelines for Steps 1–6 are provided in following text.

Guidelines for the Application of the Framework

This section is an instructional guide to the use of the integrated framework presented in the previous section. An illustration of the application of the framework for a protected is shown in the example in Figure 6.

The 6 steps in the integrated framework (Figure 5)

Step 1 is identifying management objectives for the park and evaluation subjects relevant to visitor impacts.
Step 2 is identifying natural assets and threats to those assets.
Step 3 is identifying assets used or affected by visitor use (subset from Step 2). Assets used for tourism and recreation are prioritised for monitoring effort based on their value (importance) and vulnerability/fragility and the severity of visitor use.
Step 4 is selecting ecological indicators of visitor impacts for priority assets selected at Step 3.
Step 5 is developing monitoring programs for selected indicators (Step 4). It is expected that monitoring will be conducted at a range of sites to provide data about condition of assets used by visitors. Monitoring protocols are the subject of a subsequent STCRC Report.
Step 6 is adaptive management i.e. future management of visitors is improved based on results of monitoring and evaluation. Again protocols and mechanism for this are beyond the scope of this report and should be implemented by agencies.

Detail of the six steps in the integrated framework (Figure 5)

Step 1: Determine management objectives for the park and evaluation subject/s relevant to visitor impacts on natural values.

It is necessary to identify management objectives relating to conservation and protection of natural assets and visitor use before implementing this framework. Objectives for the management of park types are usually set out in relevant state and commonwealth legislation and are also stipulated in documents such as plans of management, state of parks reporting, World Heritage reporting etcetera. The primary management objective of most national parks is to protect and conserve representative samples of flora, fauna and scenery and to conserve cultural heritage, with other areas reserved primarily for recreation and open space values.

Sustainable tourism is seen as an appropriate and desirable use of most protected areas, including national parks (Worboys *et al.* 2005) with state agencies having a range of strategies for managing visitor use.

After establishing management objectives for the protected area, it is necessary to determine the relevant evaluation subject/s for assessing visitor use. These can be found in the expanded-WCPA evaluation framework (Chapter 4). The core evaluation subject with primary relevance for visitor use impacts is ‘severity of threat from visitor use’. Other relevant core evaluation subjects are baseline value of flora, baseline value of fauna, baseline values ecosystem/habitat/land types, change in condition of flora, fauna, habitat, geological feature, landscape type as well as severity of the threat of visitor use. Additional evaluation subjects are severity of threat from weeds, severity of threat from pest animals and severity of threat from fire regimes.

A hypothetical example (Figure 6)

The evaluation subject ‘severity of threat from visitor use’ was selected in the example protected area. Other core evaluation subjects relevant for evaluation could be change in condition of flora/habitat.

Step 2: Prioritise natural assets and threats to assets

In order to focus monitoring effort natural assets are prioritised for monitoring based on three characteristics: (1) the importance/value of assets, (2) the vulnerability of assets, (3) threats to assets from visitor use.

Methodologies for prioritising the value of natural assets are documented by relevant state or territory protected area management organisations and other organisations such as the Australian Heritage Commission, and organisations responsible for state of the environment reporting. Prioritising of natural assets may already be established for some protected areas, for example, state of the parks reports for NSW and Victoria provide a comprehensive inventory of the natural values of parks. However, there is growing recognition that this is generally not the case for freshwater ecosystems (Hadwen *et al*. 2005b, Abell *et al*. 2006).

For as yet unevaluated assets, measures of importance and value should be established through the use of existing importance/significance/value assessment methodologies. Based on existing assessment it would be useful, as a minimum, to categorise the value of flora/fauna/physical feature assets as high, moderate or low.

Fragility has already been established for many assets in some protected areas. Classify the fragility of the asset as resistant/resilient, moderate or fragile which can be established through the use of existing fragility methodologies for the asset type and class.

For prioritised natural assets, identify threats to natural values. For example, removal of habitat for provision of infrastructure, spread of exotic species, altered water and fire regimes and inappropriate visitor use have been identified worldwide as processes impacting impact natural values of protected areas worldwide.

The example (Figure 6)

In the example (Figure 6), seven natural assets were identified and prioritised based on value and fragility. Five threats were associated with these natural assets. At three natural assets visitor use (inappropriate visitor loads and activities) were identified as a threat.

Step 3: Prioritise assets used by visitors for monitoring

Identify natural assets used and/or impacted by visitors. These assets will be a subset of all assets identified in Step 2. From among those assets used and/or affected by visitors, prioritise assets for monitoring. This will be based on the importance and fragility of assets and the types of visitor activities and the severity impacts.

Information on visitor activities and impacts at natural assets may already occur in plans of management, annual plans, World Heritage reporting, and GIS mapping of park assets including Recreational Opportunity Spectrum (ROS) mapping. However, not all impacts of visitor use have made their way into park management plans and a more complete list of activities and their associated ecological impacts is provided in Chapter 1 of this report.

Assess the severity and extent of threat from visitor use based on the knowledge and experience of staff. However, this is often unknown and may require the involvement of recreation ecologists. Particularly, from the aquatic perspective, there is usually insufficient data upon which qualitative judgments about visitor impacts on aquatic ecosystems can be made.

If there are no existing processes for prioritising natural assets and identifying threats for protected areas an approach based on the DSS/TNAC framework (Decision Support System and Natural Asset Classification framework) recently developed for monitoring and evaluating the sustainable tourism use of natural assets in New Zealand is suggested (Ward *et al.* 2002, Hughey *et al.* 2004) (Appendix B).

The example (Figure 6)

Assets 5 and 6 are used for camping and sightseeing and asset 6 is a lookout. Impacts from these activities have been identified and include loss of vegetation, soil, erosion, soil compaction, wildlife disturbance, as well as the introduction of weeds and fungal pathogens. Based on the value and fragility of assets and the severity of visitor use all three assets were identified as priorities for monitoring.

Step 4: Select ecological indicators of severity of the threat from visit use for priority sites identified at Step 3.

Indicators are selected based on the particular characteristics of the asset as well as on type of visitor activity (see Chapter 1 this report for details on common impacts of recreation activities). Issues in selecting indicators and lists of potential indicators are found in Chapter 2). For assets identified in Step 3 identify if appropriate visitor impact monitoring is already occurring. If not, identify relevant indicators of change in condition of asset. In some instances, appropriate indicators may not have been sufficiently field-tested to facilitate immediate implementation. Under these circumstances, it may be necessary to involve recreation ecologists in the scientific testing of indicators and their response to specific visitor activities.

Causal links between some recreation activities and impacts have often been well established by research ecologists worldwide (Chapter 1) and do not need to be experimentally established in monitoring programs (e.g. trampling and camping impacts). The assumption is that if adverse changes in condition are detected, then that change is the result of visitor use.

The example (Figure 6)

Indicators are selected to assess change in condition from camping and sightseeing at three assets used by visitors (Sites 5 and 6). Ecological indicators could be change in vegetation structure and composition at asset 5, including the extent of weeds (baseline values initially) and then spread of weeds over time. Soil erosion, bare ground (baseline) and increase in bare ground and soil erosion may be monitored at asset 6.

Step 5: Develop monitoring programs for indicators

Specific tools for carrying out monitoring will be the subject of a subsequent STCRC report in which protocols, tools and techniques are identified for monitoring. Baseline values and setting thresholds of concern is also discussed in the subsequent report.

Assessing change in condition of assets as a result of visitor use is achieved by implementing monitoring at a discrete natural asset or sites representing the asset being assessed. This step is also likely to require the involvement of recreation ecologists. From the aquatic perspective, there is not yet a ready-made list of sufficiently responsive and easy to implement indicators that can be accessed by managers.

Step 6: Develop guidelines to mitigate impacts

Information on how to mitigate the impacts of visitors can be found in technical and management reports as well as in recent reviews of visitor impacts (listed in Table 8). For example, strategies to limit the introduction and spread of weeds should take into account the role of visitor infrastructure and activities in this process.

An adaptive management approach is recommended allowing managers to assess changes in natural ecosystems and to respond accordingly. This enables monitoring to assess natural ecosystem fluxes and therefore managers can respond accordingly to by revising impact monitoring in a strategic rather than reactive manner (Salafsky *et al.* 2002, Biggs & Rogers 2003, Rogers 2003).

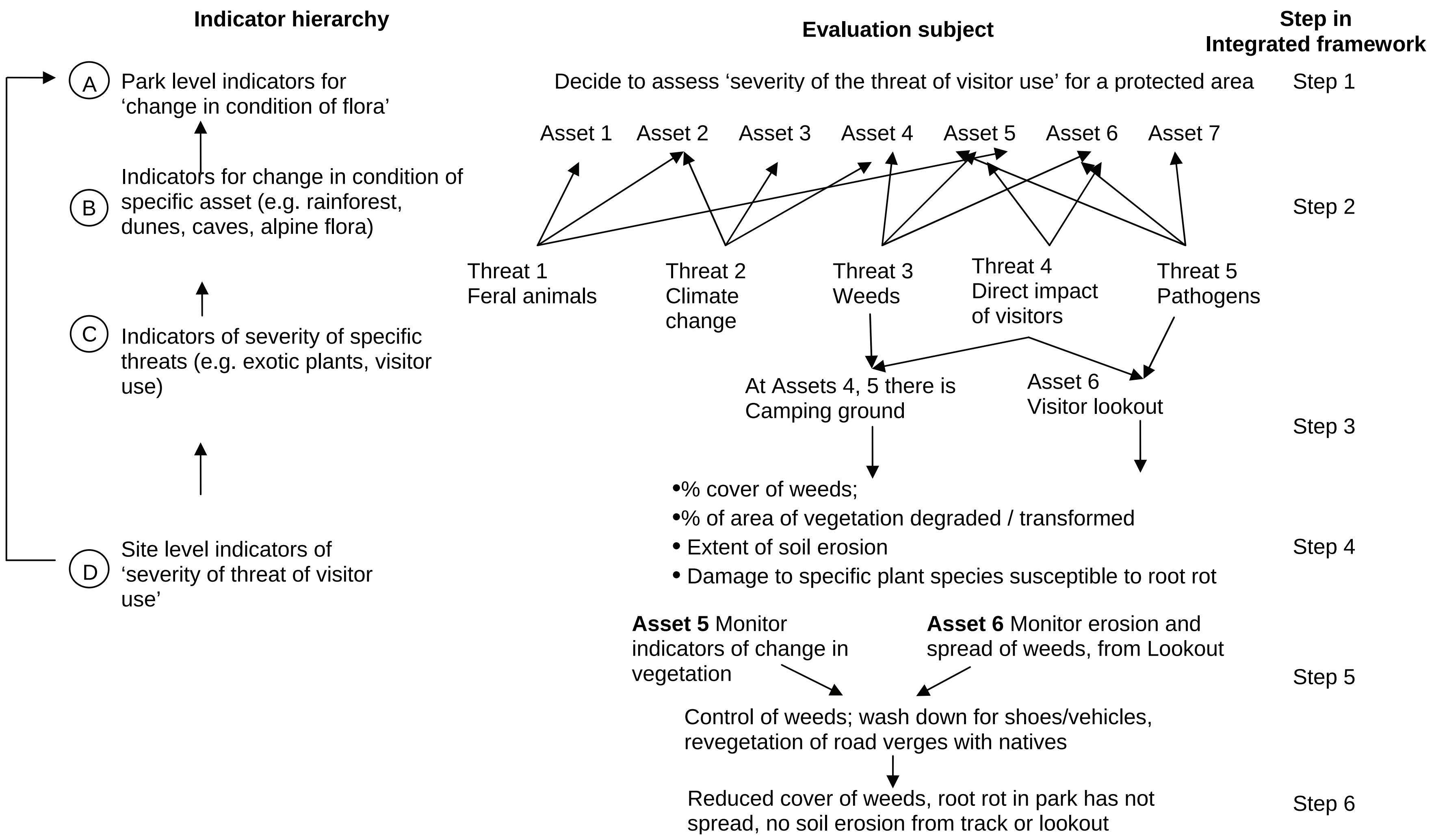

Figure 7 Example of use of the integrated framework (Figure 5) for the evaluation subject 'change in condition of flora' for a given park

Table 12 Reviews of strategies/methods to ameliorate impacts

Infrastructure	Reviews of strategies/methods to ameliorate impacts
Resorts including ski resorts	Buckley, R.C., Pickering, C.M., Warnken, J. 2000. Environmental management for alpine tourism and resorts in Australia. In: Goode, P.M., Price, M.F., Zimmerman F.M. (Eds) *Tourism and Development in Mountain Regions*. CABI Publishing, New York, pp. 27–46.
Roads and tracks	Spellerberg, I.F. 1998. Ecological effects on roads and traffic: a literature review. *Global Ecology and Biogeography Letters* **7**: 317–333. Marion, J.L. and Leung, Y. 2004. Environmentally sustainable trail management. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York, pp. 228–244.
Camping	Leung Y. and Marion, J.L. 2004. Managing impacts of camping. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York, pp. 245–258.
Pathogens	Department of Primary Industries, Water and Environment (DPIWE), 2005. Managing *Phytophthora cinnamomi*. Online documents at URL http://www.dpiwe.tas.gov.au/inter.nsf/WebPages/EGIL-53Y8FA?open. Accessed 1 July 2005. Environment Australia, 2001. *Threat Abatement Plan for Dieback Caused by the Root-rot Fungus Phytophthora cinnamomi*. Department of the Environment and Heritage, Australian Government, Canberra. Buckley, R. King, N and Zubrinich, T. 2004. The role of tourism in spreading dieback disease in Australian vegetation. In: Buckley, R. (Ed.) *Environmental Impacts of Ecotourism*. CABI Publishing, New York, pp. 317–324.
Weeds	Environment Australia. 2006. Environmental Weeds in Australia. http://www.deh.gov.au/biodiversity/invasive/weeds/. Accessed January 2006. Williams, J., West, C.J. 2000. Environmental weeds in Australia and New Zealand: issues and approaches to management. *Austral Ecology* **25**: 425–444.
Camping	Hockings, M., Twyford, K. 1997. Assessment and management of beach camping impacts within Fraser Island World Heritage Area, South-East Queensland. *Australian Journal of Environmental Management*. **4**: 26–39. Smith, A., Newsome, D. 2002. An integrated approach to assessing, managing and monitoring campsite impacts in Warren National Park, Western Australia. *Journal of Sustainable Tourism* 1**0**: 343–359.
Horse-riding	Landsberg, J., Logan, B., Shorthouse, D., 2001 Horse riding in urban conservation areas: reviewing scientific evidence to guide management. *Ecological Management and Restoration* **2**: 36–46. Newsome, D., Phillips, N, Milewskii, A., Annear, R., 2002b. Effects of horse riding on national parks and other natural ecosystems in Australia: implications for management. *Journal of Ecotourism* **1**: 52–74.

How Essential Criteria for Evaluation Frameworks are Addressed in this Integrated Framework

As part of the process of developing this integrated framework it was tested against essential criteria that have been identified in two recent reviews addressing visitor impact management in protected areas (Farrell & Marion 2002, Moore *et al*. 2003). In Table 6 these criteria, the motivation behind them and how this new framework addresses them are listed.

Table 13 Essential criteria for evaluation frameworks (adapted from Farrell & Marion 2002, Moore *et al.* 2003)

Criteria	Motivation	Our integrated framework
1) The framework is based on clear management objectives supported by defensible decision making	Objectives are required at the outset of the process across the three primary management areas—ecological, social, and economic.	Identifying explicit management objectives is central to the effective use of the framework. Not only does the framework suggest that objectives are defensible but that these are also established within the larger management context.
2) The framework should include all the WCPA-WCPA management evaluation components	Having a framework that identifies where indicators of change in condition from visitor are utilised in the cycle of management (and the WCPA framework).	Identifying the evaluation subjects relevant to visitor impacts from the expanded WCPA-WCPA framework is the first step in the planning framework.
3) Indicators are integral to the framework and are used to assess impacts and measure progress to meeting objectives in (1)	Implementation is the key to the success of the framework and little progress in the field of recreation ecology will be made if the framework is not adopted across all management sectors. Management actions will be geared towards meeting objectives defined at an early stage of the process.	The identification of indicators is a key step in the framework and relies heavily on the existing knowledge of the system. However, a review of ecological assets and potential impacts serves as an exercise to prioritise impacts prior to selecting appropriate indicators.
4) The framework should take into account the multiple underlying causes of impacts	The complex nature of socio/ecological systems suggest that simple cause and effect relationships will not be the norm and indicators that report on multiple pressures will be more suited to inclusion in monitoring programs.	The framework is able to respond to multiple drivers and is ideally suited to deriving single indicators to assess the impacts of a multitude of causal factors. This is captured by placing emphasis on the identification of potential indicators as a form of risk management.
5) The framework can be clearly understood and implemented facilitating selection of a number of management actions	Implementation is the key to the success of the framework and little progress in the field of recreation ecology will be made if the framework is not adopted across all management sectors. Management actions will be geared towards meeting objectives defined at an early stage of the process.	The framework is relatively straightforward and as a result can be readily implemented by management agencies. The framework also argues for the use of as much existing information as possible to alleviate the operational demands on agencies. The report attempts to explain each step of the framework to make this as clear as possible.
6) The framework is easy, quick, inexpensive and cost-effective to implement	Linked to the understanding of the system the success of implementation is likely to be constrained by budgets and efficient systems that are relatively inexpensive are likely to be supported. This may be more applicable in developing countries where Farrell & Marion (2002) were focusing their attention but is still a consideration in developed countries such as Australia. However, it is important that the efficacy of the system is not compromised by cutting costs and managers need to be aware that ecological monitoring is not necessarily quick or cheap.	The framework builds on existing information already within various management reports. It is unlikely that all the aspects will have been covered and there is therefore the potential of additional work being required. The framework also urges managers to identify indicators that address multiple impacts/causal drivers. This is one mechanism to reduce costs as monitoring of ecological indicators is unlikely to be inexpensive, particularly when attempting to monitor facets such as ecosystem integrity.
7) The framework has explicit provisions for involving stakeholders in one or more of its steps to build consensus and share learning	The important contributions various interest groups have to make is emphasised in numerous studies and the complex multi-disciplinary nature of the field requires that such inputs are recognised. However, the level at which such participation is required will be dictated by the complexity of the framework and its constituent components.	The framework is certainly open to the inputs from a number of sectors and this is achieved at various stages in the process. Much of this integrated approach needs to be driven by the management agency itself and areas where such input should be sought are linked to objective setting, asset identification, impact identification, impact prioritisation and indicator development.

Chapter 7

THE NEXT STEP

The framework presented in the Chapter 5 provides protected area agencies with a method for: focusing monitoring effort and selecting ecological indicators, which, if monitored appropriately, will provide information on the change in condition of ecosystems at sites. This will enable managers to develop proactive programs for managing ecosystems and their use by visitors. However, focusing monitoring effort and developing indicators are just the first stages. Effective monitoring programs are required. Protected area managers need information on how to develop and implement effective visitor monitoring (Hadwen *et al.* 2005b). This process is illustrated in subsequent STCRC reports that address issues including:

- establishing baseline values for sites selected for visitor monitoring
- choosing appropriate monitoring protocols and techniques, including measurement techniques
- integrating monitoring data into an adaptive management framework.

To illustrate the importance of this process a second report reviewed the approaches management agencies currently take to research and assessing ecologically sustainable visitor use of Australia's World Heritage Areas (*Research, monitoring and evaluation approaches for ecologically sustainable visitor use of Australia's World Heritage Areas: Even the best needs to be better*, by Wendy Hill and Catherine Pickering). To illustrate how specific indicators of visitor impacts can be developed within an integrated framework the report examined how to assess walking track impacts in protected areas, as tracks are the most common infrastructure provided by protected area managers.

In the first of three linked technical reports (sister reports), track impacts and track assessment methods in protected areas were reviewed (*Review of Impacts and Assessment of Walking Tracks in Protected Areas* by Wendy Hill and Catherine Pickering). Three common assessment methods that differ both in resources required to use them and the detail and type of information obtained were then tested. All three methods were used to assess the condition of different types of tracks in three New South Wales protected areas (*Comparison of Condition Class, Point Sampling and Track Problem Assessment Methods in Assessing the Condition of Walking Tracks in New South Wales Protected Areas*, by Wendy Hill and Catherine Pickering). Finally a manual describing how to use these three methods was provided—a how to manual for protected area staff to use when actually implementing a track assessment program (*Walking Track Assessment Manual*, by Wendy Hill and Catherine Pickering).

Adaptive Management

It is expected that data from visitor monitoring will be used when making management decisions (adaptive management) and incorporating data on visitor use and management into broader evaluation strategies and reporting mechanisms. An adaptive approach to visitor management is not yet common in protected areas worldwide. Many strategies are designed to achieve sustainable visitor use but do not have a sound basis in science instead depending on the intuition and personal judgments of managers (Monz & Leung 2006). This is no longer enough. Visitor use is an issue in protected areas worldwide, and it is vital that visitor management is based on systematic information on how many there are, where they go and what they do.

Another key feature of our integrated framework is that the final set of indicators (if monitored appropriately) would allow management intervention to take place (Cole & Stankey 1998). This will be the key to successful monitoring and reporting of ecological impacts and the importance of these feedback loops in the framework are critical to its adaptive capacity to evolve with changing circumstances (within ecological, social, political, economic climates). Managers therefore need to focus not only on the nature and consequences of any environmental/ecological change but also the resultant management implications (Sheil *et al.* 2004). Furthermore, interpreting the indicator results requires sound defensible linkages between the indicators themselves and the ecological system component they represent (Kurtz *et al.* 2001).

Wider Performance Reporting Frameworks

Another issue is that the assessment of visitor use should be one component of overall management performance evaluation. The framework presented in Chapter 5 is based on assessing subjects identified in the expanded WCPA protected area management evaluation framework. Therefore it can readily feed into wider performance reporting frameworks.

Integrating the suite of indicators and monitoring into wider protected area reporting frameworks as proposed is also critical since the assessment of ecological impacts and ecosystem integrity are but one component of the overall performance rating. It is possible to link ecological monitoring and reporting systems to these corporate measures (Moore *et al.* 2003) and explicit links need to be made to ensure that these measures are adopted at all levels of management.

Capacity of Management Agencies to Monitor

Finally, agencies are still developing their capacity to undertake visitor monitoring. There are numerous reasons for this—mainly to do with lack of staff and financial resources—but others to do with the divide between science (researchers) and managers. It is suggested that both groups should take greater responsibility for identifying impacts of visitors and monitoring impacts in parks (Cole 2006).

The remaining challenge is whether the suite of indicators that are identified can be effectively implemented using the existing capacity within protected areas. Buckley (2003) has argued strongly that in order for effective monitoring of ecological impacts to be completed managers will have to employ or contract in external ecologists. The recommendations made by ecologists will still need to be implemented by the management staff and their involvement in the monitoring process is certainly warranted and encouraged to make these processes amenable to all stakeholders (Miller and Twining-Ward 2005). The entire process is also likely to be costly, requiring both contributions of time, expertise and new research effort but as Wiersma (2005) points out these investments in a rigorous process are offset by the longer term rewards for improved management effectiveness.

Often the efficacy of indicators is limited by lack of historical data for comparative purposes and detection of trends in condition. The paucity of baseline data (ecological and social) in protected area management (Cole & Landres 1996), translates to a reduction in capacity to report on performance. Many of these restrictions deal with basic fauna and flora assessments and understanding (Worboys 2007).

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APPENDIX A

The Expanded-WCPA Protected Area Management Evaluation Framework: evaluation subjects for assessing triple bottom line visitor use; ecological, social, economic

Worboys (2007) PhD research on the evaluation of protected area management, has expanded the utility of the IUCN-WCPA framework (Hockings *et al.* 2000, 2006, Chapter 4, Figure 1) by identifying subjects managers and other stakeholders throughout the world who are actually evaluating (and want to evaluate) and then relating these to the six management elements of the IUCN-WCPA framework.

The Expanded IUCN Protected Area Management Evaluation Framework extends the Hockings et al (2000, 2006) framework by adding three evaluation criteria and three hierarchical categories for evaluation criteria (area, subject and topic). The expanded framework also identified 251 subject of evaluation (Worboys 2007). A number of the evaluation subjects from the Expanded IUCN-WCPA evaluation framework have relevance for assessing the social and economic aspects of tourism management.

From the 251 subjects that are evaluated worldwide Worboys identified a core set of 31 evaluation subjects that cover the six management elements (Chapter 4, Figure 2). His research identified evaluation subjects that have relevance for assessing the ecological social and economic aspects of tourism use of protected areas. The subjects relating to the ecological elements of tourism are presented in Chapter 4 (Figure 3). The table below identifies the evaluation subjects relevant to social and economic aspects of tourism use of protected areas.

Table 14 List of potential evaluation subjects within the Expanded-WCPA evaluation framework

Evaluation Element	Evaluation Criteria	Evaluation Area	Evaluation subjects
Context	Special social, cultural or scientific values	Social phenomena	Recreation opportunities Economic benefits and values Intrinsic, spiritual, aesthetic Community values, attitudes, needs Cultural-historical values Visitor values International values
	Baseline value	Cultural happenings, sites, places or features	Structures Sites of significance
		Social phenomena	Recreation opportunities Economic well being Intrinsic, spiritual, aesthetic Community values, attitudes, needs Economic values Visitor values
	Identified threats	Threats to social values	Intrinsic, spiritual, aesthetic Health issues
		Direct human threats	Illegal clearing Grazing Poaching Hunting Fishing Mining Trampling Visitor use Development Management policy, action, inactions Land invasion by people Conflict Crime
		Indirect human threats	Adjoining land use impacts Urban encroachment Impacts to climate Impacts to air Impacts to water quality Inadequate management resources Sustainable use Poverty Sea level rise
	Vulnerability	Local issues	Compatibility of PA objectives with local beliefs Community values, attitudes, needs
Inputs	Management inputs	Adequacy of financial resources	Capital Recurrent Grant $ effectiveness Revenue
		Adequacy of human resources	Sufficient staff resources Staff skills match competencies Volunteers Staff effectiveness
		Adequacy of equipment and infrastructure	Office accommodation Workshop infrastructure Plant and equipment Transport Access roads and electricity
		Adequacy of information resources	Information systems availability Research contribution

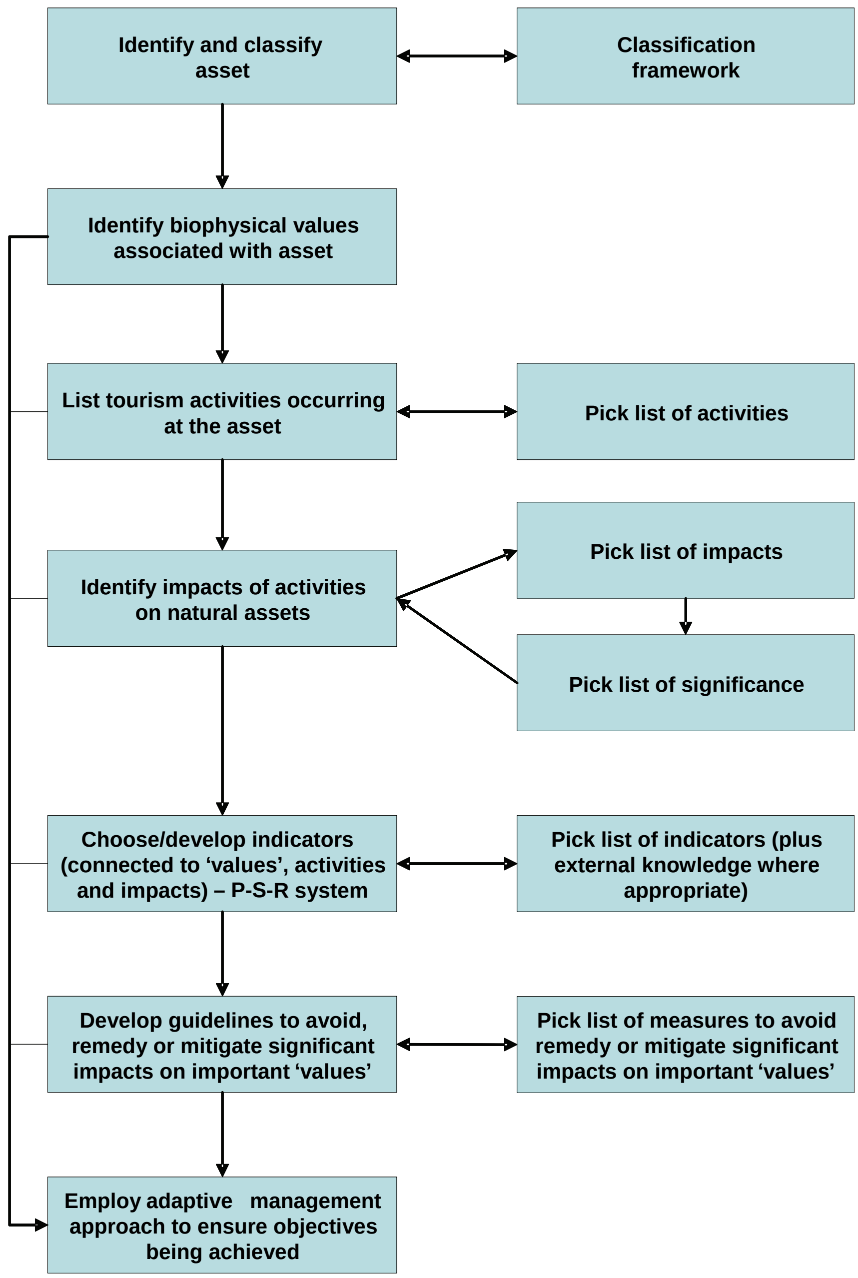
Evaluation Element	Evaluation Criteria	Evaluation Area	Evaluation subjects
		Allocation of resources	Expenditure of financial resources
		External partner investments	Amount of resources contributed
Outputs	Management outputs	Delivery of products	Development projects completed Visitor facilities provided
		Delivery of services	Visitor contact services Visitor information services Education services provided $ effectiveness Customer satisfaction Visitor use
Outcome	Change in condition	Cultural happenings, sites, places or features	Structures Sites of significance Cultural-historical values
		Social phenomena	Recreation opportunities Economic well being Customer satisfaction Community values, attitudes, needs Visitor use Economic value
	Severity of threat	Physical threats	Earthquakes Landslides Fire Severe weather Geological risks Snow/ice impacts Floods
		Biological threats	Weed invasions Pest animals Introduced organisms Fauna: unsustainable use
		Direct human threats	Illegal clearing Grazing Poaching Hunting Fishing Mining Trampling Community values, attitude, needs Visitor use Development Management policy, action/inaction Political impacts Conflict Impacts to aquatic environments Illegal flora activities
		Indirect human threats	Adjoining land use impacts Urban encroachment Impacts to climate Impacts to air Impacts to water quality Inadequate management resources Pollution Poverty Cumulative impacts

(Worboys 2007)

APPENDIX B

The Decision Support System and Natural Asset Classification Framework

The DSS/TNAC (Decision Support System and Natural Asset Classification) framework was proposed by Ward *et al.* (2002) and refined by Hughey *et al.* (2004) for monitoring and evaluating the sustainable tourism use of natural assets in New Zealand. This framework is proposed as the method for steps 2 and 3 of the integrated framework (Chapter 5) when there is no existing method for classifying the value of natural assets and threat to those assets for a park.



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The Sustainable Tourism Cooperative Research Centre (STCRC) is established under the Australian Government's Cooperative Research Centres Program. STCRC is the world's leading scientific institution delivering research to support the sustainability of travel and tourism – one of the world's largest and fastest growing industries.

Introduction

The STCRC has grown to be the largest, dedicated tourism research organisation in the world, with $187 million invested in tourism research programs, commercialisation and education since 1997.

The STCRC was established in July 2003 under the Commonwealth Government's CRC program and is an extension of the previous Tourism CRC, which operated from 1997 to 2003.

Role and responsibilities

The Commonwealth CRC program aims to turn research outcomes into successful new products, services and technologies. This enables Australian industries to be more efficient, productive and competitive.

The program emphasises collaboration between businesses and researchers to maximise the benefits of research through utilisation, commercialisation and technology transfer.

An education component focuses on producing graduates with skills relevant to industry needs.

STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia;
- the value of graduate researchers to Australia;
- collaboration among researchers, between researchers and industry or other users; and efficiency in the use of intellectual and other research outcomes.