CALMScience 2(3): 247-266 (1997)

Defining indicators and standards for recreation impacts in Nuyts Wilderness, Walpole-Nornalup National Park, Western Australia

SHANNON L. MORIN[1], SUSAN A. MOORE[2] AND WAYNE SCHMIDT[3]

[1]Major Project Review Unit, Habitat and Enhancement Branch, Department of Fisheries and Oceans, Stn 327, 555 West Hastings Street, Vancouver BC V6B 5GB, Canada.

[2]School of Environmental Science, Division of Science, Murdoch University, South Street, Murdoch, Western Australia 6150.

[3]Parks, Recreation, Planning and Tourism Division, Department of Conservation and Land Management, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983.

ABSTRACT

A central issue in wilderness management is not the number of users *per se*, but the impacts those users can have on environmental conditions and the quality of experience of other visitors. This study draws on two recreation planning frameworks, the limits of acceptable change and visitor impact management, to translate management goals into quantitative management objectives through indicators and standards. Potential indicators and standards were identified, via a mailback survey conducted in 1995, for Nuyts Wilderness Area on the south coast of Western Australia.

Environmental conditions of greatest influence on the quality of visitor experience were amount of litter, inadequate disposal of human waste, presence of wildlife, walk trail erosion, vegetation loss and tree damage. Standards were determined for two biophysical indicators - tree damage and vegetation loss - and four social indicators - number and size of groups, litter and human-made structures (e.g. signs). Respondents had the lowest level of tolerance and set the highest standards for litter and damage to trees. Tolerance levels for social effects such as the number of other groups seen were higher. Standards were similar across sites for all indicators except vegetation loss where respondents were more willing to accept change at the camp-site than elsewhere.

These results suggest that management efforts can be differentially directed toward indicators of greatest concern, such as litter and tree damage. The study findings also suggest that managing to meet the expectations of 50 per cent of visitors regarding acceptable and unacceptable impacts is feasible, especially where impacts do not currently exceed acceptable levels, whereas striving to meet the expectations of 75 per cent of visitors requires reducing impacts by at least half. Such reductions may be impossible and create unrealistic expectations among visitors and managers alike.

INTRODUCTION

An important issue in wilderness management is not the number of users *per se*, but the impacts those users can have on the environmental conditions of the area and the quality of experience of other visitors. It is these impacts that can potentially affect the ecological integrity and conservation value of the area as well as the quality of the recreational experience. Given that any use will produce at least some impact managers, in close consultation with the users of a wilderness area, need to identify where and to what extent varying degrees of change are appropriate and acceptable.

This study draws on two planning approaches: the Limits of Acceptable Change (LAC) wilderness management planning framework (Stankey *et al.* 1985) and the Visitor Impact Management (VIM) framework (Graefe *et al.* 1990). Both frameworks enable management goals, which are generally qualitative in nature, to be translated into quantitative management objectives through the use of indicators and standards. Thus, achieving environmental goals is determined by standards which are monitored through the use of suitable indicators.

A key research need in the LAC process has long been identified as the identification of indicators and standards (Stankey *et al.* 1985; Stankey and Lucas 1985; McCool 1989). Social research can help provide data about the preferences, expectations and judgements of impact acceptability held by visitors to wilderness areas which can in turn be used to establish biophysical and social standards for an area (Stankey and Lucas 1985). These standards express how much change in the various indicators is considered appropriate and acceptable.

The objective of the study reported in this paper was to apply elements of the LAC and VIM planning frameworks to the identification and formulation of indicators and associated standards for the management of recreation impacts in Nuyts Wilderness Area (Nuyts) in Walpole-

Nornalup National Park on the south coast of Western Australia. Identification of indicators and standards reflecting the broader ecological integrity of the area is also essential, but was beyond the scope of this study. The recreation standards identified and formulated are most likely a subset of a broader suite of ecologically-directed measures.

Nuyts was selected because it has a long history of bushwalking and overnight camping and because of its designation as a wilderness zone in the Walpole-Nornalup National Park Management Plan (CALM 1992). The area shows evidence of degradation from recreational use with some areas of erosion and damage to vegetation, however, the acceptability or otherwise of these effects of visitor use have not been quantified making it difficult for managers to know whether management actions are needed.

Information on indicators and standards was gathered via a mailback survey conducted in 1995. Respondents were asked to provide feedback regarding four management sub-units, namely: walk trails, camp-site, beach coves, and Mt Hopkins. Potential respondents were drawn from the visitor book, for the period January to June 1995, left at the main entrance to Nuyts.

Based on the survey results, environmental conditions of greatest influence on the quality of visitor experience were amount of litter, inadequate disposal of human waste, presence of wildlife, walk trail erosion, vegetation loss and bare ground, and human damage to trees. Standards were determined for two biophysical indicators - tree damage and vegetation loss/bare ground - and four social indicators - number and size of groups, litter and human-made structures (e.g. signs). Respondents had the lowest level of tolerance and set the highest standards for amount of litter and damage to trees. Tolerance levels for social effects such as the number of other groups seen were higher. Standards were similar across sites for all indicators except vegetation loss where respondents were more willing to accept change at the camp-site than elsewhere.

These results suggest that management efforts can be differentially directed toward indicators of greatest concern, such as litter and tree damage. The study findings also suggest that managing to meet the expectations of 50 per cent of visitors regarding acceptable and unacceptable impacts is feasible, especially where impacts do not currently exceed acceptable levels, whereas striving to meet the expectations of 75 per cent of visitors requires reducing impacts by at least half. Such reductions may be impossible and create unrealistic expectations among visitors and managers alike.

DETERMINING RECREATION IMPACTS IN WILDERNESS AREAS

In many wilderness areas, recreation use has become a major concern as the impacts of such use threatens to adversely affect both the integrity of natural ecosystems and the quality of the experience for visitors (Stankey *et al.* 1990). Formulating methods that provide for the appropriate recreational use of an area while maintaining resource impacts at an acceptable level has been a persistent problem for park managers both in Australia (Prosser 1986; Absher 1994) and North America (Stankey *et al.* 1985; Roggenbuck *et al.* 1993; BC Forest Service 1995).

Resolution of this 'appropriate use/acceptable impact' dilemma requires the recognition of the unavoidable consequences of recreation in natural areas (Prosser 1986). This leads to the inevitable acceptance that any human use of a natural area will lead to some change in the condition of that area. With use comes changes in the biophysical and social conditions of the area; soils are compacted, vegetation and wildlife are disturbed and the level of social interaction increases.

One of the central goals of wilderness management is to identify the desired resource, social, and managerial conditions and express them as explicit, measurable standards to be maintained or restored in wilderness areas (Stankey *et al.* 1990). The focus of management thus shifts from the traditional approach of attempting to define maximum use levels, to the identification of the desired conditions and to thus manage use levels and other parameters so that impacts do not exceed these conditions (Shelby and Heberlein 1986).

In developing a wilderness management program, managers and the public must recognize that the management of wilderness areas is based on value judgements. As few people make identical value judgements, the task facing agency managers is one of gaining consensus among wilderness users regarding what constitutes the desired wilderness conditions and consequently, how those conditions should be maintained. Inherent in this collective value judgement is the recognition that management of wilderness is actually the management of wilderness users and their impacts (Lucas 1973). Therefore, to determine the amount of change that will be considered acceptable involves a subjective value judgement. Decisions that reflect value judgements need to be made with the support, consent and agreement of both managers and users. This implies that wilderness planning and management is essentially a socio-political process incorporating biophysical and social data and agency policies.

Determination of recreation impacts in wilderness areas is best undertaken with full knowledge of the paradigms within which such decisions are made. The influential paradigms include recreation carrying capacity, and the LAC and VIM planning frameworks.

Recreation Carrying Capacity

Traditionally, recreational use levels in wilderness areas have been addressed through the concept of carrying capacity. The carrying capacity paradigm was developed from a biological model used to determine the appropriate levels of animal use of forage resources (Wagar 1964). This biological concept was applied to wilderness areas in the United States (US) in the 1960s when a surge in use of wilderness areas led to concerns about burgeoning

impacts. Wagar's (1964) work broadened carrying capacity to include social as well as ecological capacity (Stankey *et al.* 1990). Thus, recreational carrying capacity had two main components: an ecological capacity - the impact on the physical-biological resource (i.e. soils and vegetation) - and a social capacity, that is, the impact on the character of the recreational experience.

Recreational carrying capacity was originally articulated as a method of conceptualizing problems, however, it was misinterpreted and applied as a use-limit policy, thus confusing recreational carrying capacity as a concept for examining problems with use limits as a method for restricting access (McCool 1989). Carrying capacity was also viewed as an idea whose application was only constrained by the level of effort and ingenuity of managers and researchers rather than as the result of a judgemental process (Stankey *et al.* 1990). It was seen as a product of technical assessment rather than a decision based on a combination of value judgements that weight resources and social impacts along with human needs and values.

The carrying capacity concept failed to generate practical use limits and also failed in its assumption that regulation of use would solve the problems of resource impact (McCool 1989). Also, during the 1980s it became apparent that variances in human behaviour were as influential in causing impacts as the actual numbers of visitors (Cole and Hammitt 1987). The recognition that much of the biophysical impact caused by recreational use occurred at low levels of use (Cole 1985) completely contradicted the basis on which recreational carrying capacity was implemented - as a use-limit policy - thus rendering the concept inadequate in assisting the resolution of visitor impact problems. Many researchers argued that the concept should be abandoned (Wagar 1964; Bury 1976).

These realizations about the inability of the carrying capacity concept to provide an answer regarding 'how much use is too much', the rephrasing of the question to 'how much change is acceptable', and recognition of the importance of value judgements spawned separate yet parallel efforts to develop a more adequate framework for managing recreational use and its associated impacts. The conceptual planning frameworks - LAC and VIM - represent efforts to correct deficiencies in the traditional carrying capacity paradigm of recreation management.

Limits of Acceptable Change Planning Framework

The Limits of Acceptable Change (LAC) planning framework (Stankey *et al.* 1985) represents a major alternative approach to the carrying capacity issue, hingeing on the recognition that some level of change is inevitable and therefore decisions regarding how much change is acceptable to users and managers must be made. In summary, the LAC system as developed by Stankey *et al.* (1985) establishes a process for deciding what environmental and social conditions are acceptable and helps identify management actions required to protect or achieve those conditions. The Recreation Opportunity Spectrum (ROS) planning framework complements the LAC system by providing a process for recognizing and designating opportunity classes with different levels of recreational use, however, it leaves the selection of indicators and standards to LAC (Clark and Stankey 1979).

Five general stages summarize the steps of the LAC process (Table 1). First, the management problems and issues for an area are identified and recreation opportunity classes or zones defined and described (Steps 1 and 2). This first stage provides the broad context for the remainder of the planning process. Second, the acceptable and achievable environmental resource and social conditions are defined by a series of measurable parameters (Step 3). Third, the relationships between the existing conditions and those judged as being acceptable conditions are analysed (Steps 4 and 5). Fourth, management guidelines and actions are identified and formulated to best achieve the acceptable conditions (Steps 6 and 7). Last, a program of post-implementation monitoring and evaluating the effectiveness of the prescribed management actions is initiated.

The LAC process also embraces public involvement, being based on the recognition that the public can provide an important and substantial body of expertise in the planning process (Stankey *et al.* 1985). The public also provide the judgements essential for the selection of standards for acceptable impacts. Perhaps the most important strength of LAC lies in its continued public

TABLE 1

A comparison of the steps in the LAC and VIM planning frameworks (Sources: Stankey *et al.* 1985; Graefe *et al.* 1990).

STEPS	LAC	VIM
1	Identify area concerns and issues	Review of database
2	Define and describe opportunity classes	Review of management objectives
3	*Select indicators of resource and social conditions*	*Identify measurable indicators*
4	Inventory resource and social conditions	*Select standards for indicators*
5	*Specify standards for resource and social conditions*	Assess current conditions of impact indicators
6	Identify alternative opportunity class allocations	Identify probable causes of impacts
7	Identify management actions for each alternative	Identify a range of alternative management strategies
8	Evaluate and select an alternative	Implement selected strategies
9	Implement actions and monitor conditions	

participation which virtually guarantees successful planning outcomes (Knopf 1989).

This study addressed Steps 3 and 5 (italicized in Table 1), the selection of indicators and specification of standards for resource and social conditions. The 'best indicators' are those which reflect the highest degree of naturalness of the wilderness ecosystem under examination and the social quality of the wilderness experience. Monitoring of all the parameters of the wilderness ecosystem is essentially impossible, thus the 'key' wilderness quality indicators must be identified and monitored. A few criteria should be taken into account when selecting these key indicators: they should be capable of being measured in cost-effective ways at acceptable levels of accuracy; the condition of the indicator should reflect some relationship to the amount/ type of use occurring; social indicators should be related to user concerns; and the condition of the indicator should be responsive to management control (Stankey *et al.* 1985).

Setting standards, the aim of the fifth step of the LAC process (Table 1), assigns quantitative standards for resource and social indicators. These adopted standards provide a basis for judging whether a particular condition is acceptable or not; they establish the 'limits of acceptable change' for the resource and social conditions. While setting standards is a judgemental process, the process is explicit, traceable, and subject to public involvement and review. Standards related to appropriate use conditions are best derived with the input of visitors themselves. Standards are not meant to be idealistic goals but conditions that managers feel can be achieved over a reasonable time period. Thus, standards should be stringent enough to be meaningful, but not so stringent that they can not be attained. In formulating standards, there needs to be a balance between using existing conditions to lend realism to the specific standards, professional judgement, and public input.

Standards will often be an expression of the typical situation of an area expressed in terms of probabilities. For example, a standard for daily contacts while travelling might be expressed as 'interparty contact levels on the trail will not exceed two per day on at least 90 per cent of the days during the summer use period'. This recognizes the high degree of resource and social variability in a wilderness system which makes specific, absolute standards unrealistic, especially during peak periods of visitor numbers during a few days or weeks of the year.

LAC has been applied extensively in the US with the most intensive application directed at the Bob Marshall Wilderness Complex in Montana (Stankey *et al.* 1990). It has provided standards against which the effectiveness or otherwise of management actions, such as visitor education, area closure and infrastructure development, have been evaluated. The framework has not been comprehensively applied in Australia, although there has been limited application in the Australian Alps in eastern Australia, and Fitzgerald River National Park in Western Australia.

Visitor Impact Management Planning Framework

The Visitor Impact Management (VIM) planning framework (Graefe *et al.* 1990) is the result of a study initiated by the US National Parks and Conservation Association (NPCA) which had two main objectives: to review and synthesize the existing literature on recreational carrying capacity and visitor impacts and then build on this existing knowledge to formulate a method for managing visitor impacts in the variety of areas within the US National Park system (Graefe *et al.* 1990). Similar to the evolution of LAC, VIM can be viewed as an alternative to the original carrying capacity concept.

VIM is intended to provide a planning framework for controlling or reducing undesirable impacts of recreational use, based on the principle that both the environment and the quality of the recreational experience are complex and are influenced by a number of factors besides use levels. Use limits provide only one potential strategy for reducing visitor impacts: it is important to remember the lessons learned from previous studies that found only weak or indirect relationships between impacts and overall use levels (Kuss and Graefe 1985; Graefe *et al.* 1990). Thus, in many situations establishing use capacities and limits may do little to reduce the impact problems they were intended to solve, whereas other potential management strategies may be quite effective in reducing the impact conditions (Graefe 1989). The VIM process is also built on the widely accepted recognition that effective management involves both scientific and judgemental considerations (Graefe *et al.* 1990).

The steps of the VIM process (Table 1) essentially deal with four basic issues: the identification of problem conditions or unacceptable visitor impacts (Step 1), identification of indicators and standards based on management objectives for the area (Steps 2-4), determination of potential causal factors affecting the occurrence and severity of the unacceptable impacts (Steps 5 and 6), and selection and implementation of potential management strategies for ameliorating the unacceptable impacts (Steps 7 and 8).

As this study addressed the selection of indicators and standards, only these parts of the VIM process will be discussed (Steps 3 and 4). The third step involves identifying measurable indicators for specific management objectives. These objectives must be consistent with existing legislation and policy while being specific for the area, describing the environmental conditions and visitor experience to be provided. Similar to the third step in the LAC process, this step is based on selecting the most important variables to serve as the 'key' indicators of the desired conditions. Also, the same criteria to be considered in selecting key indicators in the LAC process applies in the VIM process. Step 4 of the VIM process focuses on selecting standards, similar to Step 5 of the LAC process.

VIM has been applied in several US national parks (e.g. Great Smoky Mountains National Park, Glacier

National Park) and has also served as the basis for studies in other areas (Buck Island Reef, US Virgin Islands) (Graefe 1989). In Australia, a recent application of VIM has been undertaken at Jenolan Caves Reserve in New South Wales (Mandis Roberts Consultants 1995). Similarly to LAC, VIM has provided standards against which the effectiveness of management actions to ameliorate recreation impacts can be assessed.

VIM and LAC are similar processes in that they are both concerned with the impacts of recreation, including impacts on both the natural environment and the quality of the visitor experience. And, both frameworks rely on the use of indicators and standards as a means to define unacceptable impacts (Table 1). They also differ in several ways. VIM has an explicit step aimed at identifying the probable causes of impacts, while LAC places greater emphasis on defining recreation opportunity classes and developing alternative class allocations. To date, applications of VIM have tended to focus on the management of relatively localized visitor impact problems (e.g. Logan Pass, Glacier National Park) in contrast to the emphasis within LAC on large scale wilderness planning applications (e.g. Bob Marshall Wilderness Complex).

RESEARCH METHODS

This study was based on a literature review and mailback questionnaire. The literature review concentrated on a review of wilderness management research, specifically related to the theory and application of LAC and VIM approaches, and identification of appropriate indicators and standards for the limits of change related to recreation impacts. The results of the literature review were used to provide direction and focus for the formulation of a mailback visitor questionnaire targeted at recent visitors to Nuyts Wilderness area.

Mail survey participants were drawn from the visitor logbook at the main trail-head into Nuyts. Upon entering Nuyts, visitors are asked to sign visitor registration sheets. The sample population for this study was visitors who filled in the logbook between 31 January 1995 and 29 June 1995. Not all visitors may have filled in the log and only visitors who entered their names with a sufficiently detailed address received a questionnaire. Thus, the results may not be a true reflection of the total population of Nuyts visitors, only the sub-population who entered their name and address details. A total of 150 mailback questionnaires was sent to Nuyts visitors.

Prior to the survey proper, a pilot survey was conducted to identify any potential misunderstandings associated with the format or manner of question presentation. A sample of 10 people, including CALM staff, University colleagues, and Nuyts visitors randomly chosen from the registration sheets, was used for the pilot test. The minor problems revealed by the pilot test, plus recommendations by this group of respondents, resulted in corrections to the question wording and style before the survey proper commenced.

The survey proper was distributed by mail, with potential respondents receiving an introductory letter, the questionnaire and stamped self-addressed return envelope. The introductory letter briefly explained the objectives of the study. Approximately two months after the initial survey was distributed, a follow-up letter and copy of the survey were sent to Nuyts visitors who had yet to respond.

The questionnaire had five parts. The first part included questions about when, how often, who with, and for how long people visited Nuyts. It also asked about activities while visiting. The second part sought visitors' reasons for visiting Nuyts providing a list of items and an importance ranking from not at all important to extremely important.

The third part was the heart of the questionnaire. It included questions about visitors' preferences regarding current conditions and the quality of their experience. Again a list of items was provided and respondents were asked to assign an importance to each item. The next two questions asked respondents to assign a maximum acceptable level, in numbers and in several cases as a percentage, for potential impacts including tree damage, vegetation loss/bare ground, number and size of groups of people seen or heard, litter, human-made structures (such as signs), and camp-fire rings for each of four management sub-units. These potential impacts or indicators were drawn from the literature and surveys conducted in other wilderness areas.

Ideally, the indicators should have been provided by visitors. The approach used may have resulted in some important indicators being omitted and unimportant indicators being included. This problem could have been alleviated by conducting two surveys; the first to identify the most important indicators and the second to set standards. This approach is time-consuming and potentially results in attrition of respondents as they find the process tedious. The approach we took, based on one survey and a core set of indicators, is widely used in this research field.

The last question in the third part of the questionnaire asked respondents their views, from strongly support to strongly oppose, on potential management actions to deal with threats to Nuyts. The fourth part of the questionnaire gathered further information on social indicators and standards, specifically group numbers and size. The last part gathered information on the origin of visitors, their age and education level.

The survey data were collated and analysed using the software spreadsheet program Excel 5.1. Analysis focused on providing general survey statistics such as visitor and visit characteristics, determining indicators and standards, and assessing the social acceptability of a range of potential management actions. Literature concerning LAC, recreation impacts, and processes for defining indicators and associated standards were used to direct analysis.

Nuyts Wilderness Area in Walpole-Nornalup National Park (Fig. 1) on the south coast of Western Australia was the selected study site for several reasons. First, it is one

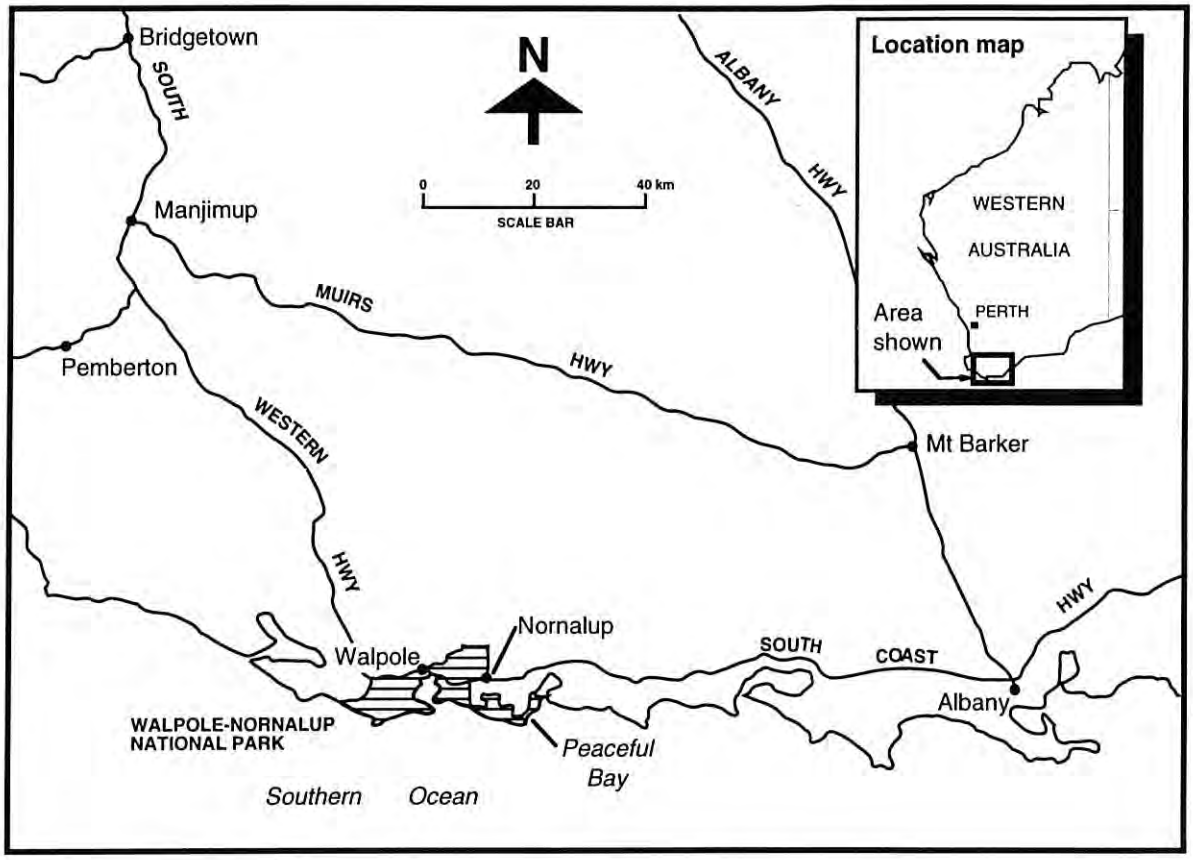

Figure 1. Location of Walpole-Nornalup National Park (Source: CALM 1992).

of the small number of areas zoned as wilderness in Western Australian national parks through formal management plans. According to the CALM zoning system for national parks (Anon. n.d.), wilderness zones are extensive areas which are good representations of each of the natural history themes of the park and which will be maintained in a wilderness state. Only certain activities requiring limited, primitive, visitor facilities appropriate to a wilderness experience will be allowed. Limits will be placed on numbers of users. No motorized access will be permitted and management actions will ensure that visitors are dispersed.

Nuyts was also selected for this study because a management plan had been recently completed (in 1992) for Walpole-Nornalup National Park including Nuyts Wilderness. The management plan provided three main objectives for Nuyts: to maximize the naturalness and remoteness of the area; maintain opportunities for wilderness-dependent experiences such as solitude while encouraging minimum impact activities; and rehabilitate degraded areas. Establishing such objectives is a critical step in both the LAC and VIM processes and made it possible for this study to address the next steps of identifying indicators and selecting standards.

In this study, the wilderness zoning accorded to Nuyts by the Walpole-Nornalup National Park Management Plan (CALM 1992) is recognized as a single opportunity class. This is consistent with Step 2 of the LAC process (Table 1). Following Step 1 of the VIM process, four visitor management sub-units within Nuyts were identified: at or beside walk trails, at the camp-site, at or around the coves (Aldridge and Thompson Coves), and at or around Mt Hopkins (Fig. 2). Designation of these sub-units was based on three important considerations: that the areas within each sub-unit had similar management requirements, they were likely to experience similar impacts, and together they covered all (most) areas likely to experience visitor impacts.

Covering an area of approximately 4500 ha, Nuyts occupies the south-western third of Walpole-Nornalup National Park on the south coast of Western Australia (Fig. 1). Recreational access is by foot via three main points: from the west from either Crystal Springs (2-3 km north-west of Nuyts), Mandalay Beach or Long Point, from the north at Deep River near Tinglewood, and one water access point near the mouth of Nornalup Inlet to the east (Fig. 2). The main access (entry/exit) point to Nuyts is the Deep River trail-head near Tinglewood.

Within Nuyts the main walk trail consists of an old vehicle track which leads from the Deep River entry to Thompson Cove and the camp-site. From this main trail, a series of shorter trails lead to Mt Hopkins, Aldridge Cove and Crystal and Boggy Lakes (Fig. 2). Facilities in the area include two bridges which cross the Deep River and a swampy tributary, markers for the first kilometre of the trail, and an information board and visitor registration sheets at the Deep River trail-head.

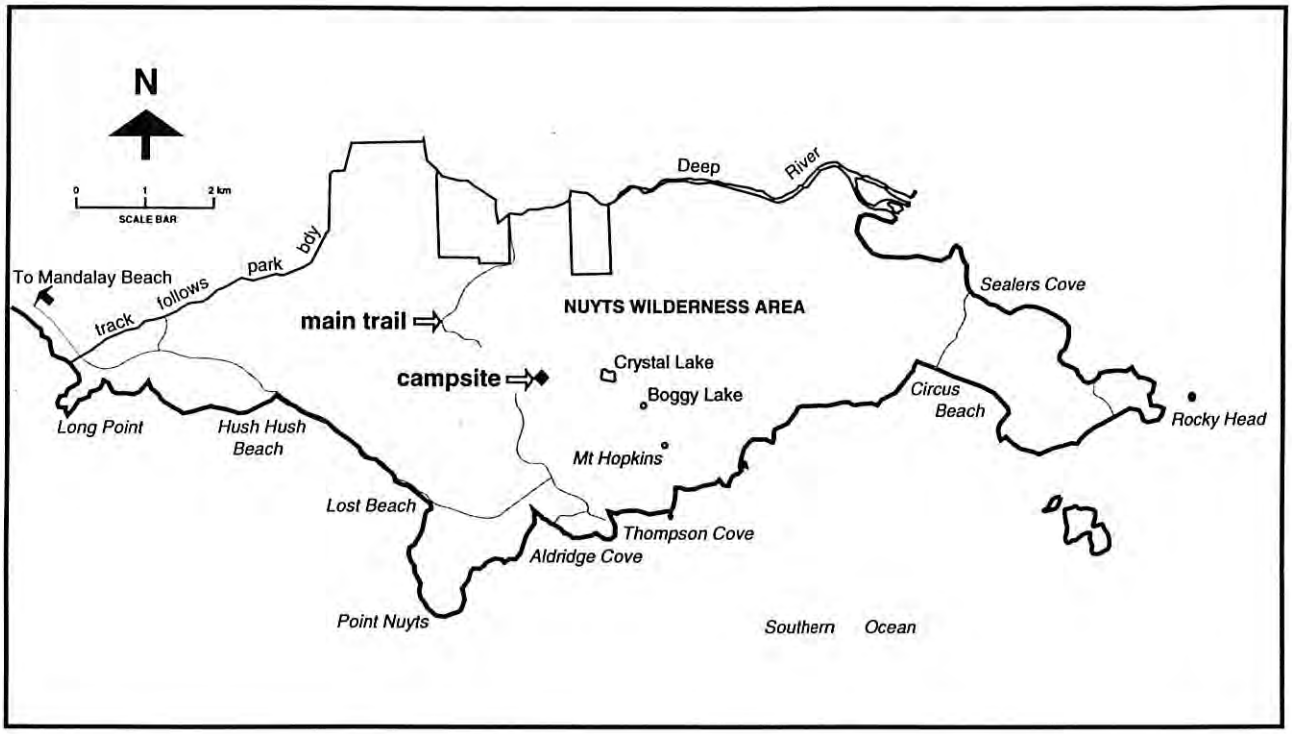

Figure 2. Location of the management sub-units used in this study (Source: CALM 1992).

RESULTS

Response Rate

A total of 150 surveys were mailed to Nuyts visitors, of which 16 per cent were undeliverable owing to insufficient address details or the person had moved. The response rate excluding the nondeliverable fraction was 76 per cent (86 people).

Visitor and Visit Characteristics

The two largest age groups of visitors to the area were those 26-40 years of age (45 per cent of respondents) and 41-60 years of age (36 per cent of respondents). A total of 17 per cent were aged 15-25, while only 1 per cent were under 15 and none were over 60. Most respondents lived in Perth (64 per cent) with 12 per cent from the Shire of Manjimup, 13 per cent from other areas of Western Australia, 7 per cent from interstate, and 4 per cent from overseas. A high number of respondents indicated they had completed post-graduate studies (32 per cent), while another 38 per cent had completed university or college degrees. This gives a total of 70 per cent of respondents with tertiary qualifications.

The number of previous visits ranged from two to more than 100 with most respondents having visited six times or less (65 per cent). The majority of respondents (60 per cent) visit Nuyts once a year. The largest proportion of respondents visited the area in April, followed by February and May.

The length of stay varied, however, the largest proportion stayed for one day or less (35 per cent), with 18 per cent staying for one night, 27 per cent for 2 or 3 nights and few staying more than four days or less than half a day. Respondents visited with family (39 per cent) or friends (38 per cent), while 14 per cent were alone and 10 per cent were with a club or organized group. The most common group size was two people (59 per cent of respondents). A substantial number of respondents were part of large groups: 16 per cent of respondents were part of a group of five or more people. Most respondents (73 per cent) saw two or less groups per day and over half (66 per cent) felt they had seen about the right number of groups on their most recent visit.

Activities undertaken by more than half of the respondents during their last visit included appreciating nature (98 per cent), walking for exercise (94 per cent), solitude (80 per cent), viewing wildlife (68 per cent), and photography (52 per cent). Other activities included camping, bird-watching, socializing, swimming and environmental education. Less than a quarter of respondents participated in beachcombing, picnicking or fishing.

The survey also investigated respondents' reasons for visiting Nuyts. Reasons were listed from previous studies by Roggenbuck *et al.* (1993) and the BC Forest Service (1995). When the results for extremely important and very important were combined, the most popular reasons given were to be in and enjoy wilderness, to view scenery, to enjoy an area free of vehicles, to enjoy outdoor activities, and solitude (Table 2). Fishing and camping were regarded as not very to not at all important.

TABLE 2
Reasons for visiting Nuyts Wilderness Area.

REASONS FOR VISITING	EXTREMELY IMPORTANT	VERY IMPORTANT	SOMEWHAT IMPORTANT	NOT VERY IMPORTANT	NOT AT ALL IMPORTANT
	Percentage of respondents[a]				
To be in and enjoy wilderness	70	24	6	0	0
To enjoy area free of vehicles	64	21	12	1	3
For solitude	44	29	20	4	3
To get away from city	42	25	15	9	9
To view scenery	41	49	10	0	0
To spend time with companion(s)	28	30	25	9	8
To enjoy outdoor activities	28	49	21	3	0
Physical exercise/challenge	17	42	33	5	3
To observe wildlife	17	34	34	15	0
To camp	16	24	13	13	33
To learn about nature (environmental education)	13	22	37	26	3
To fish	1	4	14	20	61

[a] percentages have been rounded to the nearest whole percentage therefore do not necessarily sum to 100 per cent in every case

Potential Indicators

Quality of experience was examined by asking respondents to indicate the importance of each of 16 items in influencing the quality of their most recent visit. Both biophysical and social factors or conditions were included (Table 3). Some of the listed items were drawn from Roggenbuck *et al.* (1993) and the BC Forest Service (1995) and others were formulated specifically for Nuyts. The intent was to identify potential indicators for monitoring visitor impacts, based on the premise that the best indicators are conditions of importance to visitors.

The following comments combine both the very and moderately important responses to give an overview of conditions that were at least moderately important to respondents. The two most important conditions were social: amount of litter and inadequate disposal of waste. The next four most important were all biophysical impacts: presence of wildlife, erosion of trails leading to the Coves, amount of vegetation loss or bare ground around the Coves, and number of trees damaged around the camp-site (Table 3). Other important social conditions were the number of people in a group, the number of groups camping within sight or sound, and evidence of camp-fires. An open-ended question which asked respondents to note additional environmental impacts resulted in comments regarding inadequate disposal of human waste, litter, and erosion at the Coves.

These results can also be considered on a site-by-site basis. For the Coves and on or beside trails, trail erosion was important. For the camp-site, an important condition was the number of trees damaged by humans. For all three management sub-units, the amount of vegetation loss or bare ground was important.

When the not at all and only slightly important responses were combined, width of trails appeared least important to respondents. For several conditions, such as the number of other groups seen along trails and width of trails, there was a spread of importance ratings from very important to not at all important (Table 3).

Standards for Potential Indicators

To determine standards for potential indicators, respondents were asked to suggest maximum acceptable levels before their experience would be changed for a list of impacts including trees damaged by humans, vegetation loss or bare ground, number and size of groups encountered, litter, human-made structures (e.g. signs) and camp-fire rings. In their responses, some people were unwilling to accept that use of an area results in some level of impact and so they provided a value of zero for the indicators, a standard which in many cases is impossible to achieve. Respondents were also asked to indicate the maximum acceptable levels as a percentage of the undisturbed area for tree damage and vegetation loss/bare ground. Two different forms of this question were asked to determine possible differences in responses evoked by different styles of questions. More people responded to the percentage questions than the questions requesting a number.

Results were further interpreted to provide two standards, one more stringent than the other, for each indicator. Researchers such as Roggenbuck *et al.* (1993)

TABLE 3
Environmental conditions influencing the quality of visitors' experiences in Nuyts Wilderness Area.

CONDITIONS	VERY/EXTREMELY IMPORTANT	MODERATELY IMPORTANT	SOMEWHAT IMPORTANT	NOT VERY/SLIGHTLY IMPORTANT	NOT AT ALL IMPORTANT
	Percentage of respondents[a]				
The amount of litter	71	15	3	5	6
Inadequate disposal of human waste	68	15	5	5	6
The presence of wildlife	47	36	12	5	0
Erosion of trails leading to Coves	43	29	14	10	4
Vegetation loss and bare ground around Coves	42	24	12	13	9
Number of trees damaged around camp-site	40	28	10	14	8
Erosion along main trail	35	26	19	12	9
Amount of vegetation loss and bare ground around camp-site	29	32	19	10	9
Amount of vegetation loss and/or bare ground along trails	29	30	17	12	13
The number of people in a group	27	31	19	10	12
Number of other groups camping within sight or sound of my camp-site	27	27	16	18	12
Evidence of camp-fires	26	27	22	21	5
Width of trail (size)	21	20	20	28	11
The presence of signs	21	29	25	13	13
Number of trails	18	30	30	16	5
Number of other groups seen along trails	14	32	28	15	10

[a] percentages have been rounded to the nearest whole percentage therefore do not necessarily sum to 100 per cent in every case

and the BC Forest Service (1995) use two standards, one based on the impact acceptable to 50 per cent of visitors and the other on the impact acceptable to 75 per cent of visitors. The 75 per cent standard is more stringent than the 50 per cent one as it implies acceptability to three-quarters rather than half of all visitors. For example, in the Rattlesnake Wilderness, Montana, the 50 per cent standard for percentage vegetation loss/bare ground around camp-sites was 17 per cent while the more stringent 75 per cent standard was 10 per cent loss (Roggenbuck *et al.* 1993).

These percentages, especially 50 per cent, are used because it is impossible to have total agreement between visitors. Therefore, managing to meet the expectations of at least half of them should ensure some level of satisfaction (Watson *et al.* 1992; Roggenbuck *et al.* 1993; BC Forest Service 1995). In this study, the 50 per cent and 75 per cent standards were calculated using cumulative percentages[4]. Standards for trees damaged by humans, vegetation loss or bare ground, number of groups, size of groups, litter and human-made structures (e.g. signs) were then derived. The standards calculated and included in Table 4 use numbers not percentages, as the latter were only collected for two of the six indicators. The benefits of using numbers versus percentages are explored further in the Discussion.

Regarding damage to trees, many respondents when asked about acceptable numbers of damaged trees were only willing to accept very low levels of damage: the 50 per cent standard was two trees and the 75 per cent standard one tree for all four management sub-units (Fig. 3a; Table 4). When respondents were asked to provide a percentage, they appeared more lenient regarding the acceptable level of change. The 50 per cent standard for the camp-site was up to 7 per cent of trees damaged, while for the walk trails it was up to 4 per cent and for the Coves and Mt Hopkins it was 3 per cent (Fig. 3b). The 75 per cent standard for all management sub-units was 2 per cent. Both the numbers and percentages indicate a low level of tolerance for change. The response rate was greater when respondents were asked for a percentage (response rate of 78 per cent) rather than when they were asked for a number (response rate of 62 per cent).

In terms of the acceptable area of bare ground or vegetation loss, more damage was accepted at the camp-site than elsewhere in Nuyts. For the camp-site, the 50 per cent standard was 11 m^2 and 75 per cent standard was up to 8 m^2 (Fig. 4a; Table 4). For the other sites, the 50 per

[4] Cumulative percentage is the percentage of cases in a distribution at or below that value (Bohrnstedt and Knoke 1988, p.50).

TABLE 4
50 per cent and 75 per cent standards for potential indicators.

	SITE STANDARDS (50 % AND 75 %)							
POTENTIAL INDICATOR	TRAILS		CAMP-SITE		COVES		MT HOPKINS	
STANDARDS	50%	75%	50%	75%	50%	75%	50%	75%
Damaged Trees (no.)	2	1	2	1	2	1	2	1
Bare Ground (m^2)	2	1	11	8	3	0	1	0
Group Numbers (no.)	5	4	4	3	4	3	4	3
Group Size (no.)	6	4	6	4	6	4	6	4
Litter (no. of pieces)	1	0	1	0	1	0	1	0
Signs (no.)	3	1	2	1	1	1	1	1

cent standard was more stringent: 3 m^2 at the Coves, 2 m^2 along the walk trails and 1 m^2 at Mt Hopkins. For the 75 per cent standard, again there was a lack of tolerance of damage in these three sub-units: 1 m^2 along walk trails and zero at the Coves and Mt Hopkins. Percentage responses, similarly to the numeric responses, indicated respondents were more tolerant of vegetation loss at the camp-site than in the other three management sub-units (Fig. 4b). A greater number of people responded to this question when they were asked for a percentage (71 per cent of survey respondents) rather than a maximum acceptable area in square metres (44 per cent of survey respondents).

Standards for a suite of social indicators including number and size of groups, amount of litter and number of human-made structures (e.g. signs) were also sought. Two questions were used to gauge respondents' views on the maximum number of groups they would accept seeing per day before the quality of their experience was reduced. One question asked respondents to provide a number for each management sub-unit and another asked them to circle a number already provided for the whole of Nuyts. Respondents were also asked how many groups they had encountered: 23 per cent of respondents saw no groups, 50 per cent saw one or two groups, 19 per cent saw from three to five groups and 8 per cent saw from six to 10 groups. None had seen more than 10 groups.

The 50 per cent standard for number of groups encountered, based on the site-by-site figures, was five groups per day along the walk trails and four groups per day at the camp-site, Coves and Mt Hopkins (Fig. 5; Table 4). The 75 per cent standard shows a similar trend, with up to four groups sighted per day acceptable along the walk trails and a maximum of three groups in the other management sub-units. Using the general figures obtained, the 50 per cent standard was up to six groups and the 75 per cent standard was up to four groups. These general figures are slightly more lenient than the site-specific standards.

Even more so than the maximum acceptable number of groups, there was virtually no difference across sites regarding maximum acceptable group size (Fig. 6). The 50 per cent standard based on the site-by-site figures was up to six people per group for all management sub-units (Table 4). The 75 per cent standard for all management sub-units fell to four people. Using the general figures obtained, the 50 per cent standard was up to eight people and the 75 per cent standard was six people. These general figures are more lenient than the site-specific standards, a similar difference between question responses to that obtained in the group number questions.

The next social indicator examined was litter. The majority of respondents were intolerant regarding litter, with a 50 per cent standard of up to one piece of litter and a 75 per cent standard of zero for all four management sub-units (Fig. 7). The good response rate for this question of 65 per cent indicated that participants felt particularly strongly about the issue and/or the question was easy to answer.

The last social indicator for which standards were sought was the number of human-made structures such as signs. Both the 50 per cent and 75 per cent standards reflect a greater tolerance for human-made structures along walk trails than elsewhere, with respondents tolerating up to three structures along walk trails compared with two structures at the camp-site, and one at the Coves and Mt Hopkins (Fig. 8; Table 4). The 75 per cent standard was equally restrictive across all sites, with up to one structure tolerated.

Information was also collected on visitors' tolerances regarding camp-fires although no acceptability standards were calculated because camp-fires have been banned in Nuyts (CALM 1992). Nearly all respondents indicated they would accept zero camp-fire rings around Mt Hopkins (92 per cent) and on or beside walk trails (97 per cent). They were more willing to accept camp-fire rings at the Coves and camp-site, with 45 per cent and 67 per cent of respondents respectively tolerant of one or more fire rings at these sites.

For all of the standards there was a small number of respondents who were tolerant of higher levels of impacts.

Tolerance then rapidly declined to the 50 per cent and 75 per cent standards. The shape of the curves in Figures 3 - 8 illustrates this rapid decline. For most of the indicators studied, about 20 per cent of visitors were much more tolerant of change than the remainder. The only exception was area of vegetation loss (Figs 4a and 4b), especially for the camp-site, where the curve takes longer to drop and flatten because respondents were more tolerant regarding the extent of change than they were for other indicators.

Potential Management Actions

Overall, respondents supported all the potential management actions. When the results for strongly support and support were combined, the six most preferred potential management actions were, in descending order of preference: to educate users more about minimal impact use and camping techniques; rehabilitate degraded areas; take remedial action to stop the spread of dieback by foot

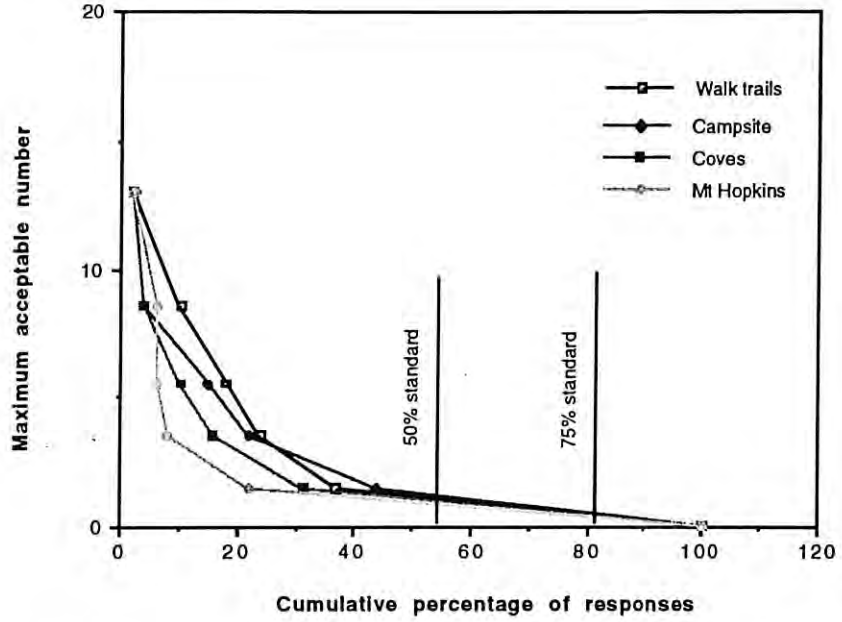

Figure 3a. Maximum acceptable number of trees damaged by humans (n=53).

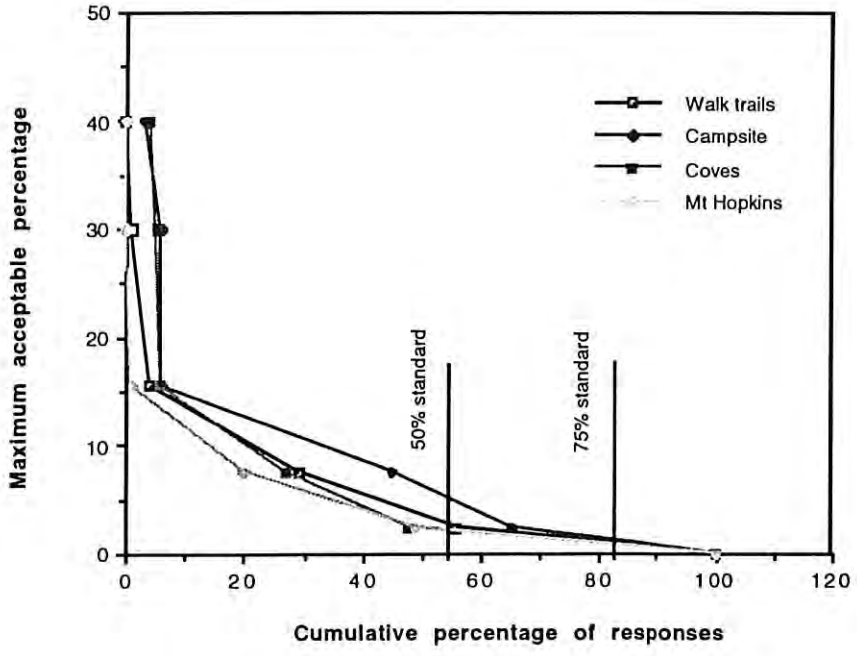

Figure 3b. Maximum acceptable percentage of trees damaged by humans (n=67).

traffic into the area; provide instructive maps of the area at main trail-head at Tinglewood; limit the number of people per group; and discourage the use of over-used areas (Table 5).

DISCUSSION

Visit and Visitor Characteristics

Successfully managing wilderness areas depends on an understanding of the use such areas receive as well as visit

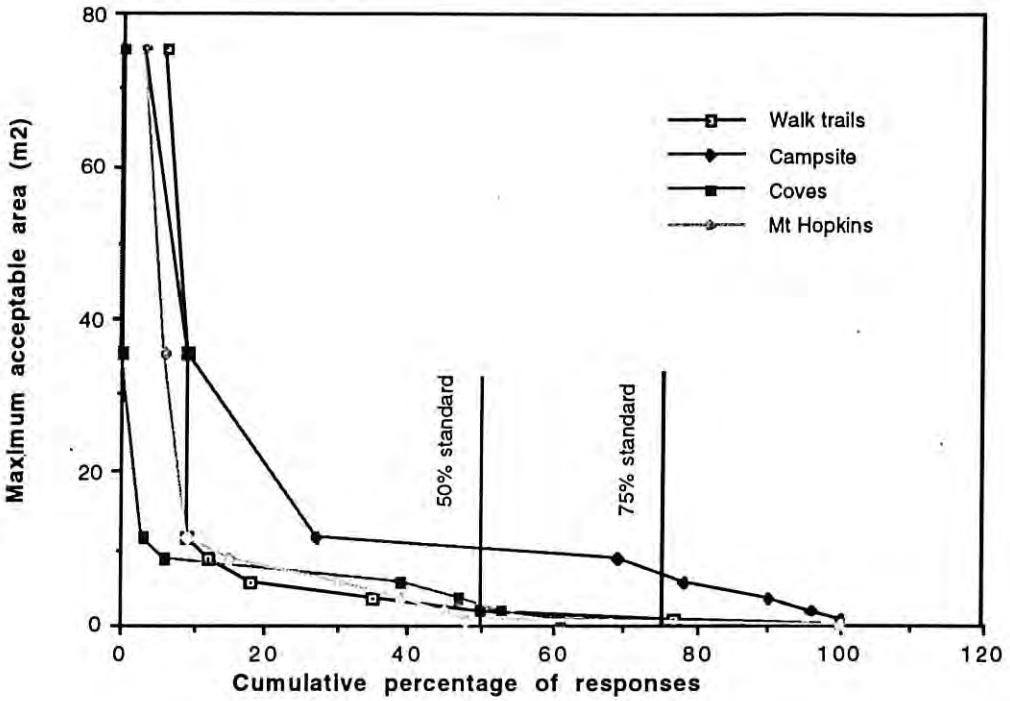

Figure 4a. Maximum acceptable area of vegetation loss or bare ground (m^2) (n=38).

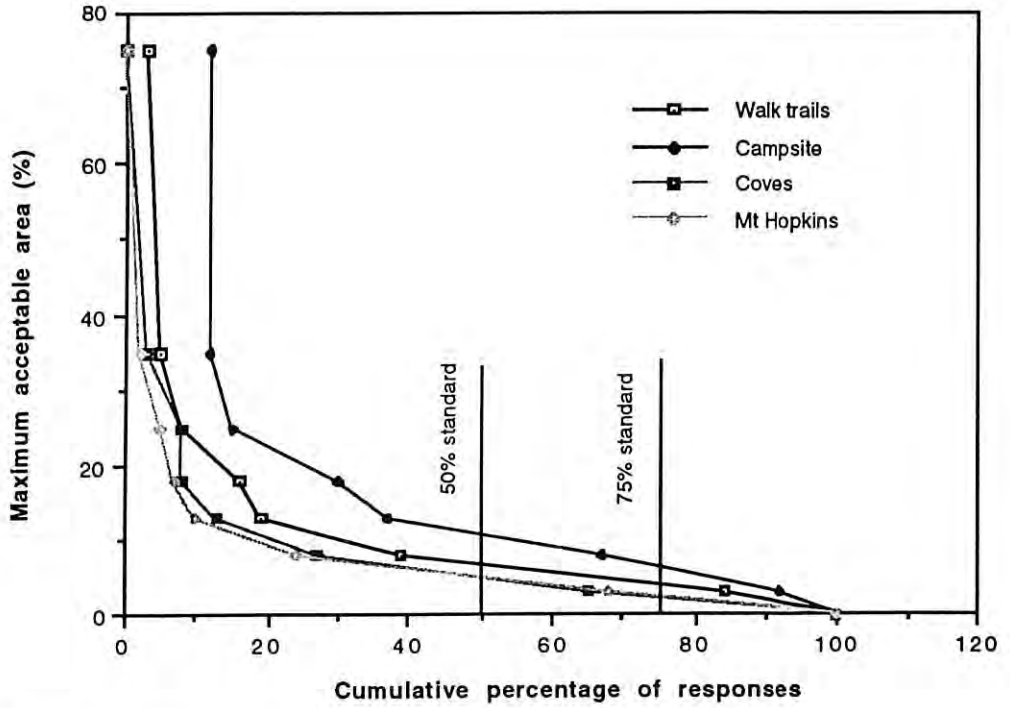

Figure 4b. Maximum acceptable area of vegetation loss or bare ground (%) (n=61).

and visitor characteristics. Activities undertaken by visitors to Nuyts are remarkably homogenous, with almost all visitors appreciating nature, walking for exercise, and enjoying the solitude. Lucas (1990) found that, typically, visitors participate in a wider variety of activities including photography, nature study, and swimming, and to a lesser degree fishing and hunting. This is in contrast to use of Australian wilderness where hunting has never been regarded as acceptable.

Enjoying an area free of vehicles was important to 85 per cent of Nuyts visitors, reflecting the current widespread access available to four-wheel-drive vehicles in some parts of Australia. There are few sections of the Western Australian coastline which are not currently accessible by four-wheel-drive vehicle. In contrast, many wilderness areas in the US are too rugged for vehicle access and, in addition, there is a long tradition of large

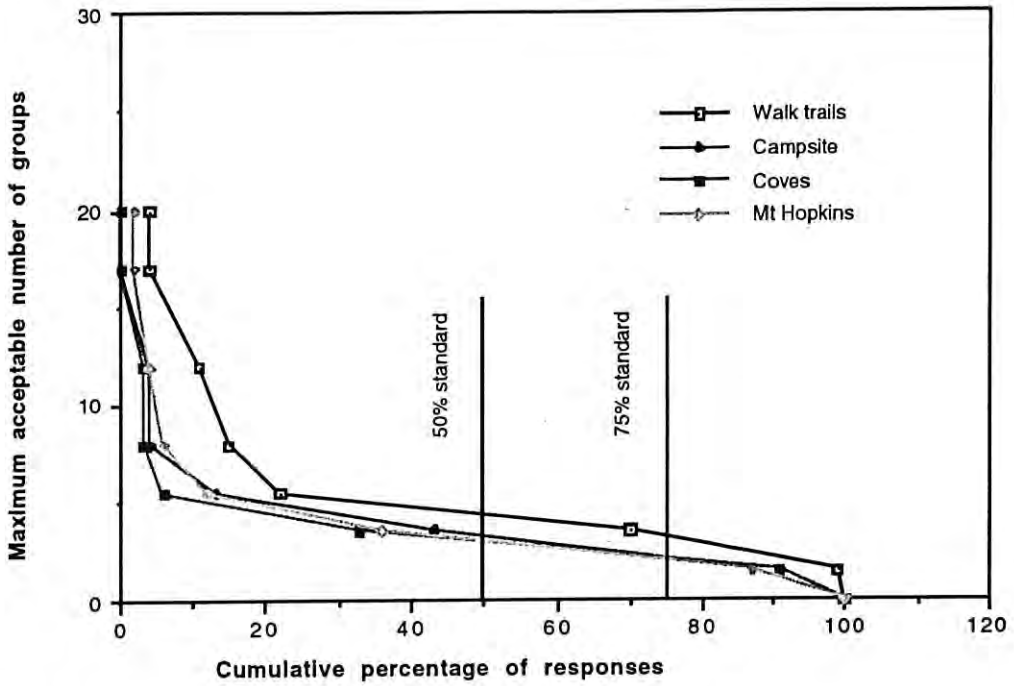

Figure 5. Maximum acceptable number of groups encountered on one day (n=52).

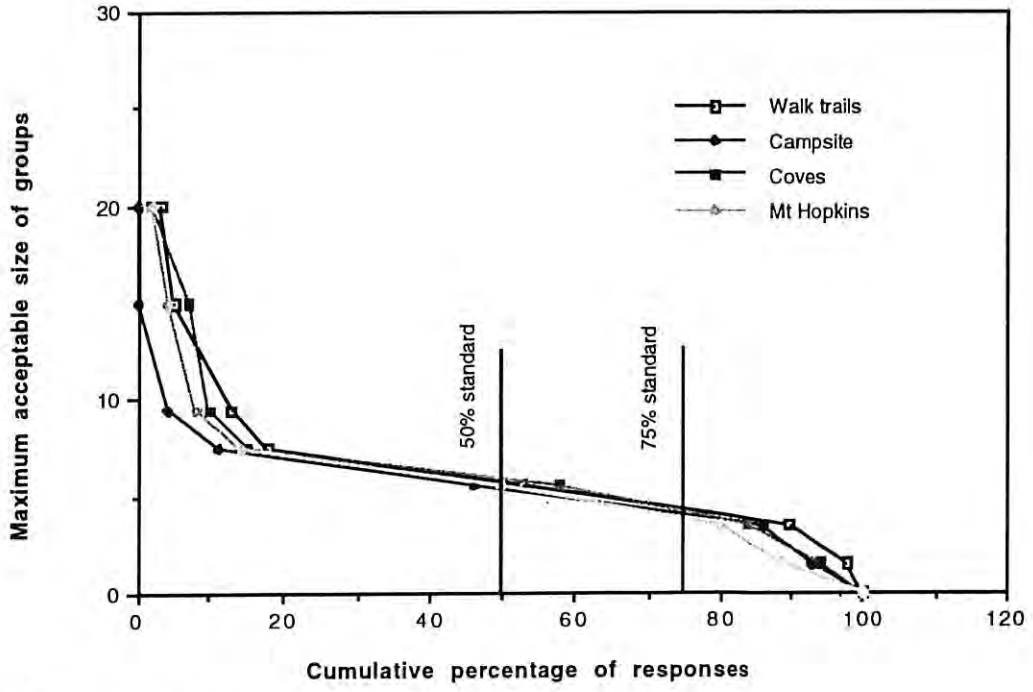

Figure 6. Maximum acceptable size of groups encountered on one day (n=51).

areas available only to non-motorized access, either on foot or using livestock such as horses.

Understanding who wilderness users are is important for both policy and management decisions. Policy is influenced by the knowledge of who receives the benefits gained from wilderness use while management, especially the use of information and education, requires knowledge of user characteristics and values (Lucas 1990). Nearly all studies agree that the most distinguishing characteristic of users of designated wilderness areas is their high education levels (Roggenbuck and Lucas 1987). With few exceptions, 60 to 85 per cent of visitors to such areas have attended college or university and 20 to 40 per cent have gone on to postgraduate study (Lucas 1990). The results of this study are consistent with these previous findings as a significant portion of visitors (70 per cent) had completed some form of tertiary education.[5] Thus,

[5] Australians of all education levels seek wilderness experiences, generally outside designated wilderness areas. Higher education levels have only been linked to use of designated wilderness areas.

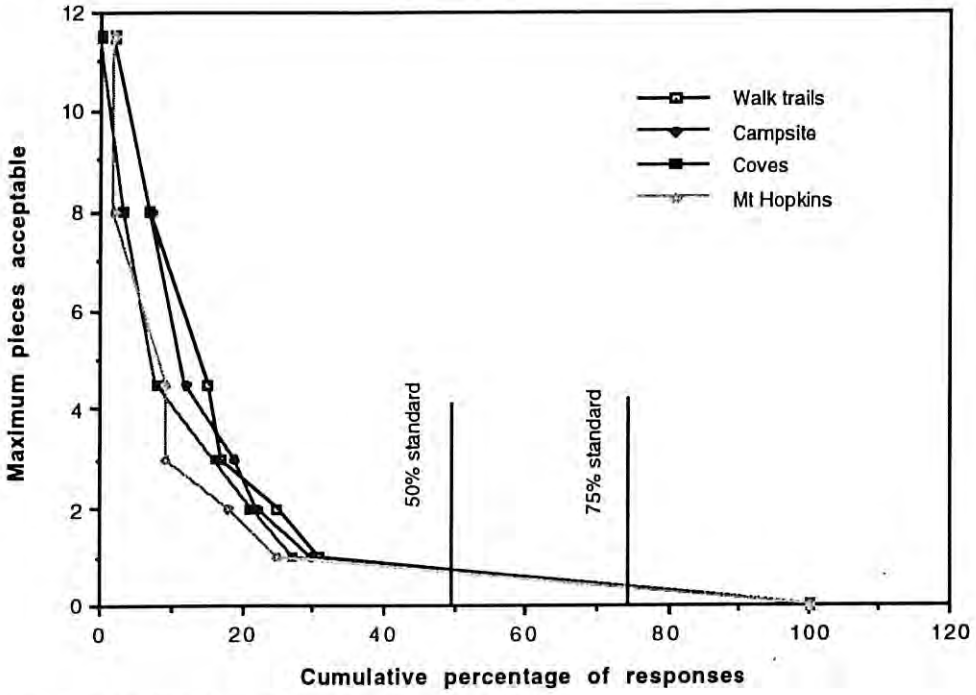

Figure 7. Maximum pieces of litter acceptable on one day (n=59).

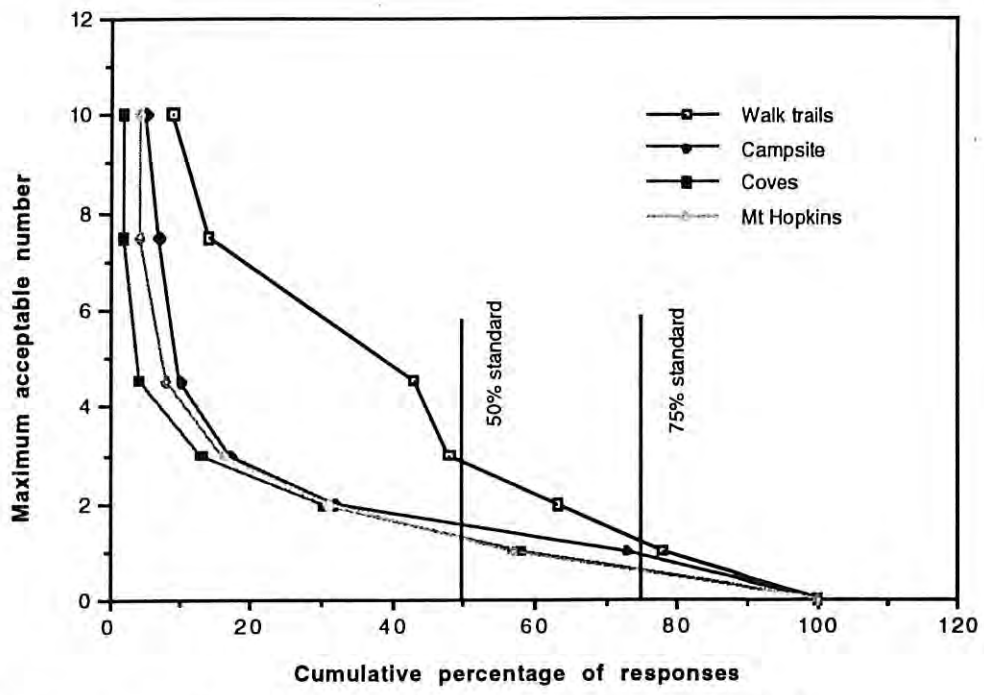

Figure 8. Maximum acceptable number of human-made structures such as signs (n=53).

TABLE 5
Survey respondents' attitudes toward potential management actions in Nuyts Wilderness Area.

POTENTIAL MANAGEMENT ACTION	STRONGLY SUPPORT	SUPPORT	NEITHER SUPPORT NOR OPPOSE	OPPOSE	STRONGLY OPPOSE
	Percentage of respondents[a]				
Educate users more about minimal impact and camping tchniques	78	20	3	0	0
Rehabilitate degraded areas	70	25	5	0	0
Take remedial action to stop the spread of dieback disease by foot traffic into the area	56	35	8	1	0
Provide instructive maps of area at main trail-head (Tinglewood)	47	42	9	1	1
Discourage use of over-used areas	41	41	9	9	1
Limit the number of people per group	43	37	11	6	3
Provide minimal structures such as stairs and boarding to protect fragile areas	41	38	11	5	5
Temporarily close areas	35	41	11	13	0
Limit length of stay during peak times	28	50	8	14	1
Provide more Rangers in area to provide information and education	27	41	27	5	0
Limit use (e.g. type, level)	22	49	15	11	3
Introduce a voluntary user fee for the management of Nuyts Wilderness Area	21	46	18	6	9
Provide signs for direction	21	38	9	22	10
Provide more Rangers in area to enforce existing regulations	19	34	34	13	1

[a] percentages have been rounded to the nearest whole percentage therefore do not necessarily sum to 100 per cent in every case

relatively sophisticated explanations about interactions between parts of the environment and the often complex reasoning behind potential regulations affecting users can be provided as part of general visitor information.

Typically, visitors to wilderness areas in the US come from all over the country but most live relatively close to the area visited (Lucas 1990). Our results are consistent with this previous finding: the majority of Nuyts visitors came from the south-west of Western Australia and of these, 64 per cent were from Perth, so they live relatively close to Nuyts. Given that most visitors are 'locals', pre-trip information and educational material can be provided from outlets in the south-west, especially from Perth. In the US, wilderness visitors tend to be younger than the general population, yet all age groups are fairly well represented (Roggenbuck and Lucas 1987; Lucas 1990). The age of visitors in the Nuyts study varied from other findings, with Nuyts visitors fairly evenly split between the 26-40 and 41-60 age groups.

Most Nuyts visitors stayed for up to a day (35 per cent) or between one and three days (45 per cent), usually once a year. Lucas (1990), in his review of wilderness use and users in the US, found that the length of stay in most wildernesses is short with many small and medium-sized wilderness areas being predominantly day-use areas. Wilderness areas in the eastern US had average stays of two or three days with 25 to 50 per cent being day use (Lucas 1990). Trips of a week or more accounted for less than one-tenth of all visits, even in large wilderness areas such as the Bob Marshall Wilderness Complex (Lucas 1990). Thus, for Nuyts as for many wilderness areas in North America, decreasing the length of stay as a means of reducing impacts would be ineffective because most people stay for short periods only, three days or less.

Over half of the survey respondents visited Nuyts with only one other companion. Roggenbuck and Lucas (1987) found in their study of wilderness use and user characteristics in the US that the size of wilderness visitor parties is generally small, with 50 to 75 per cent of parties comprising from two to four people.

Potential Indicators

Respondents were more concerned about biophysical impacts such as erosion, vegetation loss and tree damage than they were about social conditions such as number and size of groups (Table 3). This probably reflects respondents' views that current use levels, although they

may be leading to biophysical impacts, are not resulting in a decline in their social experience. The majority of respondents saw two or less groups per day and felt this was the right number. In Canada, impacts on biophysical conditions were similarly the most important in determining the quality of visitors' recreational experience (BC Forest Service 1995). On the other hand, results of wilderness visitor surveys in the US indicate more concern with social conditions such as crowding, conflict among visitors and littering than with resource conditions such as camp-site and trail impacts (Lucas 1990).

The level of concern about trail erosion, vegetation loss and damage to trees mirrors similar concerns expressed in relation to Fitzgerald River National Park on the south coast of Western Australia (CALM 1991). The amount of vegetation loss and damage to trees, especially by pack animals, have been widely chosen as indicators of impact at camp-sites in numerous other wilderness areas (e.g. Bob Marshall Wilderness Complex - Stankey *et al.* 1990). Denuded ground vegetation as a result of camping activities (e.g. Mt Rainier National Park Wilderness Management Plan, Washington State), the number of impacted sites per 640 acres (291 ha), and square feet (m^2) of barren core (Bob Marshall Wilderness Complex LAC Plan, Flathead National Forest, Montana) are other commonly-used indicators of camp-site condition. Watson *et al.* (1992) in their study of three wilderness areas in the southern US found that visitors regarded litter, tree damage and wildlife seen as the most important indicators. The least important influence on visitor experiences was the number of trail encounters with other groups on the trail (Watson *et al.* 1992).

For the three wilderness areas examined by Watson *et al.* (1992) and in the Nuyts study, the number of animals seen and presence of wildlife respectively were important influences on visitors' evaluations of the quality of their wilderness experience. However, the density of wildlife in wilderness and even the presence of wildlife are largely beyond managers' control. Thus, use of the number of animals seen as an indicator of wilderness quality in the LAC framework is of little value. It is, however, important for managers to continue to protect wilderness wildlife from human impacts both inside and originating outside the wilderness (Watson *et al.* 1992).

Two social impacts were of the greatest concern to Nuyts visitors: littering and inadequate disposal of human waste. Litter was also an important indicator in the US (Lucas 1990; Watson *et al.* 1992). Human waste disposal has not been used as an indicator elsewhere because of health issues associated with such a monitoring program.

Other social conditions of importance to Nuyts visitors were number of people in a group and the number of other groups camped within sight or sound. The indicator 'the number of camp-sites within sight or sound of others' has been widely used elsewhere (Bob Marshall Wilderness Complex LAC Plan, Flathead National Forest, Montana; Hickory Creek and Allegheny Islands LAC Task Force, Allegheny National Forest, Pennsylvania; Mt Trumball/Mt Logan Wilderness Management Plan, Utah). In the British Columbia (BC) study (BC Forest Service 1995), behaviour of people in other groups was the most important social condition to other visitors, followed by the number of other groups at camp-sites, the size of groups encountered, and the number of other groups along trails.

Standards for Potential Indicators

Several features of the standards results are immediately striking and warrant discussion: first, impacts such as litter and tree damage for which visitors have limited tolerance and second, the similar levels of change acceptable, with several noticeable exceptions, at very different sites. Other features of the results such as different responses to questions about standards depending on whether people were asked to give a number or a percentage also warrants mention.

For litter, 50 per cent of respondents were willing to accept only one piece of litter or less anywhere in Nuyts. Cumulating these responses for 75 per cent of respondents gave an increased intolerance, with no litter being acceptable. In the BC survey, both 50 per cent and 75 per cent of respondents indicated they would accept from zero to one piece of litter per site (BC Forest Service 1995). Watson *et al.* (1992) found that 75 per cent of respondents were unwilling to see any litter at any sites. Many studies have found that visitors react particularly negatively to littering and even small amounts of litter evoke strong responses. Littering is often viewed as a violation of strongly held norms and thus, as evidence of abuse rather than normal use (Lucas 1990).

There was also great intolerance across sites regarding damage to trees. For all four sites, the 50 per cent standard was two damaged trees per site and the 75 per cent standard was one. Trees are important to visitors because they are a very visible part of the natural landscape; also, on the south coast of Western Australia they provide protection from the wind and sun for both day visitors and campers. Thus, they hold considerable aesthetic and utilitarian value for visitors.

There were strong similarities across sites for the 50 per cent and 75 per cent standards. For tree damage, litter and group size these standards were the same for all four management sub-units (Table 4). Roggenbuck *et al.* (1993, p.195) noted in their study across four wilderness areas that there 'is surprisingly broad agreement across areas on what are acceptable wilderness conditions'. For conditions of great concern in Nuyts such as litter and tree damage, restrictive and high standards were desired by visitors at all four sites. The uniformity in acceptable group size - a 50 per cent standard of six people per group and a 75 per cent standard of four people per group - across Nuyts indicates that groups larger than six persons were unacceptable to many respondents at any site.

Standards for numbers of groups encountered in a day were also very similar across all four sites, with a slightly higher tolerance for number of encounters along walk trails but otherwise standards, both 50 per cent and 75 per cent, were uniform (Table 4). Slightly higher tolerance

along walk trails is based on the briefness of encounters while people are travelling contrasted with lower tolerances for numbers of other groups at destinations such as camp-sites, viewpoints and coastal, day-use destinations such as the beach coves. Similar results have been found in the US where visitors are similarly less tolerant of larger numbers of groups at destinations and more accepting of such encounters while transiting along trails (Roggenbuck *et al.* 1993).

In the US visitors expressed more stringent 50 per cent standards for camp-sites than given in the Nuyts study, preferring a maximum of one other group within sight or sound of their camp-site (Roggenbuck *et al.* 1993). Visitors to US wilderness areas also express dissatisfaction about the numbers of groups encountered in such areas. Nuyts visitors appeared satisfied with existing levels of use in terms of numbers of groups encountered. In this study 98 per cent of respondents saw five groups or less which equates with the supported 50 per cent standard of four or five groups. Thus, camp-site use in Nuyts has not reached the level where visitors are expressing dissatisfaction.

Two exceptions to uniformity of standards across sites were those for area of bare ground and signs. Visitor views regarding standards are realistic; they reflect the type of use areas are exposed to and the expectations visitors have regarding such areas. As such, they have a far greater tolerance of bare ground/vegetation loss at camp-sites than at other sites. Bare ground is an advantage at camp-sites because it provides suitable places for pitching tents. In the BC survey (BC Forest Service 1995), respondents accepted similar areas of vegetation loss/bare ground to that of Nuyts visitors: 50 per cent of respondents indicated a maximum of 9 m^2 of vegetation loss compared with the Nuyts finding of up to 11 m^2. Nuyts visitors were also tolerant of some vegetation loss along trails and at the Coves as a consequence of recreational use (Table 4). Mt Hopkins, as the most pristine site, had extremely stringent standards indicated by most respondents, with a 50 per cent standard of 1 m^2 and 75 per cent standard of 0 m^2.

Human-made structures were not generally tolerated by survey respondents, although this tolerance was somewhat greater along the trails; for the 50 per cent standard up to three structures along trails, two structures at the camp-site and one at the Coves and Mt Hopkins. This is, in part, similar to responses of Canadian wilderness users who appear similarly intolerant of such structures, with respondents accepting only one structure at most sites. In North America there is a tradition of un-signposted wilderness, although in most wilderness areas on that continent walk trails are well-worn and immediately obvious; therefore signs are unnecessary. In Australian wilderness areas walk trails are often not obvious, may be infrequently used and signs would be useful to provide direction. These reasons help explain the tolerance of Nuyts' respondents for up to three structures along walk trails and the lesser tolerance exhibited by North American wilderness users.

For most wilderness recreation standards, achieving the more restrictive 75 per cent rather than 50 per cent standard, that is, satisfying three-quarters rather than half of the visitors, means reducing the acceptable impact by at least half (Roggenbuck *et al.* 1993). Achieving the 75 per cent standard for tree damage, bare ground (especially at the Coves and Mt Hopkins), litter or signs at Nuyts requires twice the level of stringency and potentially at least twice the resources as managing to maintain the 50 per cent standard (Table 4). For example, for tree damage, achieving the 50 per cent standard means limiting damage between monitoring events to two trees per site. Achieving the 75 per cent standard requires halving the impact over the monitoring interval to one tree per site.

Number of groups encountered and group size showed less variation between the two standards with a one-quarter reduction in acceptable impact from the 50 per cent standard of four or five groups encountered per day needed to meet the 75 per cent standard of three or four groups and a one-third reduction in acceptable impact from the 50 per cent standard of six people per group to meet the 75 per cent group size standard of four people per group. The resources required to meet far more restrictive 75 per cent standards, especially if acceptable impact levels have already exceeded the 50 per cent standard as they have in many North American wilderness areas, explains why most managers prefer using 50 per cent rather than 75 per cent standards. It is unknown, for Nuyts, whether management to achieve or maintain 50 per cent standards is feasible. And, there is currently no monitoring program to assess changes against standards.

The last feature warranting discussion was the different responses evoked when respondents were asked to provide a percentage rather than a number for trees damaged and vegetation loss. For both indicators many more people answered the question when it asked for a percentage rather than a number, probably because for many it was easier to visualize a percentage of trees or vegetated area damaged rather than the numbers of trees damaged or square metres of bare ground. However, from a manager's perspective, it is much easier to record numbers of damaged trees rather than percentage of the total number of trees damaged and area of bare ground in square metres rather than percentage of bare ground. The challenge lies in researchers and managers being able to help survey respondents visualize impacts in terms of numbers and areas rather than percentages as this is how they will be measured.

Potential Management Actions

Understanding visitor attitudes towards management actions can assist in predicting the consequences of specific actions on the experience (McCool *et al.* 1990). The majority of respondents supported all potential management actions including those usually regarded as unpopular such as limiting the length of stay and use (e.g. type and level), temporarily closing areas, providing more rangers to enforce existing regulations and signs for

direction, and introduction of a voluntary user fee (Table 5).

In comparison, the BC study found that the strongest support of potential management actions lay in the areas of increased education and rehabilitation (BC Forest Service 1995). When asked their attitude towards potential management actions, the BC survey found that respondents most strongly supported educating users more about minimum impact use and rehabilitating over-used areas, followed by discouraging or prohibiting the use of over-used areas and providing more patrols to enforce regulations. In contrast to Nuyts visitors, limiting the number of people per group and limiting use (e.g. type, location and amount) were generally less well supported by the BC survey respondents (BC Forest Service 1995). It is of interest to note that in both countries there was a reasonable level of support for increased enforcement. This support is possibly linked to the strong belief that damage is caused by others and enforcement will deal with others' misdemeanours. This fits with the comments from the BC survey that the main concern associated with social conditions was the poor behaviour by people in other groups.

CONCLUSION AND RECOMMENDATIONS

General Comments

Visitors were generally happy with the biophysical and social aspects of their most recent visit in Nuyts. Like Canadian wilderness visitors, people visiting Nuyts were more concerned about biophysical rather than social impacts. Overcrowding was not a significant issue for Nuyts visitors whereas it was an unpalatable feature of visits to US wilderness areas. However, for all wilderness visitors, litter was a sensitive issue. Given these broad comments, we conclude our paper with the following management and research recommendations.

Management Recommendations

(1) Developing a monitoring program

The environmental conditions and indicators outlined and discussed in the preceding sections - number of trees damaged, area of bare ground, number and size of groups encountered, pieces of litter and number of signs - provide a suite of indicators and associated standards (Table 4) and the basis of a monitoring program for Nuyts. For several reasons it is not necessary to monitor the whole suite especially in these times of limited resources. At Nuyts, visitors were most concerned about biophysical impacts, the only notable exception being littering. Of the biophysical impacts, the one of greatest interest was human damage to trees. Therefore, a monitoring program could initially focus on litter and tree damage and to a lesser extent vegetation loss. Sites where impacts are close to being exceeded or where management actions have been taken to deal with 'unacceptable' impacts have the highest priority for monitoring.

A range of monitoring techniques could be used. LAC applications in North America have relied on site-based measurements, usually recorded as numbers and less often as percentages. Other possibilities include ground-based or aerial photography taken at fixed points over time.

(2) Management actions to minimize or ameliorate impacts

Visitors were supportive of a broad range of management actions, from education through closure of areas and other limits on use, to charging fees (Table 5). This provides a broad choice of management strategies for managers. The two conditions of most concern were littering and inadequate disposal of human waste. Education through signs and pamphlets should decrease these impacts without having to provide facilities requiring capital resources and maintenance and impinging on the area's wilderness qualities. The management sub-unit where impacts most concerned visitors was the Coves and their biophysical condition. Erosion and vegetation loss were regarded as problems, making the provision of structures such as stairs and boards (supported by 79 per cent of visitors) a potential management solution.

Recommendations for Further Research

(1) Gaining a better understanding of cause-effect relationships in Nuyts and elsewhere

This study identified impacts and visitors' preferences regarding the level of impact and mitigating management actions. The next essential step is understanding the relationship between different types and levels of use and the resulting impacts. Such research is an essential stage of the VIM process (Step 6, Table 1). Also, a better understanding of cause and effect is needed to determine which management actions to take and then to subsequently assess the effectiveness of such actions.

(2) Developing indicators and standards for recreational use of the CALM Estate

This study has provided indicators and standards potentially relevant to other coastal parts of the south-west of Western Australia used by bushwalkers and accessible on foot. Similar indicators and standards are also needed for other forms of recreational use and landscapes across the CALM estate, from the small picnic areas on granite rocks in the wheatbelt to the waterholes and waterfalls of the Kimberley. Such indicators, through allowing the recognition of impacts of concern to visitors and managers, mean management priorities can be set and management actions taken as required. The effectiveness of such actions can also be determined over time through monitoring these key indicators.

(3) Placing recreation-use monitoring in a broader context

Monitoring recreation impacts eventually needs placing in a broader monitoring program directed toward ecological 'health' or sustainability. Recreation monitoring alone is insufficient given that impacts acceptable to visitors may not be ecologically sustainable in the longer term. Also, areas such as Nuyts are managed for nature conservation values as well as recreational use. A broader monitoring program, including the recreation framework developed from this study and directed toward ecological concerns, warrants investigation and development.

(4) Determining visitor tolerance to various forms of management intervention

An essential component of both the LAC and VIM planning frameworks is implementing strategies. However, some strategies may be widely supported by users while others may prove unpopular. For example, it is generally assumed that educational strategies in natural environments will be widely supported while strategies based on limiting use may be met with opposition. Research is needed to determine visitor tolerance, in Western Australian national parks and associated wilderness areas, to various forms of management intervention including more educational materials, site rehabilitation, limiting use either by restricting visitor numbers or closing selected areas, more staff either for enforcement or educational purposes, more infrastructure such as stairs and boarding to protect fragile areas, and introducing fees.

ACKNOWLEDGEMENTS

Contributions by Cliff Winfield and Bruce Bond to the development and execution of this study are gratefully acknowledged, as are the useful suggestions and input of reviewers Jackie Alder and Ross Dowling.

REFERENCES

Absher, J. (1994). Beyond carrying capacity. *Ranger*, Spring edn, pp. 30-32.

Anon. (n.d.). Zoning for national parks in Western Australia: discussion paper. Department of Conservation and Land Management, Como, Western Australia.

BC Forest Service (1995). The 1993 Northeastern British Columbia recreation survey. Recreation Section, Range, Recreation and Forest Practices Branch, Ministry of BC Forests, British Columbia, Canada.

Bohrnstedt, G.W. and Knoke, D. (1988). *Statistics for Social Data Analysis*. F.E. Peacock, Itasca, Illinois.

Bury, R.L. (1976). Recreation carrying capacity - hypothesis or reality? *Parks and Recreation* **11**(1), 22-25, 56-57.

CALM (1991). Fitzgerald River National Park management plan 1991-2001. Department of Conservation and Land Management for the National Parks and Nature Conservation Authority, Como, Western Australia. *Management Plan* No. 15.

CALM (1992). Walpole-Nornalup National Park management plan 1992-2002. Department of Conservation and Land Management for the National Parks and Nature Conservation Authority, Como, Western Australia. *Management Plan* No. 20.

Clark, R.N. and Stankey, G.H. (1979). The recreation opportunity spectrum: a framework for planning, management, and research. United States Department of Agriculture Forest Service, Pacific Northwest Forest and Range Experiment Station, Seattle, Washington. *General Technical Report* PNW-98.

Cole, D.W. (1985). Management of ecological impacts in wilderness areas in the United States. *In* Bayfield, N.G. and Barrow, G.C. (eds), *The Ecological Impacts of Outdoor Recreation on Mountain Areas in Europe and North America. R.E.R.G. Report No. 9.* Wye, England.

Cole, D.W. and Hammitt, W.E. (1987). *Wildland Recreation*. John Wiley and Sons, New York.

Graefe, A.R. (1989). Visitor impact management. In *Towards Serving Visitors and Managing Our Resources - Proceedings of a North American Workshop on Visitor Management in Parks and Protected Areas.* Feb. 4-17, 1989. Tourism Research and Education Centre, University of Waterloo and Parks Canada, Environment Canada, Waterloo, Ontario.

Graefe, A.R., Kuss, F.R. and Vaske, J.J. (1990). *Recreation Impacts and Carrying Capacity: A Visitor Impact Management Framework*. National Parks and Conservation Association, Washington D.C.

Knopf, R.C. (1989). The limits of acceptable change (LAC) planning process: potentials and limitations. In *Towards Serving Visitors and Managing Our Resources - Proceedings of a North American Workshop on Visitor Management in Parks and Protected Areas.* Feb. 14-17, 1989. Tourism Research and Education Centre, University of Waterloo and Parks Canada, Environment Canada, Waterloo, Ontario.

Kuss, F.R. and Graefe, A.R. (1985). Effects of recreation trampling on natural area vegetation. *Journal of Leisure Research* **17**(3), 165-183.

Lucas, R.C. (1973). Wilderness: a management framework. *Journal of Soil and Water Conservation* **28**(4), 150-154.

Lucas, R.C. (1990). Wilderness use and users: trends and projections and wilderness recreation management: an overview. *In* Hendee, J.C., Stankey, G.H. and Lucas, R.C. (eds), *Wilderness Management*. North American Press (Fulcrum Publishing), Golden, Colorado.

Mandis Roberts Consultants (1995). Determining an environmental and social carrying capacity for Jenolan Caves Reserve: applying a visitor impact management system. Unpublished report, Mandis Roberts Consultants, Sydney, NSW.

McCool, S.F. (1989). Limits of acceptable change: evolution and future. In *Towards Serving Visitors and Managing Our Resources - Proceedings of a North American Workshop on Visitor Management in Parks and Protected Areas*. Feb. 14-17, 1989. Tourism Research and Education Centre, University of Waterloo and Parks Canada, Environment Canada, Waterloo, Ontario.

McCool, S.F., Martin, S.R. and Yuan, M. (1990). The 1989 Bear Trap Canyon visitor study. Institute for Tourism and Recreation Research, School of Forestry, Missoula, Montana. *Research Report* 13.

Prosser, G. (1986). The limits of acceptable change: an introduction to a framework for natural area planning. *Australian Parks and Recreation* **22**(2), 5-10.

Roggenbuck, J.W. and Lucas, R.C. (1987). Wilderness use and user characteristics: a state-of-knowledge review. *In* Lucas, R.C. (compiler), *Proceedings - National Wilderness Research Conference: Issues, State-Of-Knowledge, Future Directions*. July 23-26, 1985. United States Department of Agriculture Forest Service, Intermountain Research Station, Ogden, Utah. *General Technical Report* INT-220.

Roggenbuck, J.W., Williams, D.R. and Watson, A.E. (1993). Defining acceptable conditions in wilderness. *Environmental Management* **17**(2), 187-197.

Shelby, B. and Heberlein, T. (1986). *Carrying Capacities in Recreational Settings*. Oregon State University Press, Corvallis, Oregon.

Stankey, G.H. and Lucas, R.C. (1985). Role of research in applying the limits of acceptable change system. In *Proceedings of the Southeastern Recreation Research Conference 1985,* Department of Recreation and Leisure Services, Georgian Southern College, Georgia.

Stankey, G.H., Cole, D.N., Lucas, R.C., Petersen, M.E. and Frissell, S.S. (1985). The limits of acceptable change (LAC) system for wilderness planning. United States Department of Agriculture Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah. *General Technical Report* INT-176.

Stankey, G.H., McCool, S.F. and Stokes, G.L. (1990). Managing for appropriate wilderness conditions: the carrying capacity issue. *In* Hendee, J.C., Stankey, G.H. and Lucas, R.C. (eds), *Wilderness Management*. North American Press (Fulcrum Publishing), Golden, Colorado.

Wagar, J.A. (1964). The carrying capacity of wildlands for recreation. Society of American Foresters, Washington, D.C. *Forest Science Monograph 7*.

Watson, A.E., Williams, D.R., Roggenbuck, J.W. and Daigle, J.J. (1992). Visitor characteristics and preferences for three national forest wildernesses in the south. United States Department of Agriculture Forest Service, Intermountain Research Station, Ogden, Utah. *Research Paper* INT-455.