Environmental Indicators of Tourism Impacts on Natural West Coast Assets, Aotearoa New Zealand.

Stephen Urlich
Soil, Plant and Ecological Sciences Division
Lincoln University
Current address: Department of Conservation, PO Box 569, Kaitaia
surlich@doc.govt.nz

Jonet Ward
Environmental Management and Design Division,
Lincoln University
Wardj@lincoln.ac.nz

Ken Hughey
Environmental Management and Design Division,
Lincoln University
Hugheyk@lincoln.ac.nz

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Abstract

We examined the environmental effects of visitor activities at three different natural assets (scenic *icon* sites, *seabirds*, and *caves*) on the West Coast of the South Island, New Zealand. To catalogue the effects of different visitor activities on these assets, and to identify indicators of environmental change in relation to the effects of these activities, we used a range of methods including modelling visitor impacts, close consultation with managers, literature reviews, and at one site we observed visitor behaviour. We analysed which site indicators of visitor effects were more widely applicable, and could be used as a basis for developing management guidelines for similar types of attractions elsewhere.

Most sites we studied are managed by the Department of Conservation (DoC), and we reviewed how limits of acceptable environmental change for managing visitors were determined at these attractions, and for their attributes (i.e., their tracks). We also compared the management of seabirds at a privately owned and run colony with management of publicly accessed colonies on DoC managed land.

We found that the scenic *icon* sites, and the tracks to all different assets, were generally well constructed and maintained by DoC. Visitors were well catered for and their effects well-managed. However, at seabird and cave sites managed by DoC we found visitors were not managed to the same consistent standard, largely because access is mostly open and/or the assets are more directly sensitive and less resilient to visitor impacts. There was also a general lack of clearly defined processes and mechanisms for devising limits of acceptable environmental change at these sites, and implementation of management accordingly. In contrast, we found the privately owned seabird colony to be well managed with a long-term sustainable ecotourism operation in place. We explore the differences between the respective operations, examine the processes by which visitors were managed, and discuss the factors contributing to the differences in management and the effects on these natural assets.

Chapter 1
Introduction

On an average day, 75,000 domestic and 45,000 international tourists are travelling around Aotearoa New Zealand. Most of these tourists participate in activities based on the natural environment. Tourism that is focused on New Zealand's unique species and natural features is one of the key aspects that gives this country a competitive advantage in the global tourism sector (Parliamentary Commissioner for the Environment (PCE), 1997*a*).

Facilitating tourist access to these features also has the potential to impact on New Zealand's natural environment (PCE, 1997*a* and *b*). There is a need to improve the capability of managing such tourism sustainably if the competitive advantage is to be retained. This means safeguarding the health, wellbeing and viability of species and integrity of physical environments, which are among the attractions that entice many people to these shores. The Parliamentary Commissioner recommended support for research into the environmental effects associated with the tourism sector, specifically advocating:

- development of environmental indicators for tourism effects;
- gathering and analysis of data on domestic and international travel and activity patterns; and
- establishing limits of acceptable change for ecological and biological systems on which tourism depends.

Concurrently, the Department of Conservation (DoC) identified research and information needs associated with the management of the impacts of visitors on natural and historic resources of conservation significance (Cessford, 1997). This report emphasised the need to identify priority species or features sensitive to visitor impacts, and key sites where these were under most potential pressure from tourism. An ability to understand and predict environmental changes arising from tourism is also shared by regional and district councils, so that the sector can better manage access to, and use of, natural assets.

Limits of acceptable environmental change indicators

Most of the few long term studies in New Zealand on tourism impacts on natural features, or wildlife, have covered one season and mainly focused on impacts on vegetation or soils (Ward and Beanland, 1996). Few studies reviewed by Ward and Beanland had made links between the extent of impacts and the level and type of visitor use, and none made reference to management objectives at the specific site. Booth and Cullen (1995), in their review of recreation impact research, noted that there was lack of integration in the management and identification of recreational, ecological and social impacts, which they viewed as problematic for managers. They also concluded that there was no predictable relationship between impacts and the intensity and amount of visitor use, due to the nature, tolerance, and resilience of different ecological communities. Both reviews suggest that generic or useful ecosystem indicators of visitor effects are still to be fully developed, making it difficult to measure the significance of individual site changes within a wider context.

This difficulty may also be partly because appropriate frameworks for assessing environmental effects have not been consistently implemented by managers in New Zealand (Booth and Cullen, 1995). A fundamental aim of visitor management is to ensure that each visitor's experience is a high quality one, and is sustainable ecologically and socially (McArthur, 2000). Various models have been designed to assist with this aim by linking visitor management planning, monitoring and decision making. The most commonly used framework for managing the effects of visitors at key visitor sites is the Limits of Acceptable Change (LAC) model, proposed by Stankey and fellow workers in 1985. LAC and other visitor management planning frameworks (Visitor Impact Management Model - VIMM, Tourism Optimisation Model - TOM) came out of the unsatisfactory definition and determination of the notion of 'carrying capacity', both socially and environmentally, and its lack of generic applicability (Stankey *et al.*, 1985; Prosser, 1986; Cole, 1988; Kuss *et al.*, 1990; McArthur, 2000).

The LAC process sets the desired conditions, or levels of appropriate change, at wildlife or physical attractions, within a participatory process that brings together groups or individuals who have an interest, or a 'stake' in the attraction. This process allows for different stakeholder views and ideas to be heard and incorporated in an integrated manner, which in turn means that appropriately focussed indicators of change for these limits are more likely to be developed. The alternative approach of first selecting indicators and setting out to monitor them for change without having set clear goals beforehand, may not lead to a clearer understanding of the significance, desirability, or limits of acceptable environmental change.

In assessing limits of acceptable environmental change there are a number of key points for managers to consider (Cessford, 1997). First, it should be recognised that not all visitor effects may be adverse. Second, the significance of visitor effects may not be overt but possibly cumulative and behavioural instead. Third, natural processes or external human influences may have more ecological importance and impacts on sites; for example, Alpine Fault earthquakes of M_w 8 that alter geological formations and initiate extensive, widespread primary and secondary succession throughout the West Coast region (Wells *et al.* 1999). Therefore, to differentiate between adverse and non-adverse effects, Cessford suggests the following definitions (1997:7):

Visitor **effects** – *the physical consequences and processes associated with the presence of visitors in natural settings, which are natural phenomena and may or may not be adverse.*

Visitor **impacts** – *the specific adverse effects of visitors which represent tangible threats to key conservation values specified by management.*

Cessford (1997, 1999) also suggests a definition of conservation values that is based on DoC's management processes in setting priorities and attributing conservation importance:

Conservation **values** – *the specific elements of natural and historic resources which establish their significance for being assigned conservation priority by management agencies. These are the objects, species or associations attributed with greatest importance for conservation purposes*" (Cessford, 1997:7).

DoC as a major stakeholder in the provision of tourism facilities are currently focussing on, and prioritising, management of key tourism sites or 'hot-spots' in the front country, which have high visitor use and high conservation values (DoC, 1996; Cessford, 1999). However, in this report we also recognise that iwi, other private land owners and managers, and other public agencies also set conservation priorities and have value systems that might be quite different to DoC. It is important to note that DoC and local iwi have a special relationship in giving effect to the Principles of the Treaty of Waitangi (1840), and this is made explicit in Section 4 of the Conservation Act (1987): Management of key tourism sites involves a genuine consultative partnership approach.

Developing indicators from the 'top down' and from the 'bottom up'.

Managers have to deal with the day to day visitor flows and their effects on natural assets which, if uncontrolled, can lead to adverse negative or even irreversible impacts on physical or wildlife sites (notwithstanding the unpredictable extreme events that inevitably occur). The indicators identified through the LAC process should reflect a relationship to the amount and/or type of use occurring and be potentially responsive to management actions. Indicators should be measurable, reliable, informative and sensitive, relevant, and cost-effective. Indicators may be *biophysical* (effects on wildlife or physical formations) and/or *social* depending on the attraction[1].

Identifying key indicators to enable assessment of visitor effects can allow for proactive application of management action, and the development of early warning systems as pressure mounts on various sites due to increasing tourism growth. These effects will likely depend on the frequency, intensity and/or timing of individual and group visits on specific sites. Each site may have a unique set of conditions and *specific indicators* that require monitoring, posing different challenges in managing between sites and in assessing the acceptable limits of change at a local or site level (the *'bottom up*' approach'), and at a larger scale.

Cumulative impacts on a regional basis from increased tourism flow and volume patterns may influence the return time of negative impacts on local sites, and therefore *generic indicators* are also a key in assessing the regional impacts of increasing visitor numbers (the '*top down*' approach). An example of this interaction between the two approaches would be cumulative impacts at many local caves (such as the level and distribution of mud accumulation on cave formations as an indicator of increasing visitor pressure) leading to strategic regional planning for the allocation of some caves, and/or cave passages, for visitor access, and some allocated for future generations to see in an unmodified, pristine state.

Study aims and objectives

This study examines the interaction of visitors with different attractions at a range of scenic *icon* sites (i.e., well-known physically scenic attractions), wildlife sites, and cave ecosystems on the West Coast of the South Island. We aimed to explore and catalogue the effects of different visitor activities on these assets, and to identify indicators of environmental change in relation to the effects of these activities. We also analysed which site indicators are also more widely applicable at the generic level for management of other scenic *icon*, wildlife, and cave sites.

Because DoC are the major provider of tourism assets on the West Coast, and all but one of the attractions selected in this study are managed by DoC, we examined processes involved in the management of visitor activities and their effects, and the indicators that are, or could be used, to determine acceptable levels of environmental change. We also compared the

1 There is a tendency to separate out these two types of indicators and treat them as independent. However a strong case can be made for their interdependence as visitor attitudes, experiences and behaviour all interact with the environment (impacts to sensitive cave ecosystems provide a highly visible and often graphic example of this interaction).

management of seabirds at an ecotourism operation on private land with public management of seabirds at two sites.

Accordingly, to address the aims of this report, the specific objectives were:

1. To collect and analyse a range of ecological and management information at each attraction site to develop robust and relevant generic and site specific environmental indicators of the effects of tourism activities;

2. To postulate and test a relationship between tourist numbers and activity, and effects on particular indicators for each of the main attractions; and

3. From the above, to develop generic and site specific guidelines that will aid managers in devising approaches to set the desired conditions, or limits of acceptable change, at these types of sites.

Chapter 2
Tourism and Environmental Effects at Key Attractions

2.1 Methods

2.1.1 Site Selection

We selected a range of different attraction types that were spread throughout the West Coast, and that were also well represented in different parts of New Zealand. This meant that any generic indicators of environmental change identified could also be applied elsewhere. We selected sites that were potentially sensitive to different types of visitor activities, and that varied in their resilience to disturbance and visitor impacts. We selected two scenic *icon* sites, three *wildlife* seabird sites, and three karst *caves* throughout the West Coast region (Figure 1). These sites also differed in the main user type, or ROS (Recreational Opportunity Spectrum) descriptions of visitor groups (after Driver and Brown, 1978; Clark and Stankey, 1979), with the *icon* sites being *Short Stop Traveller* sites, whereas the wildlife and cave sites are predominantly *Day Visitor* sites (DoC, 1996).

- The scenic *icon* sites we selected are two of the most popular sites on the West Coast: **Lake Matheson** in south Westland and the **Pancake Rocks** at Punakaiki in Buller[2].
- The *wildlife* sites we studied are:
    1. **Monro's Beach** in south Westland where there is a seasonal breeding colony of the threatened Fiordland crested penguin (*Tawaki - Eudyptes pachyrhynchus*)[3].
    2. A breeding colony of the abundant and widely distributed Sooty Shearwater (*Titi* aka Muttonbirds - *Puffinus griseus*) at **Mt. Oneone**, which is at the coastal end of the Wanganui Coastal Pack Track near Harihari in south Westland.
    3. A seasonal breeding colony of the endemic and threatened Westland black petrel (*Taiko - Procellaria westlandica*)[4] on private land at **Punakaiki** in Buller, where the landowners have been actively managing the colony for conservation and tourism.
- Site visits to karst *cave* ecosystems occurred at the publicly accessible **Fox River Caves** and the **Punakaiki Cavern**, and with the sole concessionaire at **Xanadu Cave**, all close to Punakaiki.

2.1.2 Data collection

All sites were visited at least once over the summer 1999/2000, and for each attraction we interviewed managers and/or biological experts, and reviewed literature from management of

2 Broadly, *Buller* is the area from Punakaiki north on the Paparoa coast, and north of Ikamatua in the Grey Valley and Springs Junction in the Maruia Valley; the *Grey District* encompasses the lower Grey Valley and the Greymouth area; *south Westland* is the area from Hokitika south to Haast.

3 The Fiordland Crested penguin is ranked as a Category 'B' threatened species (Molloy and Davis, 1992) and has a high management priority as populations have suffered severe recent declines (Russ *et al.* 1992; Van Klink, 1999).

4 The Westland black petrel is also ranked as a Category 'B' threatened species (after Molloy and Davis, 1992), and its current status is described as vulnerable in the draft Taiko Recovery Plan (DoC, 2000).

similar types of attractions. We adopted different approaches at the scenic *icon* and seabird sites compared to the caves.

For the scenic *icon* sites and the seabird sites we devised graphical *tourism-effects* models to explore the relationship between visitor activities and the effects of those activities (sections 2.2 and 2.3). We adopted this approach to examine how management has affected and/or ameliorated the effects of increasing tourism numbers at these sites. At one seabird site (Monro's Beach) we also collected data on visitor behaviour. On the West Coast, most activities outside the towns are primarily based around walking and passive viewing of wildlife, and the scenic beauty, of the region. Therefore, the effects of walking and viewing activities at scenic *icon* and seabird sites could have some application to other attraction types throughout New Zealand[5], which may also share these activities although the primary activity focus could be quite different[6].

For the cave sites, we adopted a different approach to assessing the management of the limits of acceptable environmental change, based primarily around a synthesis of the extensive cave impact literature, interviews with cave managers, and site visits.

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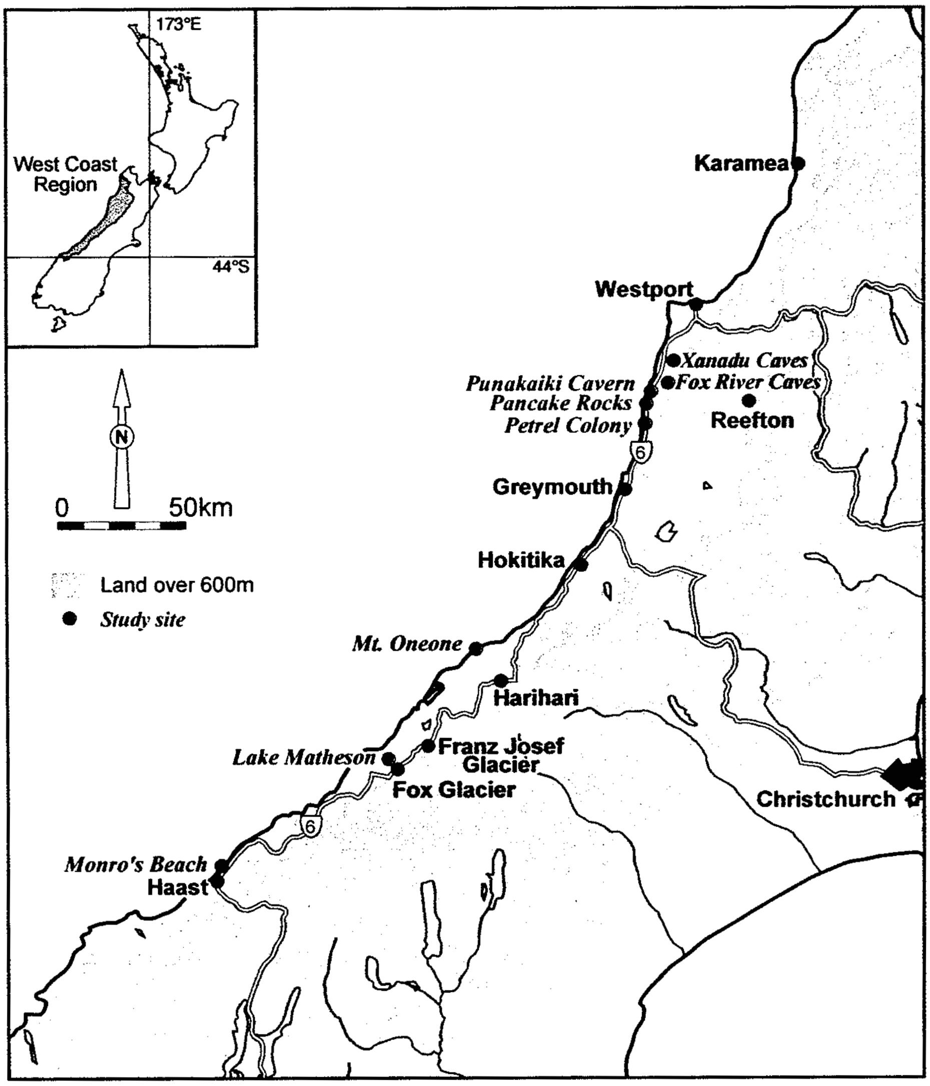
5 Generic and site-specific environmental indicators of the effects of visitor activities developed in this study, are linked into an attraction-based classification of natural assets in New Zealand in an accompanying paper (Ward, Hughey and Urlich, 2000).

6 For example, in other parts of New Zealand, activities such as swimming (e.g., with dolphins or seals), diving (e.g., beaches, marine reserves), boating (e.g., whale watch, fishing charters), or thrill seeking (e.g., bungy jumping) are more prevalent.

Figure 1
Map of the West Coast and the Locations of the Study Sites.



2.2 Scenic Icon Sites

2.2.1 Location and Description

Site 1: Lake Matheson at Fox Glacier, south Westland (43°, 26'S, 169°. 58'E) is one of the scenic taonga of New Zealand, its quiet reflective beauty formed by past glacial action thousands of years ago offers visitors a special experience (*Plate 1*). Close to 100,000 people visited Lake Matheson in 1999 (Table 1), with visitor numbers peaking between November and April. Along with the nearby Fox and Franz Josef Glaciers, it ranks as one of the most popular tourist sites in Westland. It receives all types of visitors, including those on organised coach tours and backpackers.

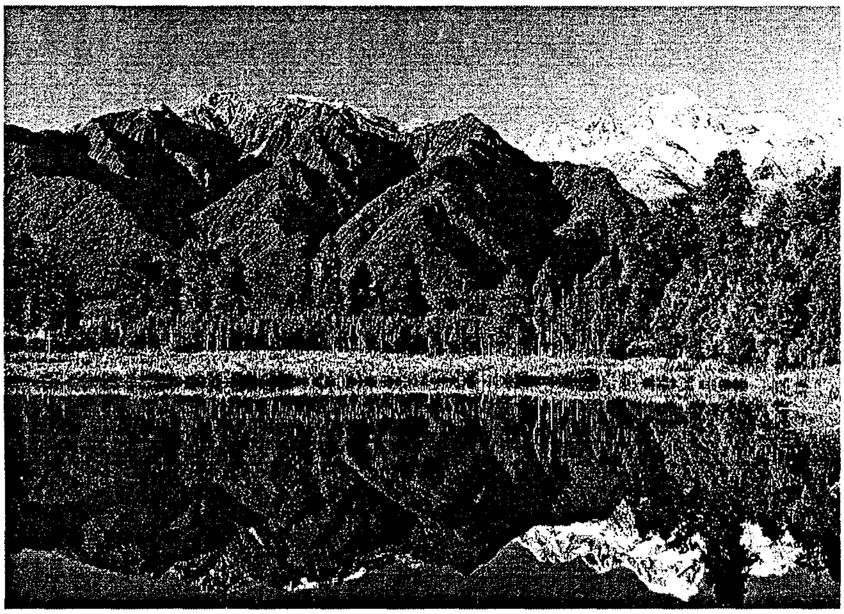


Plate 1 - Lake Matheson (DoC Fox Glacier).

Site 2: Punakaiki Blowholes and Pancake Rocks at Dolomite Point (42°, 07'S, 171° 19.5'E) is the key tourism site in Buller (*Plate 2*). It is situated close to the karst-dominated 30,000 ha Paparoa National Park. The Pancake Rocks are an outstanding natural geological feature formed by the gradual dissolving of limestone and mudstone seams to form layers of resistant, hardened limestone (Coates and Laird, 1988). The associated spectacular blowholes were formed by the collapse of limestone caverns to form funnel shaped depressions or sinkholes (*ibid*). It is a key site in Buller socially and economically, with the local economy reliant on visitor traffic to employ local craftspeople, shop owners, hospitality and service sector workers, conservation officers, and eco-tourism operators.

Both Lake Matheson and the Pancake Rocks received substantial upgrades of facilities in 1999/2000. These upgrades were a direct management response to increasing visitor impacts on the sites[7]. The sites are visibly well cared for and the standard of the facilities at both sites is of high quality. In this respect, the ongoing impacts of tourists can be measured by DoC's projected frequency and intensity of management, in maintaining and upkeeping visitor infrastructure to a standard that can safely handle existing demand and projected capacity. We investigated the management processes involved in ongoing site management, individual project management related to the infrastructural upgrades, and the processes involved in

[7] For Punakaiki – personal communication Calvin Jose, Visitor Services, DoC Westport 8 February 2000. For Lake Matheson – personal communication Kingsley Timpson, DoC Fox Glacier 4 February 2000.

prioritising capital and labour expenditure between front country and back country sites in the south Westland and Buller areas over time.

Plate 2 - Punakaiki Pancake Rocks (V. Johnson).

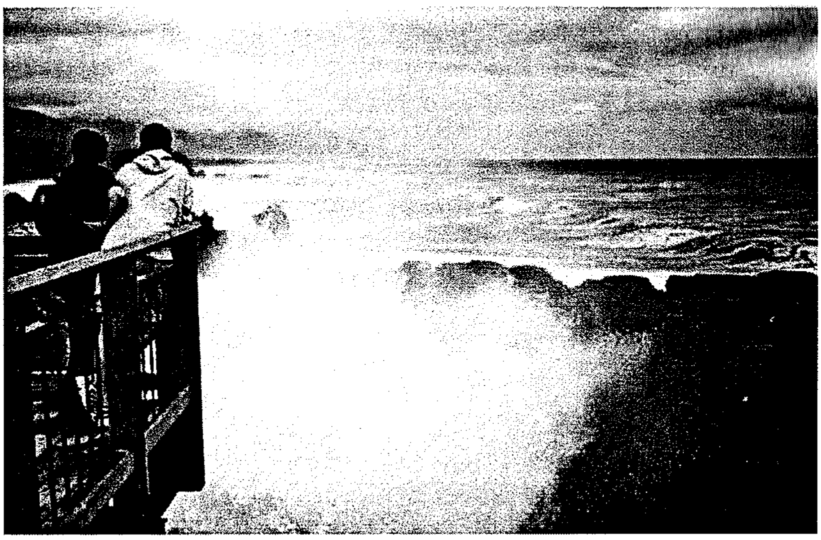


Table 1
Number of Visitors at All Study Sites on the West Coast in 1999

Location	Site	No. Visitors	Year	ROS Class
South Westland	Lake Matheson	96,560	1999	SST, DV
		105,373	1998	
		101,997	1997	
	Monro's Beach	8,000	1999	DV
	Wanganui Coastal Pack Track	5,000 (est)*	1999	DV
Buller	Punakaiki Pancake Rocks	450,000 (est)**	1999	SST
	Punakaiki DoC Visitor Centre	151,575	1999	SST
		146,698	1998	
		145,095	1997	
	Fox River Caves	10,000 (est)**	1999	DV
	Cape Foulwind	70,374	1999	SST, DV

* Estimate supplied by Rob McCallum - DoC Franz Josef 22 May 2000.

** Data supplied by Murray Thomas – DoC Punakaiki 12 May 2000. At the Pancake Rocks, the recently installed electronic counter was not functioning correctly. However an informal survey by staff at DoC Punakaiki estimated that three times the number of people visit the Pancake Rocks than the nearby DoC Visitor Centre across the road.

Table 1: No. visitors at all study sites on the West Coast in 1999, and the preceding two years where available (source: DoC). Figures determined by track counters at the scenic *icon* sites and Monro's Beach, so the margin of error is liable to be of the order of +/- 10%. *ROS* classes are Recreational Opportunity Spectrum classes used to categorise visitors in DoC's Visitor Strategy (1996) (i.e., SST = Short Stop Traveller, DV = Day Visitor).

We worked closely with DoC in examining management at Fox Glacier for Lake Matheson and at Westport and Punakiki for the Punakaiki Pancake Rocks. We also visited the sites to view the nature of the upgrades and the impacts on the environment. In addition, we carried out a social survey of visitors to the Pancake Rocks to gain an understanding of visitor responses to the management of the site to further investigate the limits of acceptable environmental change at the site (see Johnson *et al.*, 2001).

2.2.2 Hypothesis of Visitor Impact Management

We devised a graphical *tourism-effects* model that attempts to capture the frequency and intensity of management at scenic *icon* sites in response to visitor impacts (Figure 2). The *narrowing staircase* is a hypothesis to describe the relationship between growth in visitor numbers and their cumulative impacts, and the rationale of projected environmental gains and resource savings behind the substantial management upgrades that recently occurred at both Lake Matheson and Punakaiki.

Visitor impacts could take a number of different forms. Cumulative visible impacts could be evident in the gradual and visible degradation of the site itself, the deterioration of site infrastructure, and/or negative changes to visitors perceptions of natural character as a result of the management history. Alternatively if the site is visibly well managed and maintained, visitor impacts can be evident in the amount of management resources invested, and the opportunity costs of increasing frequency of management.

Figure 2
Model of Management Response to Visitor Impacts at Icon Sites

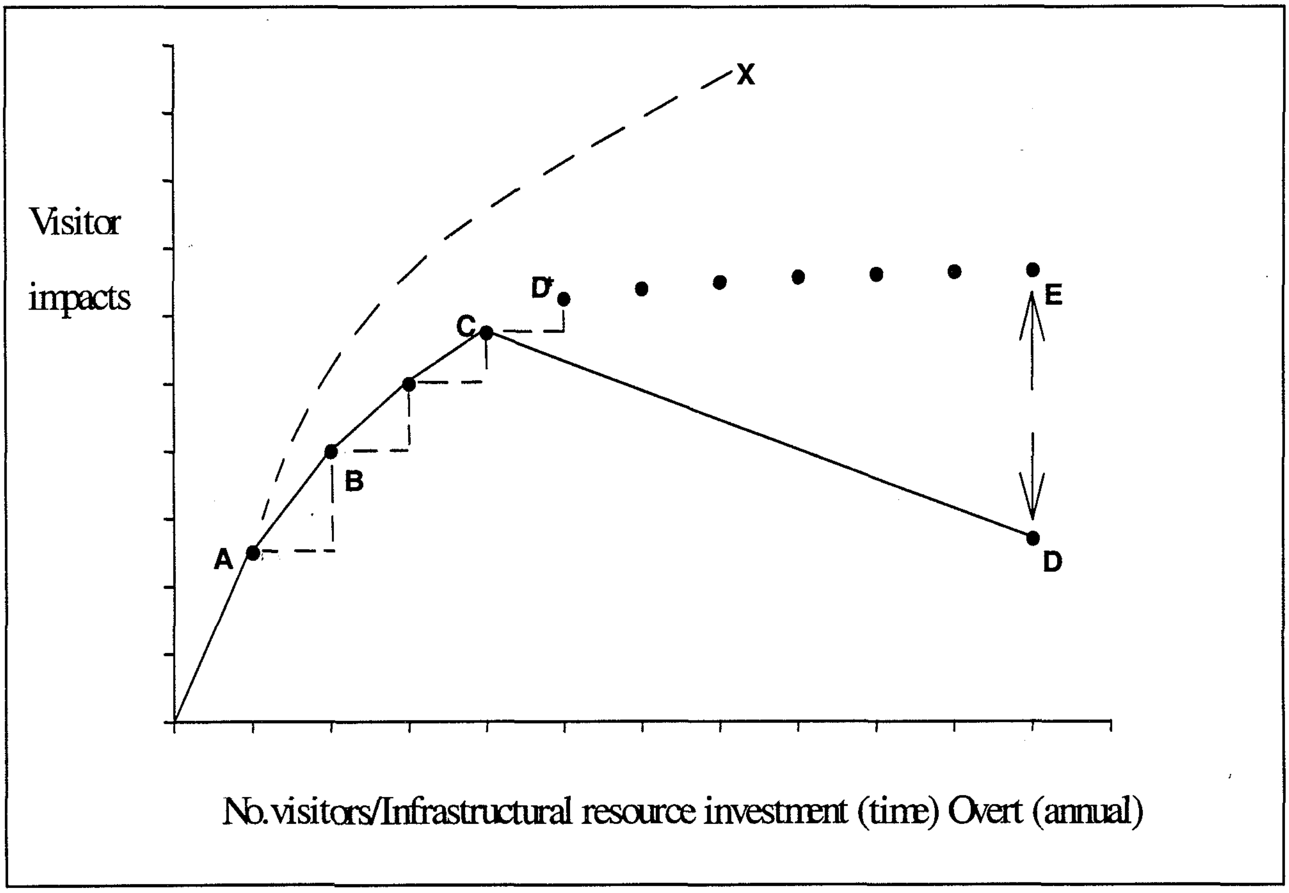


Figure 2: The *narrowing staircase* model of management response to visitor impacts.

The impact pressures of increased visitor density, frequency and/or intensity of visits are measured by the ratio of infrastructural resource investment expended to alleviate environmental effects and to increase site resilience, to cater for visitor growth. The distance from point D to point E represents the theoretical resource savings following a substantial infrastructural upgrade at the time of point C. If the upgrade did not occur at point C, more frequent infrastructural resource investment would occur (D*-E) to mitigate environmental effects of visitors, without increasing the site's capacity or resilience to disturbance over the medium/long term.

There are several assumptions inherent in the *narrowing staircase* model. Once the original opening of the site occurred in terms of the initial infrastructural development at time (*t*) a base, or fundamental, level of impact was sustained (point **A**). If there was no preventive management action at this time to accommodate the increasing visitation, the trajectory of the site could eventually have moved to point **X** (high level of visible degradation) over time with uncontrolled visitor access and lack of visitor facilities.

This presumably did not occur as historical management action occurred, although the model suggests these were taken at increasingly shorter intervals (the *narrowing staircase*) up to points **B** and **C**, in response to increased visitor pressure on tracks and facilities as the site's popularity grew. The frequency at which historical management increased is marked by the decreasing narrowness of the staircase between points **A-C**, as old tracks, or boardwalks, deteriorated more quickly following growth in increasing visitor density over time. In this sense the ratio of infrastructural resource investment to the cumulative pressure of growth in visitor numbers increases, as represented by the decreasing spacing between the black dots over time from **D*** to point **E**. Point **C** represents the point where the decision was made to undertake a substantial infrastructural upgrade in *1999/2000*.

The hypothetical jump to point **D** represents an acceptance that a substantial increased level of management and resource investment is needed to mitigate and remedy environmental impacts from increasing visitor numbers in the future. The tradeoff is that new infrastructure could result in long-term savings on maintenance, management time, opportunity costs, labour and capital costs. This long-term management resource gain is represented by the arrows in the gap between points **D** and **E**. An additional benefit of this asset overhaul is that the expected life of the asset can be prolonged with immediate and ongoing maintenance, also allowing resources to be freed up for less-intensively visited sites in the area. If the infrastructural upgrade did not take place, the model predicts the ongoing investment in resources (capital/labour) devoted to the site would be consistently frequent and probably heavy in the mid-term. This is represented by the distance between points **C** and **D***, for example, year by year replacement of existing boardwalks at Lake Matheson, or small-scale asphalt repairs at the Pancake Rocks (the narrowing of the management staircase to point **E**). The levelling off of the visitor impact curve from **D***, reflects the deterioration of different sections of the infrastructure after heavy visitor use. In this sense management would become reactive as frequent small-scale upgrades occur to repair different parts of the infrastructure at different times.

2.2.3 Testing the Model at Lake Matheson – Indicators, Projected Visitor Demand and Rationale for Infrastructural Upgrade

Work on the substantial upgrade of the Lake Matheson visitor infrastructure began in mid-1999 with the removal and replacement of the boardwalk track with a hardfill surface (*Plate 3*), and was completed in April 2000 with the placement of new interpretation boards. This involved the expenditure of around $300,000[8] on the replacement of the pre-existing boardwalk track with a hardfill surface, and the construction of new facilities such as bridges, culverts and scenic viewpoints (*Plate 4*). This was the culmination of an extensive planning, consultation and design process that was initiated three years before in 1996 after the condition of parts of the existing infrastructure deteriorated.

Plate 3 - New hardfill track at Lake Matheson installed in 1999 (DoC Fox Glacier).

Plate 4 - Infrastructural upgrade at Lake Matheson with new jetty scenic viewpoint (J. Ward).

The heavy investment in capital and staff time was triggered by several *indicators* of visitor effects, that included *deterioration* of parts of the boardwalk and *negative* public feedback, and these were confirmed by regular on-site management inspections. The desire of the management team at the Fox Glacier DoC Area Office was to have infrastructure of international quality, as Lake Matheson is a significant asset locally, regionally, and nationally in respect of cultural and economic importance. Therefore, they aimed for a consistently high standard of upgrade to accommodate existing and projected visitor demand. The upgrade included replacement of the swing bridge over the lake outlet, rebuilding of the jetty observation point, and the construction of hardfill track around the entire 3-4 km circumference of the lake. Building capacity to accommodate visitor growth also reinforces the advocacy gains of a visibly well-managed site, thereby serving to emphasise the *kaitiaki* (stewardship and guardianship) role of DoC.

There was a series of steps involved in the decision process to upgrade and secure the necessary funding. Firstly, projections of growth in demand were made on the current state of the infrastructure. These were based on two figures: a two per cent and a five per cent

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8 Costs provided by Tony Preston, Visitor Services Manager, DoC Fox Glacier, south Westland.

increase in visitor numbers every year for the next 30 years from 1997[9] (T. Preston, pers comm). Replacing the boardwalk with hardfill track on the poorly drained soils in such a high rainfall area was a difficult decision. However, the visitor projections showed that pressure on facilities would increase, resulting in the progressive deterioration of old sections of boardwalk, thereby requiring ongoing yearly maintenance and frequent minor upgrades. The decision criteria for evaluating hardfill over new boardwalk was based on a balance between quality of visitor experience, environmental impact and cost (both capital and ongoing maintenance). The hardfill option was taken due to excessive cost of new boardwalk (approx $300/m – hard fill was $60/m) and the better visitor experience that the hardfill track provides (T. Preston pers comm). Although impacts of the hardfill track were higher at time of construction than replacement boardwalk they were mitigated to an acceptable level through appropriate track construction techniques, monitoring and close supervision by the project management team.

The need to keep the site in functional condition would have necessitated an ongoing commitment of substantial management resources devoted to one, albeit important, site. This would also tie down significant resources in the long term to this site, in an area where there are many other visitor facilities in the front and back country that need to be managed. In contrast, constructing a hardfill surface at Lake Matheson meant that a consistently high standard of track could be attained, and by using a lot of resources now, the management team anticipated resources (capital/labour) would be freed up for future projects in different areas (Kingsley Timpson, pers comm).

The next step was the completion of a project proposal that involved the formal completion of an Assessment of Environmental Effects (AEE), along with planned mitigation methods during the construction of the infrastructural upgrade. At this point, close liaison within DoC between the Visitor Services staff and Technical Support specialists occurred to identify sensitive areas affected by the proposed development, and in particular wildlife species and habitat such as the wetland in the eastern corner of the lake. The benefits of the proposed development were then assessed and weighed against environmental risks before being submitted to the DoC Regional Conservator for approval. This approval is necessary before the process of getting support for funding can commence.

Following the securing of Conservancy support, formal project management began with site design, public consultation, and application to the Southern Regional Office of DoC in Christchurch for funding from the (now finished) Green Package. A portion of the funding also came from the DoC Fox Glacier Area Office's core funding[10]. The design and consultation phase is a type of Limits of Acceptable Change (LAC) process in the sense that the proposed project needed social and tourism industry support. However, because it involved the replacement of existing infrastructure rather than a whole new development, the desired environmental and social outcomes were reflected in a 'design with nature' approach. The design approach was in keeping with the natural features of the area, for example, glacial outwash rocks were used in the construction of stone bridges over flood culverts in side creeks (*Plate 5*).

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9 Projections were made from 1997-2027. From a base of 97,000 visitors in 1997, at a two per cent increase p.a visitor numbers would rise to 118,242 in 2007, 144,137 in 2017 and 175,702 in 2027. At a five per cent increase p.a projected visitor numbers would reach 158,003 in 2007, 257,300 in 2017 and 419,228 in 2027.

10 DoC's core funding for recreational facilities on the West Coast is $3.5 million per annum out of a total West Coast budget of around $10 million (Steve Addison, DoC Media Spokesperson, 26 May 2000).

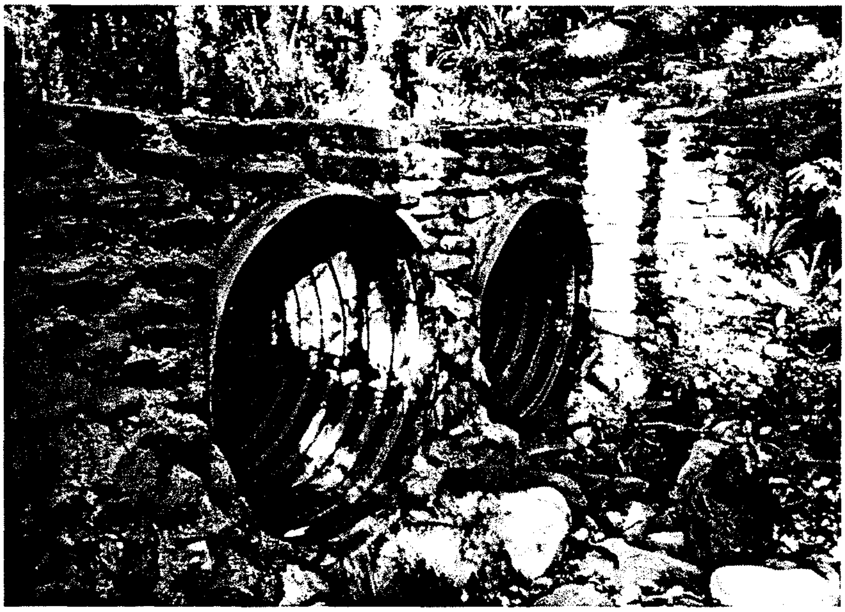

Plate 5 - Design with nature approach along Lake Matheson track (DoC Fox Glacier)

Although there was significant expenditure of several hundred thousand dollars, the savings of resources over the long term whilst effectively managing visitor impacts reflects the assumptions of the *narrowing staircase* model devised in Figure 2. The long-term savings made in management and resource investment are projected by DoC to be similar to the gap between points **D** and E, as the upgrade has resulted in an expected asset life of at least 12 years, so long as annual maintenance tasks are carried out.

The actual amount of savings made over the next 12 years may be difficult to accurately cost. However, the reduction of frequent (yearly) small-scale upgrades should theoretically more than compensate for the capital expenditure of the recent upgrade in the mid-term, barring stochastic events such as landslides or earthquakes[11]. Furthermore, to prolong the asset life, maintenance has immediately commenced, and is programmed to be ongoing and comprehensive each year. For example in the 2001 financial year, 360 labour hours are programmed for site inspections, monitoring, vegetation management, drainage work and surface maintenance. This not only prolongs the upgrade gains; advocacy benefits are gained by a well-presented and maintained site in difficult climatic and soil conditions, and this is reflected in an increased level of financial donations at the site (T. Preston, pers comm). Moreover, the freeing of resources for other projects is occurring in the south Westland area with methodical and well-planned back-country hut and track maintenance now being undertaken. DoC Fox Glacier are heading in the direction away from periodic upgrades to maintaining their assets to prescribed standards; for example, DoC have a management strategy with clear Track Service Standards (1998*a*) and Hut Service Standards (1998*b*). The completion of a number of key upgrades in the Fox Glacier Area means DoC are now able to concentrate resources on programmed maintenance.

Outcomes from the upgrade - indicators of environmental impacts

Clearly management has responded to a range of factors such as deterioration of site infrastructure and social feedback. However, the upgrade at Lake Matheson has taken place in the background context of a nation-wide programme of asset evaluation, and as part of a strategic approach to manage all visitor sites to prescribed standards.

Once these sites have been systematically upgraded to a standard where visitor safety and visitor experiences are well catered for in the long term, these assets are placed on a regular

11 Contingency planning and capacity for infrastructural repair should be part of the overall south Westland management programme, as the periodicity and effects of major movements along the Alpine Fault are becoming better known (Wells, 1998; Wells et al. 1999). Although these events are not 'unforeseen' there will obviously be more key health and infrastructural priorities to attend to following a disastrous quake.

scheduled maintenance programme. This entails each asset being placed on a cycle for planned upgrades, so that each year one or two different key sites come up for project management reviews and infrastructural upgrades. This allows managers to develop annual asset management plans for allocating resources to different work plans depending on which stage of the planning cycle each asset is at. For example, in 2005/2006 a track resurfacing of the hardfill is programmed at Lake Matheson as a follow-up to the track upgrade, and in 2011/2012 the site is programmed for another resurfacing follow-up. After this is completed the track should only require resurfacing every 10 years so long as programmed maintenance tasks are carried out. The biggest threat to the condition of the track is if programmed maintenance tasks are not carried out to counter the cumulative impacts of high-levels of visitor use.

DoC now have all their assets throughout New Zealand on a national database called VAMS (Visitor Asset Management System). Information on what work has been done to assets at different times will be contained on VAMS. Data on particular asset types such as the timing and nature of scenic *icon* site upgrades can be evaluated in and between different conservancies. However, VAMS cannot do that yet, but it is DoC's intention to develop this as a tool in the next few years (T. Preston, pers comm).

In respect of the Lake Matheson upgrade, several biophysical indicators emerged from the process to aid managers of similar types of sites to monitor environmental effects caused by management. These include:

- growth and survival of restoration plantings;
- recovery of old and abandoned tracks;
- exotic weed distribution and abundance; and
- erosion.

There may also be indicators that emerge following a formal project management team debrief after completion of the infrastructural upgrade. For example, evaluation could occur in the following areas with an aim of refining the process and disseminating the lessons/gains to other conservancies:

- During construction and following completion of the upgrade, the assessment of environmental effects should be reviewed to see how foreseen and unforeseen problems and issues were dealt with.
- Similarly, the design and consultation process should be evaluated to see if the final product was consistent with the limits of acceptable environmental change devised in the planning cycle.
- This process should also include how visitors were affected by the construction process, along with the effectiveness of measures to minimise visitor inconvenience.
- This would form part of an overall review of staff and contractor performance and could be done in tandem with a review of budgetary outcomes, to identify in which areas savings were made, or in which areas costs overran the budget.

2.2.4 Testing the Model at Punakaiki Pancake Rocks

A similar process to that at Lake Matheson also occurred at Punakaiki in terms of a major infrastructural upgrade. Managers at DoC Buller undertook to upgrade the track and visitor infrastructure to a consistently high quality of international standard. This goal or outcome was identified as being necessary to accommodate the substantial flow of visitors and to ensure there was capacity to cater for future growth.

The desire to upgrade the standard of facilities was more a recognition by DoC that Pancake Rocks is a key site, rather than a direct response to visitor impacts (Murray Thomas, pers comm). Nevertheless, three years ago the process of undertaking the upgrade commenced following analysis of different social and environmental indicators. Primarily, concerns over *visitor safety* at the site were identified. The site is exposed to extreme westerly weather conditions. Visitors were going off the track system and climbing over rock formations in an attempt to get photographs thereby placing themselves at risk in sometimes poor weather conditions. The sensitive rock formations, and coastal vegetation (including locally rare *Euphorbia glauca* and *Lepidium flexacaule* - Murray Thomas, pers comm) along the tracks and on the rock surfaces were also subject to *disturbance* from visitor behaviour off the tracks. There was also a pressing need to replace parts of the asphalt track which had *deteriorated* and broken up in places, due to the heavy use from around half a million visitors each year. Therefore, site inspections were an important tool in assessing indicators of environmental impacts.

The expenditure of over half a million dollars (Table 2) involved extensive landscape construction of stone walls, a bridge and asphalting the track around Dolomite Point (*Plate 6*). Widening of State Highway 6 to allow for more parking outside the track and safer entry from the highway has led to improved visitor safety, access and capacity at the site, although people still have to cross the highway to reach the rock formations. There are plans to redevelop the entrance and address the need for further parking.

Table 2
Financial Cost Breakdown Of The Recent Infrastructural Upgrade At The Pancake Rocks In Punakaiki (Source: Doc Buller).

Infrastructural Component	Cost
Design Concept	\$30,000
16 metre swing bridge	\$50,000
Viewing Sites and Safety Barriers	\$204,000
Interpretation	\$45,000
Regrading and Sealing track	\$85,000
New Entrance Structure	\$70,000
Subtotal	\$484,000
Estimated Staff Hours 1000* @ \$50 hour**	\$50,000

* Estimate of staff time from Murray Thomas, DoC Field Centre Punakaiki. 7 February 2000.
** Estimate only

Plate 6 - Punakaiki Pancake Rocks: inftrastructural upgrade – landscape reconstruction (V. Johnson).

The assumptions of resource gains over the long term made in the *narrowing staircase* model of visitor impacts are also applicable to the Pancake Rocks. As with Lake Matheson, historical financial management data were not available at the individual site level for Pancake Rocks with regard to the frequency and cost of previous upgrades or maintenance. So aside from the actual budgeted financial cost of various components of the most recent upgrade itself (Table 2), there are only estimates of labour spent in individual projects such as this one. This inability to accurately determine the labour costs of individual project management means that the actual cost of these upgrades is unknown, and therefore efficiencies are difficult to identify. In part, this is due to DoC management of discrete areas within regions, so that all the tracks and sites in the Punakaiki area are bulk-funded financially, rather than broken down to individual budgets for each track or site such as the Pancake Rocks or the Fox River Caves Track. However, this appears to be a sound approach when there are many tracks, huts, bridges and visitor facilities to manage over a wide area. It enables managers to have the flexibility with cost allocations to respond to stochastic events on natural assets, which are a common occurrence on the West Coast due to the high rainfall and constant disturbances in the landscape. The tradeoff is that there is a risk that the high-use scenic *icon* sites can disproportionately capture large chunks of the available resources, due to the high-density effects of constant visits to these sites.

The key outcome, therefore, in terms of management at these *icon* sites, is the freeing up of resources to address less well-visited sites in the back country. However, this is not yet happening in the Buller region, as there are several *icon* sites such as the Truman Track and Irimahuwhero Point that have yet to be upgraded due to limited resources. There are two other major *icon* sites in Buller that also place heavy demands on available resources, due to constant heavy visitor demand and cumulative impacts on site infrastructure. For example, the Cape Foulwind seal colony near Westport has recently undergone a $200,000 upgrade, and the Heaphy track from Karamea is currently being resurfaced in places (Calvin Jose, pers comm).

Design and construction

The facilities at Punakaiki are well-designed and constructed, with efforts made to ensure that the landscape design used a '*design with nature*' approach (*Plate 7*).

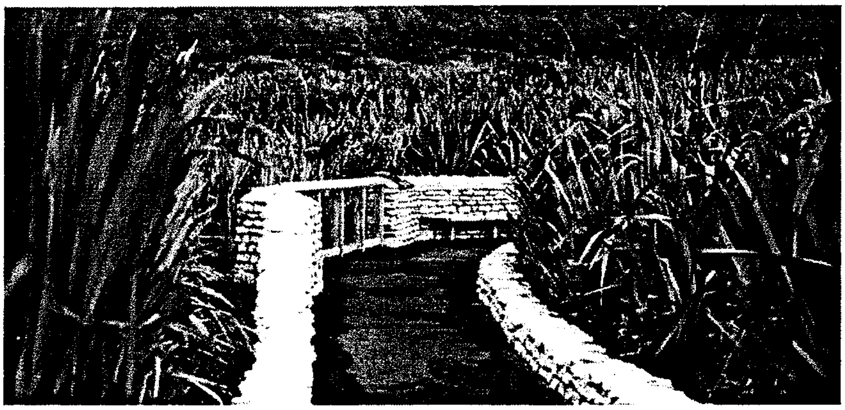

Plate 7 - Design with nature at Punakaiki with the newly constructed facilities (V. Johnson).

This is in sympathy with the *natural character* of the site[12]. Comments from visitors to the site following the implementation of the design were generally of a positive nature (see Johnson *et al.*, 2001). This is reflected in donations at the site being double that of projected budgets for the last two years, as some visitors show appreciation for their experience in a financial manner (M. Thomas, pers comm).

Indicators of visitor effects at Punakaiki that are additional to those identified at Lake Matheson include:

- Condition and abundance of rare plant species.
- Footprints off tracks and over barriers.

2.2.5 Summary

We developed the *narrowing staircase* model to examine the relationship between visitor impacts and the investment of resources in management of visitors over time at scenic *icon* sites. We tested the model at two sites on the West Coast at Lake Matheson and Punakaiki over the summer 1999/2000 period. The model supports the approach that DoC are taking on the West Coast to upgrade the assets under their management to prescribed standards. Long term resource savings are projected as assets that are being brought on to regular management cycles, although cost savings have yet to be accurately quantified and clearly demonstrated.

The design approach of each upgrade was developed to be sympathetic to, and in keeping with, the natural character of the site. In this sense they are managed within their limits of acceptable environmental change (LAEC). Environmental impacts and indicators of visitor effects are summarised in Box 1, along with management guidelines with respect to LAEC. Negative social behaviour can also impact on sites through vandalism, and on species from litter encouraging rodents, or by direct physical damage to rare plants. In this respect we see a close connection between visitor behaviour and ecological effects, although impacts can be moderated with education through good interpretation and well-maintained facilities.

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[12] A review of the cultural and ecological dimensions of the term *natural character* are discussed in Urlich and Ward, 1996 and references therein. More recent work by Stephens (1999) defines *natural character* solely in terms of the integrity of indigenous ecosystem processes.

Asset:	Physical - Scenic *icon* sites.
Activities:	Walking, viewing, picnicking.
Impacts:	Site infrastructure deterioration, trampling of rare plants, weed invasion, litter, vandalism, erosion.
LAEC:	Build capacity using *design with nature* approach to facilities management in keeping with the natural character of the site. Maintain existing ecological assemblages/processes.
Guidelines:	Provide quality visitor experience by high standard of visitor facilities and appropriate interpretation; identify and monitor key physical and social indicators of site health. Site restoration where necessary and appropriate.
Indicators:	Condition of restoration planting, recovery of old tracks, health and abundance of rare native species, distribution and abundance of weeds, footprints and erosion off tracks, visitor feedback, litter.

Box 1: Summary of impacts from visitor activities and indicators of acceptable environmental change at scenic *icon* sites (*Asset classification from Ward et al., 2000*).

2.3 Seabirds

There are many factors that influence the viability of seabird colonies in New Zealand. These include seasonal and long-term food supply fluctuations, driven by oceanic and climatic processes, which may result in variations in the numbers of birds at any one time. Other processes may be localised such as disturbances (disease, landslides) which may periodically impact on one or several colonies at different times. However, by far the greatest influence on the sustainability and long-term persistence of breeding populations on the mainland is the uncontrolled effects of mammalian predators (NZ Biodiversity Strategy - DoC and MfE, 2000). The abundance and diversity of predators such as stoats, cats, dogs, rats and the marsupial possums can mean little respite from predatory encounters for seabirds such as the Westland petrel, sooty shearwater and Fiordland crested penguin in the egg, chick, fledgling and adult phases on land. Oceanic predators such as sharks and seals also take their toll on adult Fiordland penguins, and fishing trawlers cause adult Westland petrel mortality (Murray *et al.*, 1993; Freeman, 1997).

2.3.1 Seabird Sites – Location and Description

Site 1: Fiordland crested penguin colony (*Tawaki*), Monro's Beach, south Westland (43°, 42'S, 169° 15'E). The threatened Fiordland crested penguin (*Plate 8*) shares the dubious honour of being one of the rarest penguins in the world along with the other threatened South Island penguin, the *hoiho* or yellow-eyed penguin (McLean, 1995; Heather and Robertson, 1996). The main nesting sites of the Tawaki are in the South Westland World Heritage area, Stewart Island and predator-free Codfish (Whenua Hou) Island. Pairs nest under tree roots, in hollows, cavities and under overhanging rocks on bluffs and low down on cliff faces

(Coates and Coates, 1993). The timid, shy birds are sensitive to disturbance by people and are vulnerable to predators on the mainland (McLean, 1995; Van Klink pers comm). This species has declined since European settlement. The explorer and conservationist Richard Henry (1903) observed there were 'thousands' at Dusky Sound, and the ornithologist Robert Falla also noted their abundance in the early-mid part of last century (cited in McLean, 1995). Although information is incomplete on current population numbers and dynamics on the mainland, at least 1500-2500 pairs were known in the mid-1990s (McLean, 1995; Heather and Robertson, 1996).

Plate 8 - Fiordland crested penguins (Tawaki) at Monro's Beach (P. Van Klink).

Access to Monro's Beach is by a well-constructed and maintained track that winds through bush from the State Highway 6 carpark for two km. Although there are two interpretation signs that seek to inform and direct visitor behaviour to be sensitive to the penguins, the emphasis at the beach is on visitors being responsible and self-managing. However, there are no visitor facilities at the beach such as toilets or bird hides for visitor comfort, despite coachloads of visitors arriving at the site (*Plate 9*), even in poor weather conditions which are common along this westerly exposed coastline. Visitors therefore freely roam the beach and are often visible to the penguins as they make their way between the ocean and their nest sites in the bush clad bluff at the head of the beach (*Plate 10*).

Plate 9 - Tourist bus and campervans on a rainy November day at Monro's Beach (J. Ward).

Plate 10 - Fiordland crested penguins commuting to their nests in the coastal scrub (P. Van Klink).

Potential direct disturbances from visitors on the penguins at Monro's Beach are seasonal with the birds sensitive to adverse effects during the breeding season. The penguins breed between July and November and this is when they spend most time ashore, although between January and March they also come ashore to moult. They frequently move between the sea and their nests across the beach to feed their young (Reilly, 1994; McLean, 1995). These disturbances may lead to reluctance to come ashore after foraging due to visitors walking between the sea and penguin nests in the bush, with unknown effects on nest viability and chicks. This reluctance to leave the ocean has been observed in the shy yellow-eyed penguin (Marchant and Higgins, 1990; Wright, 1998; Ratz and Thompson, 1999). Possible indirect effects on the penguins could include a build up of rubbish on the beach area, which may encourage rodents, and their associated predators such as stoats and cats, and therefore pose a potential risk to eggs and chicks.

Site 2: Sooty shearwater (*Titi*) colony, Mt. Oneone, central Westland (43°, 02'S, 170° 20.4'E). Situated on an old glacial moraine, this colony is on a 60 m high headland at the present mouth of the Wanganui River (*Plate 11*).

Plate 11 - Oneone glacial moraine headland from the Wanganui Coastal Pack Track (K. Hughey).

Plate 12 - Sooty shearwater burrows in vegetation by viewing platform on top of Mt Oneone K. Hughey).

Sooty shearwaters nest in burrows, and the burrows of this small colony lie directly underneath an established viewing platform (*Plate 12*), enabling visitors to experience the sight of these seabirds flying in from the sunset to crash noisily into the vegetation underneath the platform. There is a maintained benched and boardwalked 1.5 km long track that provides access from the road end, through mature vegetation and regrowth, and through pakihi and extensive fern cover, to the beach where the isolated headland lies (*Plate 13*).

Plate 13 - Pakihi in the glacial outwash landscape below Mt Oneone (K. Hughey).

The opening of the colony by the NZ Forest Service in 1985/1986 following the insertion of a track and visitor infrastructure, may be implicated in the accelerating decline of this previously viable colony (Wilson, 1999). This decline could be related to factors such as illegal harvest of the birds, or the facilitation of access through the previously difficult terrain of poorly drained silts and very poorly drained pakihi to the colony, for predators such as dogs, stoats, cats, rats and possums. Second, in the absence of predator control, this mainland colony is probably declining to extinction, due to the shearwater's vulnerability to predation.

Site 3: Westland Black petrel (*Taiko*) colony, Howard-Menteath farm, Punakaiki (42°, 10'S, 171° 20.8'E). This colony is situated 5 km south of the Pancake Rocks in Punakaiki, and is one of only six breeding colonies of this rare bird which are found nowhere else in the world. The colonies are located only along the 20 km stretch of north Westland coast between Barrytown and Punakaiki. The endemic and vulnerable status of the Westland black petrel means that it is a key or priority species not only in Westland but also internationally (DoC, 2000).

The colonies currently managed by DoC are presently closed to the public. The Howard-Menteath farm colony (operating as Paparoa Nature Tours) is the only one on private land and the only one currently open to visitors (*Plate 14*). It represents about five per cent of the breeding population (DoC, 2000). Access is controlled by the landowners, and has been for the past ten years, making it a key site for investigating the effects of controlled visitor access on petrel behaviour, and the viability of this wildlife population on private land.

Plate 14 - Westland black petrel and visitor (B.Stuart- Menteath).

The Westland black petrel is a winter breeder, spending the rest of the year foraging out to sea (Marchant and Higgins, 1990). Pairs of this long-lived species (20-40 years) nest in burrows on mudstone cliffs high above the sea from April/May until November/December (Freeman, 1997). The total population has trebled since the 1950s and peaked around 20,000 +/- 5,000 birds in 1982 (Bartle in DoC, 2000; Heather and Robertson, 1996). Whilst we could find no recent published long-term population studies, analysis and modelling of population data from 1970-1991 showed a decline in breeding productivity since 1982, and what appears to be a concerning decline in female survival (Bartle in DoC, 2000). Factors causing mortality of adult birds could be related to fisheries by-catch (Murray *et al.*, 1993; Freeman, 1997; Bartle in DoC, 2000).

The mudstone cliffs around the Punakaiki area are dotted with the burrows of the black petrel. This substrate can rapidly be altered by foot traffic leaving damaged burrows and/or slippery, dangerous surfaces. Therefore, the nature of the mudstone substrate means that burrows are easily damaged and vulnerable to uncontrolled visitor access, and even low visitor density could have a significant negative impact if there is not careful infrastructural placement. Predators such as stoats and dogs also represent key threats to the eggs and chicks of these ocean birds. In 1990, Paparoa Nature Tours constructed boardwalk tracks, stairs and a wooden viewing platform to avoid and mitigate potential damage to burrows, and for safety measures on the slippery mudstone. They have also performed ongoing predator control since 1990.

2.3.2 Hypothesis of Visitor Impact Management

Fiordland Crested Penguins at Monro's Beach

To investigate the relationship between visitor numbers and visitor impacts, we devised a graphical hypothesis of sustainable penguin tourism-related management at Monro's Beach (Figure 3). Although there is no comprehensive ecological data available on predator distribution and abundance, or year by year food availability for these penguins, the model makes several assumptions about the effects of visitors. First, the opening of the colony by the insertion of visitor infrastructure would have resulted in the introduction, or increase, in disturbance to the birds. This is represented by the slope between the origin and point **A**, reflecting the effects of opening a track from the main highway to the beach allowing visitor numbers to grow (Figure 3). The track opening would have also facilitated and eased predator access to the colony for predators such as dogs, stoats, and cats through the previously difficult poorly drained terrain. Second, in the absence of predator control birds in the colony are vulnerable to increased frequency of predatory encounters (the trajectory from point **B** upwards). The distance between points **A-C** is a hypothesis that reflects the increasing combined effects of uncontrolled visitor impacts and increased likelihood of predatory encounters on the penguin population. The time taken from point **C** to serious threats to the population at point **X** is unknown, but could be determined from analysing population dynamics of the colony. If visitor access is controlled through management such as the provision of visitor facilities, and predator work is undertaken, then the visitor effects could then reach point **D** representing a sustainable level of tourism at the colony.

To test the model we visited the site twice over the summer 1999/2000. We used several methods of data collection including consultation with DoC managers about the penguin population dynamics at the site. We reviewed literature from other tourism operations involving other penguins and seabirds. We also profiled visitor use of the beach to collect data on visitor behaviour patterns at Monro's Beach over a week during the peak tourism season in early February 2000 when the penguins were ashore to moult.

Figure 3
Cautionary Model of Visitor Impacts with Penguins at Monro's Beach

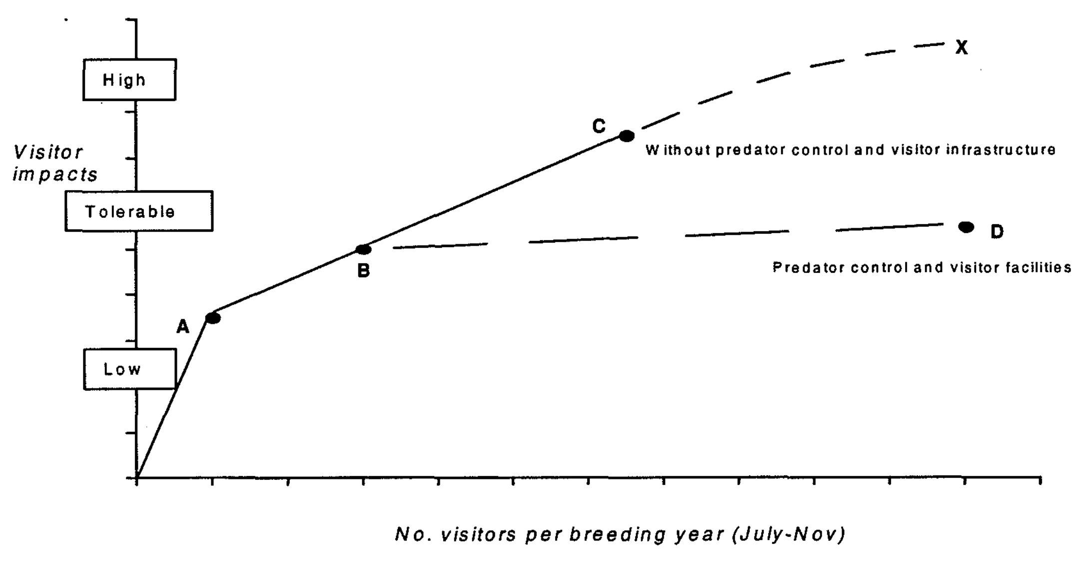
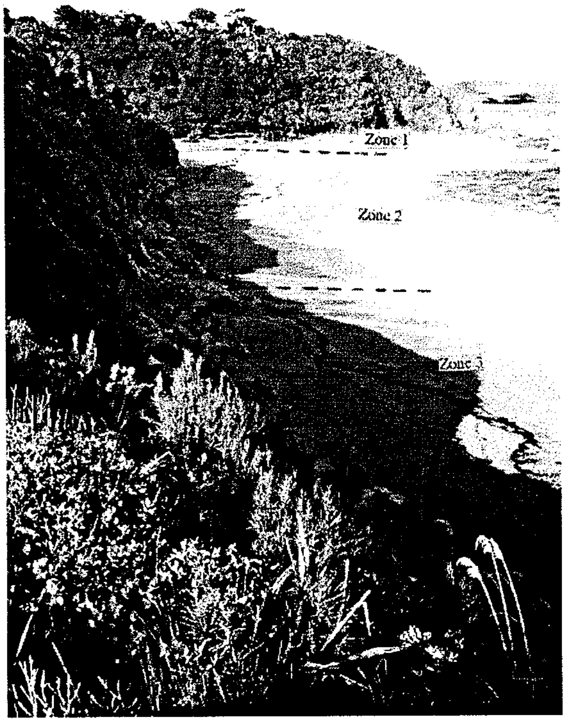


Figure 3 - Cautionary model of the relationship between the number of visitors and impacts at the Fiordland crested penguin colony, Monro's Beach.

To assess the efficacy of interpretation signs on visitor behaviour patterns, the beach was divided into three separate zones where the time and behaviour of visitors in each zone was recorded by a hidden observer (*Plate 15*). The observer had a full view of all three zones to record the nature of different visitor activities at the site. Zone 1 was the area farthest from the penguins nesting area where the track opens out onto the beach, and this is where the first interpretation sign managing visitor effects was sited. Zone 2 was the main beach area where visitors could sunbathe or relax, and was delineated as the area from the right of the track exit to the beach around to where a second sign was located (*see Plate 18, page 32*). Zone 3 was the penguins breeding area where the penguins commute between their coastal forest refuge and breeding area, and the ocean. The penguins generally moult in the coastal bush, and do not travel to the ocean as their feathers are not waterproof during this period (Van Klink, pers comm[13]).

Plate 15 - Monro's Beach with 3 viewing zones (U. Strothotte).

Plate 16 - View from Otumotu Head looking back down Monro's Beach (U. Strothotte).



The observer also noted the time of visitor arrival and departure, along with the number of visitors in each group. Further data is needed during the breeding season when the penguins regularly cross the open beach to forage in the ocean (*Plate 16*), we are confident that if visitors were actively searching for the penguins in the bush, and ignoring the signs, then we would observe this behaviour. This would then enable some insight into the merits of the current management approach in not providing visitor facilities at the beach.

Sooty shearwaters at Mt. Oneone

The model of visitor effects for the Fiordland crested penguins is also applied to the sooty shearwaters (Figure. 3). To test this model we visited the site in November 1999. We consulted

[13] Information supplied by Paul Van Klink, Biodiversity Officer, DoC Haast via email Feb-June 2000.

Kerry-Jayne Wilson from Lincoln University who has been monitoring the shearwater population at Mt. Oneone for over five years. We also compared this site management with literature from other seabird and marine mammal visitor operations throughout the country.

Although both Monro's Beach and Mt. Oneone are under DoC management, visitor access and behaviour is relatively uncontrolled. This lack of control contrasts with the other popular wildlife (bird) site in south Westland – the kotuku (white heron – *Egretta alba*) colony in Okarito At this site, the concession holders operate under strict visitor protocols and use bird 'hides' to control visitor interactions (Kazmierow, 1996). It also contrasts with the third seabird site we studied at Punakaiki, where tourists have been regularly visiting a colony of Westland black petrels managed on private land for the past ten years. We propose a '*sustained tolerance*' model of tourism for this site, where the number of visitors is maximised at a level where there is minimal disturbance to the birds, and the population has not declined, and may even have increased, during the time the colony was managed as an ecotourism operation.

Westland black petrels at Punakaiki

At the Howard-Menteath farm, we devised a different model of visitor impacts (Figure 4) to those of the DoC managed seabird colonies in this study. The installation of a boardwalk at point **A** would most likely have prevented much long term physical damage to the site, which could otherwise have eventually led to point **X** (i.e., severe damage or local extinction of the colony) if access and predators were uncontrolled. The slope of the line from the origin to point **A** is much steeper than at a geological (physical) site, due to potential short-term damage to burrows and disturbance to the birds from boardwalk construction.

Figure 4
Cautionary Sustained Tolerance Relationship with Westland Black Petrels at Punakaiki

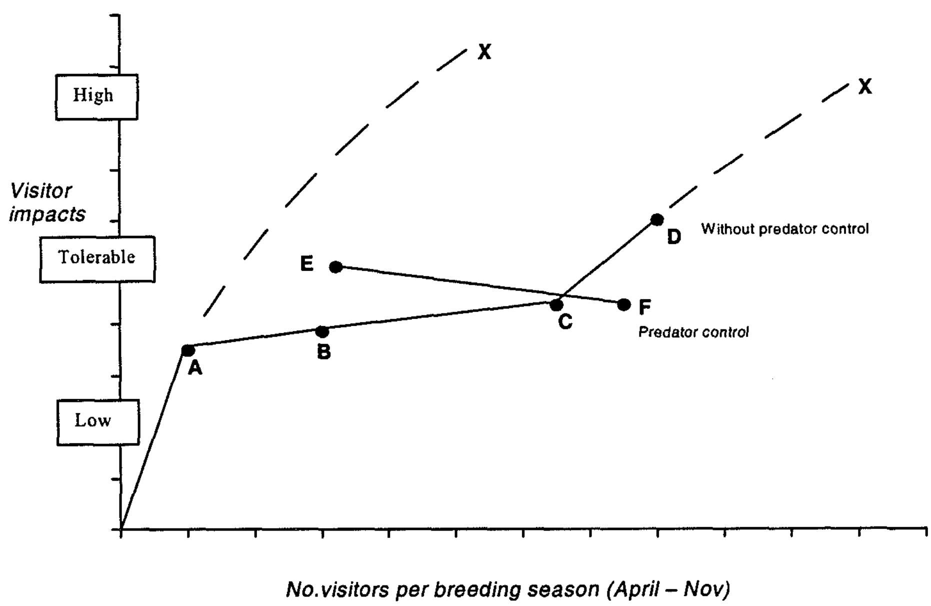


Figure 4: Cautionary *sustained tolerance* relationship between number of visitors and impacts at the Westland black petrel colony on the Howard-Menteath farm, Punakaiki.

The distance between points **A** - **C** represents the build-up of visitor numbers over time. The gradual increase in the slope of the line between these points represents the impacts on the petrels as they adjust to changes in human visitation and the level of predation at the colony.

If predator control is not instituted, then at the jump in impacts from point **C** to point **D** the colony becomes threatened by predator build-up eventually leading to point **X**. Point **D** also represents the theoretical maximum number of visitors that the birds can sustain before major changes in their behaviour could occur, such as parental distress, egg and chick abandonment and colony degradation. Coupled with increased predation pressure, point **D** may represent a critical point in the viability of the colony. However, predator control undertaken by the managers at point **E** is predicted to not only have reduced predator impacts, but also may have aided in breeding success. In this scenario, more visitors can be accommodated because the birds are less threatened by predators, moving to a maximum sustained tolerance at point **F**. This point is also more financially advantageous, as increased visitors can more than offset the cost of predator control.

To test this model we consulted the managers. We helped analyse parts of the comprehensive ten year data set collected by the managers on the breeding success of the petrels from 1990. The managers also collected data on burrow occupancy rates, visitor numbers, petrel interactions with visitors, and the history of predator control operations. The managers are to be commended for this approach, and thereby this represents an opportunity to ascertain the *maximum sustained tolerance* of tourism at this site (Figure 4). We visited the site in November 1999 when the juvenile petrels were beginning to leave the colony. We also worked with DoC to facilitate information exchange between the private and public managers to better integrate and target management of the petrels.

2.3.3 Testing the Models of Visitor Impact Management - Results

Fiordland Crested Penguins – south Westland: Population dynamics of the colony
Separating out the relative importance of different ecological factors on penguin population dynamics at Monro's Beach would require a long-term detailed study, which is beyond the scope of this report. However, we can report on breeding success of the penguins since 1990 from data collected by DoC, and also at two similar-sized nearby colonies Murphy's Beach (1 km south) and Jackson's Head (50 km south) for comparison. We also present the results of a week long survey of visitor behaviour to enable some observations to be made about the management at the site.

Data collected since 1990 suggests that juvenile or fledging recruitment is regularly occurring into the adult population at Monro's Beach (Van Klink, 1999 – Figure 5a). However, the numbers of chicks successfully fledged varies in any one year and the reason is unknown. From a high of 25 chicks fledged in 1992, the number of fledglings declined each year to a lack of any chicks successfully fledged in 1997. However, there was a reasonable recovery in fledglings recruited into the adult population 1998 and 1999. Nest numbers have not fluctuated greatly over the last decade (between 19-28), suggesting that other factors affect the variability of recruitment from year to year at the site.

In contrast, at the nearby Murphy's Beach (*circa.* 1 km south of Monro's Beach), 1997 was the second best breeding year in the 1990s with an almost 100 per cent increase over 1996 fledgling numbers (Figure 5b). Similarly, at Jackson's Head, 1997 was the year where the highest numbers of fledglings raised was recorded (Figure 5c). Nest numbers have been relatively similar at all three sites during the 1990s. This suggests that whatever factors caused the penguins to lose all their offspring at Monro's Beach in 1997, these were localised factors.

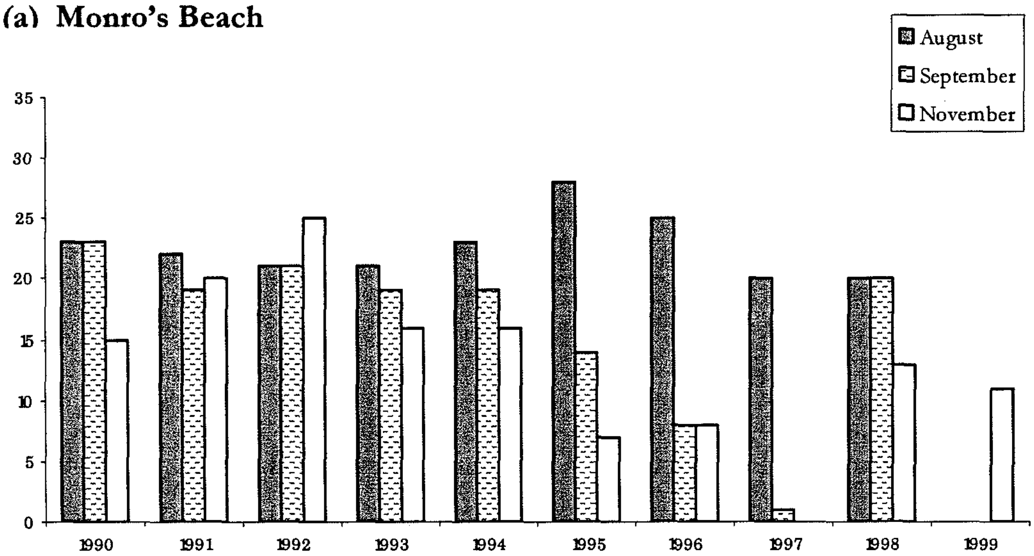
During the lowest recruitment period 1995-1997 at Monro's Beach, the survival of viable nests ranged from 50 per cent in 1995 to only five per cent during the interval between the

August and September census counts (Table 3). Subsequent relative survivorship recorded between the September and November counts did not show the same dramatic reduction, indicating that the nests were most vulnerable in the initial stages of the breeding season at this site. In contrast, there was little mortality between the August and September counts at Murphy's Beach and Jacksons Head during the 1995-1997 breeding seasons (Figure 5; Table 3). Mortality mostly occurred at these sites between the September and November censuses, also suggesting that either there were similar processes occurring at different times to Monro's Beach, or there were different processes influencing survivorship at these sites.

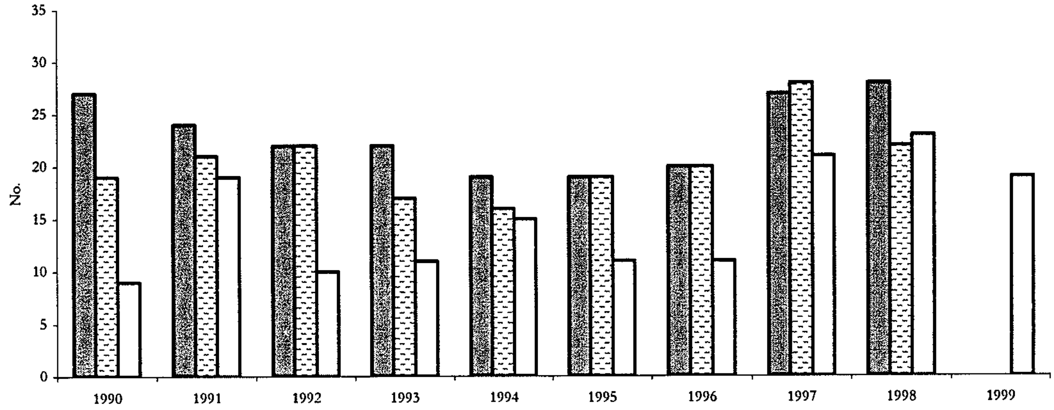
Monro's Beach has the highest number of visitors (Table 1), with Murphy's Beach receiving only ten per cent of the visitors that come to Monro's Beach (about 800 people - Van Klink, pers comm), and at Jackson's Head farther south there are even fewer visitors to that colony (Van Klink, 1999). A track counter has only been operational at Monro's Beach since 1999, however there are already clear seasonal patterns in the frequency of visits to the site. The peak times are the spring and summer months with 1000-1400 visitors per month, intriguingly the upsurge in visitor numbers in spring coincides with the commencement of the penguins breeding season (DoC south Westland, unpublished data). For example, in July 2000 only 294 visitors went to Monro's Beach, in August this jumped by over 200 per cent to 972 visitors and increased still further to 1437 visitors in September. The possibility of visitor interaction with the penguins at Monro's Beach needs further investigation.

Figure 5
Number of Penguin Nests, Nests with Chicks and Fledglings

(a) Monro's Beach



(b) Murphy's Beach



(c) Jackson's Head

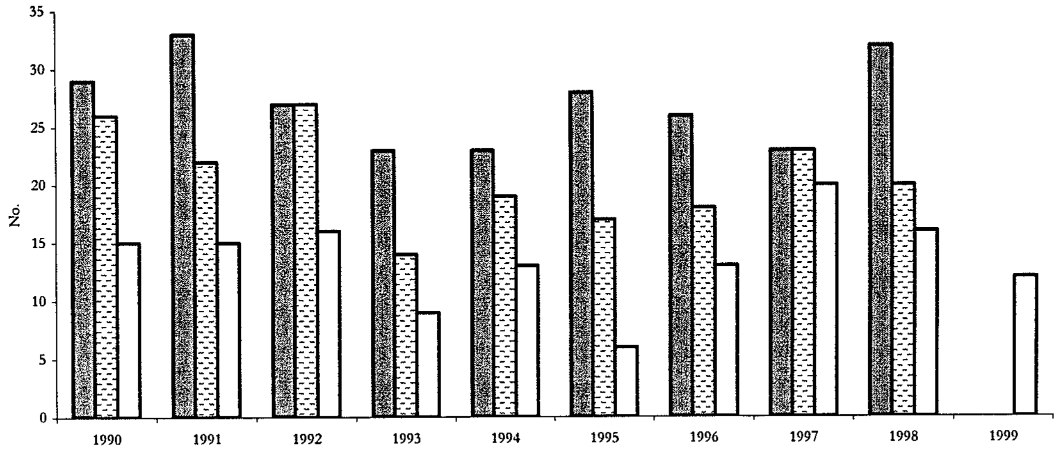


Figure 5 (a) Number of penguin nests (August), nests with chicks (September), fledglings (November) since 1990 at Monro's Beach,
(b) Murphy's Beach and
(c) Jacksons Head, south Westland. (Source: Van Klink, DoC unpublished data)

Table 3
Percentage Survival Rate of Penguin Offspring

Colony	*Breeding Season*								
Monro's Beach	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
September	100	86	100	90	83	50	32	5	100
November	65	105	119	84	84	50	100	0	65
Total Breeding Season Survival	**65**	**91**	**119**	**76**	**70**	**25**	**32**	**0**	**65**
Murphy's Beach									
September	70	88	100	77	84	100	100	104	79
November	47	90	45	65	94	58	55	75	105
Total Breeding Season Survival	**33**	**79**	**45**	**50**	**79**	**58**	**55**	**78**	**82**
Jackson's Head									
September	90	67	100	61	83	61	69	100	63
November	58	68	59	64	68	35	72	87	80
Total Breeding Season Survival	**52**	**45**	**59**	**39**	**57**	**21**	**50**	**87**	**50**

Table 3: Percentage survival of penguin offspring surveyed during the breeding season at Monro's Beach, Murphy's Beach and Jackson Head from 1990-1998. Survival calculated as number of birds remaining relative to the total surviving from the previous count (e.g, November fledglings relative to September count). Counts done in August (no. nests), September (no. nests with eggs) and November (no. fledglings) (source: Van Klink, DoC unpublished data).

Data from nearby Murphy's Beach combines breeding success from three subcolonies at the beach: Murphy's *A*, *B* and *C*. There are some intriguing patterns at the different subcolonies. Murphy's *A* is the subcolony that is closest to the track and receives the most visitors, whereas Murphy's *C* is the farthest away and receives less visitors (Van Klink, pers comm). There has been a gradual decline in numbers of nests occupied at Murphy's *A* from six occupied in 1990 to only one in 1997 and two in 1998, although successful fledgling numbers were similar throughout the decade ranging from one to three. There has been a corresponding increase in nests occupied at the farther away Murphy's *C* subcolony, from 12 nests in 1990 to a high of 19 in 1998 and a strong increase in fledgling success up from three in 1990 to 17 in 1998 (Van Klink, 1999). This may be due to a number of potentially interacting factors including displacement of the birds from visitor activity, predation, or alternatively some birds may simply be consistently better breeders than others at the different subcolonies.

The Monro's Beach colony has certainly persisted for many years and DoC believe it will probably continue to do so even in the presence of predators (Van Klink, pers comm). The major predator according to DoC are dogs, which can do a lot of damage if loose in the colony. The chicks and adult penguins are aggressive and large enough to deter most other predators, and there has been little evidence of chick predation by stoats in the past year (*ibid*), although McLean (1995) suggests stoats and cats are likely to do extensive damage. Unlike some of the declining forest birds which have weakly developed predator responses, penguins live in marine and coastal environments where they are exposed to predatory encounters from a number of different types of predators, and have well developed predator avoidance and aggressive defences.

Interestingly, adult survival figures assessed as the same birds returning to Monro's Beach to breed are only around 70 per cent annually (Van Klink, pers comm). This could be related to a number of as yet unknown factors such as predation at sea and/or food availability, individual birds not returning to breed every year, a rise in sea surface temperatures, or sampling design and techniques which are currently under study and review by DoC. DoC has also noted a general decline of adult birds on Taumaka and Popotai Islands (*ibid*). These patterns require detailed investigation to address the gaps in the literature on long-term Fiordland crested penguin population dynamics.

Visitor behaviour at the site – interpretation and management direction

The presence of the birds hidden in the coastal bush meant that we observed no birds on the beach during daylight hours from 4/2/2000 to 10/2/2000. This is probably due to the secluded and warmer environment in the coastal bush being more hospitable to the penguins than moulting standing exposed on the beach to the prevailing oceanic westerlies.

There were two interpretation signs at the beach; the first was located where visitors would see it as they emerged from the track onto the sand (*Plate 17*). We found this sign to be ambiguous in its direction to visitors, and we observed at least one person turn around and leave without proceeding to the beach. The reason for the ambiguity is that on this sign visitors are requested to "DO NOT GO BEYOND THE SIGN" beside a picture of a penguin. At the top of the same sign is the same penguin motif, which draws visitors attention to the presence of penguins at the beach, but could be confused as the sign to which the clear instruction to not proceed refers. Possibly adding to the confusion is that the second sign (*Plate 18*) is not immediately visible. The second sign was situated in an area we termed Zone 3. It is some distance from the first sign, around a headland on the beach and not accessible in high tides, and not clearly visible in driving rain. DoC managers have recognised this and are putting in new signs with clearer directions (Van Klink, pers comm).

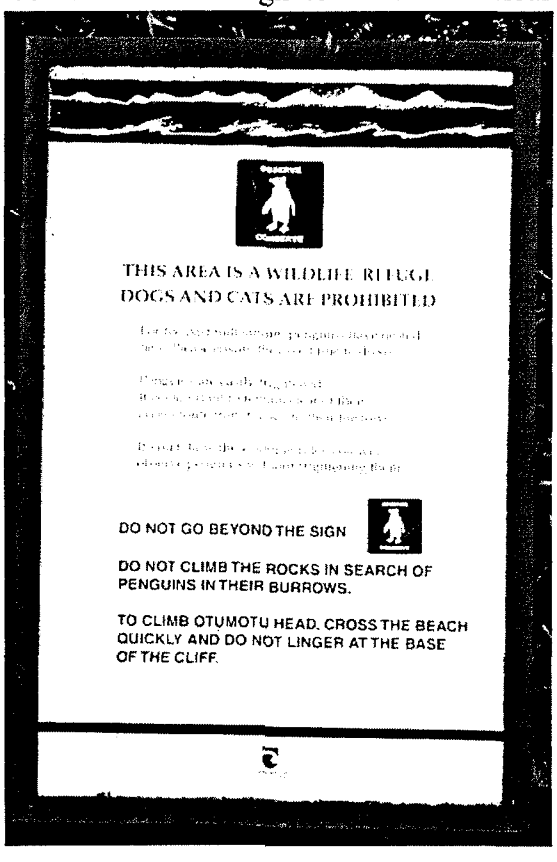


Plate 17- First interpretation board at Monro's Beach (J. Ward).

Plate 18 - Second interpretation sign on the rocks at the high tide mark at Monro's Beach (J. Ward).

We found almost all the 240 visitors observed stayed within Zones 1 and 2, and only just over ten per cent went beyond the sign into Zone 3 (Table 4). We do not know how many people knew that the penguins were close to the beach in the bush moulting, but certainly at least one curious person actively went searching for the birds. He spent eight minutes searching the bush on 9th February (Table 4). This is behaviour that is difficult to manage, and it is liable also to occur during the breeding season when visitors know from interpretation panels and guidebooks that the penguins are there.

Table 4
Summary of Number of Visitors Per Day Visiting the Fiordland Crested Penguin Colony at Monro's Beach

Day/ Weather	Total no. Visitors	No. Groups	Time Spent	No. Pairs/ individuals	Time Spent	Zone 3	Activity in Zone 3
Fri 4 Feb Overcast	18	2	17 m	9	13-45 m	1	View
Sat 5 Feb Overcast	40	2	22-72 m	21	10-55 m	3	View
Sun 6 Feb Heavy Rain	28	2	35-47 m	5	15-58 m	3 2	View Rock Climb
Mon 7 Feb Overcast	52	4	5-37 m	26	2-65 m	5 2 2	Rock Climb Walking View
Tues 8 Feb Fine	63	3	18-60 m	36	2-70 m	2	Walking
Wed 9 Feb Overcast	29	4	10-60 m	8	5-25 m	6 2 1	Walking Rock Climb In Bush
Thur 10 Feb Fine	12			12	5-25 m		

Table 4: Summary of number of visitors per day visiting the Fiordland crested penguin colony at Monro's Beach (data courtesy of U. Strothotte). Visitors broken down into groups or individuals/pairs along with the range of visit length. Zone 3 = the number of visitors who went beyond the second sign, and their activity whilst there.

Of the visitors who went walking in the area that the penguins use during the breeding season, a simple and inexpensive way to manage those curious visitors who want to see the penguins during this period would be to construct a simple three sided shelter. One possible site in Zone 1 is a small, flat elevated dune facing the path of the penguins, and would encourage people to watch the penguins in comfort *(Plate 16)*. Importantly, it would also enable visitors to watch the penguins from a distance. This would thereby minimise the potential contact time with the birds, and go some way towards overcoming their reluctance to come ashore when people are in their commuting zone. This is a simple and inexpensive way to manage impacts of visitors that conveys positive proactive management and *kaitiakitanga*. It would also enable visitors to get some relief from the often extreme westerly weather conditions, as we know from our survey that there were large groups visiting even in poor weather. A toilet may also be an essential piece of infrastructure for a site that currently accommodates 8,000 visitors per year. It is surprising that there is not one, considering the proactive advocacy that DoC in south Westland does to encourage people to visit and view the penguins as an active tourism site for advocacy purposes[14].

In terms of the model proposed for visitor impacts on the penguins (Figure 3), there is no long term data on visitor numbers during the 1990s to assess the direct impacts of visitors on the penguins[15]. Therefore, we are unable to examine the historical patterns of visitor use and relative survivorship during the breeding season from 1990-1998 and directly link them to the model. However, in their assessment of the effects of human disturbance on the penguins, DoC have identified research needs related to visitor interactions (Van Klink, 1999). Our analysis of the data supports the need for a more detailed study of visitor effects especially during the breeding period, where uncontrolled visitor behaviour in the nesting area itself could lead to chick and parental stress. This has the potential for causing negative effects on the birds.

The causes of stochastic disturbances on the penguins need detailed investigation to ascertain likely causes of the localised disastrous breeding year of 1997, and the general downward trend in fledging success during the 1990s. Unfortunately, in 1999 DoC ceased collecting data in August and September during the early stages of the breeding cycle, restricting their data collection to the number of fledglings in November only for 1999 and 2000. Potential management actions and tools, aside from a visitor viewing shelter and toilet, could include resuming full data collection. Importantly, this will enable direct long term breeding trends to be examined with likely increases in visitor numbers and associated pressures. In addition, restricting visitor access during the vulnerable August/September phase of the breeding cycle is one tool to examine the effects on recruitment over time.

In summary, we see that although the model needs further, more detailed investigation, we hypothesise that the colony is somewhere between points **C** and **D** at present barring stochastic events such as dogs or very negative visitor behaviour.

Sooty shearwaters – south Westland: Population dynamics of the colony

Since DoC commissioned a report on the status and conservation of the shearwater population at Mt. Oneone in 1999, the colony has declined further and is close to point **X** on the model in Figure 3. The colony is declining to extinction due to egg, chick and adult

[14] Currently, DoC are developing prescriptive amenity standards for the insertion of toilets in terms of visitor pressure. New toilet placement at present takes place within the project planning and bidding process.

[15] According to DoC, the track was constructed some 40 years ago and received a significant upgrade when World Heritage Area status was granted to south Westland in the early 1990s, and probably received an increase in visitors from around that time (Van Klink, pers comm).

predation probably from stoats, although possum and rodent numbers are also high in the area (Wilson, 1999). In her report, wildlife biologist Kerry-Jayne Wilson warned that unless a predator control programme was immediately implemented, it would certainly be the end of another mainland colony of native birds. And in a recent survey subsequent to the report only one breeding pair remained at the site (Wilson, pers comm). This is despite timely information and scientific data concerning the need to act with predator control to enable the restoration of the colony. There is a slim chance that with a number of young non-breeders that could return and attempt to breed, it could recover.

The abundance of shearwaters on offshore islands, where there is also permitted sustainable customary harvest, means this mainland colony is low on the DoC conservation priority list[16]. Wilson (1999) suggests that as a narrow sand isthmus is the only access from the beach to the headland, there is a practical opportunity for ongoing and effective control of predators (*Plate 11*). However, predator control is costly, and DoC have only a limited budget for biodiversity work in the area and most is focussed on the Okarito Brown Kiwi recovery farther south.

There has not been any cost analysis done on undertaking an ongoing predator control programme at Mt. Oneone[16]. According to DoC, a cost/benefit analysis would not be done in this instance because the species is not a Category A or B species, and therefore it does not get priority for funding consideration as the overall population is in good shape nationally. Possible partnerships to fund predator control have also not been explored with the local community.

There are policy and resource allocation questions at this site, and any preventable loss of indigenous biodiversity on the mainland is concerning. The old NZ Forest Service placed the visitor infrastructure (stairs, viewing platform) in 1985/1986, however such a structure may not be built in today's funding environment. Nevertheless, it is being regularly maintained by DoC. Wilson (1999) argues that the acceleration of the shearwater decline at the site could be linked to the insertion of visitor infrastructure to the site in 1985/1986 which may have facilitated and eased predator access. Evidence for this is indirect as the colony is situated in difficult to access terrain and had been persisting in the presence of predators in Westland over the last century. When the track system was constructed, with boardwalk over the most poorly drained sections, it is possible that it counteracted the previously natural barrier of very poorly drained pakihi and thickly vegetated poorly drained river silts (*Plate 13*). Although this hypothesis is not accepted by DoC due to the abundance of predators in Westland[16], it probably means that it was a question of when and not if the colony became extinct.

Westland black petrels at Punakaiki - Population dynamics of the colony

Since 1990, recruitment into the adult population has been steadily increasing at the colony, with over 50 fledglings per year taking their first flight into the West Coast skies from the dense bush (Figure 6). Around the time of the young petrel's first flight, visitors to the site are treated to a close-up wildlife experience (*Plate 14*). Visitors get to share the viewing platform with the nonchalant young birds as they stretch out their impressive wingspans, and the power of their wings is evident in periodic vigorous beats that strengthen their flight muscles.

[16] Email communications from Rob McCallum, DoC Area Manager at Franz Josef (12 May and 17 May 2000).

Figure 6
Number of Westland Black Petrels Successfully Fledged

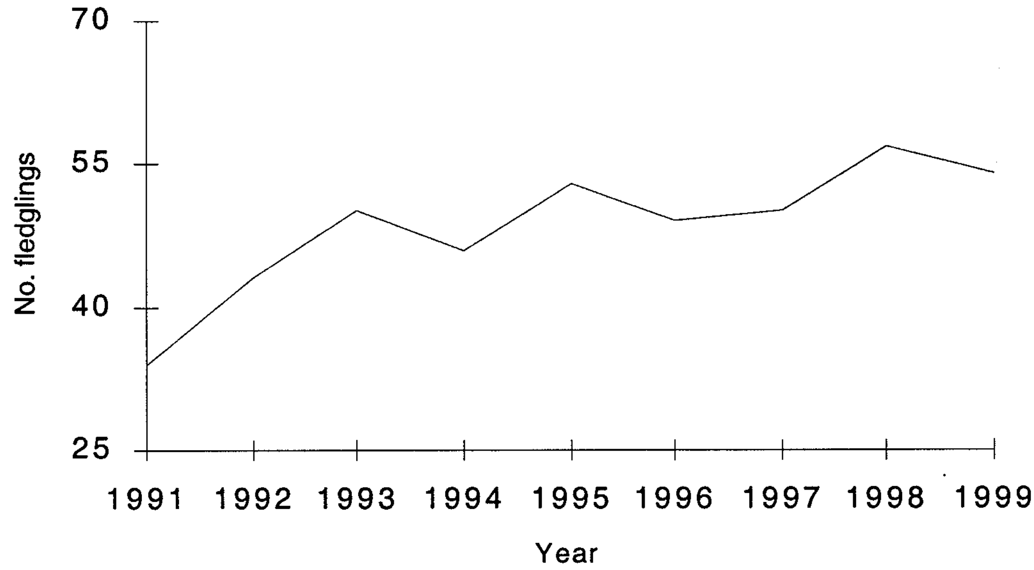


Figure 6: Number of Westland black petrels successfully fledged since 1990/91 at the Howard-Menteath colony near Punakaiki.

The wooden platform is set deep in bush on a hillside, and faces out over one of the prime take-off sights in the colony low down in a clump of epiphytic kiekie (*Freycinetia banksii*). As the long November twilight sets in, the young petrels emerge from their burrows to test their nascent flying abilities and experiment with tree climbing to get elevated take-off points, hungry and ready to follow the departed adults to the ocean.

Visitors reach the viewing platform by walking along carefully placed boardwalk paths, and up a series of wooden stairs. The manager observed the petrels for two seasons, mapping burrows, landing sites and flight paths, and recording petrel behaviour before construction began. Once a route had been devised for placing the infrastructure that minimised disturbance to the birds and burrows, construction commenced during the summer period of January - February 1990. This is when the petrels were out foraging in the ocean (petrels are absent from the colony from December to March/April). Viewing is allowed at the site from April to December each year.

Burrows throughout the colony were mapped from 1990 and most burrows were mapped by the end of 1991, along with the distance of the burrow from the visitor walkway. The walkway winds its way through the two most densely packed clusters of burrows, enabling visitors over the course of their walk to the platform to have contact with the birds. Throughout the trip, knowledge about the birds and their ecology is conveyed to the visitor, and a conservation message is an integral part of the experience.

The conservation of the black petrels also extends to predator control by the managers, which has been ongoing since 1990. There is a comprehensive data set on the types and numbers of predators caught since operations began, which are mainly related to stoat captures. There is also a dog control gate at the walkway entrance to the colony, as there has been at least one dog loose in the nearby DoC colony which killed about 40 black petrel chicks in 1989/1990 before it was caught (B. Stuart-Menteath, pers comm). Weka (G*allirallus australis)* and cats *(Felix cattus)* are periodic and opportunistic predators of black petrels, one weka was caught in the colony in 1995, and in the nearby DoC colony in 1985 a cat was caught after she had killed about 20 chicks (B. Menteath, pers comm). Active management has probably lengthened the time between predatory encounters for the petrels at the Howard-Menteath farm, and there has likely been positive benefits for petrels on the managed colony located in Doc lands.

We found the assumptions made in the model in Figure 4 to be incorrect, and the shape of the *sustained tolerance* graph to be different to the hypothesis. In Figure 7, the line from the origin to point **A** is not as steep as we predicted due to the care of the managers in their construction and placement of the infrastructure. The management of visitors in relation to the black petrels appears to minimise disturbance to the birds, and there are commercially sensitive data collected over the years on petrel behaviour in response to visitors at different stages of the breeding cycle to support this. The black petrels are aggressive parents in the guard stage following egg laying and chick hatching so this is important information in handling visitors at potentially sensitive times for the birds.

Figure 7
Sustained Tolerance of Tourism of Westland Black Petrels on Private Land Near Punakaiki

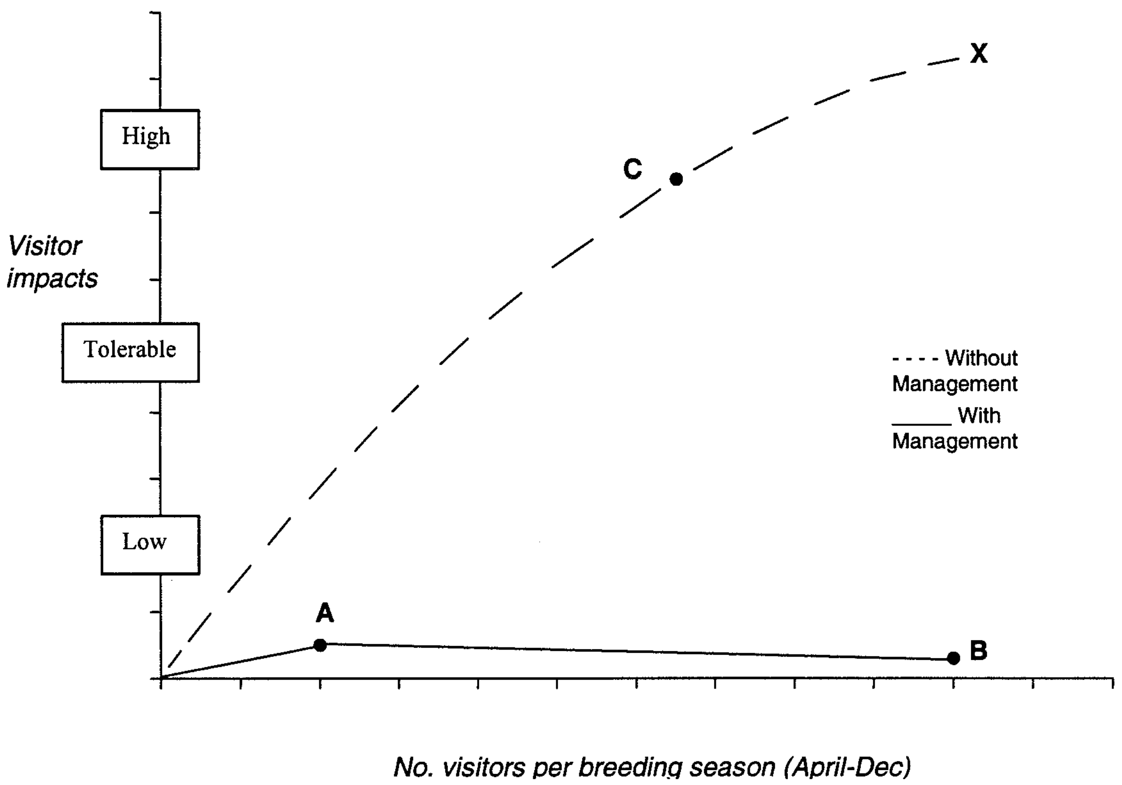


Figure 7: *Sustained tolerance* of tourism of Westland black petrels on private land near Punakaiki.

The ongoing predator control, and the trend upwards in fledgling numbers successfully raised each year, suggests that the manager's careful control of visitor density has little adverse effect on the petrels, and the colony is at point **B** in terms of environmental impact. This is currently at a low level although it is conceivable that stochastic events such as the inadvertent introduction of avian disease or dogs by visitors could raise the level of impacts to a higher level in the future. Had predator control and careful placement of the infrastructure not occurred, and visitors not been well managed at the site, impacts could be somewhere around point **C**, similar to the state of the sooty shearwater colony at Mt. Oneone. The maximum number of visitors the colony can accommodate per night is 25, which is the capacity of the viewing platform. The actual numbers of visitors per night over the course of the ten years of active management and ecotourism operations is also commercially sensitive, hence although there is a sustained tolerance of tourism at the site, we are unable to use actual figures. The sensitivity is because in the proposed DoC Westland Petrel (*Taiko*) Recovery Plan 1999-2009, there is a possibility for DoC to open colonies on Doc managed lands to private concessions (DoC, 2000)[17].

2.3.4 Indicators of Acceptable Environmental Change at Seabird Sites

There are several generic indicators of visitor effects that are common to all three seabird sites. These include *population changes* and *displacement*, *species behaviour* and *negative visitor behaviour* summarised in Table 5. The impacts of visitors in large part depends on the frequency, intensity and/or timing of disturbances, and management measures taken to mitigate, avoid, and/or remedy their effects.

Table 5
List of Management Requirements and Effects – Seabird Sites

Generic to all seabirds	Specific to some seabird sites
Courtship/breeding/incubation disruption	Illegal access
Nest and chick abandonment	Noise
Spatial and/or temporal displacement	Burrow erosion/damage
Predator abundance and diversity	Habitat modification
Exotic weeds/pests	Human waste
Hazards, and introduction of hazards	Recreational activities
Damage/vandalism	
Negative visitor behaviour	
Litter	
Track wear and tear	
Interpretation/visitor experience	
Taha Maori	
Safety	

Table 5: List of management requirements and effects of visitors generic to all or most seabird sites and those that are specific to some sites. The key mechanism to understand the significance of impacts is the frequency, intensity and/or timing of disturbance caused by visitors in any given situation (*see text*).

Sources: Kuss *et al.*, 1990 and references therein; Montgomery, 1991; Booth and Cullen, 1995; Ward and Beanland (1995, 1996) and references therein; Walls (1999) and references therein.

[17] The Westland Petrel Recovery Plan (p13) states that one of the management actions is: *To only allow tourist concession activities within the Westland petrel (taiko) Specially Protected Area if they do not impact on Westland petrel (taiko) or their habitat and comply with the Paparoa National Park Management Plan (DoC, 1993).* DoC acknowledge the competent management of Paparoa Nature Tours and that a conservation advocacy opportunity for petrels is catered for on private land. Despite this DoC are obliged to process any concession application it receives under the Conservation Act 1987, although any application would be subject to a rigorous environmental impact assessment.

Population changes
The key measurable variable to monitor is the number of fledglings successfully raised over time, so there is cumulative data to assess whether there is sustainable recruitment occurring into the adult population. Seabird populations generally face urgent threats to their survival from introduced predators, so any *sustained tolerance* model of tourism needs to fundamentally incorporate control and monitoring of predator numbers. Fluctuations in seabird populations are probably largely independent of visitor behaviour where there are adequate visitor facilities and infrastructure, except in the most extreme cases of deliberate negative behaviour (DoC Otago Conservancy, 1992) and poaching, and where infrastructure placement enhances predator access. There is a possibility for example, that decline of the shearwaters at Mt. Oneone may not be entirely due to predators, but could be also contributed to by poaching as the shearwaters are also edible. The lack of overt *kaitiakitanga* at this site means that there is no advocacy message or deterrent to counter negative visitor behaviour.

Species behaviour
The approach taken by the managers at the Westland black petrel colony to passively record behaviour of the birds to visitors over time enables a sound knowledge base on which to base visitor management. Visitor management can then be undertaken to reduce potential direct stress on seabirds, such as bird hides, viewing platforms, and visitor barriers. Site-specific indicators could be related to the particular characteristics of individual species, for example some species such as the Fiordland crested penguin or the yellow-eyed penguin are shy and timid and require different types of management than the larger winged seabirds such as Westland black petrel or sooty shearwater.

Visitor behaviour
Visitors to wildlife on public lands managed by DoC are expected to be self monitoring and responsible, and this behaviour is supported by interpretation signs. At the seal colony in Cape Foulwind visitors are managed by a series of elevated platforms and barriers 50 m above the seals which act as a barrier to visitors. However, there is little DoC can do if visitors are not self-managing at wildlife sites, although a well-maintained site can send a message of care. At the privately managed wildlife site we studied, there was good control over visitors allowing disturbances to be minimised.

2.3.5 Summary

We developed cautionary models of visitor impacts for three seabird sites on the West Coast. For the two publicly managed colonies, we examined the effects of unaccompanied and unmanaged visitors on Fiordland crested penguins and sooty shearwaters. For the Westland black petrel colony managed on private land, we developed a sustained tolerance model of visitor effects, which included predator control.

We found that although the means by which visitors get to seabird sites (i.e., site attributes such as tracks, bridges) were generally to a high standard at the publicly managed sites, visitors were not managed well at the ends (i.e., the site attraction). Because the DoC managed sites are open access, there is potential for visitor behaviour to negatively affect breeding success. For the Fiordland crested penguins, the model requires more long-term data to rigorously test the assumptions. There are a range of management options available to mitigate visitor impacts and there is the opportunity for managers to more fully study the effects of visitors on the birds, and the effects of controlling visitor access at different times of the year. In the case of the sooty shearwater colony at Mt. Oneone, it appears likely that the construction of a visitor structure has had unintended consequences on the population. In terms of the model, the colony is almost at point X (extinction). Despite this, the structure is being maintained although there are no accompanying resources for predator control.

We found the Westland black petrel colony to be well managed, however the actual fit to the model was poor. The model was revised for this site to reflect the careful ongoing management and low impacts of visitors on the birds. Appropriate placement of infrastructure, along with small groups of visitors accompanied by the managers, meant that visitor effects were consistently minimised on the birds. Unpublished data collected over time by the manager supported this.

We identified a number of visitor impacts associated with visitor activities at the different colony attractions (Box 2). We also suggest limits of acceptable environmental change for these seabird sites, and associated management guidelines, along with indicators for monitoring visitor effects.

Asset:	Wildlife - Seabird sites.
Activities:	Walking, viewing,
Impacts:	*Disturbance to birds*: courting/breeding/incubation disruption; egg and chick stress/abandonment; spatial and/or temporal displacement, facilitation of predator access, pest, weed and hazard introduction, negative social behaviour (nest damage/destruction, vandalism, litter, noise, blocking access to colony).
LAEC:	Maintain viable colonies and minimise disturbances to wildlife, especially during breeding season. Provide quality visitor experience by high standard of visitor facilities and interpretation that minimises disturbances.
Guidelines:	Appropriate monitoring to identify the occurrence, severity or extent of visitor impacts. Management response to adverse effects will vary for different species and could include type of hides or barriers, set times of visitation at appropriate times of day/night and season, length of visit, and prescribed number of visitors per visit and per season.
Indicators:	*Population changes* (nesting and fledgling success), *Species behaviour* (spatial and/or temporal displacement, stress, failure to breed, egg and/or chick abandonment at site of people). *Visitor behaviour* (compliance with interpretation and/or guide instruction, litter, burrow or nest damage, sticking to tracks/paths – footprints and erosion off tracks, visitor feedback).

Box 2: Summary of impacts from visitor activities and indicators of acceptable environmental change at seabird sites (*asset classification from Ward et al., 2000*).

2.4 Cave Ecosystems On The West Coast

2.4.1 Background and Methods

Cave systems are extremely sensitive to human impact, and, as such, could be described as density-independent and vulnerable, as it does not take many visitors to cause extensive damage depending on the cave ecology and morphology. In the Paparoa National Park

Management Plan cave structures in the region are described as fragile and highly sensitive to damage and degradation (DoC, 1993). Managing caves, therefore, becomes a trade-off between allowing visitor access so people can experience these exciting ecosystems while trying to do what is possible to minimise their impacts.

Overt signs of physical damage include speleothem theft and breakage, etchings into cave walls or wooden structures, litter, human waste, and cave floor erosion and waterway sedimentation (Wilde and Worthy, 1992; Bunting, 1998 and references therein). Less obvious impacts also occur on cave fauna, which can be caused by damage to cave habitat, or alteration of ecosystem processes (Wilde and Worthy, 1992; DoC, 1993; Bunting, 1998). For example, impacts can affect endemic cave dwellers like *Erebotrechus infernus* (an eyeless, flightless, depigmented ground beetle), *Sperlungula cavernicola* (an endemic cave spider which is New Zealand's largest), and other fauna such as millipedes, cave weta, crustaceans and harvestmen. However, visitor impacts do not just come from tourists in open access caves; recreational cavers can also cause significant impacts and a code of behavioural ethics has been developed by the NZ Speleological Society (NZSS)[18] in recognition of this fact.

We adopted a different approach for investigating appropriate site-specific and generic indicators of environmental change for cave ecosystems than for the rest of this study. There is already comprehensive literature concerning environmental impacts of visitors on caves and ways to mitigate them[19], and DoC in the Buller Region are developing a current cave management and monitoring indicators programme (Martin Abel, pers comm[20]). This is based in part on Bunting's (1998) work in developing a Cave Impact Assessment Rating System (CIARS) for recreational impacts on New Zealand caves. The CIARS uses a range of techniques including photo monitoring, and a set of criteria to visually assess and quantify physical impacts over time on different sections of the cave environment (floor, wall and ceiling). DoC are also reviewing access arrangements to caves in the region and work will soon commence on developing a new classification system for access. Therefore our main approach was to review the current literature, consult with DoC, a caving concessionaire, and recreational users of the caves, so as to review management processes involved in devising and monitoring indicators of acceptable environmental change in these sensitive ecosystems. We also examined the way in which caves were allocated for visitor access and concessions in relation to the mitigation and/or prevention of environmental damage.

We visited and described the visual condition of three caves in the Punakaiki area, which differed in access and management, to get a sense of the nature of impacts on these caves. The **Fox River Tourist** caves have open access (*Plate 19*), and require an hour-long walk through native forest from the road. The **Punakaiki Cavern** is a sea cave 500 m from the Pancake Rocks with open access beside State Highway 6. Lastly, **Xanadu** Cave is 5 km inland from SH 6 along the Bullock Creek Road, and safe access is with a concessionaire due to the frequent flood-prone nature of this cave. Because of the recreational and visitor interest in caves, DoC have a policy whereby some caves are set aside for public exploration (DoC, 1993). These 'robust' caves can be explored with care reasonably safely and offer a visitor contact opportunity with some of the special features of the extensive West Coast karst landscapes.

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18 www.massey.ac.nz/~SGlasgow/NZSS/welcome.htm (also has links to Australian Speleological sites)

19 For example, Williams and Wilde 1985 and references therein; Wilde and Worthy 1992; Thurgate and Hamilton-Smith 1998; Bunting 1998 and references therein.

20 Martin Abel - Cave Management Program - DoC Westport.

Plate 19 - Fox River Caves (K. Hughey)

2.4.2 Cave Classification and Access

There are several different methods for classifying cave environments for visitor access. Worthy (1990) classified 103 caves and/or karst features based on the criteria of their geomorphology (solution caves; lava caves; sea caves; karst features; karst systems) and the cave contents (sedimentary features, speleothems, and cave life). Worthy ranked these systems in terms of their local, regional, national or international significance, and ascribed a status related to their vulnerability (1= High, 2= Moderate, 3= Robust).

From these rankings, Wilde and Worthy (1992) developed the Cave and Karst Management Strategy and Operational Guidelines (*CKG*) for DoC's West Coast Conservancy, in which caves were allocated into four categories for visitor access: *Open* access, *Tourist* caves, *Limited* access and *Restricted* access. Currently DoC Buller are using this classification for different caves in the region (Wilde and Worthy, 1992: pp 40-42).

Caves that are *Open* in their access are available to those visitors who wish to experience a cave environment, and are sufficiently robust or damaged to a level where further visitation has little more significant impact. *Tourist* or adventure caves are caves where concessionaires can operate and impacts can be controlled in a guided situation, such as in black water rafting operations[21]. *Limited* access caves require a permit from DoC and at least one of those entering has to be a current member of the NZSS, and conform to the Society's code of ethics. *Restricted* access caves or sections of caves are typically very sensitive or fragile to enter, and are usually gated to restrict entry for scientific or special purposes only.
This classification system operates at the cave or individual site level. Sections or passages of individual cave systems may have a combination of different access arrangements and be managed accordingly. The NZSS have developed this concept further with an additional level of within-cave classification recognising the need for introducing more flexible cave management for the purpose of access and conservation[22]. The within-cave level addresses the need to manage individual passages within caves, and recognises, for example, that there may be open passages and restricted passages in the same cave.

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[21] One of the management recommendations in the *CKG* was that only one concession per cave be permitted (Wilde and Worthy, 1992). This aids in accountability and transparency if there is any damage, and concession rights can be limited to one company if there are conservation reasons to do so. However, DoC can issue more than one concession in robust caves.

[22] Cody, A.; Wilde, K.A.; and Worthy, T.H., (1982) A Basis for NZ Cave and Karst Management. *NZ Speleological Bulletin* 7 (124): 94-98 - also at www.massey.ac.nz/~SGlasgow/NZSS/policy.htm

Another way of classifying individual caves and within-cave environments is by describing caves in terms of the energy levels within them as *high* energy, *moderate* energy and *low* energy (Heaton 1986, cited in Bunting, 1998). Under this method, Xanadu Cave fits the category of a *high energy* cave due to the frequent flooding it experiences. These flood events scour passages making speleothem formation rare and/or confined to less flood affected areas. Floods also introduce terrestrial and aquatic insects into the cave providing energy for glowworms and other predatory fauna. In these dynamic *high energy* caves, visitor impacts are likely to be less significant due to the background forces of frequent and intense disturbance impacts. Fox River Tourist caves fit into the level of a *moderate energy* cave. This type typically has less frequent stochastic events, and energy inputs are less, although they can often have numerous speleothem formations due to abundant saturated water (Tercafs, 1993, cited in Bunting, 1998). *Low energy* environments are caves where there is a much slower and less frequent level of change, with delicate and small formations from the slow deposition of material, and accordingly are the most sensitive to impacts from the sudden introduction and release of energy from visitors (*ibid*).

2.4.3 Effects of Visitors and their Management

Table 6 has been collated from a number of different sources for individual caves and within-cave attributes. Most effects are also indicators of negative impacts that need active management, others are direct management obligations and requirements that can be met through consultation, interpretation and/or monitoring.

These effects can occur within the individual cave, or be related to above ground activities such as surrounding land uses across the landscape. Land clearance or farming may impact on cave ecosystems with respect to increased sedimentation from these activities. This has been an issue for some North Island caves in particular, such as the Waitomo caves, although in the Buller region of the West Coast the main landscape influences on caves are more likely to be mining or earthquake related.

However, determining the effects in an individual cave from visitor monitoring cannot in itself necessarily tell managers how to mitigate them, or inform managers as to the level of desired conditions or acceptable environmental change at the site. Over the last two years, DoC have recently begun to grapple with cave management issues in Buller. This is in response to reports of increased levels of impacts since the *CKG* were produced, and the changing nature of cave use and cave users over the last decade. In 1992, when the *CKG* were approved by DoC's West Coast Conservator, there were fewer recreational cavers and concessionaires. Now, there are more recreational cavers who have not come through the local club/NZSS path, but have been introduced to caving through outdoor education classes at Tai Poutini Polytechnic and Buller High School (Martin Abel, pers comm). There has been a slight increase in concessions issued, although NorWest Adventures and the Last Resort in Karamea are still the two main operations, and both have had significant visitor growth.

Table 6
List of Management Requirements and Effects – Caves

Generic to all caves	Specific to some caves
Taha Maori	Speleothem condition
Safety	Discolouration of limestone
Hazards	Illegal access
Damage/vandalism	Cave flora
Negative visitor behaviour	Lighting
Litter	Carbide dumping
Waterway sedimentation	Humidity/temperature
Mud	CO_2
Water quality (eutrophication/faeces)	Surrounding land use/alteration of hydrology
Human waste	Damage from cave cleaning
Passage enlargement	Displacement into other caves through overuse
Erosion of rock surfaces	Endemic fauna decline/displacement
Track wear and tear	Effects on cave flora
Interpretation/visitor experience	Fungal pathogens
Exotic weeds/pests	Fossil disturbance/damage/removal
	Entrance enlargement
	Noise
	Heavy metals
	Formation corrosion
	Cave desiccation
	Physical damage from cave divers
	Human skin/hair, dust and lint from clothes

Table 6: List of management requirements and effects of visitors generic to all or most caves, and those that are specific to some caves.

Sources: Williams and Wilde, 1985 – and references therein; Wilde and Worthy, 1992; DoC, 1993; Manidis Roberts Consultants, 1995; Thurgate and Hamilton-Smith, 1998; Bunting 1998 - and references therein.

Although historical management of different areas for access in the Buller region has relied in large part on the identification of suitable caves and cave passages discussed in the *CKG*, implementation of the *CKG* has not proceeded in an integrated way until recently. The specific goals outlined in the *CKG* document (p1) were:

- To maintain natural ecological, hydrological and geological processes and the natural scenery of cave and karst areas.

- To engender an awareness by the general public of the scientific, scenic, cultural and recreational significance of cave and karst resources.

In order for these goals to be achieved, several objectives were also set:

- Educate landowners and managing bodies of the consequences of actions they may take which could affect the cave and karst resource.

- Formulate detailed management policies and guidelines for areas containing caves that will embrace the natural, cultural, scientific and aesthetic values of these features, and which will provide for a suitable level of protection.

- To engender an awareness by resource managers and the general public of the way in which caves and karst are vulnerable to human visitation and changes in surface land uses.

As a recent first step to understand the nature of the current situation, DoC's Cave Management Program has begun to identify the values associated with different caves (e.g., speleothem formations, fossil remains, pollen deposits). The next step has been (and is still ongoing) to identify the type and level of impacts in the most popular caves. Photo monitoring points have been set up following management inspections in Honeycomb, Fox River, Babylon, Crazing Paving and Box Canyon, Metro, and Megamania caves (Carden, 1998[23]). Passages in several of these caves have been taped to direct visitors, interpretation is being upgraded at some sites, and more frequent visits by DoC staff are occurring to reinforce their management role. These caves vary in their access and predominant user groups, and there are different sets of issues in each cave (Martin Abel, pers comm; Carden, 1998). For example, the Naked Ladies speleothem formations in Babylon cave are rated as some of the most spectacular in Buller, but there are substantial mud deposits on the cave floor leading into the main chamber and increased visitation is slowly transporting the mud into the chamber. Metro Cave has issues associated with heavy concession use in respect of passage and entrance enlargement for easing visitor access, and the movement of a moa skeleton from nearby Waireka Cave[24]. Access to areas of Honeycomb have been gated and restricted to permits issued to NZSS member parties only, due to the sensitivity of various passages and formations, and accumulated impacts of recreational use.

What is clear from DoC's assessment of visitor impacts is that all cave users and user groups have impacts (Martin Abel, pers comm). In order to investigate the relationship between impacts and accumulated visitor use DoC have several strategies in place. For example, in Megamania cave which was only relatively recently discovered, there had only been relatively few visitors before DoC established photo monitoring points in an attempt to gather data on the degree of physical impacts over time, associated with increased use. In a newly discovered cave as yet unnamed, DoC provided surveying tape for mapping to help in working together co-operatively with recreational cavers. DoC also managed to institute monitoring of cave condition soon after discovery. Although these are physical monitoring points, DoC should also consider monitoring for changes in invertebrate diversity, abundance, and distribution over time.

DoC have been developing relationships and networking with different cave interest groups to promote better understanding of users' rights and responsibilities. For example, DoC and the Canterbury Caving Group, with assistance from DoC have taped and cleaned sections of Babylon cave with similar work proposed for Metro cave. Relationships with the NZSS are also developing with DoC consulting the NZSS over cave conservation issues.

Gating is a sensitive issue as it sends a strong message to users, especially when there has been historical use of a cave. Gates can be used to deny access or they can be used to restrict access to NZSS members or concessionaires. Permitted entry retains a record of the amount of use and lines of accountability. Gates can be effective with careful placement and construction, but they can be, and often are, destroyed by those who believe that they have a right of access anywhere at anytime. Gating is a last resort to restrict or deny access, but it is an important management tool in determining what levels of access are appropriate for

[23] A list of impacts at different caves and management response is summarised in the DoC West Coast Conservancy – Visitor Monitoring Plan Visitor Use and Impacts (Carden, 1998).

[24] DoC spokesman Steve Addison quoted in *The Dominion* newspaper, Wednesday September 6, 2000.

different cave passages. Examples of fossil damage, speleothem breakage, carbide dumping, and human waste in sensitive areas of Buller caves all leave a permanent record of impacts and irreversible damage in these ecologically unique systems.

To set the limits of acceptable change for individual caves and/or within-cave areas, requires an *a priori* set of processes involving close liaison and networking. Primarily this should occur between DoC, or private cave managers, with NZSS members, iwi, researchers and concessionaries as to the outcomes or conditions for different caves that differ in their access arrangements. Behavioural change is linked to acceptance that with rights of access, users have obligations and responsibilities. It must be stressed that most users have comparatively little impact, but due to the accumulation of impacts, genuine mistakes, or carelessness, cave environments retain an unfortunate permanent record of disturbance and human-induced change, as most medium or low energy caves are not ecologically resilient.

DoC have a range of regulatory tools to restrict access to caves, and some thought should be given to the merits of an allocation model for caves to protect the rights and options of future generations, if the levels of impacts continue to accumulate in caves throughout the region. Under Section 6 of the Conservation Act (1987), DoC are charged with the responsibility *"to manage for conservation purposes, all land, and all other natural and historic resources"*. Visitor access is allowed on DoC managed land *"to the extent that the use of any natural or historic resource for recreation or tourism is not inconsistent with its conservation...*s6 (e).

Conservation is defined as the *"the preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations"*. Clearly uncontrolled impacts on some caves, and the deterioration of their intrinsic values as a result, means that DoC can and should restrict, or deny, access in certain circumstances as a management tool, in order for it to meet its obligations under the Conservation Act.

2.4.4 Local cave condition and management around Punakaiki

Fox River Caves

These caves have been a tourist attraction since late in the 19th century and continue to be popular with visitors to the region (Table 1). Visitors walk for an hour along a pleasant well-maintained lowland forest track beside the Fox River, passing underneath podocarp/hardwood forest dotted with impressive rimu, kahikatea and northern rata trees, interspersed with the characteristic nikau palms of the area. There are two caves: the River Cave and the Tourist Cave. The larger River Cave has 2720 m of surveyed passages, and a number of different obstacles, which make it the region's premier sporting cave (Wilde and Worthy, 1992). However, there are deep rifts 100 m into this cave making it unsafe for casual or ill-equipped visitors, and there is a sign placed by DoC closing this cave to visitors (*Plate 20*)[25]. A stone path leads to the entrance of the smaller Tourist Cave, and visitors can explore for 150-200 m before a tape placed over a narrowing low passage discourages further access. This cave is designated as open access due to its historical use.

[25] DoC have also placed a sign in the carpark at the track entrance warning of hazards such as pothole and grikes (chasms) off the marked tracks in this limestone landscape. Visitors are also appraised of hazards in the area associated with caving at the DoC Punakaiki Field Centre, and there are signs advising people to care for cave formations.

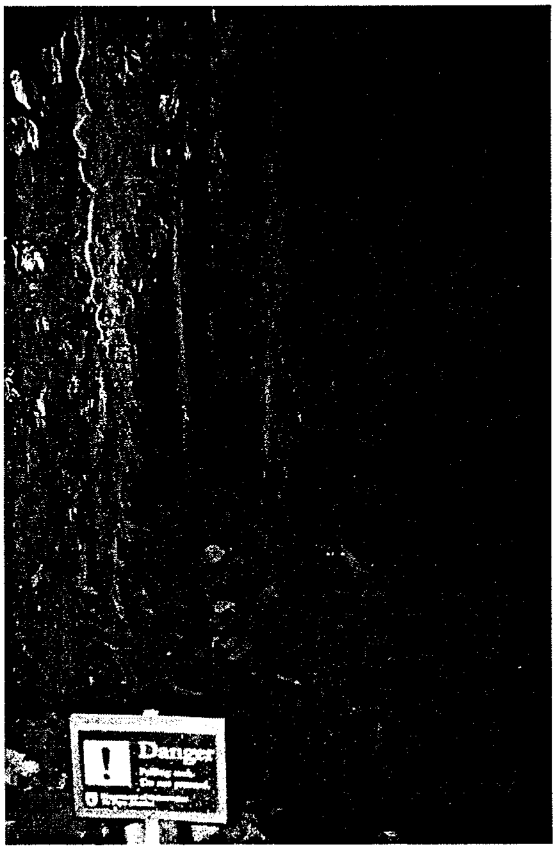
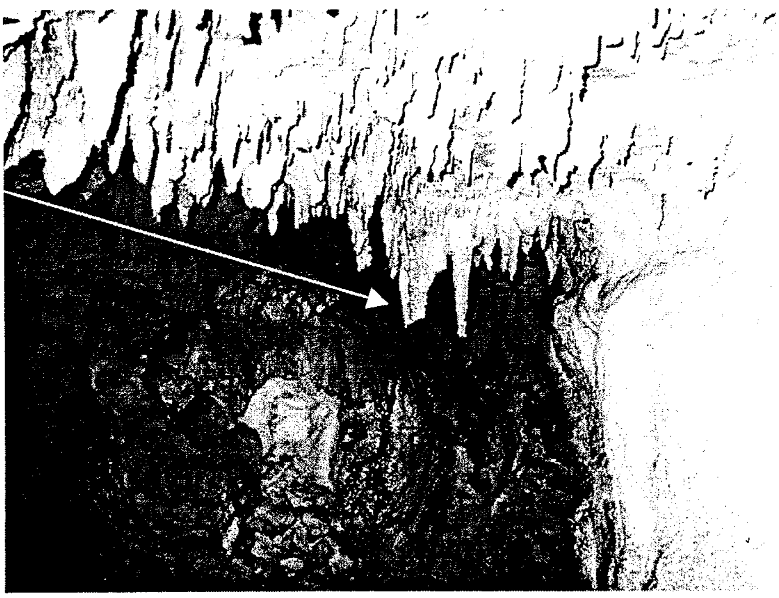


Plate 20 - DoC sign outside entrance to the main Fox River Cave (K. Hughey).

The Tourist cave has a large number of speleothems enabling visitors the opportunity to see these delicate formations, however most of the large stalagmites and stalactites within reach are damaged or snapped off (*Plate 21*). The cave floor is also discoloured by mud (*Plate 22*) and the cave floor waterway is disturbed with sediment (see also Johnson *et al.*, 2000, for visitor observations of impacts). There are also etchings into the rock around the cave entrance. Although there were obvious impacts pointed out by visitors surveyed at the caves, most visitors enjoyed their opportunity to experience a cave environment, emphasising that even after a century of historical usage this cave still has tourism benefits despite being a 'sacrificial' cave (Johnson *et al.*, 2000). Despite this, DoC have actively managed this cave to mitigate the worst of these effects. For example, there was a recent clean up organised by DoC in May 1999 which involved 12 people for four days washing formations, carrying out mud, and re-laying a stone path up to the entrance, as part of the DoC's *Mana Wahine* community liaison[26]. DoC intends to now put these caves on a regular cleaning cycle involving user groups such as outdoor education classes (Martin Abel, pers comm).

Plate 21 - Speleothem damage in the smaller Fox River Tourist Cave (K Hughey)



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[26] Murray Thomas DoC Punakaiki - correspondence dated 7 February 2000.

Plate 22 - Mud on cave floor in the smaller Fox River Tourist Cave (D. Simmons)

The Punakaiki Cavern
Access to this sea cave is open to all, and its close proximity next to the State Highway 6, between the Pancake Rocks and the township, means that it probably receives many more visitors than the Fox River Caves. The cavern is wide but it is relatively short, and it is considered a robust cave suitable for open access (Wilde and Worthy, 1992). It is classified as a Short-Stop Traveller site, and DoC plan to manage it to that standard (Murray Thomas pers, comm). It is currently regularly maintained, but there are no plans to upgrade facilities.

In terms of infrastructure, there are a series of small wooden staircases placed from the road leading to the base of the cavern, a standard DoC sign, a rubbish bin, and marker poles within the cavern. Visitor impacts include the presence of litter in the bush around the cavern base, and etchings in the wooden stair rails and cavern walls. Several foot trails were also evident around the site causing localised erosion. The open access and the shape and geomorphology of the cavern make it difficult to manage for visitor impacts, and in this sense it is subject to the vagaries of visitor behaviour, although DoC are managing it appropriately.

Xanadu Cave
Safety issues are the paramount concern for this epiphreatic[27] maze cave where flash flooding can be perilous (Wilde and Worthy, 1992). The entrance is by the bed of Bullock Creek, and the passage floors in many areas are littered with the debris of previous floods, as the water submerges for 5 km before re-emerging at Cave Creek. The high energy inputs from flooding mean that this cave system is robust and considered suitable for tourist access with appropriate safety precautions. The concessionaire, Paparoa Nature Tours, operates with an observer stationed farther up the catchment to warn the tour in the event of rain. A safety briefing is carried out prior to entrance into the cave and visitors are provided with appropriate safety gear. Visible impacts from visitors are minimal due to the scouring and deposition from frequent floods, although occasional graffiti has been noted (Carden, 1998). There are few speleothems and these are found in areas less prone to flooding. Visitors are appraised of the correct behaviour towards these delicate formations where they view them by the concessionaire Paparoa Nature Tours, and DoC are carrying out routine inspections of the cave crystal section (Carden, 1998).

2.4.5 Summary

Cave ecosystems open to visitor contact often bear highly visible impacts, particularly those that are described as low energy and moderate energy caves. Although, moderate energy caves such as the Fox River Tourist caves have been heavily impacted by decades of

[27] Wilde and Worthy (1992: 85) *Epiphreatic* refers to the passages that are intermittently flooded and these lead to 'growth' of passages during total flooding. Flooding can be seasonal, diurnal or random as at Xanadu. At other times passages do not have flowing water in them.

visitation, they can still provide visitors with a positive advocacy experience. Impacts to caves we studied and their associated physical structures and biotic assemblages are diverse (Box 3) and considered largely density independent. In effect, this means the highest level of impacts occurs within a short period following exploration from relatively few visitors, rather than at the scenic *icon* sites and seabird sites we studied where cumulative impacts from increasing visitor pressure over time can potentially trip tolerance thresholds.

From our review of cave literature, there are a range of management tools and options available to assist DoC in their management to give effect to statutory responsibilities. These include taping visitor pathways, mitigation of mud and sedimentation, and closure of high conservation value caves and cave passages to safeguard the options of future generations.

Asset:	Physical - Caves.
Activities:	Walking, viewing (includes breathing for CO_2), exploring, rafting.
Impacts:	Damage/vandalism to formations and speleothems; discolouration/mud on flowstone and cave floors; change in diversity, abundance and distribution of cave fauna (esp. rare and/or endemic species); increased exotic species distribution and cover; water quality (faeces, sediments, eutrophication, heavy metals); entrance and passageway enlargement/erosion; litter (incl. carbide dumping); fossil disturbance and/or removal; fungal pathogens.
LAEC:	Work to safeguard options for future generations by developing allocation model for visitor access. Prevent and/or minimise damage to high value areas with special and unique formations (incl. flowstone, speleothems, fossils). Maintain rare and/or endemic fauna.
Guidelines:	**(generic)** Reduce and mitigate mud accumulation, cave waterway sedimentation, and pollution. Provide clear interpretation for visitor behaviour and safety. Develop partnerships with user groups and individuals. Monitor key fauna species (distribution and abundance). **(specific)** Tape pathways in individual passages. Restrict and/or deny access to highly sensitive and fragile formations/fossil areas. Monitor effects of CO_2. Mitigate and remedy weed invasions. Mitigate impacting surrounding land use practises with landowner consultation.
Indicators:	Number, percentages and distribution of damaged speleothems. Level and distribution of mud accumulation. Diversity, abundance and distribution of cave fauna (for endemic *Sperlungula cavernicola* spider may also include condition and number of hanging egg sacks). Footprints and erosion of surfaces off marked/taped routes. Change in water quality (turbidity, choliform and metals in cave waterways). Presence/absence of exotic organisms.

Box 3: Summary of impacts from visitor activities and indicators of environmental change at cave sites.

Chapter 3
Environmental Indicators and Limits of Acceptable Environmental Change (LAEC) at Natural Assets

3.1 Identification of indicators and management of visitor activities

In this study we examined visitor activities and management of the effects of these activities at different assets, following the development and testing of *tourism-effects* models at scenic *icon* sites and seabird sites, and after a review of cave impact literature. We identified indicators associated with visitor activities which were primarily based around walking and viewing. We suggested for each asset type, how these different indicators could be used in monitoring to assess and help develop the process of setting the limits of acceptable environmental change (LAEC) (Boxes 1, 2 and 3). For the seabird and cave sites, we also identified management requirements and effects of visitors generic to all or most sites, and those that were more site specific in nature (Tables 5 and 6), that also need to be considered in the LAEC process.

Much of this report has focussed on sites managed by the Department of Conservation (DoC), primarily because they are the major tourism provider on the West Coast, managing a diverse array of physical and geological scenic sites, wildlife and cave ecosystems. We found that there are some areas that DoC were managing well such as scenic *icon* sites and tracks. However, at the wildlife sites managed by DoC, and in cave ecosystems, we found visitors were not managed to the same consistent standard. There is also a general lack of clearly defined processes and mechanisms for devising limits of acceptable environmental change at these sites, and implementation of management accordingly.

Setting the desired conditions, or levels of acceptable environmental change, is a complex task at any individual site. At one level there are generic indicators relevant to a particular asset type (e.g., fledging success at seabird sites), and at the site level there are particular sets of conditions or species characteristics (e.g., penguin behaviour) that need to be considered in monitoring for change. Moreover, determining which effects are due to visitors and which are due to normal population fluctuations, or natural erosion processes, are not easy to unravel without detailed observational studies, but for all that a common sense approach is required especially when visitors are encouraged. For example, at seabird sites some management of visitors is necessary to keep them from trampling burrows, or disturbing birds either in the nesting or guard stages of their breeding cycle, and when foraging. This may be as simple as constructing an observation hide or a visitor shelter in some areas, to alleviate potential interference from all but the most determined visitor. The privately managed Westland black petrel colony in Punakaiki is an example of appropriate management, with foresight and planning to accommodate visitor access without compromising the wellbeing of the target species.

Therefore, indicators of environmental change should be selected that both relate to visitor management, and to the health and condition of the attraction itself (the *ends* in other words). This requires an integrated site approach. Table 7 outlines one approach to applying guidelines to managing impacts of visitor activities, from monitoring of indicators at the generic (*top down*) and site-specific (*bottom-up*) level at different attractions.

3.2 Limits of acceptable environmental change - scenic icon sites

The scenic *icon* sites are effectively the 'shop window' of conservation management on the West Coast. The effectiveness of DoC's management and the sensitivity of the design of the upgrades have resulted in high levels of visitor satisfaction at the Pancake Rocks (Johnson *et al.*, 2000). The message of *kaitiakitanga* is conveyed to visitors through the high standard of maintenance and interpretation at these sites. Therefore, visitor impacts are well mitigated. Although managers at the sites have focussed more on upgrading the facilities to prescribed standards, rather than acting in response to the level of visitor impacts, regular site inspections meant that indicators of cumulative visitor impacts were observed in the deterioration of tracks, and also in negative visitor feedback. Meeting the prescribed standards in the DoC Track Service Standards (1998*a*) and Hut Service Standards (1998*b*) manuals are methods of determining and managing the level of acceptable change at an individual site. Consultation with stakeholders means that the desired conditions for the site are also determined through the design process. Establishing and monitoring for the limits of acceptable environmental change occur through public input, mitigating construction activities, growth in visitor numbers and patterns of use, visitor experience and satisfaction, population dynamics and vigour of key species (e.g., weeds or rare natives), and restoration plantings.

Table 7
Generic and Site Specific Indicators and Management Guidelines

Attraction Type	Generic Indicators	Generic Guidelines	Site-specific Indicators	Site-specific Guidelines
Scenic *icon* sites	Infrastructure condition	Develop to avoid *narrowing staircase*	Condition of rare/endangered spp.	Protect and/or restore
	Visitor behaviour	Interpretation, well-maintained facilities and tracks.	Growth and survival of restoration areas	Maintenance of ecological processes and communities
	Damage/vandalism	Interpretation, *kaitiakianga* (care and repair)		
	Pollution (incl. Litter)	Interpretation, amenity provision		
	Invasive species	Monitor and/or Control		

Attraction Type	Generic Indicators	Generic Guidelines	Site-specific Indicators	Site-specific Guidelines
Seabirds	Nesting success	Visitations at certain times of day, night or season	Burrow damage/ erosion	Track provision, Interpretation
	Fledging success	Develop long-term popn. dynamics study		
	Species behaviour	Minimise disturbance and stress		
	Predator monitoring	Traps, capture frequencies		
	Visitor behaviour	Interpretation, visitor facilities, hides, amenities, tracks		
	Damage/vandalism	Interpretation, *kaitiakianga* (care and repair)		
	Invasive weeds/pests	Monitor and/or Control		
Caves	Visitor behaviour	Creating taped visitor pathways, interpretation	Fossil disturbance and/or removal	Interpretation, restrict access
	Pollution, water quality, mud/sedimentation	Interpretation, periodic clean-ups	Speleothem condition	Interpretation, restrict access to high value areas
	Cave fauna	Diversity, distribution and abundance of species – review access, interpretation	Surrounding landuse	Interpretation, consultation with landowners for mitigation
	Damage/vandalism	Interpretation, Restrict access	Passage erosion/ enlargement	Interpretation, consultation

Table 7: Generic and site specific indicators and management guidelines to manage the effects of visitor activities at the different attraction types examined in this study.

We found that the assumptions of the *narrowing staircase* model to be robust in respect of the expected long-term resource savings gained from substantial site upgrades, by not having to do more frequent minor upgrades. The necessity for regular maintenance to begin immediately after project completion to consolidate the gains, and to prolong the life of the asset upgrade, was emphasised by the DoC Fox Glacier management team. Their systematic, methodical approach to asset management means that DoC in Fox Glacier are well on the way to upgrading their physical front and back country assets to prescribed standards, and placing assets on regular programmed management cycles.

3.3 Limits of acceptable environmental change - wildlife sites

The indicators we found to be generic at all three seabird sites, which can be used in the process of determining levels of acceptable environmental change, were fledging success, bird displacement and behaviour, predator abundance, visitor numbers and use patterns, and visitor experience. Site-specific indicators related to individual species breeding areas, and site characteristics such as geomorphology and vegetation. Some of the generic indicators will vary seasonally, or diurnally, or at different stages of the breeding cycle. In monitoring for different impacts on birds by visitors, Ratz and Thompson (1999, and references therein) summarise various spatial and temporal disturbance effects that could occur at three levels: *Inter-annual*, *Intra-annual* and *Instantaneous*. *Inter-annual* effects relate to reductions in bird abundance and/ or localised shifts in distributions. *Intra-annual* effects are a reduction in breeding success and/or shifts in the centre of activity. *Instantaneous* effects are primarily behavioural or physiological responses such as increased vigilance, fleeing, and/or a change in heart rate.

The wildlife sites we studied on DoC managed land are classified as *Day Visitor* sites (DoC, 1996). DoC identified this type of visitor activity as a priority for increased management and financial expenditure, because of the potential for high environmental impacts associated with increasing demand for accessible outdoor experiences. The emphasis in the *Visitor Strategy* (1996) is on the provision of infrastructure and facilities for these visitors, focussing on a *'high standard to minimise discomfort or risks to their* (visitor) *safety'* (p33). There has been an emphasis on managing the quality of the attributes (or *means*) by which visitors reach the attraction at the two wildlife sites we studied, rather than perhaps explicitly managing visitors at the attraction itself (the *ends*).

DoC has a range of potential management tools outlined to deal with visitor impacts where values and environmental conditions are at risk of degradation (Carden, 1998:16-17). These are to: *reduce the use* of the site by restricting visitor numbers; *modify visitor activities* and behaviour mainly through interpretation and education; *modify the timing* of visitor activities; *move the activity*/facility/service somewhere else better able to cope; and/or *increase the site resistance* by barriers to separate visitors from the target resource. The method that DoC mainly use for different types of sites to manage Day Visitors is by interpretation and education, as it is expensive and impractical at current funding levels to have staff on-site directly managing visitors. On-site interpretation panels and signs are used to reinforce appropriate visitor behaviour, and rely in large part on the voluntary compliance of visitors. However, this approach may not be successful if interpretation is not accompanied by shelters or observational facilities to directly manage visitors at the attraction, such as for the penguins at Monro's Beach. In the case of the Mt. Oneone platform there are no signs at all to inform visitors to be careful around the shearwater burrows. In contrast, there was on-site management and control of visitor behaviour at the privately-run Westland black petrel colony, visitors were managed effectively and generally received a close-up quality contact experience with these seabirds.

Arguably, the nature of the species and its behaviour determines the quality of the experience visitors receive. For example, shy, timid Fiordland crested penguins are less likely to allow visitors to get close up than the more robust Westland black petrels. However, other studies of seabird sites in New Zealand have found implementation of visitor management to be important in reducing disturbance and stress on different bird species, whilst allowing visitors a positive experience (Robertson, 1993; Wright, 1998; Ratz and Thompson, 1999). In the case of the similarly shy yellow-eyed penguin (*hoiho*) which is sensitive to human disturbance, a system of covered trenches and observation hides at a privately run and managed colony allows visitors to observe normal penguin behaviour (Marchant and Higgins, 1990; Ratz and Thompson, 1999). This colony at Pipikaretu Beach near Dunedin receives over 30,000 visitors per year, yet nest numbers have increased over time suggesting that with careful management of visitors, these shy and timid birds are not experiencing detrimental impacts, and visitors are also getting a quality experience (Ratz and Thompson, 1999). However, these authors observed that penguins fled when people got out of the trenches and approached them. Wright (1998) found that if people were present in the area where the yellow-eyed penguins nest and their landing site at Sandfly Bay in Otago, they were less likely to come ashore than if people were elsewhere on the beach. However, Wright found that when visitors complied with the instructions on the DoC interpretation panels and proceeded directly to the observational hide, the yellow-eyed penguins readily came ashore. The Fiordland crested penguin, like the yellow-eyed penguin, is sensitive to human disturbance (McLean, 1995), and is reluctant to come ashore if people are visible between their nests in the coastal scrub and the shore (Van Klink, pers comm). How significant relatively uncontrolled visitor access on the beach at Monro's is on fledging success, could be determined by a detailed observational and comparative site study (e.g., visited vs non-visited colonies).

Management can mitigate some visitor effects, but where there is heavy demand for viewing wildlife such as the royal albatross at Taiaroa Head near Dunedin (>100,000 visitors), changes in bird behaviour and displacement can still occur (Robertson, 1993). Despite the construction of an observatory for viewing, there were significant changes in short- and long-term breeding behaviour. Robertson (1993) reported there was an increase in the number of birds breeding out of view, of birds that were bred in front of the observatory most (60%) chose to breed out of sight. Fencing of the reserve by DoC was necessary to mitigate negative human impacts at the Taiaroa Head colony including vandalism, stoning eggs and parent birds, taking eggs and disturbing the birds at critical times of the breeding season (DoC Otago Conservancy, 1992; Clearwater, 1993). Other impacts have been recorded for seabirds that are not directly managed (Clearwater, 1993; PCE, 1997*b*). For example, Stewart Island shags were reported to readily have deserted their nests if there was even a mild degree of human disturbance (Lalas, 1993), and on the Otago Coast, Gales (1984) reported that when spotted shags left their nests in response to human disturbance red-billed gulls took their eggs.

Clearly, thoughtful management can reduce or mitigate impacts. This has been demonstrated on private land with the Westland black petrel in Punakaiki and the yellow-eyed penguin in Otago, where with an ethic of *kaitiakitanga* that includes careful observation, managers gain knowledge about species behavioural ecology and conservation. The visitor receives a strong conservation and advocacy message at the Westland black petrel colony, and this educative approach is a fundamental component of ecotourism (Valentine, 1992). We observed that there was potential for integrated links between private, iwi and DoC managers, to share research and cooperate through consultation, co-ordinate predator control, and devise limits of acceptable environmental change associated with visitors.

In the case of the one breeding white heron (*kotuku*) colony in south Westland, DoC manage the resource in partnership with an ecotourism operator. There are less than 200 white herons, and although white herons are found elsewhere in the world, funding is provided by DoC for predator control with DoC receiving revenue in return in the form of a concession license fee. In addition to restricting visitor numbers, DoC manage visitor behaviour through a comprehensive set of 13 prescribed conditions that the concession operator has to adhere to (Kazmierow, 1996). The implementation of these standards has been evaluated as successfully eliminating negative short-term effects of visitors on white heron behaviour, although long-term effects in terms of nest displacement in terms of distance from the observation hide are still unknown (Kazmierow, 1996).

The disturbance of different freshwater bird species from boats along waterways was the main effect of the concession operation at the white heron colony. A recent comprehensive literature review of effects of visitors on freshwater avifauna also found boat traffic commonly disturbed birds (Walls, 1999). Freshwater birds are particularly sensitive to loud noises, sudden movements or rapid movements from visitors. The impacts of these have been found to be accentuated during the bird's breeding season, moulting and times of climatic stress (Walls, 1999). This literature synthesis showed that disturbance from human impacts came from a diverse array of cultural, recreational and economic activities. In this respect, generic indicators identified in our study of seabirds can also be applied to freshwater avifauna. Site specific indicators of environmental change will vary with the target species as some freshwater species are more susceptible than others to short term disturbances. The ability of species to cope with human activities depends on several factors, including the frequency and intensity of disturbance, the proximity of the disturbance and its effects to nests, and the availability of quiet refuge areas or available habitat (Montgomery, 1991; Keller, 1996; Smith *et al.*, 1997; Walls, 1999).

3.4 Limits of acceptable environmental change - cave ecosystems

In contrast to the other sites, resilience to disturbance and reversibility of impacts in medium or low energy cave systems are low. Impacts to cave physical structures are often irreversible and limit the opportunity for future generations to see unspoilt caves. If access is permitted it is unrealistic to expect that impacts will not occur - as encapsulated in the comment '*no people - no problem*'. However, it is unreasonable to deny people the chance to experience these environments.

The physical indicators of visitor impacts are reasonably well understood and generally visibly obvious, although impacts on cave fauna and cave geochemical processes are less well understood and documented. DoC are making progress in understanding the physical impacts, but have yet to go through the process of setting limits of acceptable environmental change for individual caves in consultation with stakeholders. They are currently commencing a review of cave access arrangements, which presents an opportunity for this to occur. One option to safeguard the options of future generations is to consider the merits of a cave allocation model where some caves or cave passages are taken out of the available network and entry is denied by gating. Whatever mechanisms DoC use, there is a clear obligation under s6 of the Conservation Act 1987 for the values of cave systems to be conserved and visitor access allowed if use does not affect these conservation values.

Determining the limits of acceptable environmental change in different above and below ground areas of the Jenolan Caves in Australia, has been a feature of their management (Manidis Roberts Consultants 1995; Thurgate and Hamilton-Smith, 1998). The management approach has been to identify different issues and processes at the caves and to set the desired conditions, or limits, to address these (for example - air quality, hazards, hydrological processes, water quality, visitor experience, etc).

The framework for understanding the numerous environmental and social issues at the Jenolan caves is based around seven essential elements, so that the caves are maintained in good condition for the future (Thurgate and Hamilton-Smith, 1998). These are:

1. Environmental and social issues identified for above ground areas and different caves.
2. Key indicators to be used to monitor issues.
3. Desired conditions for each issue.
4. A method for monitoring the indicators.
5. Causes of problems associated with issues.
6. Priority of cause and limiting factors.
7. Management response.

At Jenolan Caves, there was an independent Social and Environmental Monitoring Committee established in 1996 to advise, oversee and make recommendations as to priority of research and monitoring needs at the caves. This committee, comprising researchers and cave enthusiasts, has instigated many research projects and works closely with managers from the Karst Resources Department to better integrate management at the caves.

Here in New Zealand, although the NZSS works with DoC at a regional and national level in the allocation of caves for visitor access, there may be some scope for an integrated stakeholder oversight committee led by DoC in the Buller region, involving different groups to set limits of acceptable environmental change on a cave by cave basis.

Chapter 4
Conclusions

We examined the relationships between tourist numbers, tourist activities and tourism assets for three sorts of natural assets on the West Coast of the South Island, New Zealand. For all of these assets the tourism-impact relationship is complex. There is a major seasonal issue with wildlife attractions with the greatest potential impacts likely to occur in the breeding and/or moulting seasons. Tracks are complex because they are often 'means' to an 'end' and the impacts can be classified in a number of ways (e.g., weed and pest encroachment, compaction, erosion and rubbish – in this situation we have combined the impacts to create one overall measure of impact). Caves are also relatively simple because most impacts are physical and relatively easily measured. Tracks, at least of the assets studied, can be developed in such a way that biophysical environmental impacts can be largely avoided, remedied or mitigated. LAEC can therefore be set with strict environmental objectives in mind. Managers and policy makers need to note, however, that despite such achievement the social acceptability of the development of such infrastructure etc. is unknown and beyond the scope of this study.

The models derived for these tourist-impact relationships are mostly complex. For these models to be verified and used in other applications, such as for other components of our current work, they need to be simplified further and more data collected from other locations. This simplification and collection are key aspects of our continuing work.

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Appendix 1
Environmental Indicators For Tracks On The West Coast

Introduction

To identify indicators of the environmental effects of visitors on track systems, and to assess the management of these effects, we inspected the current state of six tracks on the West Coast. All tracks are on land managed by the Department of Conservation (DoC).

These tracks are in the front country[28] (Figure 1), and therefore receive frequent, and at times intensive use. Three tracks are high-use tracks leading to scenic *icon* attractions: the **Pancake Rocks** at Punakaiki and **Cape Foulwind** Seal Colony near Westport in Buller, and **Lake Matheson** in south Westland (Table 1). These encompass short popular walks to scenic geological sites or to see wildlife, and visitor use is mainly classified *as Short Stop Traveller* (SST) in DoC's *Visitor Strategy* (1996). The other three tracks are medium- to low-use tracks that receive less visitors: **Fox River Caves** near Punakaiki, the **Wanganui Coastal Pack Track** to Mt. Oneone, and **Monro's Beach** in south Westland. These tracks are classified as *Day Visitor* (DV) by DoC for management, and are distinguished from high-use tracks by their greater distance and time taken to walk them[29].

Methods

We used a combination of site inspections and interviews with DoC managers, to assess the environmental effects of visitors on the tracks. All sites were visited at least once over the summer 1999/2000. At each site we used a range of different visual indicators to evaluate the current condition of the tracks:

⇒	Recovery of old abandoned tracks	⇒	Exotic Weeds
⇒	Litter and Visitor Amenities	⇒	Vandalism
⇒	Interpretation/ Signage	⇒	Track Erosion and Washouts

Results and Discussion

We found the six tracks we inspected to be generally well constructed and maintained. Overall, we found management approaches to tracks in different areas to be sound, with programmed regular maintenance, and regular site inspections to keep sites visibly well managed to a consistently high standard. The associated track infrastructure, such as bridges and boardwalks, also appeared well designed and maintained, as at Monro's Beach in south Westland (*Plate 23*).

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[28] The *front* country are sites that are easily accessible to visitors from main roads, *back* country are less accessible areas.

[29] Some tracks such as Lake Matheson and Cape Foulwind have both short popular walks for SST's and longer walks for day visitors (DV's). Accordingly, the management of these sites caters for different types of users. For the purposes of this track section, we examined the short popular walks at these sites. At Lake Matheson we looked at the track from the car-park to the Jetty, and at Cape Foulwind from the car-park to the seal viewing platforms.

Plate 23 - Bridges and boardwalks – Monro's Beach

The technology involved in the design, construction and implementation of tracks means they generally have low impacts on the environment when they are evaluated as a *means* (an *attribute*) to an *end*. The '*ends*' in this case are the actual site *attractions* on the West Coast, such as the Punakaiki Rocks or the Fiordland crested penguins at Monro's Beach. What happens at these *attractions* in terms of managing the environmental effects of visitors can be significantly different to management of the tracks (section 2).

Recovery of Old and Abandoned Tracks

We examined the recovery of old tracks mainly at Lake Matheson and to a lesser extent at the Pancake Rocks in Punakaiki. We found that native regeneration was generally rapid and robust in the poorly drained, leached podsols and peats of Lake Matheson. Native seedlings were also common even in the broken up old asphalt track on the better-drained soils at Punakaiki.

Plate 24 - Recently abandoned track – Lake Matheson.

On the predominantly poorly drained podsols in the glacial landscape of Lake Matheson, a temporal sequence of abandoned tracks showed rapid recovery of native plant species within a relatively short time period. *Plate 24* shows a recently abandoned track (< 6 months ago) where the boardwalk was removed during the upgrade. Close inspection of the soil revealed the presence of different tree and fern seedlings including *Quintinia acutifolia* (Westland quintinia), *Dacrydium cupressinum* (rimu), *Griselinia littoralis* (broadleaf), *Phyllocladus alpinus* var. *aspleniifolius* (toatoa) and *Blechnum procerum* (fern) under an intact canopy dominated by a large Hall's totara (*Podocarpus hallii*). *Plate 25* shows a track abandoned less than one year ago with mosses and umbrella fern (*Sticherus cunninghamii*) and *Blechnum* ferns starting to regenerate over and around the old track. *Plate 26* shows more advanced regeneration around old wooden steps, suggesting this track has been abandoned for some time. No exotic weeds were detected at these three sites.

Plate 25 - Track abandoned less than one year ago – Lake Matheson

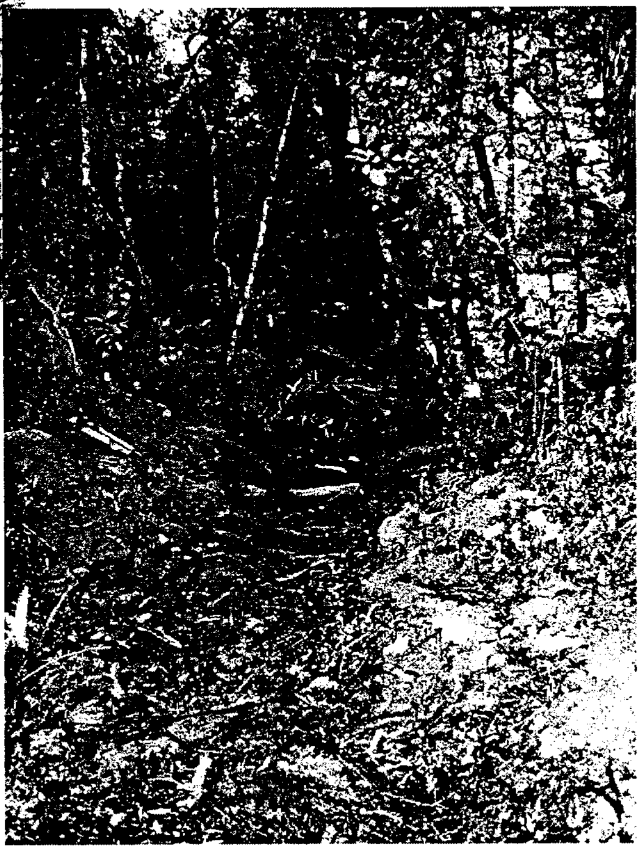

Plate 26 - More advanced regeneration around old wooden steps – Lake Matheson

Exotic Weeds

We did, however, note the presence of exotic herbaecous weeds in more fertile recent alluvial surfaces at Lake Matheson near the start of the track. These exotic weeds are likely to remain localised and ephemeral if left undisturbed, due to the existing native canopy cover and the acidic leaf litter dropped from existing trees over time. Herbeacous weed species, particularly members of the *Asteraceae* family, were common along the sides of tracks in relatively high light and/or recently disturbed situations along every track we visited. Weeds tend to be fewer where light and opportunities for establishment were more limited in the forest interior, and on relatively infertile and/or poorly drained soils there was little visual evidence of weed invasion into the forested interior.

However, there were some exotic weed species on the Fox River Caves track near Punakaiki that appeared to be more persistent. On rocks outside the cave entrance, we noted the presence of a large patch of the South African exotic perennial *Plectranthus ciliatus*, and in a small pond at the base of a limestone bluff at the start of the track, swamp lily (*Ottelia ovalifolia*) was locally abundant. Pasture grasses were also evident in abundance around the Cape Foulwind track. Along the Wanganui Coastal Pack track, persistent invasive grey willow (*Salix cinerea*) were locally abundant, along with gorse (*Ulex europeaus*), yorkshire fog (*Holcus lanatus*) and introduced buttercup (*Ranunculus* spp.) in relatively fertile gleyed recent silts.

Persistent and invasive species that occur in a range of sites are issues for managers, in addition to management related to providing visitor access. The project developments undertaken by DoC on the West Coast (at Lake Matheson for example), had an internal West Coast Conservancy requirement to perform an Assessment of Environmental Effects (AEE) (T. Preston, pers comm). The AEE identifies risks or effects to conservation values posed by development and the type of construction methods employed, and outlines the required mitigation methods needed and how to implement them. This is carried out prior to any decision being made to proceed with a development, and is a necessary management tool to weigh up potential benefits of an infrastructural gain with identified environmental effects. For example, managers should be aware of the risk of allowing persistent plant invaders into intact native plant communities when constructing tracks, and implement monitoring and control measures where needed as in the case of *Plectranthus* or *Ottelia*[30]. Biological invaders can affect ecosystem processes, alter disturbance regimes, and can cause plant community change in a number of vulnerable systems (Vitousek *et al.,* 1997), such as in waterways, along tracks that pass through fragmented landscapes, in more fertile soils, and in warmer frost-free latitudes.

Litter and Visitor Amenities

Litter was observed at all sites although it was low in quantity, and therefore liable to be removed with DoC's regular programmed maintenance. Regular rubbish removal from bins occurred at sites such as Punakaiki, reducing the build up or dependence of rodents and other pests like wasps on visitor waste.

However, issues surrounding the availability and proximity of visitor toilets around tracks are unresolved on the West Coast. Whilst there are toilets available at scenic *icon* sites, there are no toilet facilities at the medium- to low-use tracks we studied despite significant visitor numbers (e.g., 8,000 p.a. at Monro's Beach – Table 1). There are jurisdictional funding issues between DoC, Transit NZ, the West Coast Regional Council, and the Buller, Grey and Westland District Councils as to where the appropriate institutional responsibility lies for constructing basic visitor conveniences, and for ongoing upkeep and maintenance of these facilities. A recent report for the Westland District Council identified various kinds of toilet waste and/or rubbish at most visitor sites in south Westland, often visible, but also hidden in vegetation around carparks and picnic areas (Rasmussen, 1996). The other finding of concern was that most toilet waste was close to waterways, with probable contamination and pathogens introduced into otherwise pristine areas. The report discusses the possibility that some of these pathogens carried by overseas visitors may be new to the country. DoC found 43 per cent of high-use site areas on conservation land tested positive for *Giardiasis* in a 1994 study (DoC, cited in Booth and Cullen, 1995).

Vandalism

Unfortunately vandalism of public spaces is a salient problem that managers have to deal with. Interpretation signs, safety rails, seats for contemplation and rest, cave walls, and even

[30] DoC have a Track Inspection Form for conducting monitoring of individual tracks. This has the capacity to identify problems like exotic weed invasions or track washouts, and to record work history and maintenance to mitigate environmental problems in ongoing asset management. This can now be done on the VAMS computer system through setting work tasks on a hand-held datalogger.

a 600-1000 year old Matai (*Prumnopitys taxifolia*) tree at Lake Ianthe in south Westland, have initials carved into them or were defaced in some manner. Managers at scenic *icon* sites such as the Pancake Rocks are conscious and diligent in removing or remedying these occurrences. However, at less well-visited sites there are often long-term reminders of the vandalism of some visitors. The importance of stewardship or *kaitiakitanga* in managing these sites means that well maintained sites can send a message of care, and possibly deter vandalism. However, this may still not stop some negative behaviour. For example, even though there is regular maintenance occurring along the relatively sparsely visited Wanganui Coastal Pack Track, we observed damage from motorcycle tyre tracks that resulted in soil churning and alteration of soil drainage, causing ponding and mud puddles along sections of the track. The cost of vandalism of interpretation signs is substantial at this site, with $1000 budgeted each year on this track to deal with this persistent problem diverting resources[31]. It is difficult to see how DoC can stop this sort of behaviour as it is a reflection of individual attitudes to public resources.

Interpretation

Interpretation varied in its standard, complexity (amount of ecological and/or geological information presented), clarity and positioning at the different sites we visited. The highest standard and complexity of interpretation was at the scenic *icon* sites and Monro's Beach, with more rudimentary signage at less well-visited sites. The clarity and positioning of signs also reflected this with scenic *icon* sites having visually clear, informative, and well-positioned signs. However, signs related to wildlife were mixed in their standard, with a combination of informative and ambiguous signs concerning the penguins at Monro's Beach (section 2.3.3), or the absence of signs about the sooty shearwaters at Mt. Oneone.

Track Erosion and Washouts

At the medium- to low-use tracks, track erosion was most pronounced on the Wanganui Coastal Pack Track where tidal inundation in the lagoon had recently washed out more than 100 m of track. Close to the Fox River Caves we observed a small washout (5 m) caused by recent flooding of a side creek. This is a relatively common occurrence in the dynamic, high-rainfall West Coast landscapes and management responds accordingly. For example, DoC undertakes monthly track inspections along the Fox River Caves track, and 160 staff hours each year are programmed to repair flood or washout damage to the track[32].

Tracks as Pest and Predator Highways

Completed and well-maintained tracks can act as corridors, or highways, for pest and predator dispersal. Stoats, rodents and other mammals have been recorded as using roads in penetrating forested areas (Murphy and Dowding, 1994; King *et al.*, 1996). Insertion of new tracks can increase the risk to a wildlife colony that may have had some protection in the past from terrain where access was difficult (Spellerberg and Morrison 1998 for review and references therein; Wilson, 1999).

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[31] Correspondence from Rob McCallum. DoC Franz Josef Field Centre, 17 May 2000.
[32] Correspondence from Murray Thomas. DoC Punakaiki Field Centre, 7 February 2000.

Asset:	Physical – Landscapes/Scenery - Tracks/Walkways.
Activities:	Walking, viewing.
Impacts:	Weed and pest invasion and dispersal; Damage/vandalism; Erosion; Litter
LAEC:	Prevent deterioration in track condition. Maintain capacity and safety. Maintain natural character of area.
Guidelines:	**(generic)** Provide clear interpretation for visitor behaviour, safety and litter. Follow prescribed hut standards. **(specific)** Monitor and/or control weed and pest invasions. Restrict access to culturally, and physically, sensitive and fragile formations. Mitigate impacting surrounding land use practises with landowner consultation.
Indicators:	Litter, track recovery, weeds, erosion, track widening/pugging, vandalism.

Box 4: Summary of impacts from visitor activities and indicators of environmental change for tracks examined in this study.