Ecological Indicators of Tourist Impacts in Parks

Ralf Buckley
International Centre for Ecotourism Research, School of Environmental and
Applied Sciences, Griffith University, Queensland, Australia

For tourism in parks there are many lists of potential ecological indicators that have not been implemented in practice, many systems of management indicators with little ecological basis or significance, and many ecological studies of recreational impacts that do not provide management indicators. Indicators that are both scientifically defensible and feasible and valuable in management, however, are very rare. Broad-scale indicator systems developed for tourism ecolabels and environmental accreditation schemes are inadequate for testing the impacts of people in parks. Monitoring visitor impacts needs ecological baseline data that incorporate seasonal cycles, long-term trends, extreme events, and internal patterns. It needs indicators that reflect the priority conservation values of the protected areas concerned, and the types of use, not merely management processes. It needs specific indicators that are discriminating, quantifiable, actionable, sensitive, ecologically significant, integrated, and feasible in practice. And it needs experimental design that distinguishes tourist impacts from other sources of variation. Interested and experienced rangers and volunteers can make a major contribution to such monitoring programmes, but reliable ecological monitoring needs qualified ecologists.

Introduction

Protected areas worldwide are becoming more and more crowded, with more and more people visiting them for more and more different activities. This applies to all types of protected area, but particularly to IUCN Category II areas, referred to here as national parks or simply parks. Visitors include private individuals, non-profit groups, and commercial tour clients. Global demand for nature and adventure tourism and recreation continues to grow, and parks provide one of the main opportunities. Parks agencies now have to devote a considerable proportion of their time and resources to visitor management; often, much more than they can now devote to conservation management. Their research and information needs have changed accordingly. The same applies for other public and private owners and managers of land with high recreational use.

In parks with low visitation, the major monitoring requirements relate to external environmental threats, such as weeds and feral animals entering the park from neighbouring properties and becoming established; unscheduled fires; outbreaks of plant or animal diseases; illegal human activities such as poaching, logging or seed collecting; and air or water pollution in the park from external sources upwind or upstream. In parks and other land with high levels of visitation, land managers also need information on visitor characteristics, visitor impacts, and the effectiveness of visitor management tools. Visitor characteristics may include numbers, origins, activities, expectations and satisfaction, and

are determined principally from on-site visitor surveys, sometimes coupled with automatic counters and similar approaches. The effectiveness of visitor management tools can be assessed both in terms of increased visitor satisfaction, and reduced visitor impacts.

Monitoring visitor impacts requires somewhat different approaches from monitoring impacts of external threats, though many of the impact mechanisms, environmental parameters affected, and sampling or measurement techniques are the same. The significance of ecological impacts from tourism and recreation has been recognised widely by protected area management agencies (Parks Canada, 2001; USNPS, 2001), environmental non-government organisations (GYC, 2001), and researchers (Buckley, 2001, 2002; Leung & Marion, 2000; Newsome *et al.*, 2002; Sirakaya *et al.*, 2001). The practical issues involved in monitoring these impacts, however, still seem to be problematical for many agencies. For tourism in parks there are many lists of potential ecological indicators that have not been implemented in practice, many systems of management indicators with little ecological basis, and many ecological studies of recreational impacts that do not provide management indicators. Indicators that are both scientifically defensible and feasible and valuable in management, however, are very rare.

Context for Indicators

Uses of indicators

Broadly, parks agencies use environmental indicators in order to determine what impacts tourists and other visitors are having on the park's natural environments; compare them with impacts from other sources; and undertake and evaluate management responses. In particular, environmental degradation caused by local visitor impacts can be addressed most effectively by managing the visitors, whereas those caused by other external impacts can only be addressed by management of natural resources directly. Commonly, individual protected area management agencies have specific administrative frameworks within which they collect and use such indicators. For example, some parks agencies have policies or requirements to produce regular reports on the state of the parks, whereas others may use impact indicators to allocate funds for infrastructure and rehabilitation work.

Green and brown indicators, local and global scales

The effects of the human economy on the natural environment may conveniently be classified into two major categories, known respectively as green and brown (or grey) impacts. Broadly, green impacts are those which involve consumption of biological resources, for example by the forestry sector, with consequent loss of biodiversity and ecosystem area. Brown impacts damage the natural environment though discharge of wastes. Burning fossil fuels to generate electricity or drive cars, for example, releases greenhouse gases and various other atmospheric pollutants. Energy consumption can thus be used as an aggregate measure of global atmospheric impacts. Brown indicators such as these are therefore used widely in environmental performance measurement and accreditation schemes, including those in the tourism industry (Font & Buckley, 2001).

For tourism in protected areas, however, local-scale but proportionally large impacts on in-park biodiversity are more significant ecologically than broad-scale but proportionally smaller impacts on global air quality. Certainly, tourists can have considerable impacts on air and water quality in some parks, but these are ecologically significant more because of local-scale effects on vegetation and aquatic ecosystems, than because of their contribution to global pollution. Generic indicators of brown impacts are therefore not particularly relevant for managing tourism in parks, unless they are carefully selected and customised for a particular waste management issue of immediate ecological significance to conservation of the natural environment in the park concerned.

For example, at a global scale, burning wood for small-scale heating generally produces less total environmental impacts than burning highly refined petroleum products. In a number of heavily-used parks in the Himalayas, however, collecting firewood for trekkers has caused widespread deforestation, whereas the quantity of fuel needed to replace fires with fuel stoves is very small on a global scale. In this instance, therefore, fuel stoves are environmentally preferable.

Local-scale indicators of green impacts, in contrast, whilst of little relevance for airlines or urban hotels, are critical for tourism and recreation in protected areas and similar fragile environments. The many generic guidelines, checklists, indicators and accreditation schemes for sustainability in tourism overall, therefore, are of little use for tourism and recreation in parks. A very different set of indicators is needed, focusing on local-scale green rather than global-scale brown impacts, and devised by biologists and ecologists rather than engineers and social scientists. Many potential indicators have been identified (Leung & Marion, 2000; Newsome *et al.*, 2002; Sirakaya *et al.*, 2001); but rarely have they been implemented in practice.

Baselines and benchmarks

Impacts can only be detected as a change relative to a prior baseline. Even indicators that measure environmental quality rather than environmental impacts can only be used for management if there is a benchmark to compare them against. Benchmarks are also needed if environmental degradation or management at one park is to be assessed in a national, regional or global context. And if indicators of different types are to be aggregated to yield an overall comparative measure of environmental quality, impact or management performance, they must first be expressed as numerical measures with similar means, range and variance; and normalisation against a benchmark is generally the first step. Standardisation can be useful in comparing different indicators against each other, for example to determine which changed the most or the fastest. Aggregate indices compiled from a suite of standardised indicators are useful for comparisons between parks in the same geographic region or legal jurisdiction; for comparisons between regions and countries; and for tracking trends over time whether locally or globally. The availability of baselines or benchmarks, or the feasibility of establishing them, is hence a significant consideration in selecting specific indicators or tourism impacts in parks.

Fluctuation, cycles and trends

Most environmental parameters that are responsive enough to serve as indicators of tourist impacts are also likely to experience considerable natural variation. A baseline for such parameters is hence not a single fixed numerical value, but a pattern of variation in space and time, with defined confidence limits. Depending on its purpose, a benchmark may need to be defined in a similar way. Relevant patterns of variation will typically include seasonal cycles, and perhaps also diurnal and multi-year cycles; fluctuations related to events such as floods, frosts or fires; spatial patterns related to terrain and geology; and spatial patterns associated with internal processes such as the formation and regeneration of gaps in forest cover caused by the death of individual trees, or periodic fires regulated by the gradual accumulation of plant biomass. In addition to natural sources of variation, many environmental indicator parameters may also be affected by a range of anthropogenic factors not associated with tourism or recreation; and these must also be quantified and taken into account in establishing and using indicators of tourism impacts specifically. For example, air and water quality in a protected area may be subject to off-park impacts from nearby roads or factories, or towns or farmland upstream. In most countries, for example, the proportion of watercourses which effectively retain wilderness water quality is extremely small. Indicators of environmental quality to be used in, for example, state-of-the-park or state-of-the environment reporting, need to include impacts from all sources, including those off-park. Indicators to be used in managing tourists and other visitors, however, need to differentiate clearly between impacts associated with tourism and recreation, and those associated with other human activity.

Users, ecosystems and impact types

Different types of user engaged in different types of activity have different types of impact in different types of ecosystem. To be useful in management, indicators in any particular protected area need to focus on impacts which are ecologically significant for its particular ecosystem, and which reflect the particular characteristics and activities of its users. For example, if a park is free of a particular weed or pathogen species, but at risk that visitors may import it on their clothing, livestock or vehicles, then the distribution of the weed or pathogen in areas around the park, and the effectiveness of visitor quarantine measures, become particularly important indicators. In a park where wildlife suffer significant disturbance in winter from off-track recreational snowmobiling, however, with potential effects on individual energetic balance and overwinter survival, then indicators of snowmobile noise and activity patterns, and animal stress and response, will be more critical.

Short and long-term impacts

Some of the effects of tourism and recreation on the natural environment are lasting, others evanescent. This applies both to immediate and direct impacts, and to their indirect consequences. For example, the sound of an engine backfire or a pneumatic tool is sharp but short. If repeated sufficiently, however, it may drive wildlife away from the area for an entire season or longer, particularly if the

species concerned are also subject to hunting; and this may have long-term effects on the species populations. Similarly, if a toxin is discharged into a river or a coral reef, its effects on aquatic ecosystems may last long after the toxin itself has been flushed away. Indicators for short-term impacts, therefore, need to be able to detect individual events and if possible, quantify both their magnitude and frequency. For longer-lasting impacts, the time when indicators are measured is less critical. Detecting a change relative to a baseline or benchmark, however, may often require a more subtle sampling scheme than for short-term effects.

Types of Indicator

Priority conservation values

Most protected areas are protected in order to conserve particular species or ecosystems. In some cases, notably World Heritage Areas, these specific conservation values are defined both in the nomination process and as an adjunct to establishing legislation. In this case, managers of the areas concerned need indicators for those specific priority conservation values, irrespective of the particular factors which may be affecting them. Such indicators might include, for example, areas of remaining undisturbed vegetation or animal habitat or of particular ecosystems such as mangroves or vine thickets; physicochemical indicators of stream water quality; or the number of individuals in a local population of an endangered species.

Even where priority conservation values are not defined in established legislation or management plans, protected area agencies may require broadscale environmental quality indicators such as those listed above. In parks where external threats are a major management consideration, indicators that show the intensity or effects of these threats may be particularly important. These might include, for example, populations of feral animal species, or indicators of water quality immediately upstream of a park boundary.

Management process indicators

A second major category of indicator includes those relating to management processes, effort and outcome. Indicators of management processes, for example, may include the existence of a management plan, and the level of detail it contains; existence and detail of implementation plans for specific management issues such as weed control or visitor education; emergency response procedures and equipment; and visitor infrastructure and interpretation programmes. Budget processes and allocations, staffing processes and numbers, management targets and monitoring programme can all be used as indicators of environmental management processes. The extent, quality and maintenance of tracks, fences, signs, parking, and other visitor facilities may also be useful indicators, particularly if related to targets in implementation plans. Other indicators of frontcountry management effort include, for example, management expenditure per unit area or per visitor; weight or volume of litter removed or taken to landfill; and staff time devoted to particular activities. All of these are easy to measure and easily modified by changed management practices; but they are

only indirectly related either to primary conservation values, or to the specific impacts of tourism and recreation.

Indicators of backcountry ecological impacts

In managing recreation to minimise conservation impacts, the most valuable types of environmental indicator are those that measure visitor impacts on backcountry areas directly. Such indicators need to reflect ecological processes rather than management processes. Common examples include track erosion; weed distribution; human noise; microlitter at backcountry campsites; measures of stress, individual mortality, behavioural changes or population impacts for particular wildlife species; and analogous measures for particular plant species.

Design of Impact-indicator Systems

Criteria for indicators

Selecting broad indicators of environmental quality, management efforts or tourism sustainability, is relatively straightforward. Possible indicator parameters are tabulated by Manning (1999: 123), Newsome *et al.* (2002: 270–2, 277, 281), and Sirakaya *et al.* (2001). Likewise, there are numerous research-level scientific studies of specific ecological impacts, reviewed by Buckley (2001), Leung and Marion (2000), Liddle (1997); and manuals of ecological monitoring techniques, such as Elzinga *et al.* (2001).

Effective indicators of significant recreational impacts on protected area ecosystems, however, which are scientifically meaningful and defensible as well as useful in practical management, are more difficult to select. In general, the most useful ecological indicators for management will fit the following criteria:

- discriminating, so that they can differentiate the impacts of tourism from other natural or anthropogenic sources of variations;
- quantifiable, at least approximately or at a categorical level, so that management responses can be matched to the level of impact;
- actionable, so that if an impact is detected, something can be done about it;
- sensitive, so that a change in the degree of impact produces a clearly distinguishable change in the indicator;
- ecologically significant, so that any change indicates an effect which is important for the park's conservation values;
- integrated, so that the indicators used in a particular park or set of parks provide a balanced overall picture of the impacts of tourism and recreation;
- feasible, in the sense that resources and expertise can be made available to monitor them in practice.

Distinguishing tourism impacts

To detect an impact over a given time period in a given area from a specific source such as tourists, generally requires: (1) a sampling pattern with unimpacted control sites as well as sites with impacts; and (2) measurements before, during and after the time period concerned. To ecologists this is known as a BACI design: Before/After, Control/Impact. For statistical confidence, measurements need to be replicated for all four of these categories. In addition, to

comply fully with the mathematical requirements of statistical tests, the sites should be allocated randomly between impacted 'treatment' sites and non-impacted 'control' sites. In practice, as with environmental impact monitoring in many sectors and circumstances, these requirements often cannot all be met. Sampling designs must be adapted to circumstances. The price is usually either higher sampling effort, or reduced reliability of results.

To distinguish visitor impacts from other sources of variations, several approaches are possible, separately or in combination. The first is to use an indicator which is specific to tourism and recreation, or at least where other sources are negligibly small in comparison, i.e., control values remain zero throughout the monitoring period. This approach is generally most practicable for physiochemical indicators. Examples include concentrations of petroleum residues in water samples from otherwise undisturbed lakes used for recreational power boating; or atmospheric concentrations of nitrogen oxides, or other components of car exhausts, in a valley subject to heavy use by recreational vehicles; or the proportion of time during which engine noise from recreational vehicles such as snowmobiles, helicopters or jetskis is audible in an otherwise peaceful wilderness area. Biological and microbiological indicators where this approach can be used are less common. An example might include the frequency of horse droppings along a track in an area with no wild or feral horses. For most biological indicators, however, controls are required; and there are some, such as the first record of a new weed or pathogen in a given park, where even with controls it is difficult to determine whether the introduction was caused by visitors or other sources.

The second main approach is to use a very localised control, where it can be assumed that any natural variation between impacted and control site, over either space or time, is negligible compared to the impact of tourism and recreation. For example, soil compaction on a walking track or campsite might be compared with undisturbed off-track areas nearby. This approach can only be used, however, if it can reasonably be assumed that without the impact, there would be no distinction between control and impacted sites. For a track crossing flat ground, with the same vegetation on both sides, such an assumption would be reasonable; for a track running along the boundary between subalpine forest and alpine meadow it would not.

Similarly, for a vehicle ford across a uniform stretch of river, the impacts of the crossing on instream turbidity can be examined by comparing water quality immediately upstream and downstream of the ford. To test for the impacts of recreational swimming on a forest stream, however, it is not enough to compare water quality upstream and downstream of a swimming hole, because there might be systematic differences upstream and downstream of all pools in the stream, irrespective of swimmers. In such circumstances, the difference between water quality parameters upstream and downstream of the swimming hole must be compared with the corresponding difference for a similar and nearby pool in the same stream, but without swimmers (Buckley *et al.*, 2001; Warnken, 1996).

Even with a control of this type, strictly speaking a single comparison can only test for an impact at the particular site concerned. To test whether the relevant impact occurs more generally, or determine its magnitude and significance, would require a replicated set of relevant comparisons. This could be done, for

example, for a set of swimming holes in the same creek, a set of creeks in the same catchment, or a set of tracks in the same forest or meadow. A broader-scale control, such as a comparison between different creeks with high and low levels of tourist use, will generally be more robust in the sense that the results are likely to be reliable and broadly applicable. Smaller-scale controls, such as neighbouring pools in a single creek, will generally be more sensitive in the sense that they can detect a smaller degree of impact.

The third main approach is to measure the selected indicator parameter or parameters at a number of sites with known and different degrees of tourist activity, and examine the effect of tourism activity on the environmental indicator through correlation or regression. If the indicator parameter is also subject to influences from other factors, and those factors can be quantified at each site, then the relative significance of tourism can be distinguished through multiple regression. This approach is generally most useful where a large number of potential monitoring sites are available; where the impacts of tourism are diffuse rather than localised; or where broadscale impacts over a relatively large geographical area are of greater interest. Examples include the amount of microlitter at backcountry campsites, in relation to number of visitor nights; or the number of different weed species in different areas of similar terrain and vegetation, relative to the number, density and use of walking tracks.

Self-limiting and self-propagating impacts

Some types of impacts are self-limiting, in the sense that if the source of impacts is removed, its effects will gradually reduce. The timescale of recovery may be minutes, e.g. for noise disturbance to bird calls along a rainforest track; months, as for the introduction of a weed seed which germinates but does not survive over winter; decades, as for the recovery of vegetation on an abandoned walking track; or centuries, as for damage by off-road vehicles to cryptogamic crusts on desert soils. Other types of impacts are self-propagating, in the sense that once triggered by tourism, they continue to spread even if the source is subsequently removed. A fire started by a tourist's cigarette butt, campfire or car muffler can expand very rapidly in a period of minutes, hours or days. A weed or pathogen inadvertently introduced in a tourist's car or clothing, horse feed or human waste, may subsequently spread over following years and decades. Even an impact such as litter can sometimes effectively be self-propagating through a social or psychological mechanism, if tourists are more likely to discard litter in areas where it is already present than in areas where there is none.

Self-propagating impacts are commonly more critical in the design of indicator systems, because the chance of controlling them through management action is far greater if they are identified as soon as they first occur. For control of an established weed, for example, it will probably be useful to track its areal extent and rate of spread in relation to tourist corridors and other disturbances, using quantitative on-ground measurements and perhaps also aerial photography or remote sensing. For a new weed species, however, the critical issue is to find and identify it when it first arrives and there is still a possibility of eradicating it. If it is not yet present in the park, there is no opportunity to measure its in-park distribution; and even if it is present, remote sensing will not detect it until there is a sizeable patch with a recognisable signature. If the critical indicator is simply

presence or absence, then no sampling technique can substitute for experienced field staff who can search areas of suitable habitat at intervals and identify the species reliably if they find it.

Note that particular types of impact may behave differently in different environments, being self-limiting in some but self-propagating in others. For example, fire only spreads in dry vegetation with a sufficient fuel load. Trampling vegetation on a steep downslope alpine track may cause expanding erosion gullies; whereas trampling a thicket of lawyer vine in subtropical rainforest is likely to injure the person more than the plant.

Indirect impact mechanisms

Where tourist infrastructure and activities affect plants and animal populations through indirect mechanisms, the first step in establishing an indicator system is to identify what those mechanisms are. This may be far from straightforward, particularly if similar mechanisms have not previously been identified elsewhere. It may not be immediately apparent to a land manager or tour operator that grooming snow on ski slopes can affect small montane mammals by crushing their undersnow burrows; that the noise of helicopter overflights in a scenic mountain range may affect the population of rare bird species by drowning out their territorial and courtship calls; that introduced weeds may affect native plant species by competing for insect pollinators; that an orienteering event can cause major disturbance to deer populations; or that duck subject to recreational hunting may be killed not only by a direct hit, but by accidentally ingesting spent lead shot when feeding from bottom sediments. All or most of these impacts do occur, however, and many more besides.

Many more indirect ecological impacts associated with infrastructure development have been identified in various parts of the world, and some of these could apply equally well to tourism. For example, in one case on the west coast of the USA, a proposed real estate development would have cleared plants which serve as the only food source for the caterpillars of an endangered butterfly species during part of the year. Even if the butterflies were elsewhere when the vegetation was cleared, therefore, the real estate development would have caused the extinction of the butterfly population concerned (McDonald & Buckley, 1993). Another example is reported from the Brazilian Amazon, in an area where a network of tracks is dividing an area of forest into smaller patches. One of the characteristic bird species of the forest is an antbird, which gets its food by following the foraging columns of a particular species of army ant. The ants live in large colonies which require a minimum area of forest to survive. If the tracks divide the forest around a colony into a patch smaller than this minimum size threshold, the ant colony will move *en masse* to a larger forest fragment, crossing the tracks in order to do so. The antbirds, however, live only in undisturbed forests, and do not venture to the forest edge or out of the forest canopy. If their ant colony crosses a track, therefore, the antbirds are unable to follow. Once a patch of forest is too small to support an ant colony, therefore, the ants can move elsewhere but the antbirds die. Without a detailed knowledge of ant and antbird ecology, however, it would not be obvious that the disappearance of antbirds was due to tracks.

The point about these cases is not the particular mechanism involved, since

this may be highly specific to the ecosystem or individual species concerned. It is simply to show that impacts which are not immediately obvious may in fact be quite commonplace, and may also be highly significant for the survival of particular species. A system of environmental indicators that is designed to quantify particular known tourist impacts is unlikely to detect previously unanticipated indirect impacts such as these, even though these impacts may be both ecologically significant, and caused by tourism. If a particular protected area, or other area of high conservation value that is used for tourism and recreation, is known to contain species or ecosystems of high conservation value, an effective environmental indicator programme also needs to monitor those components directly. And if land managers do not know what species occur in the areas for which they are responsible, as is indeed the case for many protected areas, then a system for environmental indicators of tourist impacts should start with relevant baseline studies before any tourism is permitted in the protected area concerned. Without such baseline information, land managers cannot tell whether tourism and recreation will damage the park's primary conservation function.

Ecological skills and knowledge

Approaches and information such as those outlined above are a fundamental part of the knowledge and skill base of any professional ecologist. Diagnostics on the function of any complex system generally require specialist information, training and experience if we want to know what is causing abnormal symptoms. In a human body, for example, we use a doctor to prescribe and interpret relevant physiological and pathological tests. Even for a far simpler structure such as a gas pipeline, we insist on qualified specialist engineers to commission and assess non-destructive tests to determine whether the structure is still in good repair. Natural ecosystems are far more complex than either human bodies or any human mechanical device or social institution. We should therefore expect that diagnosing impacts of tourism in protected areas would require an ecologist with at least as much skill as a doctor, engineer or lawyer. And for any of these complex systems, we expect to seek specific professional advice for every separate symptom or check-up, incident or inspection. There are innumerable books in each of these fields, both popular and reference, but we do not expect these to substitute for individual professional consultations. Why should it be any different for ecological expertise?

Of course, in any of these fields, expertise may be gained by experience as well as training. Some bush mechanics, paramedics and paralegals may be as competent as their more highly qualified colleagues, but this is the exception rather than the rule. Professional qualifications are intended as a guarantee of competence. Similarly, there are many naturalists and park rangers with a detailed knowledge and understanding of particular areas and environments which can only be gained by long experience in the field; and for some types of tourist impact, their observations may be as least as valuable as more formal monitoring programmes. Such local expertise is becoming rarer, however, as financial pressures force protected area agencies to move rangers between regions more frequently, hire casual field staff during peak seasons, and use their most experienced rangers in administration. So if parks agencies are to monitor tourist impacts, they will need to hire ecologists, whether on staff or on contract. Note,

incidentally, that hiring staff trained in tourism is not an adequate substitute: designing environmental indicators needs skills in science, not business. It is also far easier for an ecologist to learn how the tourism industry works than for a tourism graduate to become an ecologist.

Many tour operators in national parks do appreciate the significance of environmental indicators and are keen to assist in environmental monitoring. Some operators, indeed, trained as biologists before turning to the tourism business. Tour operator observations can be particularly useful where, e.g., tours visit particular sites or areas repeatedly, perhaps more often than rangers; or where tour clients are keen to take part in environmental programmes as an educational experience. Similarly, parks agencies may be able to make use of environmental data compiled by other government agencies. Examples include aerial photographs and satellite imagery from, e.g. national mapping authorities; or water quality sampling conducted by health authorities. Whether or not these are sufficiently specific to distinguish the impacts of tourism and recreation is generally fortuitous, but sources such as these are often relevant for broadscale indicators of environmental quality.

Indicators in practice

As with management indicators of any type, environmental indicators of tourism impacts in parks are most valuable if there is an operational framework in which they are used. For example, many land management agencies use management frameworks based on conceptual approaches such as limits of acceptable change, recreational capacity etc. (Buckley, 1998, 2000; Fennell, 1999: 124; Hockings *et al.*, 2000; Manning, 1999; McCool & Cole, 1997; Newsome *et al.*, 2002; Stankey *et al.*, 1985; Weaver, 2001: 82–4).

In establishing an indicator programme, therefore, the way in which results are used may be as important as they way in which they are collected. For example, if there are many different indicator programmes within a single park agency, as is often the case, is there any routine coordination mechanism so that managers in different regions can easily find out what projects are under way elsewhere and with what outcomes? Is the same information available and accessible to volunteers, environmental groups or members of the public? Is the methodology fully specified so that the reliability of results can be assessed or audited? Is information on indicators shared across agencies, land tenures, and legal jurisdictions so that comparisons can be made or aggregate indices compiled? Are indicators used for testing the effectiveness of management tools, for routine reporting on the state of the protected area estate, or for budget allocation; and if so, how are the results checked or audited before they are used? If these issues can be addressed at the design stage, they may influence the selection of indicator parameters and the way in which data are collected, analysed, stored and reported.

Conclusions

Several straightforward but nonetheless significant conclusions may be drawn from these considerations. The most basic is that you can't monitor impacts without a baseline, either measured or assumed. If you don't know what

plant or animal species may live in the backcountry areas of your park, you won't be able to tell if visitors are affecting their populations. So basic biological surveys should be a high priority for any protected area monitoring system. And until this information is available no access should be granted unless it can easily be cancelled later; and no infrastructure should be built unless it can be fully removed and rehabilitated.

Another basic conclusion is that protected area agencies need field staff with training in ecology, and the ability to identify plant and animal species accurately and recognise changes in plant and animal communities. Detailed monitoring programmes do not substitute for the breadth of knowledge and observational skills of an experienced ranger. So, keep plenty of rangers in the backcountry, and keep them at the same park long enough to learn how it changes year-to-year.

The third major conclusion is that for effective ecological monitoring, hire ecologists. Ecology is a profession which requires learned skills and knowledge like any other. Indeed, it is considerably more complex than many other professions where we rely routinely on qualified specialists. Staff trained in tourism, management, or education, for example, should not be expected to design or carry out quantitative ecological monitoring programmes; particularly those which test for more complex indirect impacts, or involve indicators which need instruments to measure.

This does not mean that other parks staff, visitors and tour operators cannot take part or assist in ecological monitoring. There are many useful monitoring exercises that rely on volunteer labour and individual reporting systems. To be effective, however, these systems must usually be established and operated by ecologists. And in addition, they will rarely be able to distinguish tourism impacts specifically.

There are many park rangers, and some tour operators, who do indeed have the interest and knowledge to recognise which of their observations can demonstrate a tourist-related impact and which do not. Science, it has been said, is only applied commonsense; and distinguishing tourist impacts often needs only commonsense science. But not all parks staff have sufficient interest or practice for this approach to be sufficient on its own. Systematic volunteer observations are useful, commonsense science by rangers is better, but the only reliable way to monitor the ecological impacts of tourism in parks is to hire ecologists.

Correspondence

Any correspondence should be directed to Ralf Buckley, International Centre for Ecotourism Research, School of Environmental and Applied Sciences, Griffith University, Queensland, Australia (R.Buckley@mailbox.gu.edu.au).

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