Research Note

Linking Visitor Impact Research to Visitor Impact Monitoring in Protected Areas

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Growing demand for natural area recreation and tourism has seen a rise in visitor numbers to protected areas. In response, there has been an increase in research into visitor impacts. There has also been increased interest in establishing and maintaining visitor impacts monitoring programmes. Here, we evaluate the relationship between recreation ecology *research* and visitor impact *monitoring* and discuss how the aims and scope of these two activities often differ. We highlight that recreation ecologists design observational and experimental treatments to test causal relationships between a particular load or stress and environmental indicator(s) of interest. Some of these studies identify thresholds of concern, with the intention that managers can use thresholds of indicator response in their monitoring programmes. However, agencies interested in monitoring visitor impacts often do not need to establish causality, but rather detect change in the indicator of interest. Therefore, simplified protocols which can be easily conducted by agency staff in the field at regular and operationally appropriate time intervals can be used. We present a visitor assessment flow chart that demonstrates how research and monitoring objectives can interact and contribute to the cost-effective management of heavily visited sites within protected areas.

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Researching Visitor Impacts in Protected Areas

With growing visitor loads in protected areas, managers have become increasingly aware of visitor impacts and the pressures that visitors can place on popular icon sites (Buckley, 1998, 2004; Leung & Marion, 2000; Monz & Leung, 2006; Newsome *et al.*, 2002). In response to these growing threats, the field of recreation ecology emerged in the 1970s with a view to increasing our understanding of ecological responses to visitors and facilitating better management of natural

resources (Leung & Marion, 2000; Liddle, 1997). Recreation ecologists typically design scientifically rigorous, observational, or more commonly manipulative experiments to evaluate the causal relationships between particular activities and various ecological parameters (Hadwen & Bunn, 2005; Leung & Marion, 2000; Liddle, 1997; Marion & Cole, 1989; Talbot *et al.*, 2003; Underwood, 1996). Many of these experiments have assessed the ecological impacts of hiking and camping, particularly on soil and vegetation (Cole, 1978, 2004a; Cole & Monz, 2003; Leung & Marion, 2000; Liddle, 1997; Milazzo *et al.*, 2004; Whinam & Chilcott, 1999), although similar studies have also examined other activities/ecosystems, such as the effects of swimming and littoral zone activities on heavily visited waterbodies (Butler *et al.*, 1996; Hadwen & Bunn, 2005; Hadwen *et al.*, 2005a; Underwood & Kenelly, 1990).

Studies investigating the effects of hiking/trampling, on soil and vegetation have advanced our understanding of the ecological consequences of nature based tourism (Cole, 2004; Leung & Marion, 2000; Liddle, 1997). This includes empirically testing a range of factors that have the potential to mediate the extent and type of trampling impacts (Cole 1995a, 1995b, 2004a; Leung & Marion, 2000; Liddle, 1997). For example, visitor type, visitor numbers, types of vegetation and seasonality (both of visitor use and plant growth) all influence the response of vegetation to trampling (Buckley, 2004; Cole, 1978, 1995a, 1995b, 2004; Cole & Monz, 2003; Leung & Marion, 2000; Monz, 2002; Whinam & Chilcott, 1999). Research has also examined spatial and temporal effects of specific activities and how they interact with other types of disturbance (Hadwen *et al.*, 2005a; Leung & Marion, 2000; Liddle, 1997; Marion & Cole, 1989; Underwood, 1996).

While the earliest recreation ecology research was conducted using relatively simple techniques often quantifying visually obvious effects of activities such as hiking/trampling, recent technical advances have seen the application of a wide range of sophisticated methods (Hadwen & Bunn, 2004, 2005; Leung & Marion, 2000; Liddle, 1997). Many of these studies have thus gone beyond the realm of using traditional indicators of ecological response, to the point that recreation impacts research often requires expertise and technical support beyond that available to most protected area managers (Buckley, 2003).

Some studies examined impacts (by measuring indicator performance) in response to gradients of simulated use in order to determine whether or not there are identifiable threshold levels of camping, hiking or swimming pressure beyond which environmental changes are undesirable and/or irreversible (Cole, 2004a, 2004b; Hadwen *et al.*, 2003, 2005a; Leung & Marion, 2000; Liddle, 1997). Linked to these thresholds are the concepts of site carrying capacity (Buckley, 1999; Cole *et al.*, 2005; Davis & Tisdell, 1995; Leung & Marion, 2000) and 'Limits of Acceptable Change' (LACs) (Cole & McCool, 1998; Leung & Marion, 2000). From an academic viewpoint, thresholds, carrying capacity and LACs contribute to our understanding of the resilience and resistance of the study system (Cole, 1995a). However, for protected area managers charged with the difficult task of balancing visitor use and conservation objectives, these concepts have been shown to have limited operational capacity beyond conceptualising, designing and implementing strategies for the sustainable management of campsites, trails and ecosystems of interest (Cole, 2002, 2004b, 2006; Leung & Marion, 2000). While visitor thresholds

therefore do not contribute significantly to the assessment and management of visitor impacts, recreation ecologists have shown that indicator thresholds (i.e. levels of indicator response) can be used to trigger appropriate management actions (Hadwen & Arthington, 2007).

While recommendations (like threshold levels) are often made to protected area managers to assist them in the management of their area, there appears to be a significant gap (in knowledge, expertise and support) between receipt of a scientific assessment of impacts and the implementation of a monitoring programme based on those findings (Buckley, 2002, 2003; Cole, 2002, 2004b, 2006). Cole (2002, 2006) noted that fundamental and applied ecological research within protected areas is needed to underpin management strategies for species and/or sites of conservation and visitor value, yet the reality is that visitor monitoring is limited in many parks (Cole, 2006).

Monitoring Visitor Impacts in Protected Areas

While not always openly articulated, the aim of monitoring programmes is to detect change, hopefully before long-term and/or irreversible changes in the condition of the ecosystem have occurred (Boulton, 1999; Hadwen *et al.*, 2005a; Monz & Leung, 2006). The fulfilment of this aim requires measurement of sensitive indicators at appropriate temporal and spatial scales (Hadwen *et al.*, 2003; Leung & Marion, 2000; 2005a; Monz & Leung, 2006), yet a monitoring programme does not necessarily need to demonstrate a causal relationship between any given disturbance and the indicator(s) being measured. To this end, the approach taken to develop a monitoring programme should be different to that required to design a recreation ecology research project (Figure 1). In simple

Figure 1 Visitor impact assessment flow chart. Conceptual flow diagram showing the links and differences between visitor impacts research and visitor impacts monitoring in protected areas. (Black arrows represent components of the process likely to be undertaken by research scientists, grey arrows represent the components of the process likely to be undertaken by protected area agency staff.)

terms, visitor impact research establishes a causal relationship between an activity and environmental indicator(s), whilst monitoring can often presume causality and focus on reporting changes in indicators. Ultimately, we suggest that while monitoring programmes and protocols need to be informed by science (Cole, 2006), they do not always need to be science themselves.

By removing the need to demonstrate causality, the cost and expertise required for the establishment and maintenance of a monitoring programme is reduced. Given the documented difficulties associated with funding and technical support of monitoring efforts in protected areas (Buckley, 1996, 1998; Cole, 2006; Monz & Leung, 2006), this distinction between the aims and needs of visitor impacts research and visitor impacts monitoring is critical. As monitoring can use simplified, standardised protocols that do not require extensive training in ecological sampling techniques and statistical analyses (Monz & Leung, 2006), it should be easier to establish and maintain monitoring programmes.

Linking Visitor Impacts Research to Visitor Impacts Monitoring

To demonstrate the links between research and monitoring, we have developed a Visitor Assessment Flow Chart (Figure 1), which articulates a process that protected area managers can follow to implement strategies to assess visitor impacts in their protected areas. There are four key steps in the process: (1) identifying visitor activities; (2) researching visitor impacts; (3) monitoring visitor impacts; and (4) assessment of visitor impacts monitoring. The first step, identifying the range, frequency and extent of visitor activities at focal sites represents an important, yet often overlooked component of visitor assessment (Cole, 2006; Hadwen *et al.*, 2005b; Newsome *et al.*, 2002). Visitor profiling, as it is sometimes called, is the necessary first step in formulating a management strategy that relate visitors and the environment at key sites. As numerous studies have shown that different sites and different users lead to different intensities and types of activities (Hadwen *et al.*, 2005b; Hammitt & Cole, 1998; Liddle, 1997), it is important that visitor monitoring be conducted at many sites before research and monitoring activities begin. However, as noted by Newsome *et al.* (2002), visitor monitoring is often not conducted, as it is often given lower priority than other operations within protected areas, like providing facilities for campers. Despite often being overlooked, the assessment of visitors and the types of activities they partake in is important in establishing a frame of reference for future management actions and monitoring approaches. For example, following the collation of information regarding visitor types and activities, activities that are dominant, or particularly threatening to the local environment, should form the focus of future research and monitoring (Hadwen *et al.*, 2005b).

Researching visitor impacts is the second step in the process (Figure 1), wherein recreation ecologists and protected area staff can become involved in hypothesis-testing experiments that aim to examine ecological responses to an activity, or stress, of interest. This type of research will normally take the form of a spatially and/or temporally replicated and controlled experiment that generates information relevant to the development of monitoring protocols. For example, it might identify indicators that are particularly responsive to the activity of interest and indicate how monitoring programmes might be spatially

and temporally established to capture impacts should they occur. By following this scientifically-validated approach to the establishment of a monitoring programme, protected area managers have a defensible position for their monitoring and management (Cole, 2006).

The third step in the process is monitoring visitor impacts (Figure 1). As mentioned earlier, the distinction between research and monitoring is that monitoring protocols are often simplified and less well replicated than those used in research projects, as they need to be easily implemented by agency staff (Buckley, 2003). To this end, monitoring activities focus resources on attaining achievable goals by investigating change in particular indicators of interest.

Once the monitoring of visitor impacts is underway, ongoing assessment of visitor impacts and the success of the monitoring programme need to be undertaken. This is the fourth step in the process, which we refer to as assessment of visitor impacts monitoring. This step is largely an interpretation and management response to the process. To this end, there are numerous feedback loops from this step that require evaluation to further guide research and monitoring efforts (Figure 1). These feedback loops are particularly important, for while the goal of monitoring can be simple (i.e. to detect change), the complex nature of natural systems ensures that indicator response(s) and monitoring results can sometimes be confusing and/or difficult to interpret. When confusing results are achieved, it may be necessary for protected area managers to consult with recreation ecologists (in-house or external) to examine the possible causal relationships behind the confusing results or obtain independent evaluation of their monitoring and management strategies (Buckley, 2003; Cole, 2006). This may also be the case when politically sensitive issues or sites require independent assessments from outside the park agency. While further scientific investigations may be necessary at this point, once causality is established (or variability in indicator response is more clearly understood) and thresholds of concern or LACs have been identified for the indicators, monitoring can once again proceed without the cost and expertise required of manipulative experiments testing for causal relationships. Another important feedback loop exists to facilitate the development of management action plans when indicator thresholds of concern are exceeded (Figure 1). This loop highlights the fact that monitoring programmes need to be linked to management plans for sites within protected areas, because monitoring in isolation of operations serves no purpose. Protected area agencies need to be resourced to be able to respond to the results of their monitoring efforts to develop and implement actions plans that will improve indicator response in future monitoring rounds. Assessment of management actions therefore flows back into the flow chart by informing scientists and managers of processes and indicator threshold levels of interest and also informing protected area staff of the success, or otherwise, of their management action. Through this process, recreation ecologists and protected area managers can become more strongly involved in collaborative projects that will build our knowledge on both research and management issues. We feel that this very simple process shows the important links between research and monitoring that are required to underpin protected area management of heavily visited sites. Ultimately, the relationships between each of the steps in the process

needs to be well understood (and enacted) if the joint goals of sustainable visitation and conservation are to be met in heavily visited protected areas.

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