Monitoring and Management of Visitor Flows in Recreational and Protected Areas
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Methods for Visitor Monitoring in Recreational and Protected Areas: An Overview

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Abstract: The objective of this paper is to present a systematic overview on methods used for visitor monitoring in recreational areas. Emphasis is given on quantitative methods such as direct observation, video observation, counting devices and registration books. The various approaches are discussed with regard to practical, legal and organisational aspects, such as costs, maintenance requirements, dependence on infrastructure (e.g. electricity), risk of vandalism or suitability for remote and ecologically sensitive locations.
For the design of a visitor monitoring scheme in a specific recreational area it is necessary to determine the best combination of devices and methods, depending on the objectives of the monitoring program. This relates also to the temporal resolution of monitoring activities (permanent, periodic, selective). In areas where the recreational use is largely depending on external factors such as weather, daytime and season, the representativity of a sampling scheme becomes crucial for the statistic validity of the obtained data.
As visitor monitoring can also be regarded as an interference with the privacy of the persons being monitored, ethic aspects of the application of the various methods must also be addressed.

INTRODUCTION

Monitoring of vegetation and wildlife in recreational and protected areas has a long tradition. In particular in national parks, the scientific interest in creating inventories and in observing the development of ecosystems has often been a driving force for the establishment of monitoring schemes. In many countries, systematic long-term research programs are seen as part of the duty of a national park service.

Opposed to that, a systematic monitoring of recreational uses and visitor flows is rarely carried out. This is particularly true for the situation in most European countries, where visitor monitoring, if at all done, is usually organised on an ad-hoc basis without systematic planning. Very often, results from improvised one-day countings are being extrapolated and used for management decision without consideration of the significance of the results.

The design of a monitoring project has to consider many practical, organisational, financial and also legal aspects:

Why should be monitored?

The goal of a monitoring scheme has to be clearly defined. Very often, it is unclear, whether a monitoring campaign is carried out to identify specific problems within a protected area, e.g. overuse, or simply to justify funding requests. Other goals could be to check the adherence to limitations of use, to minimise conflicts between user groups or to collect comprehensible data for planning decisions such as the allocation of infrastructure and services. Every such goal will require a different mix of monitoring methods.

What should be monitored?

From the definition of the goals of a monitoring scheme the measurement units can be determined:
Number of visits
Number of (individual) visitors
Visitor load (e.g. visitor hours)
Visitor flow (e.g. persons/hour/direction)
Visitor density (e.g. persons/length unit of trails)
Visitor activities etc.
In many cases it will be essential to register not only the visitors themselves and their activities but also some external factors which might have an effect on the visitation such as weather conditions, special events (e.g. sports competitions) or holidays.

Who should be monitored?

Not every person encountered in a park or recreation area is a visitor. The typical motives of a visitor are outdoor recreation or cultural appreciation (Hornback & Eagles 1999). Persons just passing through (e.g. by car on their way to work) or persons working in a recreational area such as forest workers, farmers or park employees should therefore not be considered as visitors. In order to report visitor numbers, they should not be included in use statistics. This distinction is only

feasible in remote areas, whereas in urban recreation areas it is almost impossible to identify the motive of a person entering a park.

In any case, if the goal of a monitoring scheme is to quantify the interactions between humans and the ecosystem, the total number of persons has to be accounted, independent from the reasons of their presence.

Where should be monitored?

Very often, monitoring is primarily carried out at entrance points (e.g. park gates, parking grounds) or visitor centers. These are also the locations where counting stations can easily be installed (electricity supply, security etc.). This leads to an over-representation of short-time users or users with minimal activity radius (e.g. picnickers) in the usage statistics. If the goal of the monitoring activities is to quantify interactions between visitors and the ecosystems, visitor monitoring in the core areas of a park is essential.

It might be easy to select counting points in recreational areas with a limited number of entrance points or key attractions. In the European context, the more typical situation is an open road or trail network with multiple entrance points. This is particularly the case in urban forests. In such situations, numerous pre-tests will be necessary to determine the most significant nodes in the trail network for the placement of counting stations.

When should be monitored?

In most European countries, systematic long-term visitor monitoring is hardly ever carried out. The most frequent type of counting activities are single-day countings. Very often, expected peak visitation days (e.g. Sundays in early summer) are selected for counting campaigns, and the results from these days are then being used to alarm the public because of excessive use-levels.

From numerous monitoring projects both in urban and in remote locations we learnt that for the understanding of the dynamics of recreational uses it is essential to have data which cover all seasons and all other external influences such as weather, daytime etc. However, this does not mean that every single visitor has to be recorded: For our time-lapse video monitoring projects we found that in heavily used recreational areas a sampling time of 15 minutes per hour is sufficient (Brandenburg 2001).

MONITORING TECHNIQUES

Numerous techniques are available for the monitoring of visitor flows in recreational areas. In the following section a short description of each approach will be given. A summary of the techniques and their fields of application is given in Table 1 (see also Watson et al. 2000).

Interviews

Oral and written interviews are an integral part of visitor monitoring concepts. They provide mainly qualitative information about the needs and motivations of visitors, their origin, their habits and activities as well as their routes within a recreational area. When combined with quantitative data from counting stations, important conclusions can be drawn for the management.

Direct observation

Roaming observers: In many national parks, rangers also records of the number of people they meet during their inspections of the area. These data can be used as additional information within a data gathering process, in particular in remote areas, but need to be treated cautiously, unless the roaming is set up in a systematic way.

Fixed counting stations: Specific manned counting stations are usually only set up for short observation periods. However, personnel working at information booths, souvenir shops etc. can also be integrated in a long-term monitoring concept, provided that the circumstances are clearly described (keeping of records also at peak times etc.).

Indirect observation

Automatic cameras, time-lapse video: Video recordings or photographs are an excellent source of information for visitor monitoring. In order to maximise the operating time without maintenance (change of tapes), time-lapse video recorders can be used, which take images at fixed intervals (e.g. 5 seconds). Most of the devices available commercially had been developed for security surveillance of homes, public buildings, factories etc. and usually depend on standard electricity supply.

The main cost factor is the interpretation of the video images, in particular, if not only the number of persons has to be recorded but also other aspects such as group size, mode of transport (hiking, biking), direction of movement etc. First attempts to automate the interpretation with the help of digital image analysis had been promising (Muhar et al. 1995), yet the calibration of the system for different locations and under different seasonal and weather conditions turned out to be very difficult.

Current development directions are independence from standard electricity supply (e.g. solar panels with buffer batteries) and wireless transmission of image data. There are already commercial systems available which can transmit image data over a short distance via an infrared interface, a combination with mobile telephones seems also possible.

Arial, satellite imagery: Airphotos can only be used for the detection of users in open areas such as beaches, lakes, grassland, or roads. New high-

resolution satellite images such as those from the IKONOS project will probably take over the role of conventional airphotos in many fields of application. However, both types of images offer only a single snapshot of the recreational use, the acquisition of a time series is usually far too expensive.

Counting of access permits and tickets

Where access to an area is restricted either by a quota or by selling entrance tickets, it is very easy to keep records of the permits or tickets issued to visitors.

Records from commercial facilities such as cable-cars, ferries, or even restaurants (number of meals served) also form a good source of information, provided that private enterprises and park administrations are willing to cooperate.

Counting devices

As counting of persons in the field is very labour-intensive, automatic counting devices are often applied in order to reduce costs. Some these devices have originally been developed for road traffic counting and are of limited use for non-road traffic.

Turnstiles: The use of turnstiles is usually limited to entrance situation of areas with restricted access (e.g. fenced areas) and high visitor numbers. Visitor numbers derived from turnstile countings are very often over-estimated, in particular when the devices are not permanently guarded (children love to play with turnstiles) and serviced (unwanted freewheeling).

Photoelectric counters: Light barriers, active or passive infrared sensors, linked with data loggers are very useful counting devices. Their energy consumption is relatively low, therefore they can be installed as battery-supplied counting stations even in remote locations.

A big challenge for all types of counting devices is the site-specific set-up and calibration of the counting station: A counting signal can be triggered not only by visitors, but also by wildlife or - on windy days - by twigs. Visitors walking in groups, even visitors with very dark or light clothing might also be wrongly recorded (Gasvoda 1999). In our own projects, we found good correlations between monthly or daily sums of visitors and the corresponding sensor signals, however, on an hourly basis, the correlation was sometimes weaker. The results illustrated in Fig.1 could only be achieved after a long calibration phase.

A big disadvantage of most of these devices is that they usually only record the number of visitors but not their direction. Differential approaches (e.g. two light barriers at short distance) work only in settings with low use levels.

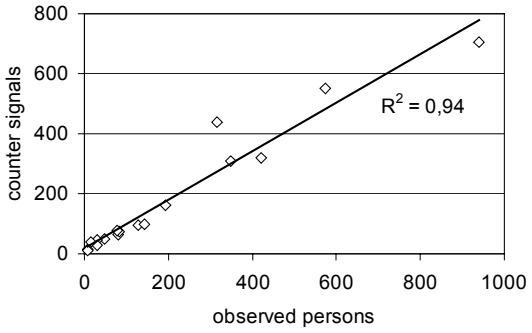

Fig.1: Correlation between light barrier signals and daily numbers of visitors at 16 counting days in the Danube Floodplains National Park

Pressure sensitive devices (Pneumatic tubes, mats): Various types of pneumatic tubes and other pressure sensitive devices have been developed, mainly for the detection of road traffic. When used for counting hikers, there is again a need for a good calibration to infer from the number of signals to the real number of persons (bikers will trigger a tube twice etc.).

Inductive loop sensors: These devices are extensively used for the monitoring of road traffic. As the signal is triggered by the movement of metallic objects, their application makes sense only for vehicle counting within a recreational area (including bike travel; also horseshoes might trigger a signal).

Self-registration

Trail registers: There are two types of trail registers: In many American parks trail registers are placed at trailheads on order to monitor the number of visitors, to check for permits and sometimes also to provide information for rescue teams about the intentions of a group. These data can be used to determine the number of persons entering an area and their routes, provided that the ratio between the total number of visitors and the number of persons actually registering can be estimated (Leatherberry & Lime 1981).

In European countries, registers at trailheads are uncommon, however, registers are sometimes placed in climbing routes, usually at the end of the most difficult section. They are then a good source of information on the number of persons actually mastering a route.

Summit books: It is again more a (Central) European tradition to place books on summits. The primary function of these books is not visitor registration but rather the provision of a "guest book". It is very difficult to determine the percentage of persons actually signing theses books. As a general rule, the higher the number of visitors, the lower will be the percentage of registration. On the other hand, on "famous" peaks, more people will like to have their names in these books than on "normal" hikes.

Hut or campground registers: In many areas it is compulsory to register in a hut or campground when staying overnight. Therefore data derived from these registers can be quite reliable. The registration usually also includes data on the origin of the visitor and the next destination. Therefore, they can be a useful source for the determination of typical routes (Muhar 2001).

In some areas e.g. of the Alps, also day visitors register in huts, but the percentage of registered visitors can vary from hut to hut, depending on the placement of the register within the hut, the policy of the warden and also the weather: In dubious weather situations, more hikers would register in a hut and leave information on their next destination in order to be found by rescue teams.

Mapping of traces of use

Although it is obvious that there is a correlation between the intensity of recreational use and "traces" left by the users in the landscape, it is very difficult to conclude from the mapping of these traces to actual visitor numbers (Coch & Hirnschal 1998).

Garbage: The amount of garbage left either in bins or in the landscape certainly is not only correlated to visitor numbers, but also to individual behaviour and local traditions.

Trail deterioration, damage to vegetation: Long lasting effects of recreational use are often seen as an indicator for overuse, however, there are so many other factors that contribute to this (e.g. trail design). Also, once a trail is already damaged, deterioration will continue even with lower use levels.

Footprints and sandbeds: Footprint data are used extensively in wildlife monitoring. In areas with low use levels human footprints can also be counted. As the age of a footprint is difficult to determine, it would, again similar to a technique applied in wildlife studies (Angold et al. 1999), be possible to provide sandbeds which are checked and raked at regular intervals.

USEFUL COMBINATIONS OF METHODS

It is obvious, that in the design of a monitoring scheme a mix of methods will be considered in order to compensate for the disadvantages of single counting techniques and to derive additional information from comparisons and correlations.

As an example, temporally selective counting at many different locations can be combined with permanent video observation on a few selected sites. Once the correlation between the various locations has been established, an extrapolation of the number of visitors can be performed.

Also visitor counting at selected locations can be combined with qualitative interviews on the motivation of visitors and their routes in order to determine the visitor load in different sections of the area (Arnberger et al. 2000).

One of the big advantages of combined monitoring schemes is the possibility to crosscheck data from one method with data from a different method. Fig.2 shows the results of different approaches to determine the percentage of dogs kept on leash in the Danube Floodplains National Park. In this park it is compulsory to keep dogs on leash.

			visitor numbers	direction of motion	routes	distribution within area	group size	visitor charac- teristics (age, sex)	visitor characteristics (origin, expectations etc.)	behaviour
direct methods	interviews	oral interviews			x	x	x	x	x	x
		written interviews			x	x	x	x	x	x
	direct observation	roaming observers	(x)	(x)	(x)	(x)	(x)	(x)		(x)
		fixed counting stations	x	x		x	x	x		x
	indirect observation	automatic cameras	x	x		x	x	x		x
		time-lapse video	x	x		x	x	x		x
		arial, satellite imagery	(x)	(x)	(x)	(x)	(x)			
	counting of access permits	tickets sold	x							
		permits issued	x				x			
	counting devices	turnstiles	x	(x)			(x)			
		photoelectric counters	x	(x)			(x)			
		pressure sensitive mats	x	(x)						
		pneumatic tubes	x	(x)						
		inductive loop sensors	(x)	(x)						
	self-registration	trail registers	x	x	(x)		x			
		summit books	x	x	x		x			
		hut registers	x	x	x		x			
indirect methods	mapping of traces of use	garbage	x			(x)				
		trail deterioration	x			(x)				
		damage to vegetation	(x)			(x)				
		footprints	x	(x)		(x)				
		sandbed	x	(x)						

Table 1: Techniques for visitor monitoring and their fields of application

People were interviewed at a visitor information both about their willingness to accept this rule. At the same location the actual number of dogs on leash was counted. The results were almost identical. However, the data from a hidden video observation station a few minutes away from the information booth show a much lower percentage for the same day. On days when the information both was not manned, the percentage was even lower.

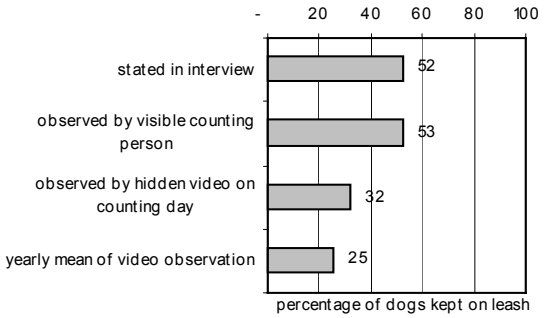

Fig.2: Rate of dogs kept on leash in the Danube Floodplains National Park, determined from different data gathering methods (Brandenburg 2001)

DISCUSSION

Ethic aspects

Some visitor monitoring methods can be seen as an intrusion into the private sphere of a visitor. This is true for most methods where images are taken (video recordings, automatic cameras), but also for other methods of hidden observation (human observers), in particular in remote locations, where visitors do not expect to be watched: In urban environments, people are already quite familiar with video surveillance, and it can even bee seen as a motive to visit remote areas, that one can behave there more freely, without being monitored.

However, as discussed in Fig.2, data on the behaviour of visitors derived from hidden observation can be much more realistic than from open observation (see also Vanderstoep 1986)

For our own research projects, we established a rule that every observation station (video camera) should be set up in a way, that it is not possible to identify individual persons in these images. The image resolution is just fine enough to count people and to identify e.g. their direction of movement, but not to identify the individual. As a second precaution, we do not use persons from the study areas as interpreters, who might be able to infer from identifiable behaviour to certain locally known persons. Nevertheless, we think that park managers should be very cautious when installing video cameras in remote locations; wherever possible, alternative solutions should be considered.

Vandalism

Counting devices in unguarded situations are of course exposed to vandalism. The mildest form of vandalism is the manipulation of devices so that they report no or wrong results, but sometimes gear will also be completely destroyed. We found that light barriers are in particular attracting vandals, even when we had the impression that they were well hidden. In such cases the application of totally buried counters (pressure sensitive devices) might be a useful alternative.

Costs vs. accuracy

Many devices currently used for visitor monitoring are mass products from the security surveillance sector. Therefore the hardware costs are no longer a big issue. The main cost factor are labour costs, for the installation and maintenance of counting devices, for conducting interviews or for the analysis of data (e.g. video interpretation). It is crucial for the success of a monitoring concept that from the beginning the required accuracy level is clearly identified. Reasonable accuracy can be defined as the level which is good enough to detect changes that are significant for management decisions (Hendee et al. 1990).

CONCLUSIONS AND OUTLOOK

A large number of techniques and methods have been developed for visitor monitoring.

From our point of view there are three key issues for the future developments in visitor monitoring:

Awareness of decision makers: First of all, there is still not enough awareness of the needs of visitor monitoring and management. At least in the European context, there is a big gap between the importance of recreation for the public and the resources invested into the management of recreational and protected areas as well as into research activities.

Standardisation of methods: It is very difficult to compare results from different areas when also different methods are applied. While for example within the US Forest Service a nation-wide monitoring program with standardised methods has been installed (English et al. 2001), not much has been done at the European level. On an international level, there are initiatives to establish standardised guidelines for visitor monitoring (Hornback & Eagles 1999). However, these initiatives did not have much response yet at national level.

Development of more reliable automatic sensors: As discussed above, privacy of visitors must be respected. Video monitoring, although well-tried, and delivering excellent results for further analysis, will always remain a criticisable technique in this context. We hope that in the future more reliable automatic counting devices with better options for analyses (e.g. direction of movement) will be available.

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