## Monitoring of visitor flows and visitor needs as a basis for protected area management

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## Abstract

The objective of this paper is to discuss the research and management needs for monitoring of recreational uses in protected areas, to provide an overview of visitor monitoring methods and to demonstrate their practical application in systematic monitoring programs for three specific protected areas with different character, Dürrenstein Wilderness Area, IUCN Cat. Ia/b, Donau-Auen National Park, Cat. II, and Wienerberg Protected Landscape, Cat. V.

Options for data analysis are discussed using three examples: Analysis of trail use intensity, forecast of visitor numbers based on the weather situation and the day of the week, and identification of the social carrying capacity of an urban protected area.

## Introduction

Scientific research and monitoring programs in Alpine protected areas, in particular in national parks, frequently focus on ecological aspects such as vegetation and wildlife. Compared to that, social aspects of park management, such as recreational uses, are not equally recognised as essential components of a research program. Very often, recreational uses of protected areas are, if at all, only investigated with regard to the ecological carrying capacity of the site, but usually not included in a comprehensive research and monitoring framework, which also considers the various social aspects of recreational uses, such as the social carrying capacity, spatial and temporal displacement behaviour as a consequence of crowding, and inter-group conflicts.

Systematically acquired quantitative and qualitative information on recreational use can be relevant for various different aspects of protected area management (HORNBACK, EAGLES 1999, MUHAR, ARNBERGER, BRANDENBURG 2002, CESSFORD, MUHAR 2003), such as:

Identification of the social, economic and political significance of the recreational uses

Identification of relations between use levels and physical and social impacts

Evaluation of visitor compliance with use regulations

Identification of problem spots within the protected area

Minimisation of conflicts between user groups

Identification of demand trends and generation of forecasts of visitor numbers and visitor activities

Definition of design standards for visitor facilities

Provision and allocation of infrastructure and services

Currently there is hardly any standardisation of visitor monitoring schemes throughout the various protected areas in Europe, therefore it is very difficult to compare results from individual areas.

## Monitoring methods

A large number of methods for quantitative and qualitative monitoring of recreational uses in protected areas is available (see Tab.1). The choice depends on the data needs for visitor management and on the specific situation on-site, which may include aspects such as energy supply, susceptibility to vandalism or service intervals. Some methods such as video observation may also interfere with the visitors' privacy and will therefore not be appropriate in some remote areas.

	monitoring methods of	Chone Tauem National Park, download t	visitor numbers	direction of motion	routes	spatial distribution	group size	visitor characteristics (age, sex)	visitor characteristics (origin, motivation etc.)	visitor behaviour
direct methods	interviews	oral interviews			x	<u>x</u>	x	x	x	х
		written interviews			x	x	x	x	x	_ X_
	direct observation	roaming observers	(x)	(x)	(x)	(x)	(x)	(x)		x
		fixed counting stations	x	x		х	х	x		(x)
	indirect observation	automatic cameras	_x	x		x	x	(x)		x
		time-lapse video	x	x		x	x	(x)		х
		aerial, satellite imagery	(x)	(x)	(x)	(x)	(x)			
	counting of access permits	tickets sold	x							
		permits issued	x				x			
	counting devices	turnstiles	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	х	(x)		х			
		summit books	x	х	x		x		_	
		hut registers	x	х	x		x			
		GPS-tracks		x	x					(x)
indirect methods	mapping of traces of use	garbage	(x)			(x)			_	
		trail deterioration	(x)		_	(x)				
		vegetation damage	(x)			(x)				
		footprints	(x)	(x)		(x)				

Tab. 1: Methods for monitoring of recreational uses in protected areas

(CESSFORD, MUHAR 2003, MUHAR et al., 2005)

x = direct relevance; (x) = limited relevance or relevance only in conjunction with other methods

As illustrated in Tab.1, no single method will satisfy all data needs for the management of a particular protected area, therefore the standard procedure should be to combine individual methods. This is particularly indispensable when applying automatic counting devices such as photoelectric counters or pressure sensitive mats: all such devices need careful cross-checking, e.g. by correlations with results from other monitoring methods such as personal observation. Further, quantitative data from visitor counting can be reasonably overlaid with data from interviews.

Table 2 shows the method mixes chosen for three protected areas in Austria with different protection status, recreational use levels and management challenges.

## **Data Analysis**

Quantitative data on recreational uses together with collateral data (e.g. weather, season, daytime) provide the basis for numerous analysis methods. The following examples have been chosen to illustrate the spectrum of possible analyses and models:

Protected Area	IUCN- Type	Use levels/types of touristic/recreational uses	Management challenges	Research methods applied
Dürrenstein Wilderness Area (Lower Austria)	Ia/Ib	<ul> <li>low use levels</li> <li>hiking, nature observation</li> <li>most visitors from the region</li> </ul>	<ul> <li>exclusion of recreational use in core areas (primary forests)</li> <li>minimisation of disturbance of key species (grouse)</li> <li>visitor information about protection goals</li> <li>stabilisation of visitor numbers at current level</li> </ul>	<ul> <li>periodic counting at car parking areas</li> <li>periodic counting at trail network nodes</li> <li>roaming observers in remote locations</li> <li>interviews at mountain hut (routes, motivation, activities)</li> </ul>
Donauauen / Lobau National Park (Vienna)	II	<ul> <li>high use levels</li> <li>walking, biking, jogging, dog walking</li> <li>most visitors from neighbouring residential areas</li> </ul>	<ul> <li>ecological carrying capacity</li> <li>minimisation of wildlife disturbance</li> <li>total annual visitation</li> <li>guiding of recreational uses</li> <li>minimisation of inter- group conflicts</li> <li>leashing of dogs</li> </ul>	<ul> <li>permanent time-lapse video counting at main entrance points</li> <li>periodic counting at trail network nodes</li> <li>interviews (routes, motivation, activities)</li> </ul>
Wienerberg Protected Landscape (Vienna)	V	<ul> <li>very high use levels</li> <li>walking, biking, dog walking</li> <li>most visitors from immediate neighbourhood</li> </ul>	<ul> <li>total annual visitation</li> <li>social carrying capacity</li> <li>crowding</li> <li>minimisation of inter- group conflicts</li> <li>leashing of dogs</li> </ul>	<ul> <li>permanent time-lapse video counting at trail network nodes</li> <li>interviews (motivation, activities, crowding perception, displacement behaviour)</li> </ul>

Tab. 2: Combinations of recreation monitoring methods applied in three protected areas with different visitation characteristics and management challenges (BRANDENBURG 2001, MUHAR, LEDITZNIG 2004, ARNBERGER 2003)

#### Analysis of trail use intensity

Visitors to the Dürrenstein Wilderness Area were asked to mark on a map the route that they took or planned to take. By linking the route data and other interview results, an analysis of spatial use patterns was possible (Fig. 1). The spatial distribution of visitor use was then linked to the visitor counting data. With the support of such frequency maps the most heavily used paths could be identified, and potential conflicts highlighted between nature conservation and recreational goals.



Fig. 1: Spatial distribution of visitors to the Dürrenstein Wilderness Area, derived from 182 interviews (MUHAR, LEDITZNIG 2004)

#### Forecast of visitor numbers in anational parkark; download unter www.biologiezentrum.at

In the Danube Floodplains National Park visitor numbers and visitor activities were gathered with permanent time-lapse video recording systems. Meteorological data were provided by a nearby meteorological registration station of the Central Institute of Meteorology and Geodynamics in Vienna (ZAMG). In linear regression models the daily totals of the various user groups such as bikers, hikers etc., the differentiation between workday and weekend, the Physiological Equivalent Temperature (PET), the precipitation as well as the type of cloud cover, were included. With the models it was possible to quantify how the visitor types and the daily visitor numbers are influenced by day of the week and the weather (BRANDENBURG, 2001).

Extent of interference	Total number of visitors	Bikers	Hikers
Workday, weekend and holiday	high	high	high
Precipitation	small	moderate	small
PET	high	high	moderate
Cloud Cover	moderate	moderate	small
Interaction between weekday and PET	moderate	high	moderate
Value of model	adj. R²=.745	adj. R²=.769	adj. R²=.629

Tab. 3: Explanatory value of the total number of visitors per day and the user types

#### Identification of the social carrying capacity of an urban protected area

Protected area management requires information about the tolerance thresholds of user groups for encounters and other social factors. A trade-off approach was applied for the recreation area Wienerberg (ARNBERGER, 2003), using a stated preference model with digitally calibrated images displaying various trail use scenarios including such factors as number of visitors, user type, presence of dogs on or not on a leash, etc (Fig. 2). Social carrying capacities were developed by asking user groups whether the presented recreation scenario was so unacceptable that they would shift their use away from the presented section (Fig. 3). Stated preference results were then linked with video observation data, resulting in an estimate of the number of hours which are assessed as beyond the limits of social carrying capacity in course of a year.





Fig. 2: Example of systematically manipulated images depicting different levels of six social setting attributes



Fig. 3: Share of respondents with use displacement behaviour

## Conclusions

The implementation of a visitor monitoring needs careful consideration of the specific management challenges and the resulting data needs. Only systematic monitoring schemes will provide reliable data for management authorities to support management decisions. Such monitoring programs therefore need to be planned well in advance and with an appropriate time horizon in order to be able to detect temporal and spatial trends and variations in visitation numbers, visitor activities and behavioural patterns. In order to achieve comparability between individual protected areas at national or European level, standards for data acquisition and data management need to be developed.

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Zeitschrift/Journal: Nationalpark Hohe Tauern - Conference Volume

Jahr/Year: 2005

Band/Volume: 3

Autor(en)/Author(s): Muhar Andreas, Arnberger Arne, Brandenburg Christiane

Artikel/Article: <u>Monitoring of visitor flows and visitor needs as a basis for</u> protected area management 153-157