How to elaborate precise visitor numbers?

Reto Rupf, Michael Wernli, Ruedi Haller

Abstract — Visitor numbers and visitor distribution are required information for various management tasks of recreational areas. Automatic data collection is a low-price opportunity to obtain data. The main problem of automatic methods is data precision. In the Swiss National Park, automatic visitor counting with acoustic slab sensors started in 2005. As precision did not appear to be satisfactory, the counting problems were investigated. Sensor installation strictly followed the instruction manuals given and fine tuning during the calibration period led to a deviance of 5%. Precise counting data resulted in the sum of persons counted whereas direction separated data was not as precise. Recommendations for counting site selection, installation and calibration counting are given.

Index Terms — Acoustic slab sensor, calibration, visitor census, visitor monitoring, Swiss National Park

1 Introduction

Visitor management in nature parks requires a good data of visitor numbers. Effects on regional economy, carrying capacity, necessary infrastructure, disturbance of wildlife etc. can only be estimated from reliable data e.g. [1] (based on survey and estimated visitor numbers form 1993 [2], Küpfer [3] estimated the economic effect of the National Park on the region of about 17.4 Million Swiss Francs). The quality of visitor experience influences a visitor's attitude towards nature and the environment. Positive experiences promote understanding of the need for nature conservation [4]. In the Swiss National Park, the first visitor counting and survey took place in the nineties [2], [5]. In 2006 and 2007 surveys of visitor structure and requirements were carried out [6], and the Swiss population's perception of the National Park was ascertained [7]. In 2005 automatic visitor counting started in the Swiss National Park. Acoustic slab sensors recording hikers were chosen because they are imperceptible and use little energy [8]. However, the precision of the visitor counting was not satisfactory. On-site precision did not correspond to counting under lab conditions [9]. Reasons for this lack of accuracy are discussed in Ross [10]. Therefore, the aim of visitor counting during the hiking season 2007 was to enhance the counting precision.

2 Method

During the 2007 season, an improvement in counting certainty was sought to reduce the difference between automatic and manual counting to less than 10%. Three calibration loops were made. Each loop lasted one month and contained 2-8 hours of manual counting per sensor. Loop results were analyzed and followed by system adjustments if required. Exact manuals for the installation (based on the manual of the producer Eco-Counter [11]) and calibration counting were written.

Eight acoustic slab sensors from the eco

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counter company were installed. The sites were selected based on the path network and further sensor requirements [11]. The systems were combined and tested before on-site installation. This process was documented. Sensor functionality was checked after installation. The data collected included total numbers of visitors per hour as well as the direction in which they passed the sensor. Manual calibration counting lasted at least 2 hours per sensor and loop. Calibration counting was always operated by the same well-trained counting team. Detailed protocols supported the counting. Due to the sensors being imperceptible, visitors' behaviour was not influenced. Absolute deflection of calibration and automatic counting was tested using a Wilcoxon test [12].

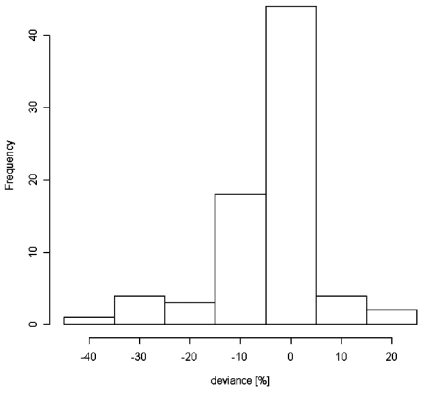

Fig. 1: Histogram of relative deviance of automatically and manually counted visitors; N=76.

TABLE 1

RESULTS OF CALIBRATION COUNTING

loop	n	mean abrolute deviance	p-value wilcoxon test
1	31	8.0%	0:007
2	18	6.2%	**0.005**
3	27	4.7%	**< 0.001**
1 - 3	76	6.4%	**< 0.001**

3 RESULTS

The calculated deviance detected by manual calibration counting is shown in Fig. 1. Most counting hours showed a deviance less than 5%. Negative deviance (the sensors counted fewer people than actually passed the site) occurs more often than positive deviance. In Table 1 the average deviations and the test results for expected deviance of less than 10% are given. Counting precision was ameliorated during the project. However, the data indicates the importance of sensor calibration and fine tuning of the counting site. Despite very careful preparation and installation at the beginning, automatically counts differed about 8% from manually counted visitors. The precision of automatic counting was enhanced during the project by adjustment of counting site settings. The deviation fell significantly, to below the target of 10%. The indicated deviance of 5% given by the company Eco-Counter was reached only in the 3rd loop.

Besides counting passing visitors, the sensor used detects the directions in which they are walking. The deviance was greater for direction separated data. Especially groups walking very closely can cause big relative deviance. Mean deviance is about 25%. Directional data can provide information about the amount of use of a path in a particular direction, but cannot be used to estimate visitor numbers.

On-site sensor results differed from lab conditions [9]. With adjustments concerning path width, cover material, path stabilization etc. precision was enhanced but deviance was still about 5%. Optimal system settings are very important to determine precise visitor numbers. Repeated calibration counting is necessary to obtain optimal sensor and path settings, to correct and interpret counter data, and to estimate visitor numbers.

6 Recommendations

To obtain precise visitor counting data using acoustic wave - sensitive sensors, the requirements are as follows:

Site selection:
- Path width must be very narrow, less than 80 cm using one slab of 50 cm width. This restriction prevents visitors from following each other too closely and impedes crossing directly over the slab sensors.
- The view from the sensor site should not be particularly interesting so visitors are not tempted to stop.
- Proximity to obstacles should be avoided in order not to provoke jams on the slab sensors.
- Placing the slab sensors near path crossings and rest areas should be avoided as there is a risk of multiple counting of visitors crossing repeatedly the counting systems.
- As stairs regulate the hikers' steps, they are recommended for visitor counting with automatic sensors [13]. Fixing installations of stairs proved not to transfer information satisfactorily to the slabs provoking counting mistakes.
- Path erosion should be considered as sites with narrow paths are often situated at exposed locations.
- Steep sites are not recommended for installations of sensors as erosion may expose the sensors. On flat sites drainage should be considered.

Sensor installation:
- The sensors should be tested before and after installation [10].
- The cover material has to transfer pressure and should not be too smooth [9]. Furthermore, it should be the same material as the path not to attract attention and change visitors' behaviour.
- The exact sensor site should be recorded to watch the visitors' behaviour just over the system in calibration counting and to relocate the sensors [14].

Calibration counting:
- It is recommended that well-trained staff is used for calibration counting. Written field instructions are very useful.
- Before calibration counting, time levelling with the sensor should be performed [9].
- The staff involved in counting should be out of sight so as not to disturb the natural behaviour of visitors.
- The visitors' behaviour passing the sensor has to be watched due to following data check.
- Counting should be recorded in detail to avoid unnecessary mistakes.

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