A comparison of passive infrared counter results with time lapse video monitoring at a shared urban recreational trail

Albert Kahler and Arne Arnberger

Abstract — This study compared two visitor counting methods at a heavily used multi-use access trail to the Donau-Auen National Park in Vienna, Austria. We compared visitor numbers gained by video monitoring with passive infrared counter results (Ecocounter – Ecotwin©). Both devices were installed at the same place and recorded the recreation use along the trail between December 2007 and January 2008. During daylight the video camera took pictures every 1.6 seconds. Counting by Ecotwin resulted in 3477 counts, while the total amount of counts by video monitoring was 4405. We will discuss causes for the differences in visitor numbers, and the pro and cons of both methods.

Index Terms — Passive infrared sensor, shared trail, video monitoring, Vienna.

1 Introduction

The monitoring of visitors to recreational and protected areas and forests has long been regarded as an important component of recreation and ecological management [1], [2], [3], [4], [5], [6], [7], [8], [9]. Data on recreational use are essential for selecting appropriate visitor and area management and marketing strategies [1], [3], [4], [5], [7].

Over the past decades, numerous techniques and methods have been suggested for the purpose of monitoring visitor flows in recreational and protected areas [1], [2], [3], [4], [5]. [6], [7], [8], [10], [11] [12] [13]. Area managers must decide on the most appropriate observation strategy and most suitable methods for their visitor monitoring. Consequently, knowledge about the many technical and methodological options, their costs, and their respective advantages and disadvantages is a prerequisite for sound decision making. For that purpose, methodological comparisons are essential.

Especially for recreational and protected areas close to a large conurbation, managers and researchers have to cope with many problems due to a multifaceted visitor structure and high use loads [7], [11], [12], [14], [15],. Therefore it is important to have reliable data on the amount of visitors and the temporal use patterns.

Usage of automatic counters is most common in the different protected area systems worldwide [1], [2], [3], [4], [5]. [6], [7], [8], [9], [10]. These include active and passive in-

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frared counters, acoustic counters, radar, pressure pads, seismic sensors, magnetic and pneumatic sensors etc. Newest developments have equipped some of these counter types with remote download systems [16].

These long-term counting systems, however, have several disadvantages. Automatic counters provide no indication as to the activities, in which visitors are engaged, the size of the group or visitor behaviour, and their interactions [7], [11]. Especially for automatic counters, a calibration process is necessary, as counts may be biased for many reasons [1], [5], [11]. For example, an active infrared counter can be triggered by wildlife, swaying grass and moving leaves, breaking branches, or curious visitors tampering with the device, in addition to properly passing visitors. Miscounts from a passive infra-red counter can be associated with visitors walking past in tight groups or can also be caused by certain colors of user clothing [10]. For the calibration of automatic counters one usually relies on counting by observers or to use a video- or camera-based system [1], [5], [6], [7], [8], [11], [15], [17].

Compared to automatic counters one main advantage of video monitoring is that it adds the opportunity for analysis by user types, user behavior and use levels. However, the analysis of the video tape data is time consuming [4], [7], [11], [14], [15], [18]. Comparing passive infrared counter results with time lapse video monitoring at a shared urban recreational trail allows identifying factors, which bias passive infrared counter results.

2 Study area

The Danube Floodplains National Park is situated in the east of Austria and stretches from the city of Vienna, the capital of Austria with a population of 1.7 million inhabitants, along the Danube River to the Slovakian border. In 1996, the area was declared as a national park and accredited by the IUCN in 1997. The National Park covers an area of about 9300 hectares. The Lobau, the Viennese section of the National Park, covers an area of 2400 hectares. Since several decades, the Lobau has been a traditional recreational area for the Viennese population as well as for the inhabitants of the surrounding communities. Visitor counting resulted in an annual use estimate of around 0.60 million visits to the Lobau [18].

The entrance near the new National Park Information Centre Lobau at the Dechantweg (Fig. 1), is one of the main access points to the national park. It is a paved and flat trail of about 4 m of width. Based on previous visitor monitoring studies about 90,000 visitors are entering and leaving the National Park at this point. This entrance is used by several user groups. Walker, dog walker, bicyclist, jogger, horse rider and car use is observed.

3 Methods

Between December 19, 2007 and January 19, 2008 a passive infrared counter and a time-lapse video camera were installed at the access point Dechantweg. Both devices observed the same trail section during the same time period.

3.1 Time-lapse video recording

The video monitoring unit consisted of a weatherproof black-and-white video camera with integrated heating and two time-lapse video recorders. In order to avoid vandalism the video camera was fixed to a fenced building inaccessible for visitors. The time-lapse video recorder took images

Fig. 1. The Danube Floodplains National Park (www.donauauen.at): The observed entrance point, called Dechantweg, is located at the west side of the National Park.

of the trail every 1.6 seconds during daylight. With the low resolution of the black-and-white camera and a minimum distance between visitor and camera the anonymity of the visitors was ensured.

The following data were captured from the video tapes and recorded on a MS-Excel spreadsheet: date and day of the week, time of visit, direction of movement, number of persons, group size, activity type and number of dogs.

3.2 Passive infrared sensor

The passive infrared unit consisted of a pyroelectric sensor (Ecocounter – Ecotwin©) and a logger (Fig. 1). The system is weatherproof and the included batteries should last for up to ten years. The sensor was fixed on a pole about 90cm above ground. The cables were buried and the logger was hidden behind a tree. In order to avoid vandalism the system was set up within a fenced plot bordering the trail and camouflaged by bushes and leaves. With the two-way sensor, not only the number of passing persons could be recorded, but also the direction of movement. For the data download from the logger a Pocket PC with an infrared link was used.

4 Results

Video monitoring resulted in 4405 “events” entering and leaving the park. About 68% were walkers, joggers or dog walkers, and 13.5% were bicyclists. Further users were motorbikers and horse riders. Close to 18% of the “events” observed were cars. Car traffic originated because of a nearby riding stable about 100m behind the monitoring place, and cars of the national park management and other area administrations.

The passive infrared counter recorded only 3477 “events” during the same time period, about 20% less than video monitoring.

Although the correlation between the hourly video and sensor results was very high (R^2 = 0.943), the scatter plot (Fig. 2) documents a permanent undercounting of the sensor for low as well as for high use times.

Further analysis explored causes for this undercounting of the passive infrared sensor, focusing on activity types. For that purpose the relative differences between video and sensor counts were divided by the median into two groups: In one group with higher differences between video and sensor results and one group with no or few differences.

Times with higher differences in counting results are characterized by a significantly higher walker and lower car use. Further analysis targeting the walker group identified group size as one influencing factor. During times with high discrepancies between both methods, the group size was significantly larger. Obviously, when two or more people were walking side by side the passive infrared counter counted only one person.

Fig. 2. Ecocounter ECO-TWIN (www.velometer.at)

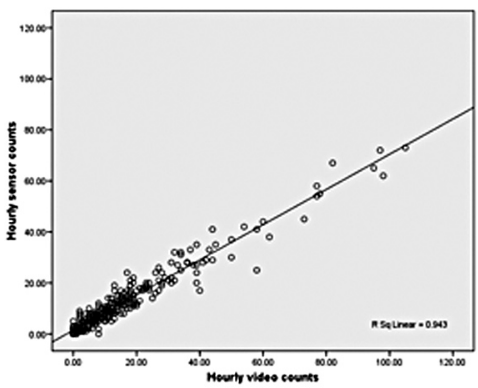

Fig. 3. Scatter-plot of the hourly video and sensor counts.

5 Conclusion

Each monitoring method has its advantages and disadvantages. The advantages of this passive infrared counter are that it is not dependent on electricity, is very easy to handle, and it needs very little maintenance efforts. That makes the counter valuable for many in particular remote recreational areas. However, the undercounting of walkers may limit its use. We recommend using this device at more narrow trails which force the visitors to walk one behind the other. On the other hand, the consistent undercounting of the counter (Fig 2) documents that a calibration factor is very useful for producing reliable counting results.

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References

[1] A. E. Watson, D. N. Cole, D. L. Turner and P. S. Reynolds, “Wilderness recreation use estimation: A handbook of methods and systems”, General Technical Report RMRS-GTR-56. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, 2000.

[2] J. C. Hendee and C. Dawson, “Wilderness management: Stewardship and protection of resources and values”, (3rd ed.). Golden, Colo.: Fulcrum Publishing, 2002.

[3] K. E. Hornback and P. F. J. Eagles, “Guidelines for public use measurement and reporting at parks and protected areas”, International Union for Conservation of Nature and Natural Resources. Gland, Switzerland, 1999.

[4] G. Cessford and A. Muhar, “An overview of monitoring options for visitor numbers in national parks and other protected natural and recreation areas”, *Journal for Nature Conservation*, vol. 11, no. 3, pp. 240-250, 2003.

[5] L. Kajala, A. Almik, R. Dahl, L. Dikšaitė, J. Erkkonen, P. Fredman, F. J. Søndergaard, K. Karoles, T. Sievänen, H. Skov-Petersen, O. I. Vistad and P. Wallsten, “Visitor monitoring in nature areas – a manual based on experiences from the Nordic and Baltic countries”, Nordic Council of Ministers, 2007.

[6] T. Sievänen, A. Arnberger, J. Dehez, N. Grant, F. S. Jensen and H. Skov-Petersen (eds.), “Forest Recreation Monitoring – A European Perspective“, Working Papers of the Finnish Forest Research Institute 79, Helsinki, pp. 43-58, 2008.

[7] A. Arnberger, W. Haider and C. Brandenburg, „Evaluating visitor monitoring techniques: A comparison of counting and video observation data”, *Environmental Management*, vol. 36, no. 2, pp. 317-327, 2005.

[8] W. L. Hadwen, W. Hill and C. M. Pickering, “Icons under threat: Why monitoring visitors and their ecological impacts in protected areas matters”, *Ecological Management & Restoration*, vol. 8, no. 3, pp. 177-181, 2007.

[9] R. Beunen, C. F. Jaarsma and R. N .A. Kramer, “Counting of visitors in the Meijendel dunes, The Netherlands”, *Journal of Coastal Conservation*, vol. 10, pp. 109-118, 2004.

[10] D. Gasvoda, “Trail traffic counters: Update”, Report 9923-2835-MTDC. USDA Forest Service, Missoula Technology and Development Centre, Missoula, MN, 1999.

[11] A. Arnberger, C. Brandenburg and A. Muhar, “Besuchererfassungstechnologien als Beitrag für eine nachhaltige Erholungsgebiets- und Stadtentwicklung”, In: Schrenk, M. (Hrsg.): CORP 2006 & Geomultimedia06, 13.-16. Februar 2006, Wien: 573-580, 2006.

[12] K. Madden and K. Love, “User analysis: An approach to park planning and management”, American Society of Landscape Architects, Washington, D.C., 1982

[13] A. Arnberger, C. Brandenburg and A. Muhar (Eds.), „Monitoring and Management of Visitor Flows in Recreational and Protected Areas”. Conference Proceedings. Institute for Landscape Architecture and Landscape Management, BOKU - University of Natural Resources and Applied Life Sciences Vienna, pp. 485, 2002.

[14] A. Arnberger and R. Eder, “Monitoring recreational activities in urban forests using long-term video observation”, *FORESTRY*, 80(1), 1-15, 2007.

[15] A. Arnberger and R. Eder, “Assessing user interactions on shared recreational trails by long-term video monitoring”, *Managing Leisure*, vol. 13, no. 1, pp. 36-51, 2008.

[16] S. Melville and J. Ruohonen, “The development of a remote-download system for visitor counting”. Pages 37-43 in T. Sievänen, J. Erkkonen, J. Jokimäki, J. Saarinen, S. Tuulentie, and E. Virtanen (eds.) Proceedings of the Second Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas. Rovaniemi, Finland, 2004.

[17] M. Campbell, “Monitoring tail use with digital still cameras: strengths, limitations and proposed resolutions”. In: Siegrist, D., Clivaz, C., Hunziker, M., Iten, S. (Eds.), Exploring the Nature of Management. Third International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas. 13.09.2006 - 17.09.2006, Rapperswil; Proceedings of the

Third International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas. University of Applied Sciences Rapperswil: 312-316, 2006.
[18] A. Arnberger, “Recreation use of urban forests: An inter-area comparison”, *Urban Forestry & Urban Greening*, vol. 4, no. 3-4, pp. 135-144, 2006.

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