

# Sample Selection Bias in Visitor Surveys: Comparative Results of an On-Site and an Off-Site Survey Assessing Recreational Benefits of Forests

**Katrin Bernath & Anna Roschewitz**

Swiss Federal Institute for Forest, Snow and Landscape Research, Switzerland

katrin.bernath@wsl.ch  
anna.roschewitz@wsl.ch

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## Introduction

Information about visitors of recreational areas establishes an important basis for the management of these areas. Frequently, the data on visitor characteristics, their behaviour and requirements is collected in on-site surveys. This approach is efficient because the target population can be addressed directly. However, the selection probabilities of visitors depend on external factors and so they differ, for example, according to visit frequencies. Therefore, results of on-site surveys have to be interpreted carefully and generalisations from on-site samples to the population of all visitors have to take into account unequal selection probabilities. In particular, the sampling strategy affects estimates of recreational benefits in economic valuation studies.

Differences between on-site and off-site samples were examined in our study on recreational benefits of the forests in the city of Zurich. Furthermore, we analyzed the impact of weighting and other methods to correct for selection bias in on-site samples and tested them empirically by comparing the corrected on-site results with estimates from an off-site random sample.

## Methods and Data

Recreational benefits can be assessed in monetary terms either with revealed preference methods as for example the travel cost method (e.g. Parsons

2003) or with stated preference methods (Bateman et al. 2002). In our study, we estimated recreational benefits of Zurich's city forests with the contingent valuation method and assessed visitors' willingness to pay (WTP) for an annual permit allowing them to visit the forests within the city area. As these valuation methods rely on survey data, sample selection and data collection are crucial steps of the valuation process. Approaches to adjust mean sample estimates include the calculation of weighted averages (Morrison 2000).

Sample weights are commonly calculated by adjusting distributions of sample characteristics to the respective distributions within the population. This approach assumes that these characteristics are correlated with the target variable, which is 'individuals' WTP' in contingent valuation studies. Alternatively, sample weights can be determined according to the probability of an individual being sampled. A framework incorporating different aspects of sample selection probability in on-site surveys was proposed by Elsassner (2001). We adopted this approach to derive weighting factors for our on-site sample.

The data in this study came from two surveys carried out in September 2004. In an on-site survey, visitors were interviewed at ten different sites within the forested area of Zurich. An off-site mail survey was carried out among randomly chosen residents of Zurich. The questionnaires were almost identical and both surveys evaluated WTP for a visitor permit in order to derive rec-

reational values of the forest with the contingent valuation method. Furthermore, we assessed visit frequencies for the urban forests and other green spaces within the city area, forest visiting behaviour and socio-economic characteristics.

## Results and Conclusions

According to the mail survey, 88% of the city residents have visited the urban forests at least once during the past 12 months. Comparing these forest visitors in the off-site sample with the on-site sample revealed substantial differences. Visit frequencies for all urban green spaces were higher among on-site sampled visitors than in the population sample. Furthermore, average WTP for an annual visitor permit varied significantly. The on-site value exceeded the off-site value because WTP increased with the number of visits and frequent visitors were more likely to be sampled in the forests. Moreover, the two samples differed regarding several variables describing forest visiting behaviour and socio-economic characteristics. For example, the respondents in the on-site sample were older, educated to a higher level and were more likely to live in a city-district adjoining a forest.

The results of the different methods to correct on-site estimates for sample selection bias showed that the weighted mean of visitors' WTP corresponded to the residents' mean WTP. Similar findings were observed regarding other variables. Our results suggest that weighting on-site data according to individual selection probabilities approximates off-site estimates and therefore provides a valid approach to estimate population values with on-site sample values. However, weighting the data increases the variance of the estimates. Therefore, on-site surveys have to be based on larger samples than off-site random surveys to achieve the same confidence level.

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