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Would You Displace? It Depends! A Multivariate Visual Approach to Intended Displacement from an Urban Forest Trail

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A dichotomous choice survey was applied to explore the contributions of various social conditions to intended displacement from the main trail of a recreation area in Vienna, Austria. The trail scenarios were depicted as digitally calibrated images which systematically displayed combinations of levels of crowding with different mixes of user types, group sizes, compliance behavior, direction of movement, and placement within the image. Intended displacement was measured by interviewing 237 visitors on-site. The resulting model documents that the intention to displace is influenced by all six systematically controlled social factors as well as the interactions between crowding and several other design variables. High visitor numbers, unleashed dogs, small group sizes, more face to face encounters, a mix of user types moving at different speeds and several combinations between them increased intentions to displace.

KEYWORDS: *Controlled experiment, crowding, urban forest, social carrying capacity, stated preference model, use displacement, visitor behavior.*

Introduction

Over the past decades, investigations on use displacement have made significant contributions to outdoor recreation research. The concept of displacement describes one type of behavior visitors exhibit in reaction to unwanted conditions (Kuentzel & Heberlein, 1992, Shelby, Bregenzer, & Johnson, 1988). Besides management actions and resource specific conditions (Hall & Shelby, 2000), crowding, user conflicts and visitor behavior have been recognized for modifying behavior of visitors to recreation areas. Most

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studies on social aspects of displacement have measured crowding, visitor behavior or user conflicts as a scaled variable in one specific setting (Manning & Valliere, 2001; Shelby et al., 1988). Such a study design does not account for the complexity of real-world situations in which displacement may be affected by other social setting components. This shortcoming may be more serious for studies in urban environments, as trail use in multiple-use and high-use urban settings is characterized by diverse visitor groups and diverse behaviors, which results in a more complex recreation experience compared to wilderness settings or remote areas. For example, besides crowding, other and often competing socials factors such as the direction of movement, different degrees of visitor behavior, mixes of user types, personal needs for space, and various shares of group size might influence displacement of urban trail users. Consequently, investigations of use displacement should consider these influencing factors and present these concomitantly, leading to a more realistic description of trail use.

Researchers focused on use displacement as one potential explanation for the consistently low relationship between visitor satisfaction and concurrent reports of crowding (Manning & Valliere, 2001; Robertson & Regula, 1994; Shelby & Heberlein, 1986). Displacement is a behavioral coping mechanism and was originally described as a process of social succession (Schreyer & Knopf, 1984), where original visitors are replaced by succeeding visitors better adapted to changes in the recreation setting.

Several types of use displacement have been recognized (Manning & Valliere, 2001): spatial displacement occurs when visitors shift their use to other locations within the same area (intra-spatial) or move away from the area to other areas (inter-spatial). Another type of displacement describes visitors' change in their timing of visits. Activity displacement is defined as visitors changing their primary activity (Robertson & Regula, 1994). Some studies observed several displacement mechanisms concomitantly (Arnberger & Brandenburg, 2002; Johnson & Dawson, 2002; Manning & Valliere, 2001; Robertson & Regula, 1994).

Use displacement by crowding has been investigated for several types of areas and activity types. Among water-based users displacement by crowding was found in many studies (Hall & Shelby, 2000; Kuentzel & Heberlein, 1992; Robertson & Regula, 1994; Shelby et al., 1988). Regarding trail users, Johnson and Dawson's survey (2002) among Adirondack wilderness hikers documented spatial and temporal displacement by crowding. Similarly, Arnberger and Brandenburg (2002) documented both spatial and temporal displacement by crowding of suburban national park visitors. Manning and Valliere (2001) found relatively high levels of use displacement by local residents caused by visitor behavior and high use levels around Acadia National Park.

While research has repeatedly documented a relationship between crowding, user conflicts or visitor behavior and displacement, there has been limited success in establishing causal connections between use displacement and other social factors such as the direction of movement and the distance to other users as well as in assessing the effects of social factors in combinations with other social factors. One reason for these deficiencies may be the research methods employed to measure displacement behavior. Most past research used verbal descriptions, which may be unable to capture the complexity of recreation experiences in dense situations. Over the past few years, visual approaches using digitally manipulated images have been applied to investigate crowding in general as well as the relationship between displacement and crowding specifically (Laven, Manning, & Krymkowski, 2005; Manning, 2001; Manning, Valliere, Wang, & Jacobi, 1999). Respondents were asked about the maximum number of other users or user groups tolerable before they would shift their use to a different location or time. Especially denser situations are much more conducive to visual presentation than to verbal descriptions, and allow for a more realistic and accurate evaluation of indicators causing displacement (Manning, Lime, Freimund, & Pitt, 1996). These benefits apply equally to research and management applications, as interviewees on the one side and managers and researchers on the other are truly confronted with the same conditions, as opposed to inferring from mere verbal or written descriptions.

Most of these visual-based studies, however, used an univariate approach in the sense that visitors are asked about displacement in a single-item question focusing on crowding or conflict only, instead of treating the recreation experience as a multi-attribute phenomenon. If one were to investigate the same topic in high-use recreation areas with high probabilities for crowding perceptions and user conflicts due to user mixes and various visitor behaviors, the deficiencies of the conventional method would quickly become apparent. Consequently, especially in high use areas, investigations of displacement should also consider other influencing factors and explore causes for displacement from recreation trails more holistically based on a more realistic mode of presentation.

The purpose of this study is to explore several driving forces of use displacement in one multivariate approach. We will investigate whether (1) intentions to displace are inherently influenced by several competing social factors such as visitor behavior and user composition, and (2) these factors might influence each other in a positive or negative manner, leading to measurable interactions between these variables; for example, the importance of visitor composition might differ under low-use and high-use conditions. In order to accommodate the multivariate nature of these research questions, this study will use a dichotomous choice survey with visual presentation of several social factors which might contribute to intended displacement. Besides the number of people, five additional variables (i.e. placement of visitors within the image, user types, visitor behavior, group size and direction of movement) will be strictly controlled in a fractional factorial design. For simplicity this study will focus on variations in the social setting only, while keeping the physical setting constant. As such, this study will contribute to the theory and method of displacement research by developing an innovative method of data collection (i.e. digitally calibrated images) that depicts elements of crowding, conflict and different types of visitor behavior in one image, and applies displacement research to an urban setting.

Methods

Study Area

Data were collected in the Wienerberg recreation area, which is situated in the south of Vienna, Austria. The municipal forest department manages this 120-hectare area. Forest dominates the area, and several sections of it are conservation areas. The urban forest provides about 14 km of gravel trails and many paths. Bicycling is permitted on some trails, and dogs are allowed, but must remain on a leash. Residential and business areas, a hospital, and garden allotments surround the area. The forest was established in the late 1980s and its recreational use has increased steadily since, especially as a result of continuous housing developments nearby. Long-term visitor counting was conducted using permanent video monitoring at access points resulting in an annual use estimate of around 1.2 million visits by mostly very regular users (Arnberger, 2003).

Data Sampling

The data used for the analysis in this study were collected as part of a larger project designed to develop a baseline understanding of recreational use in the Wienerberg forest (Arnberger, 2003). Several investigations of recreational use were conducted between 2002 and 2003 using a mix of long-term and short-term counting methods, as well as on-site interviews. On six days during the late summer and early fall of 2002, on-site interviews were conducted in the forest along the main trail section. The interviews took place on three randomly selected work days and three Sundays. The interviewers were employees of the institute, mostly students, who were carefully trained in the use of the survey forms. They asked visitors if they were willing to participate in a 15-minute interview. Once the interview was completed, the next visitor encountered, regardless of user type, was asked to participate in the study. Interviewers registered group size, activity type (biking, hiking, etc.), whether the visitor was accompanied by dogs on or off a leash, and interview time. In total 629 visitors were approached and 292 visitors agreed to the interview (46% response rate), of which 237 (38%) completed all of the questions. Reasons for refusal mostly included trivial issues, but more systematic biases were introduced because bicyclists and joggers were less likely to stop for an interview than walkers. As a result, walkers with and without dog were over-represented in the sample compared to actual numbers (Arnberger, 2003).

The survey instrument consisted of two components. The first part contained a conventional questionnaire on socio-demographic characteristics and visit-related questions such as motivations, perceived crowding, origin, and length of stay. In the second part of the interview, each respondent was shown the digitally calibrated images in four choice sets. Each set contained four color images presenting various recreational scenarios (Figure 1). Thus each respondent evaluated 16 images. The presentation order of choice-sets and their versions were rotated systematically to avoid starting point bias. First, generic preferences were assessed by asking visitors to choose the most and the least preferred scenario of the four assembled in each choice set (see Arnberger & Haider, 2005); thereafter intended displacement was extracted by asking the visitors whether 1) the scenario considered the best of the set of four, and, as a separate question, 2) the worst scenario of the four was so intolerable that it would prompt them to shift their use from the trail. Only the results about intentions to displace from the main trail will be presented below.

Measuring Intended Displacement: a Referendum Style Question

The intention to displace from the main trail of the study area was investigated with a referendum style choice question pertaining to two images, the best and the worst, of each set. The referendum style choice ques-

Figure 1. Example of a choice set consisting of digitally calibrated images—each image depicts a different combination of six social setting attributes.

tion is one possible question among the many question formats used in stated preference / choice surveys, which consider the multivariate trade-off behavior of respondents (Louviere, Hensher, & Swait, 2000). The referendum style question elicits a dichotomous choice response to yes or no question instead of a rating scale. This format has been suggested as the most appropriate form of response elicitation of intended behavior, particularly in contingent valuation (Arrow, Solow, Portney, Leamer, Radner, & Schuman, 1993). Obviously, this question goes beyond preference elicitation and clearly extracts a behavioral intention.

The strength of stated choice lies in its ability to predict how the public will respond to various policy or management alternatives, including arrangements of resources, quality of visitor experiences, facilities, services and/or regulations that may not currently exist, and avoid the problem of multicollinearity (Haider, 2002). Stated choice analysis has been applied to study public preferences and choice behavior concerning a range of recreation-related issues such as visitor preferences for wilderness management issues (Lawson & Manning, 2002), tourism destination choice (Haider & Ewing, 1990), and beach preferences of rafters (Stewart, Larkin, Orland, & Anderson, 2003).

In stated preference models, alternatives are defined as combinations of attributes and each alternative is evaluated as a whole. Random utility theory postulates that choices can be modeled as a function of the attributes of the alternatives (Ben-Akiva & Lerman, 1985). The overall utility of alternative i is represented as (McFadden, 1974):

$$U_i = V_i + \varepsilon_i. \qquad (1)$$

It is assumed that the overall utility (U_i) contained in the alternative is represented by a utility function that contains a deterministic component (V_i), defined as $V_i = \beta_0 + \beta_1 X_{1,i} \ldots + \beta_k X_{k,i}$ where the betas are the part-worth utilities, and a stochastic component (ε_i). Selection of one alternative over another implies that the utility (U_i) of that alternative is greater than the utility of any other alternative (U_j).

The maximum likelihood analysis produces a regression estimate, standard error and *t*-value for each attribute level. The results of the logit model supports the estimation of parameters that allow the estimation of the probability of choice of a given alternative as a function of the attributes comprising that alternative and those attributes of all other alternatives in the choice set (for a detail discussion about stated choice see Louviere et al., 2000).

The referendum style question applied in this survey can be analyzed in a binomial logit model (Ben-Akiva & Lerman, 1985) of the form

$$\text{Prob}\,\{i \text{ chosen}\} = e^{V_i}/(e^{V_i} + 1). \qquad (2)$$

During data preparation for analysis the rule of transitivity was applied to classify the responses to the remaining two images of each choice set, which were rated neither best nor worst: Whenever the most preferred scenario out of four was judged as leading to displacement, the other three scenarios of the choice set were also deemed as contributing to displacement. On the other extreme, when the least preferred scenario was not judged as inducing displacement, the other scenarios were also deemed as not contributing. When the best image was judged as not contributing while the worst was, then the two middle images were ignored for analysis.

Attributes

In the analysis each image is treated as a generic scenario containing all attributes under consideration, except of the scenario with no people in the image. The computer-generated images contained six attributes (Table 1) and were constructed following an Addelman type asymmetric main effects plan (Addelman, 1962) with one eight level variable and 5 four level variables, requiring a total of 128 images, which were presented in 32 choice sets. Fractional factorial designs involve the selection of a particular subset of complete factorials, so that particular effects of interest can be estimated as efficiently as possible without loosing substantial information. Orland, Daniel, and Haider (1995) called the generation of images that follow a strict design plan "digitally calibrated images".

The images contained systematic representations of the following six attributes: (1) number of visitors, (2) user type, (3) group size, (4) placement of visitors within the image, (5) presence of dogs and whether dogs are on or not on a leash, and (6) the direction of movement. The number of visitors was shown in eight levels, the next three attributes consisted of four levels each, and the direction of movement and the dog attribute were defined in three levels. The three levels of direction of movement were also treated as one four-level variable, as the balanced situation of 50/50 was used twice. Adobe Photoshop 6.0 software was used to create the images according to the fractional factorial design plan. The background of the images was a 200m-section of the main trail in the north of the forest. The presented trail segment is well-known, popular and heavily used by various user groups, because it offers a panoramic view. Most visitors to the forest use this trail section at one time or another. Consequently, the topic of use displacement was particularly relevant to this trail section.

In order to contain the calibration of images within realistic visitor numbers, the maximum number of people to be presented in the images was determined from actual counting results (Arnberger, 2003). Peak hourly visitor numbers were translated to approximately 12 persons visible in the scene at the same time and therefore this eight level variable was measured with 0 to 12 persons per scene. User types were displayed to assess the potential influence of user conflicts and were depicted as various shares of walkers, bicyclists and joggers. Different subtypes of users, such as sportive fast moving bicyclists and recreational bicyclists were not included. In a further simpli-

TABLE 1
Estimates of the Binary Logit Model

Attributes and levels	Parameter estimate	*SE*	*t*
Intercept	***3.425	0.173	19.753
Number of persons depicted			
Linear (L)	***−0.340	0.078	−4.378
Squared (S)	***−0.120	0.030	−3.987
Placement of visitors			
30% Fore-, 40% Mid-, 30% Background.[a]	−0.016		
60% Fore-, 40% Mid-, 0% Background.	−0.241	0.192	−1.256
10% Fore-, 60% Mid-, 30% Background.	0.068	0.140	.485
0% Fore-, 40% Mid-, 60% Background.	0.188	0.235	.802
Dog number and leash rate			
No dog.	**0.475	0.158	2.886
Dogs leashed.[a]	0		
Dogs unleashed.	**−0.437	0.158	−2.765
Group size			
30% Single, 40% Pair, 30% Triple.[a]	0.174		
60% Single, 40% Pair, 0% Triple.	*−0.310	0.129	−2.396
30% Single, 60% Pair, 10% Triple.	−0.140	0.127	−1.102
0% Single, 40% Pair, 60% Triple.	0.275	0.152	1.810
User type			
80% Walkers, 10% Bicyclists, 10% Joggers.[a]	0.297		
40% Walkers, 50% Bicyclists, 10% Joggers.	−0.152	0.135	−1.122
40% Walkers, 10% Bicyclists, 50% Joggers.	−0.046	0.220	−.209
20% Walkers, 40% Bicyclists, 40% Joggers.	−0.100	0.210	−.476
Direction of movement			
50% towards, 50% away from camera.[a]	−0.127		
75% towards, 25% away from camera.	−0.087	0.129	−.678
25% towards, 75% away from camera.	0.214	0.143	1.494
Interactions			
L × 60% Fore-, 40% Mid-, 0% Background.	**−0.303	0.115	−2.638
L × 0% Fore-, 40% Mid-, 60% Background.	***0.487	0.135	3.608
L × 40% Walkers, 10% Bicyclists, 50% Joggers.	**0.389	0.122	3.186
L × 20% Walkers, 40% Bicyclists, 40% Joggers.	**−0.367	0.130	−2.820
S × 60% Fore-, 40% Mid-, 0% Background.	**0.124	0.046	2.711
S × 0% Fore-, 40% Mid-, 60% Background.	***−0.197	0.056	−3.542
S × 40% Walkers, 10% Bicyclists, 50% Joggers.	**−0.139	0.050	−2.805
S × 20% Walkers, 40% Bicyclists, 40% Joggers.	***0.171	0.049	3.462
S × 75% towards, 25% away from camera.	***0.110	0.031	3.588
S × 25% towards, 75% away from camera.	**−0.088	0.032	−2.752
Rho^2	.745		
$Rho^2_{adj.}$	.680		
Log Likelihood (0):	−3408.21		
Parameter model:	−870.54		
Log likelihood ratio test compared to main effects model	***35.94		

***$p < .001$; **$p < .01$, *$p < .05$
Note. [a] = Reference category.

fication, only adults were displayed to avoid confounding with variables that were not controlled in the study design.

The attribute "placement within the image" described the placement of persons in the fore-, mid- or background. For an accurate position of people, the 200m-trail section was divided into three equal distance zones. To ensure that the scale and size of people was correct, size comparisons of people in actual photos depending on placement within the image were undertaken. By means of that attribute, the influence of the distance to others on the intentions to displace could be assessed. Dogs were always placed in the mid- or foreground to enable a differentiation between leashed and unleashed dogs.

The influence of visitor behavior was presented in two ways. Potentially unwanted behavior was included by displaying unleashed dogs, and groups walking, jogging or cycling side by side thereby narrowing the trail. Due to design limitations, reliable results concerning the latter attribute were only possible when more than three persons were displayed in the picture. The 3-level attribute dogs was described by no dogs, leashed dogs and unleashed dogs. Only walkers were depicted with dogs because the counting inventory showed that only a small minority of joggers and bikers were accompanied by dogs. Dogs were only displayed when more than two people were on the scene. The attribute "direction of movement" contained three levels and described the proportion of people walking, cycling or jogging away from the vantage point, as opposed to facing it. In all images, all persons and dogs in the images were placed in a manner that each dog and person remained fully visible as much as possible.

To test propositions about the social factors and their interactions at use levels of only one or two people per scene, several rules needed to be established for executing the statistical design plan: the variable number of users always had the highest priority; the distribution of these individuals within a scene was regarded as more important than group size, and group size was regarded as more important than the direction of movement. When allocations within a specific attribute level were not unambiguously clear, i.e. in the case of some combinations between the number of people and their distribution, then the highest shares of each level were considered: when one person was required in the image and the distribution level required a distribution of 60% in the foreground, 40% in the midground and 0% in the background, then the person was placed in the foreground; on the other hand, when the design plan called for a distribution within the image of 30% in the foreground, 40% in the midground and 30% in the background, than that single person was placed in the midground. When one person was supposed to be in the image and the direction of movement level required a 50:50 direction, then this level was systematically changed: one image contained the person walking, jogging or cycling away from the vantage point, in the next image the person was facing it. When the design called for two persons and a user mix of 40% joggers, 40% bikers, 20% walkers, one jogger and one biker was displayed; for a user mix of 50% joggers, 10% bikers and

40% walkers, one jogger and one walker was depicted. Finally, situations of low use levels (i.e. images with none, one or two persons) were presented less frequently, because these situations were not conducive to all possible combinations with other variables. In the analysis, the impossible combinations of zero people in the image and all other attributes were set to zero.

For the analysis, all attributes except the crowding variable, were effects coded (Louviere et al., 2000), where an *N*-categorical variable needs to be defined by *N*-1 estimates only. Consequently, for all attributes one level is defined as the negative sum of the other level estimates, and these base levels do not contain any reference to a standard error or *t*-ratio. Effects coding guarantees independence of all variables from the intercept, and the estimates indicate the magnitude of difference of the respective attribute level from the mean for that attribute (Louviere et al., 2000). The attribute "number of persons" was transformed into a continuous variable with a linear and squared term using centered orthogonal polynomial coding (Louviere et al., 2000; Montgomery, 2001), fitting the eight parameter coefficients best and allowing the estimation of two-way interactions between user numbers and other attributes. Therefore, the estimates of a binomial logit model are all relative to each other, and should be interpreted as such. Since the model has been designed as a multivariate study with six variables from the outset, the joint interpretation of all variables is possible. This data analysis was undertaken in LIMDEP 7.0 (Green, 1998). A significance level of $p < .05$ was chosen.

Results

Visitor Characteristics

Respondents consisted of an equal mix of women and men, and 53% were between 31 and 60 years of age. The majority of visitors interviewed were walkers (63%) and dog walkers (25%), whereas only 6% were joggers and 4% were bikers. More than half of the visitors live within a 15-minute walking distance to the forest, and nearly all visitors reside in Vienna. One quarter of the respondents visits the forest daily in summer and a further 52% at least once a week. About 13% of the interviewees perceived the forest as overcrowded on weekends and on holidays, and a further 49% reported crowded or slightly crowded perceptions; on work days, in contrast, use levels were reported as too high by only 0.4% of respondents.

Intended Displacement

Table 1 presents the binomial logit parameter coefficients and standard errors for the main effects as well as select interactions between user numbers and other attributes, which were significant at the $p < .05$ level. Only interactions between the number of people and the other variables were estimable, because the variable number of people was coded as a linear and quadratic parameter, which provided the degrees of freedom to estimate these interactions. In the main effects only model (not shown here), all effects except the direction of movement were significant at the $p < .05$ level. When adding all interactions between the number of users and the respective other attributes, only two main effects remained significant, but each attribute had at least one significant interaction parameter. Therefore, for the final model all main effects, but only the significant interaction estimates, were retained. The log likelihood ratio test between this final model and the main effects only model (Louviere et al., 2000, p. 53) showed a significant improvement of fit for this latter model (last row of Table 1). The rho-square statistic of .68 indicates an excellent fit for the model, although leading authorities in choice modeling clarify that while the rho square statistic is statistically analogous to the R^2 in a multiple regression, it cannot be interpreted as such (Train, 2003, p. 72).

The high positive intercept indicates that the majority of the recreational scenarios were deemed as not contributing to displacement by a majority of respondents. We purposely do not express this share in terms of percent of the total sample during our initial discussion of the individual results, because of the relative nature of this observation as a function of the other variables, as will be discussed below. The utility curve for number of people depicted in the images reflects an increasingly negative slope after two persons all the way to 12 persons per scene (Figure 2). None of the main effects of the attribute "placement of people within the image" was significant in the model. However, the significant interactions implied that at high-use levels people in the foreground contributed much more negatively to the evaluation of an image than at low-use levels. When only one person was displayed in the background, the evaluation also resulted in a negative coefficient, hinting towards a negative evaluation of undercrowded situations.

A situation with no dogs resulted in the highest positive part-worth utilities of that attribute, and unleashed dogs were evaluated as the worst attribute level. Single individuals contributed to intended displacement significantly more than larger groups. The attribute "user type" also had no significant main effect; however, the interactions revealed that the more people an image contained, the more respondents expressed intentions to displace under the most diverse mixes of users (20% walkers, 40% bicyclists, 40% joggers), while scenes with high proportions of walkers received the most positive evaluation. At low-use levels, joggers were evaluated negatively compared to mid-use levels. Similarly, none of the main effects of the attribute "direction of movement" had an influence, but the interactions were significant. The level with more users walking, cycling or jogging away from the vantage point was evaluated more positively at high-use levels, whereas the direction of facing the observer was evaluated correspondingly more negatively.

The statistical nature of the binary logit model, and the assumption that utilities are integrated additively in the exponents, makes the model compensatory. Therefore, the part-worth utilities can be used to calculate the proportion of respondents with displacement intentions for any specific com-

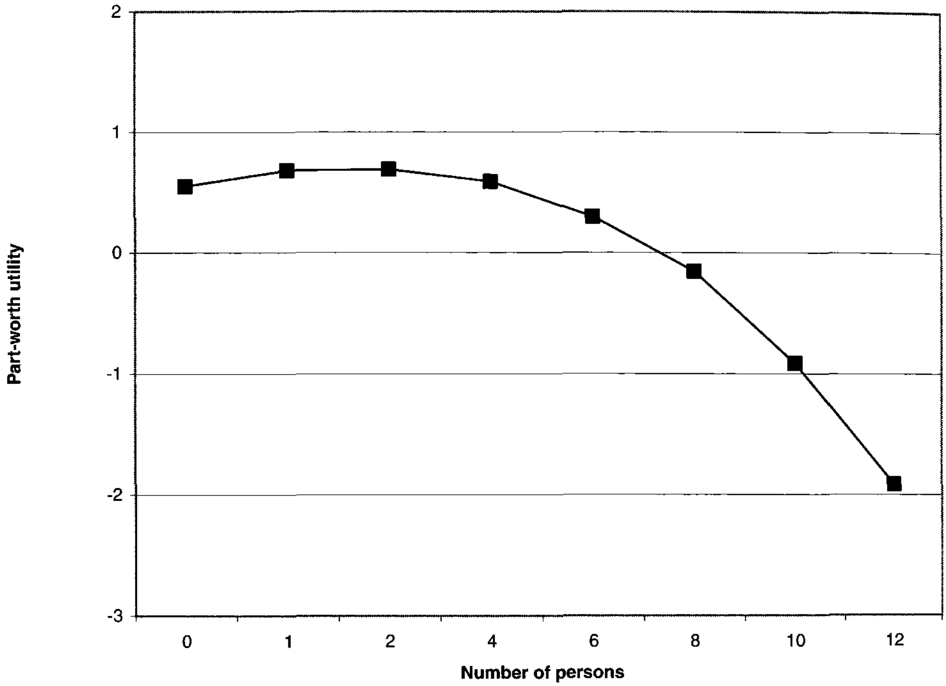

Figure 2. Part-worth utilities of respondents' intentions to displace as a function of the number of persons in the images.

bination of variables, by substituting the estimates into Equation (2). Results for six such scenarios are graphed in Figure 3, where the number of users in the image are shown on the x-axis, and the proportion of users with intended displacement on the y-axis. The scenarios consist of different combinations of the other five attributes and one can plot the proportion of respondents with displacement intentions for each of these scenarios as a function of the number of users shown in the image. These scenarios were simply chosen for the purpose of documenting the huge discrepancies that may be associated with different combinations of the six social factors, affecting displacement behavior by varying magnitudes. Scenario 1 assumes a rather simple situation with a homogenous user mix (80% hikers) placed mostly in the foreground of the image, predominantly single users, an equal direction of movement by users, and leashed dogs. Scenario 2 introduces a more diverse user mix, equally distributed along the trail with dogs still being leashed, and couples and a low proportion of people facing the observers. Relative to Scenario 1, in Scenario 2 the proportion of users with intentions to displace actually drops slightly between four and ten users in the scene. Scenario 3 depicts mostly single users, who are predominantly placed in the foreground, without dogs and an equal share of direction of movement.

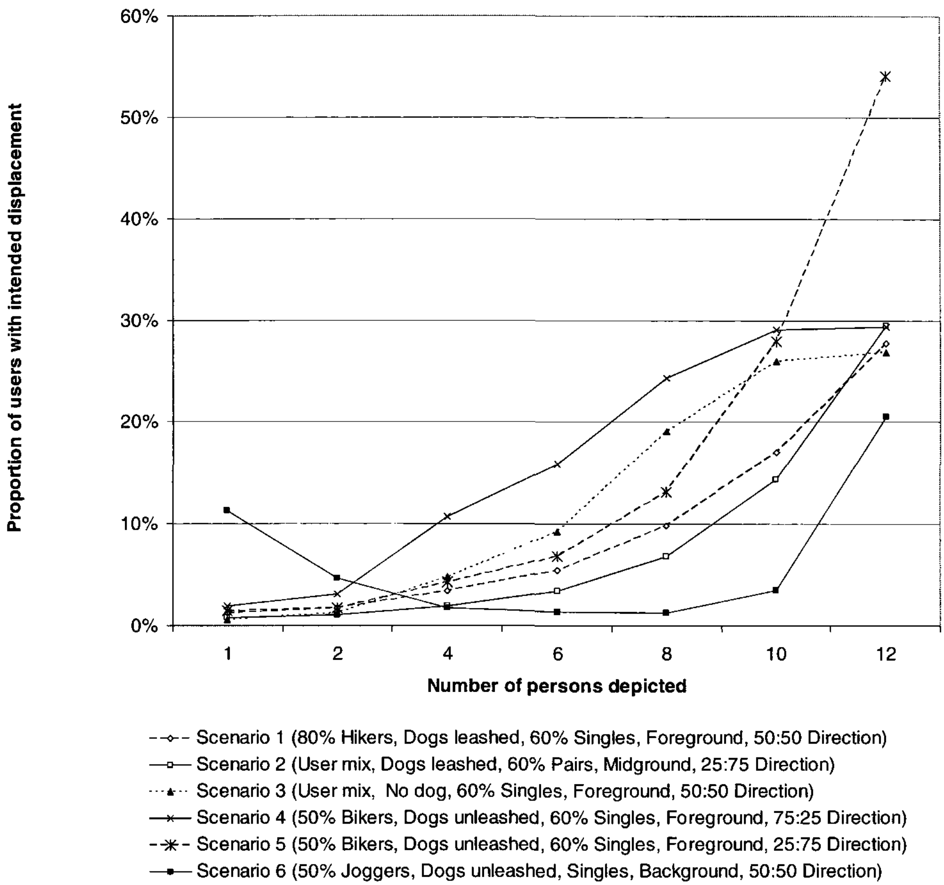

Figure 3. Share of respondents with intended displacement as a function of the number of persons in image for six select scenarios.

Compared to Scenario 2, the share of respondents with intended displacement rises, especially when 6 to 10 people are present. Scenario 4 contains mainly single cyclists in the foreground and this scenario also adds unleashed dogs and a low proportion of people facing the observers, further increasing the shares of visitors with intended displacement. Overall it is noteworthy that for these first four scenarios the proportion of respondents with intended displacement are uniformly low (below 3%) for one and two persons in the image, and uniformly high (between 27% and 30%) at 12 persons in an image. However, the shapes of the displacement curves differ for each scenario, potentially leading to huge differences between four and ten people in a scene. The properties of Scenario 5 are identical to Scenario 4 on all attributes except for direction of movement (predominantly towards the observer). It represents an extremely intolerable situation at very high-use times (12 individuals in the image) when 54% of respondents would displace. Scenario 6 contains the highest share of joggers, and users were shown predominantly as singles and placed into the background. This scenario leads to a high level of intended displacement at both low and high user numbers. These few examples should suffice to document that intended displacement indeed depend on additional circumstantial characteristics.

Discussion

The results of the analysis of these images containing six social variables controlled by an experimental design document clearly that several variables in addition to visitor numbers affect the park visitors' intentions to displace. Furthermore, several of these variables are also affected by the magnitude of other social variables, which is reflected in the significant interactions between use levels and other attributes. The fact that these subtleties of behavior are recognized in the data analysis seems to reflect the high quality of the responses to these digitally calibrated images.

When interpreting in the following the part-worth utilities of each of these variables it is important to keep in mind that the nature of fractional factorial design keeps the estimates of each of the variables independent of the others. The crowding curve by itself (number of people in scene, Figure 2) shows that once use levels increase to six or more people, the likelihood to displace increases rapidly due to the combined effect of a significant negative linear and quadratic estimate. Similar to other studies in different environments (Hall & Shelby, 2000; Kuentzel & Heberlein, 1992; Robertson & Regula, 1994; Shelby et al., 1988), crowding was found to be a crucial factor of displacement in an urban forest. However, its exact contribution to displacement and absolute magnitude depends on the situation characterized by the five other social factors included in the model.

The position of people in the images did not matter per se (as a main effect), but it matters under high use conditions, when people placed mostly into the foreground of the image are judged more negatively, indicating that respondents may be very susceptive if they are with many others in close distance. On the other hand, a situation of very few people in the background also contributed to displacement. Maybe concerns about personal safety and low levels of social stimuli evoke minimum capacities for some respondents given a situation with very few visitors on-site in the park (see Luymes & Tamminga, 1995). Displacement by undercrowding is a rather neglected area of research with potentially important implications for urban recreation (Kaplan & Kaplan, 1982).

The presence of unleashed dogs, representing a variable of inappropriate behavior, is another factor increasing intentions to displace, regardless of use levels. The negative evaluation of unleashed dogs is understandable, because dogs are not always under control. In the forest itself, there is a high actual share of dog walkers present: more than 16 % of all park users counted by the one-year observation walked dogs, and at 22% the rate of keeping them on leash was very low (Arnberger, 2003). Therefore, situations with no dogs will entice respondents to continue using the trail, while leashed dogs were regarded as neither contributing to displacement nor keeping users on the trail.

Another variable affecting visitor behavior was group size, which defined a group simply as individuals walking side by side. Surprisingly, bigger group sizes contribute less to displacement intentions compared to single persons. Initially we had assumed that the behavior of walking side by side, which narrows the trail for other passing users, would be judged as less tolerable by park users, in particular at high-use times. This result about group size also contrasts findings by Manning and Valliere (2001) who found that large visitor groups blocking recreation trails would lead to displacement by local residents. Similarly, Roggenbuck, Williams and Watson (1993) and Stankey (1973) found in their research about crowding perceptions that group sizes with more than six persons were less preferred by hikers. However, research by these authors was focused on remote areas, and the discrepancy in the definition of group sizes makes any direct comparison between the studies difficult. One can assume that at least in situations of up to three persons per group, bigger groups imply fewer social contacts in total and seem to produce a more ordered situation that requires less attention compared to situations with high shares of singles, where each individual can display different behavior patterns (Baum & Paulus, 1991). In contrast, one single person in the image contributes significantly to displacement behavior. Investigating more specific reasons for this observation, whether it is the fear of one single person, especially if the person is male, or the lack of entertainment due to too few social contacts should be the focus of future research.

The interactions between user type and the number of persons reveal that the more people an image contains, the less tolerant respondents become about a mixed use situation, especially with a high share of faster moving users such as bicyclists and joggers, while the most homogeneous condition with high shares of slow moving users (80% walkers) received the most positive evaluation. The concurrent presence of several activities pursued with different speeds results in different user behaviors and may contribute to displacement due to the more heterogeneous and unpredictable trail situation, which may also lead to user conflicts; the high share of walkers among respondents in this study might have contributed to this trend. In particular, a situation with one single jogger contributed to use displacement. Similar responses in low-use situations can be evoked by displaying one walker or one biker in the background. These responses may document concerns about personal safety by some respondents due to the lone situation; alternatively, other respondents might be displeased because the low-use situation provides insufficient stimulation and entertainment.

Finally, the evaluations of these recreation scenarios worsen even more when the direction of movement is towards the observers at high-use levels; respondents may dislike to be confronted with many fleeting social contacts, and prefer to walk behind others. So far, the direction of movement has not been researched extensively in recreation research (Fredman & Hörnsten, 2001), and the evaluation of this factor as a function of use levels brought new insights.

Consequently, when the number of visitors encountered exceeds more than six people, and the situation is at the same time characterized by inappropriate visitor behavior, i.e. unleashed dogs, high shares of individuals, people situated in the foreground, more face to face encounters, a mix of user types moving at different speeds, or any combination between them, the cognitive complexity of the rather heterogeneous situation and the chance for user conflicts increases, and intentions to displace increase even faster.

These insights can be documented in a more holistic and meaningful way in a scenario analysis, in which combinations of attributes can be compared for their respective likelihood of displacement. Especially due to the significance of several interaction effects these scenarios improve the ease of interpretation, and also make cumulative effects more apparent. The overall pattern of the scenarios in Figure 3 shows that at very low user counts, the other social variables remain without major influence on the propensity to displace in most cases, except in Scenario 6, where a remarkable share of respondents expressed intentions to displace because of one single person, in particular one jogger, placed in the background. On the other extreme, when the number of users reaches peak numbers as is usual for a Sunday afternoon in spring (i.e. the 12 people in the scene correspond with the absolute peak number of visitors as determined from long-term video observations), then several different scenarios will quickly prompt approximately 30% of respondents to displace, and extreme scenarios exist for which the model predicts over 50% displacement (Scenario 5).

Interesting variations between the scenarios occur for the variable number of people in between those extremes. Scenarios 1 and 2 exceed the 10% tolerance mark only for more than eight and nine individuals in the image respectively, while Scenario 3 reaches that same threshold already at six people, and Scenario 4 below four people. Despite the fact that Scenarios 1 to 4 had similar starting points (at 1 person per image) and end points (at 12 persons per image), the shapes of these curves are rather different, and would lead to rather disparate interpretations of displacement. This shows that intentions to displace appear to be affected by several variables and especially by the interactions among those variables. These variations in use displacement intentions should have implications for future research on displacement as well as park management.

Conclusions

This study started from the premise that classical displacement research, with its univariate focus on the number of people or user conflicts in a recreation area, might be too constrained a focus, which does not do justice to the true complexities of urban trail use. It was proposed that other salient variables influence the evaluation of trail use, and therefore, the study adopted a visual-based dichotomous choice survey, in which six variables characterizing typical social trail use conditions were depicted in each digitally calibrated image. The results suggest strongly that intended displacement depends on several factors as well as their interactions and that user numbers, visitor behavior or user conflicts used as sole variables of investigation are insufficient indicators for exploring displacement for urban trail uses.

The technique of digitally calibrated images, which allows for the visualization of several variables by strictly following a fractional factorial design plan, has been crucial in achieving the high quality of data collected here, which permitted the investigation of the role of social factors and their relationship among each other in dependence of the other factors in a controlled manner. In appreciation of the technique it must be emphasized that respondents evaluated these complex images without any additional written descriptions. Therefore, the fact that all six variables emerged as statistically significant proves their influence on use displacement, and also shows the applicability of the research method to a dense multi-use urban recreation setting. The fact that several interactions between the number of users in the image and other social factors also were significant and actually instrumental for making the model much more interpretable enhances the relevance of this approach even more. Apparently, respondents managed to process this complex visual information consistently and systematically.

The predictive capacity of the binomial logit model can be potentially used to explore the likely effects of different scenarios, which may represent different, yet nevertheless feasible management options (Figure 3). If the management goal is to increase social carrying capacity of the trail, this study has documented that it seems to be possible to influence carrying capacity in several ways, as the dynamic relationships between six social factors significantly influence visitors' decisions in a compensatory manner. Consequently, controversial management measures such as limiting use, which may be unacceptable in an urban setting can be avoided and substituted by other, more acceptable, management actions such as influencing visitor behavior or user composition.

However, before deriving any management implications and policy inferences, further research should investigate whether some features in the images such as the identification of user types placed in the background had an influence on responses. Maybe some respondents were not able to differentiate between walkers and joggers when placed in the background. One additional challenge when using digitally calibrated images is that pictorial representations inevitably contain clues in addition to the design variables which can also affect the evaluations. Some of these additional stimuli could be categorized and added as non-orthogonal variables to the analysis. In our study, one example for such an "uncontrolled" additional variable might be the kind of persons (i.e. gender) displayed. Some of these relationships could be detected using additional interactions between all these variables, for example between placement and user type. Accommodating these concerns would of course require either a much larger fractional factorial design, a larger sample to treat these factors as covariates, or a separate study which would focus specifically on one of these aspects.

This research design accounts for the multiple-use and high-use character of an urban trail. Although we established rules, the design may have some limitations for use levels of only one or two people per scene. Future designs used for studying displacement in relation to social factors should use more suitable attribute levels for very low use levels. This could be accomplished by specifying more explicit attribute levels such as 100% of joggers displayed in the image instead of 40% joggers, 30% of walkers and 30% of bicyclists. However, this approach would limit the assessment of the mixes of use typically for urban settings.

Of particular methodological interest would be also a comparison of the results for the referendum style question for displacement under a different mode of presentation and sequencing of questions: Would similar results be obtained by presenting the referendum questions with the presentation of single images only, as opposed to the initial presentation of a choice set of four images of which the best and worst are identified first? This question is important, because the presentation of the preference task prior to the tolerance question might constitute a relevant learning task, during which respondents familiarize themselves with the visual profiles in more detail, and at the same time establish a crude personal ordering for each set by each respondent.

The arguments in this paper focused solely on the wide range of interpretations associated with the overall model based on all respondents. Obviously, this model provides the opportunity to undertake a series of segmentations along different criteria in order to add further insights (see Hunt, Haider, and Bottan (2005) for a more detailed discussion of segmentation approaches in recreation research). However, a rather small sample size and a short sampling period limited this study. Regarding sample size, one should consider that each respondent evaluated 16 images, effectively increasing the sample size for the study significantly. However, this has been an exploratory study and future research should further explore the relationships among the various social variables in similar and different settings. In addition, displacement behavior might be more accurately addressed with a systematic survey in the residential areas as another source of information for inter-area displacement within an urban system.

Future research should also investigate the relationships between perceptions of crowding and the intentions to displace based on such visual stimuli for which no other studies exist. Similarly, the relationship between intentions to displace and actual and revealed displacement behavior would require a much more detailed investigation. Using the same images, Arnberger and Haider (2005) found that crowding-averse respondents preferred low-use levels, homogeneous trail use conditions and people placed in the background, whereas crowding-tolerant respondents preferred a certain amount of social stimulation in the form of some encounters and more heterogeneous trail use conditions. These findings constitute one piece of empirical evidence that crowding perceptions and the evaluation of the images might be related.

It should be tested whether use displacement is influenced by variables reflecting stimulus overload (Milgram, 1970). This concept proposes that a situation is considered undesirable when an individual is exposed to excessive levels of stimulation and psychic stress due to the size, density, and heterogeneity of other visitors (Andereck & Becker, 1993; Baum & Paulus, 1991; Sundstrom, 1978). Future research should also test whether the position of visitors in the images are related to violations of personal space requirements. Finally, our study did not include any variables describing the physical conditions of the area. Obviously such an expansion of attributes describing trail surface, amount of litter, signs of vandalism and erosion could be easily accommodated in a stated preference approach, ideally with digitally calibrated images.

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