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BIODIVERCITY, A TRANSDISCIPLINARY APPROACH TO URBAN ECOLOGY

INTRODUCTION

This paper describes a research project named 'BiodiverCity' that aims to develop strategies to encourage urban biodiversity in Switzerland. The project is part of a national research program to encourage sustainable development of the built environment. However, the difference between the priorities of academic researchers and the needs of practitioners is widely acknowledged and anecdotal evidence suggests that this gap also exists in Switzerland. Furthermore, the research agenda was set at a national level, while implementation would, almost by definition, occur at a local level.

Urban areas harbour diverse forms of nature, ranging from indigenous vegetation, semi-natural habitats and parks to wastelands and other highly human-influenced habitats. In Switzerland, urban areas have steadily increased and are present in the form of towns, spreading conurbations and large cities, particularly on the Plateau and in Southern Switzerland. The built areas of cities and conurbations are characterized by specific environmental conditions, a high diversity of substrates and structures in a mosaic pattern, inherent man-induced disturbances and a higher rate of introduced species. Therefore, urban and peri-urban areas may be seen as an ecosystem emerged from local-scale, dynamic interactions among socio-economic and biophysical forces.

The presence of urban nature plays an important role as determinant of life quality for citizens. In urban ecology it is generally assumed that a high urban biodiversity is esteemed by the citizens and improves their quality of life in the urban area. However, this appreciation has recently been questioned and was never investigated for different types of urban and peri-urban areas in the required detail. Yet, thorough knowledge of people's relationship with nature is necessary, if they should be motivated to accept and actively support nature conservation measures. The relationship between social and cultural values, biodiversity, and quality of life in urban areas has to be investigated and understood if we hope to develop sustainable urban environments that lessen their ecological footprint in future.
The **main goal** of the project is to understand the relationships between urban biodiversity, the built environment and the acceptance of residents, in order to identify first measures for integrating the emerged results how to enhance urban biodiversity and acceptance of the residents in urban development processes.

METHODS

Methods used in the ecological module

The ecological module of the BiodiverCity project collected data from 32 study sites in three cities (total 96 study sites). Study sites were identified along three gradients;

- Age (from 1 year to 156 years)
- Proportion of sealed area (proportion of the sealed area in a 50 meter radius of the sample point, from 2% to 98%)
- Management of the area (number of times grass had been mown in the 6 months prior to sampling, from 0 to 20 times)

The study sites included many different habitat types within the urban landscape, including historical neighborhoods and residential areas with old gardens, business districts and former industrial sites that had been redeveloped or converted to new uses.

For each site, additional habitat variables were included in a GIS (structural variables as the number of trees, bushes, buildings etc.) and habitat heterogeneity (calculated from the units and the variation of different habitat variables).
In the 96 study sites, different recording methods were used to record invertebrates, birds and bats:

Invertebrates: The study period was from 15 June to 7 July 2006. The Rapid Biodiversity Assessment (RBA) method was used for the determination of species composition of trapped invertebrates. RBA is an efficient method for estimating the number of species based on the number of identical-looking individuals (so-called morphospecies) (Duelli & Obrist 2005). At each study site, three cup traps (7 cm diameter, with 2% formaldehyde solution) and a yellow window trap (two crossed 45 x 50 cm plexiglas plates fixed on a 45 cm diameter yellow funnel filled with water and detergent). The number of morphospecies was determined within 29 taxonomic groups (Diptera and Collembola were excluded from the analysis). For seven of the 29 taxonomic groups, namely, Neuroptera, Lucanidae, Buprestidae, Carabidae, Curculionidae, Cerambycidae, Cetonidae, Araneae, Coccinelidae, Apoidea, the number of specialist species were determined. The taxonomic groups were also classified by their functions with regard to mobility, nutrition, and environmental benefits.

Birds: The study period was from April to June 2007. Birds were recorded with standard methods, which are based on visual observations and song recordings (point counts). Each examination site was visited six times for 15 minutes (total 90 minutes). Birds were recorded both inside and outside a 50 meter radius. The influence of environmental variables on the number of species and species composition and their functional characteristics (diet, nesting and migration patterns) and functional diversity were analyzed with advanced uni-and multivariate methods.

Bats: The study period was from June to September 2007. The method of recording bat presence was based on echolocation calls through bioacoustic methods in which bat species can be identified by their echolocation calls. At each examination site, four times for 45 minutes (total 180 minutes) with self-developed recording equipment, the echolocation calls of bats were recorded. The devices consist of two microphones, connected with a central unit by a cable. The recorded call sequences were analyzed with a specially developed software that automatically assigns echolocation calls of bat species.

Methods used in the social science module

The data collection of social science research was conducted in two phases: a) Inductive phase, b) Deductive phase.

a) Inductive phase
The aim of the inductive phase was primarily to gain an understanding of the complex relationships between people and their environment and find out which concepts of urban green spaces are important. This is essential preparation for quantitative research since ways of perception can exist that the researcher, the respondent, or both have not yet articulated. The Repertory Grid method takes account of this problem by researchers and respondent jointly developing a survey instrument, which is then completed by the respondent. Nine photographs were used as stimulus materials. These photographs depicted urban green spaces, which had been selected in collaboration with an ecologist and which are typical for the different types of green space in Zurich. For data analysis, the software "Repgrid IV" was used.

b) Deductive phase
The deductive phase consisted of two surveys: 1) a nationwide survey and 2) a case study in the cities of Zurich, Lucerne and Lugano

b1) Nationwide survey
The nationwide questionnaire survey was developed based on the results of the inductive phase and also included an established scale from the field of environmental psychology (New Ecological Paradigm NEP, Dunlap et al. 2000), a section on charismatic species, a section on the benefits of different landscape elements and demographic data. From a total of 4000 questionnaires sent to a random sample of the Swiss population, 899 questionnaires were returned for an overall response rate equivalent of 22.9%.
b2) Case Study
The participants in the case study were shown photo montages of urban landscapes containing various levels of habitat quality (four levels) and infrastructure (3 levels). In addition, information was given to the costs of various scenarios (four levels).

The participants were randomly divided into three groups and asked to evaluate the different scenarios. A third of the respondents were informed that a relationship between the environmental diversity, the proper functioning of ecosystems and the likelihood that the charismatic species, the great spotted woodpecker (Dendrocopos major) would be seen in an area. Another third of the respondents also received similar information, although rather than the great spotted woodpecker, they were informed of the likelihood that the less charismatic corn weevil (Ischnopterapion virens) would be seen. In the third group, no additional information about the ecological quality was given.
For this study, 3000 questionnaires were mailed to randomly selected households from Lugano, Lucerne and Zurich. 902 completed questionnaires were returned, representing a response rate of 30%.

Interdisciplinary Aspects
The interdisciplinary approach between the ecological and sociological modules is an important characteristic of this research. Areas of overlap included that a) the same study areas were selected, b) comparable habitat variables were used in both the ecological study and in the landscape scenarios for the social sciences study, c) with respect to the social science surveys of the perceived qualities of nature, the ecologically relevant differences to biodiversity were taken into account, d) interfaces were developed between the two study areas, which have allowed flagship species to be identified that are both charismatic and are indicators of high biodiversity.

KEY RESULTS

• Cities are areas of high biodiversity: Urban areas are characterized by proximity of different habitat types (habitat mosaic) and elevated ambient temperatures, and these varied habitats are available to accommodate a variety of flora and fauna.
• In cities, there is an evident shift to widespread and invasive species; a process that is also called biotic homogenization by McKinney (2006).
• Cities provide certain alternative or additional types of specialized sites, such as habitats for rock or alpine swifts, or jackdaws.
• Cities are heat and dry islands, and thus offer different heat-loving species suitable living conditions. As a result, more and more species from the Mediterranean can establish themselves north of the Alps in cities.
• Often, the settlement is due to its high dynamic and high mobility of local populations and thus also the starting point for most unwanted invasive plants and invasive species relocations, some with invasive potential (eg Asian tree bug Halyomorpha halys; Wermelinger et al 2008).
• In general, residential development will, in the course of densification, cause built up areas to focus on a reduction of natural habitats and a consequent reduction in the ecosystem services to the remaining land. These may best contribute to ecosystem services when grassed areas are managed extensively (eg infrequently cut). In particular, numerous

landscaped gardens and green spaces in residential areas can provide important replacement habitats.
• The complexity of structures and vegetation are the dominant criteria for the social landscape preferences in urban areas. However, this applies only as long as the accessibility and usability are not restricted.
• A high structural wealth (measured at different spatial scales) shows a positive effect on the population for most species groups, because the structural complexity of the green space promotes the welbeing of the human population as well as biodiversity.
• The acceptance of certain habitats may be increased by specifically informing the public about the environmental benefits. The concept of flagship species can be a useful tool support information campaigns.
• The experience of a diverse biodiversity in the direct living and working environment of an increasingly urban population will be crucial for the development of positive individual attitudes towards nature and biodiversity.

TWO MAIN 'TAKE HOME' MESSAGES FROM BIODIVERCITY

Cities are places of high biodiversity.
Although strongly influenced by man, a surprisingly high biodiversity is found in the built environment. The number of species increases with age and heterogeneity of habitat. Intensive management and an increase in the sealed area have a negative impact on biodiversity. Variety in vegetation promotes biodiversity.

Needs and desires of the urban population are in line with high biodiversity.
The complexity and diversity of urban nature makes it attractive to urban residents. The threshold for appreciation of more complex urban green environments is quite high as long as the complexity does not impinge on usefulness and accessibility.

COMMUNICATION UND IMPLEMENTATION

The results showed that urban residents prefer more complex landscapes, which are also the landscapes that encourage highest biodiversity. The study has thereby provided a tool for those taking a conservation stance within a city's governance when arguing with those whose priorities lie elsewhere. However, alignment with the landscape preferences of residents is clearly not the only criterion for designing urban landscapes since many urban landscapes, in particular in semi public spaces are both socially and ecologically poor. Further research is underway to assess the effect of the weight of public opinion and to identify which other criteria are included in the decision making process.

Communication of the results of the BiodiverCity project has been carried out in three phases. In a first phase, public relations was avoided in order not to influence the national and regional surveys and communication concentrated on cooperating with local authorities. In a second phase, we came in close cooperation with the communication of NRP 54, with information of local interest to the media and informed then in a third phase, through various national media about the results of BiodiverCity.

Tools for a successful implementation of the results were developed and debated in internal project workshops, in meetings conducted with the competent authorities in the three cities to help them present the results and possible implementation of proposals. A wide range of implementation measures have been undertaken, concentrating on the distinct target groups of decision makers (such as publishing results in national high impact architectural magazines) and the general public (such as public outreach excursions, and publications in the popular press).