Green roofs, storm water management, and biodiversity in Malmö, Sweden

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Abstract

The residential district Bo01 in Malmö, south Sweden, was built in the years 2000-2001 on former industrial land. Measures have been undertaken to counteract the negative impact of urban sprawl on the ecosystem. Houses are built close together to use the land efficiently. Still, it is a green district, thanks to two planning instruments, green space factor and green points, e.g. a majority of the buildings have green roofs. The greening of the area aims to present an attractive green surrounding for people, promote biodiversity, and minimise storm water run-off. Storm water is managed in an open system which includes ponds with native vegetation. The green space factor means that different types of surfaces are given different credits. Plant beds, climbing plants, green roofs, and ponds are given high credits. No credit is given to sealed surfaces. The green points include for example: a bird nesting box for each apartment, a courtyard containing at least 50 Swedish wild flower species, food for birds all year round in the yard. In the parks, semi-natural biotopes have been built comprising meadow, oak and beech woodland, and alder carr. The soil and the species composition of grasses, wild flowers, bushes and trees conform as far as possible with their natural counterparts. Before the area was developed, sea birds such as avocet and terns, nested on the old industrial sites. A compensation biotope for birds will be created in the northern harbour of Malmö. Studies show that the inhabitants are very satisfied with the quality of the parks and gardens. Biodiversity is lower than in a similar, but older residential district that has been used as a comparison. Biodiversity is expected to increase with time.
Keywords: urban, biodiversity, green roof, storm water management, biotope, habitat.

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1 Introduction

1.1 The residential district Bo01

The residential district Bo01 in Malmö, south Sweden, was built in the years 2000-2001 on former industrial land (fig. 1). The land is a landfill in the sea, Öresund (fig. 2).

The housing area has been built with focus on ecological sustainability, for example 100% locally renewable energy serves the area. Measures have been undertaken to counteract the negative impact of urban sprawl on the ecosystem. Houses are built close together to use the land efficiently (fig. 2). Still, it is a green district, thanks to two planning instruments, green space factor and green points, e.g. a majority of the buildings have green roofs. The greening of the area aims to present an attractive, green, healthy surrounding for people, promote biodiversity, and minimise storm water run-off. Storm water is managed in an open system which includes ponds with native vegetation.

1.2 Green environment is healthy environment

During the last decades research has shown that parks and nature can have an astonishing effect on people's health [1, 2]. The view through the hospital window effects the recovery after surgery: patients with a view over a park recovered significantly faster than patients with a view over a naked wall [1]. Stress recovery during exposure to natural environments, measured as i.e. blood pressure, happens within 4-6 minutes, while exposure to urban environments gives no recovery at all [2]. Children in day care centres with good admission to green areas are healthier, play better, and are more capable to concentrate than children with low admission to green areas [3]. Elderly people with a high demand of care are more active and less care demanding if they regularly visit parks than if they don't [4].

1.3 Green space factor

To achieve a certain amount of green space on the yards and to minimise the sealed areas, a green space factor is used. The green space factor means that different types of surfaces are given different credits. No credit is given to sealed surfaces. Low credits are given to unsealed but not green areas. Plant beds, climbing plants, green roofs, and ponds are given high credits. The use of green space factor has led to that almost all houses have at least one part with green roof. The green roofs are exclusively moss-sedum carpets, by far the most common type of green roof in Sweden. Most yards are very green, with trees, bushes and perennial herbs, and they all have a pond. In some of the yards there are biotopes with high qualities in terms of biodiversity, for example a sea shore meadow (fig. 3), and a pond (fig. 4). The green space factor is borrowed from Germany, where a similar system is used in Berlin and Hamburg.

Figure 1: Malmö is the third largest city in Sweden with 265,000 inhabitants.

Figure 2: An aerial picture of the housing district Bo01.

Figure 3: An artificial sea-shore meadow in one of the yards at Bo01.

1.4 Green points

On every yard the developer was to realise 10 out of 35 green points. The green points include for example:

- a bird nesting box for each apartment
- courtyard containing at least 50 Swedish wild flower species
- food for birds all year round on the yard
- bat boxes for each plot
- courtyard containing traditional cottage garden with various sections
- part of the courtyard left to grow by natural succession
- a habitat constructed for a specific insect group
- all unsealed areas in the courtyard has deep and good enough soil to allow vegetable cultivation
- courtyard consists of habitats that has regional nature as an example
- at least half the yard is covered by water
- all trees on the yard are fruit trees, and all bushes carry berries

1.5 Habitats in the parks

There are two parks in the area, Ankarparken and Daniaparken. In both of them, semi-natural biotopes have been built where the soil and the species composition of grasses, wild flowers, bushes and trees conform as far as possible with their natural counterparts. In Ankarparken, a beech woodland, an oak woodland and an alder carr are surrounded by maintained grass areas. The vegetation in these

biotopes has been planted, not sown. A saltwater canal in which macro algae, fish and other creatures have been introduced, is also included in the park. Salt water is pumped into the canal from the sea, Öresund. In Daniaparken, a part of the grass area has been sown with typical Swedish meadow plants.

Figure 4: A pond with regional wetland vegetation in a yard at Bo01. In the background a green roof.

1.6 Replacement habitat for birds

Before this brown-field area was developed, sea birds such as avocet, little tern and common tern nested in the old industrial sites. Brown-fields of harbours, old industrial areas and marshalling yards often contain a species-rich fauna and flora. Work is under way in Malmö harbour on the creation of a replacement habitat similar to the one which disappeared.

1.7 Storm water management

Storm water in the Bo01 area is managed in an open system, with miniature canals and ponds in the courtyards, squares and streets. Most ponds have natural

wetland vegetation, and increase the diversity of biotopes in the yards and in the streets. Green roofs and a high degree of green and unsealed areas aim to minimise the storm water run-off. Also the water quality should be improved by the high degree of infiltration, sedimentation and decomposition in the system.

Table 1: Number of breeding bird couples in Bo10 and Ön in the years 2002 and 2003.

	2002		2003	
Species	Bo01	Ön	Bo01	Ön
Larus canus	1	4-5	8-10	5-6
Passer domesticus	-	1-2	-	2-3
Anas platyrhynchos	0-3	-	1-3	1-3
Delichon urbica	-	12	-	13
Carduelis cannabina	-	1-3	-	3
Turdus merula	1	5-6	2-3	4-5
Hirundo rustica	-	-	-	2-3
Passer montanus	-	-	1	1
Columba palmumbus	1	4-5	1	1
Pica pica	1	1	1	1
Mergus serrator	0-1	-	-	1
Sturnus vulgaris	-	7-9	-	6-8
Oenanthe oenanthe	-	1	-	1
Haematopus ostralegus	-	-	1-2	1-2
Phoenicurus ochruros	-	4-5	-	3-4
Motacilla alba	2	1-2	3-4	4-5
Parus major	2	2	2-3	2-3
Apus apus	-	2	-	2-3
Sylvia communis	-	-	-	1
Sylvia curruca	-	-	-	1
Total number of breeding species	6-8	13-14	9	20
Total number of breeding couples	9-13	43-52	20-28	55-68

2 Evaluation

2.1 Biodiversity

Bird surveys quantify the diversity within this organism group, but abundance and breeding of birds may also be an indicator of biodiversity in a broader sense. A large abundance of birds indicates good food abundance – i.e. insects, other small animals, plant seeds and fruits. Good breeding by different bird species indicate a varied range of breeding places and/or habitats. Factors like the age of the area and human activities of course also effect the behaviour of the birds.

During 2002 and 2003 bird surveys have been performed in Bo01 and in another seaside residential area of approximately the same size in Malmö called Ön. The last construction work in Ön was completed five years earlier than in Bo01. Both years' species number and number of individuals are about twice as large in Ön as in Bo01 (table 1).

In Sweden there are 16 species of bats, of which at least eight have been found in Malmö. They eat flying insects, and prefer to hunt close to water where the abundance of food is high. Bats are good indicators of biodiversity of flying insects. Bo01 with all its ponds could be a good area for bats, especially behind the sheltering houses closest to the sea. Bat boxes have been placed in some of the yards. During the bat survey 2003, however, only one individual of the bat species *Pipistrellus pygmaeus* was found. In Ön, several hunting individuals of *Nyctalus noctula* were found, but were not regarded as nesting there.

In the park biotopes of Ankarparken, vegetation analyses have been performed once or twice a year during 2001 to 2003. The analyses show that the forest flora of the beech and oak woodlands has decreased in both species number and individuals. Simultaneously, a large number of weeds have colonised the biotopes. In the oak woodland a total of 152 species have been noted, of which only 22 were planted originally. In the alder carr, the more humid areas still hold much of its planted wetland flora, while the drier parts are colonised by weeds. In the meadow of Daniaparken, several of the meadow species that were sown in 2002 could not be found in 2003, and several could only be found in small amounts.

In the saltwater canal that goes alongside Ankarparken, algae, flowering plants and animals were introduced during 2001. In 2003 the flowering plants *Zostera marina*, *Ruppia cirrhosa*, *Potamogeton pectinatus* and *Zannichellia sp*., had expanded in the sandy areas. The alga *Chorda filum* had disappeared, and the large plants of *Fucus vesiculosus* had died, but small individuals and spontaneously colonised individuals expand. Introduced creatures like e.g. *Gammarus sp*., *Idothea sp*., *Mytilus edulis*, *Theodoxus fluviatilis*, *Nereis diversicolor*, and *Gasterosteus aculeatus* have all increased in numbers. Filamentous algae of *Chlorophyta* and *Rhodophyta* have colonised spontaneously.

Vegetation analyses have been performed during 2001–2003 in five storm water ponds. The vegetation was introduced into them in the form of large, established plants wrapped up with their substrate in coconut fibre net. Throughout the investigation period, the vegetation has been rather constant, and is completely dominated by the planted species with a very small number of weeds.

2.2 Human values

In 2002 a questionnaire was sent to 210 inhabitants of Bo01, of which 142 answered. On the question if you did not agree at all (1) to if you agreed completely (5) with the statement that the own courtyard was attractive, the mean answer was 4,1. On the question if you were very unsatisfied (1) to very satisfied (5) with the quality and size of the parks and green areas, the mean

answer was 4,4. A question if the open storm water system was good and safe was answered by the mean value 3,2.

A qualitative assessment of the courtyards showed that they are in many ways well designed. They were given high values for qualities like a well defined room, it is well managed and looks fresh, that it has development potentials and that there is shelter from the wind in the yard. Less high values were given for qualities like children can play in the yard, there is space for sitting down in the yard and it gives a green/lush impression. Low values are given for qualities like varied plant material, diversity of cultural plants, many insects in the yard, and the yard offers a lot of experiences.

In an interview, some of the Bo01 landscape architects expressed a certain dislike of the green space factor and the green points. But still they believed that their work with these planning instruments had given them an insight in the importance of the courtyard for sustainable development. They also thought they would bring this new insight into future projects.

3 Discussion

Number of bird and bat species was not as high as expected in Bo01, and in the case of the birds much lower than in the reference area. Two years is a very short time when dealing with biodiversity, and number of species in Bo01 is expected to increase in the future. The last buildings were completed several years earlier in the reference area as compared to Bo01, trees and bushes have grown larger and the vegetation has had time to establish, which can explain some of the difference. But even regarding these circumstances there are some problems in the green concept of Bo01. First, there are no areas left (except in the canal) for spontaneous plant colonisation. In the reference area, Ön, a non maintained grass area with high herbs and grasses and wild roses host several of the bird species that are not present at the Bo01 site. Second, the construction of biotopes that mimic nature is still a rather new topic in Sweden although there is some experience. More research and full-scale trials are needed to refine this art. Also the management of such biotopes needs more competence. Third, the ambition of the landscape architects of the yards and parks varied. Some had a large interest in biodiversity and therefore high ambitions, while others have given the green areas a conventional design.

Still, the focus on the outdoor environment in the planning stage has made Bo01 a green, lush area that is highly appreciated by its inhabitants. And, maybe most important, the green concept of Bo01 is a large and very important step towards seriously including biodiversity in city planning. The experience from Bo01 will be very important in the future, and will be carried by the people involved in the project as well as thousands of professional visitors from all over the world.

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