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Clearance of understory in urban woodlands: Assessing impact on bird abundance and diversity

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ABSTRACT

Clearance of understory to enhance the recreational value of the forest is common in urban woodlands. Open forests are generally perceived as safe and pleasant, but clearance is likely to be negative for woodland birds as the shrub layer is important for foraging and protection. In this 3-year experiment with a before after control impact (BACI) design, the effects from understory clearance on woodland bird abundance and diversity in five suburban broadleaved forests in south-western Sweden were studied. Understory clearance was either made in regular patches, with 50% removal of understory, or as "Complete" (90%) removal. Adjacent stands of equal size were left unmanaged as controls. Woodland birds and understory vegetation were surveyed before and after the management. The total density of breeding forest birds decreased in the plots with "Complete" removal of the understory compared to plots with "Patchy" clearance. "Patchy" clearance had no significant effect on bird density. Bird diversity was not affected by the management. Woodland birds are highly valued animals in urban green areas and the impact on bird fauna should therefore be taken into consideration in the development of management plans for urban woodlands. The present study has demonstrated that clearance of understory can have negative effects on bird abundance if carried out over large areas. Clearance in patches was not found to have negative effects on bird abundance and can promote recreational values by increasing visibility and structural variation of the forest.

1. Introduction

Urban woodlands are receiving growing attention for their important contribution to human health by providing recreational areas for urban citizens (Hörnsten and Fredman, 2000; Tyrväinen et al., 2003; Matsuoka and Kaplan, 2008). Even though urban woodlands to a large extent are fragmented and highly influenced by human use, they have been shown to have relatively high values for biodiversity conservation (e.g. Araújo, 2003; Rickets and Imhoff, 2003). In Sweden there are larger amounts of dead wood and more deciduous trees in urban woodlands than in an average rural forest, making them potentially important for conservation of biodiversity (Hedblom and Söderström, 2008). The concept "urban woodland" is used in this paper as in Lehvävirta and Rita (2002), i.e. as indigenous forest stands within or in the surroundings of a city where the field and shrub layer is not managed intensively as in a park and stand structure is more similar to that of a natural forest than a park.

Clearance of understory is common in urban woodlands as it is a way of increasing recreational values by creating a semi-open forest. A field survey across an urban-rural gradient in 34 Swedish cities showed that urban woodlands to a high extent were managed for recreational purposes, and clearance of shrubs was a common management practice (Hedblom and Söderström, 2008). Visiting frequencies have been estimated to be 250 times higher in urban woodlands than in other forested areas and more than half of all forest visits in Sweden are estimated to be conducted in urban forests (Carlborg, 1991). Preference studies show that people in general prefer semi-open forests with large trees and little undergrowth, while forests that usually have high biodiversity and conservation values, with large amounts of dead wood, dense understory and signs of forest fires, are among the least appreciated for recreational purposes (Hultman, 1983; Ribe, 1989; Tyrväinen et al., 2003). The experience of seeing wild animals and plants is an important reason for forest visits, and birds are among the most highly valued animals (Grahn, 1991; Holm, 2001; Bjerke and Østdahl, 2004; Caula et al., 2009). As woodland birds have been shown to respond quickly to habitat alteration from forest management (Slagsvold, 1977; Rodewald and Smith, 1998; Camprodon and Brotons, 2006) and because of their large contribution to recreational values, they were chosen as the response group in this management experiment. A well developed understory has been shown to be positively correlated with both species diversity and abundance of forest birds (e.g. MacArthur et al., 1962; MacArthur, 1964; Donald et al., 1997;

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Fuller and Green, 1998; Brokaw and Lent, 1999; Forslund, 2003; Diaz, 2006). Clearance of understory might, therefore, be an area of conflicting interests between bird conservation and recreational values in the management of urban woodlands.

The aim of this study was to investigate how clearance of understory would affect density and diversity of breeding forest birds in urban woodlands by using a large-scale field experiment with a before after control impact (BACI) design. There are numerous studies on the impact of forestry on woodland birds, but few of these have a replicated BACI design (Sallabanks and Marzluff, 2000). Manipulative experiments with controls, randomization and replication, provide powerful ways of learning about natural systems and causal relationships, but such studies are rare in the field of forest management (Johnson, 2002). In the present study, the density and diversity of woodland birds was examined in relation to three different understory management regimes. Bird populations were surveyed before and after clearance of understory in five suburban woodlands in south-western Sweden. The tested hypothesis was that the density and diversity of breeding woodland birds would be affected by the management conducted at the study sites.

2. Methods

2.1. Study sites

The management experiment was carried out in the county of Västra Götaland in south-western Sweden in the boreonemoral zone, i.e. between the boreal forest in northern Europe and the temperate forest in the middle part of Europe (Niklasson and Nilsson, 2005). The five experimental sites were located in woodlands on the fringe of three midsized cities: Alingsås, 23,000 inhabitants (Statistics Sweden, 2006), Borås (63,000 inhabitants) and Skövde (33,000 inhabitants). The land on the study sites was owned by the municipalities and the experimental sites were selected in consultation with the local authorities. In all sites, the dominating tree species were oak (*Quercus robur*), rowan (*Sorbus aucuparia*), lime (*Tilia cordata*) and birch (*Betula* spp.). The most common shrubs were rowan (*S. aucuparia*), hazel (*Corylus avellana*) and alder buckthorn (*Frangula alnus*). None of the sites had been subject to any recent (<10 years) clearance or thinning before the experiment. The understory was therefore well developed with dense vegetation, consisting of bushes, shrubs and low trees. All sites were popular recreation areas, frequently used by the public for walking, jogging and other activities. Below is a brief description of the five study sites:

Ängabo (10 ha) is located southeast of the town of Alingsås. The study site was surrounded by coniferous forest on two sides and a residential district and a health care centre on the other two sides.

Hultaberg (11 ha) is located south of the city of Borås, surrounded by oak forests on two sides and a residential district and an industrial estate on two sides.

Rya åsar (11 ha) is part of the Rya åsar nature reserve, a large forest (550 ha) in the northern outskirts of Borås, dominated by coniferous forest. The study site is surrounded by a road on one side, coniferous forest on one side and oak forests on the remaining two sides.

Rånna Ryd (11 ha) is located 5 km northwest of the city of Skövde and part of the Rånna Ryd nature reserve, a large nature reserve (443 ha) consisting of mainly grazed grassland and deciduous forest. The study site is surrounded by deciduous forest on two sides, grazed grassland on one side and a small road on one side.

Stöpen (8 ha) is located about 10 km north of the city of Skövde, next to the small village of Stöpen (1300 inhabitants). The study site is surrounded by deciduous forest on three sides and a large road on one side.

2.2. Experimental procedure

The management experiment started in autumn 2006. Three experimental plots were established at each of the five study sites. Mean plot area was 3.9 ha (range 3–5.5 ha, $n = 13$). Most of the plots were square or rectangular in shape, with some variation due to the shape of each forest stand. At three of the sites (Rya åsar, Rånna ryd and Stöpen), the experimental plots were placed next to each other, while at two sites (Ängabo and Hultaberg) there was a distance of 50–250 m between the plots. This variation was due to the patchiness of the forest stands at the study sites. The three management treatments "Complete", "Patchy" and "Control" were assigned to the plots in a random order. In the plots with "Complete" clearance most of the bushes, shrubs and small trees (base diameter <10 cm) were cleared in the whole plot area. In the plots with "Patchy" clearance the plot was divided into patches in a regular pattern, each patch roughly square in shape and measuring 50 m × 50 m. Every other patch was cleared, the rest were left unmanaged. Mean number of cleared patches in the plots with "Patchy" clearance was 8 (range 6–10, $n = 4$). "Control" plots were left untreated during the whole experiment.

Clearance of understory was carried out in autumn 2006 and early winter 2007 by municipal forestry workers equipped with clearing saws. Bushes and trees with a diameter of 10 cm or less at the base were cut close to the ground, except from multi-stemmed bushes of hazel (*C. avellana*) which were retained. The fine woody debris from the clearance was transported out of the forest with light forestry machines.

In three of the sites, Ängabo, Rya åsar and Hultaberg, plots with the treatments "Complete", "Patchy" and "Control" respectively, were used in equal areas of the forest stand. In Rånna Ryd only the "Patchy" and "Control" treatments were used, as the management plan for the nature reserve did not allow "Complete" clearance. In Stöpen only the "Complete" and "Control" treatments were used, as the area of the forest stand (8 ha) was insufficient for all three treatments. Thus, the experiment had a slightly unbalanced set-up with a total of four plots with "Complete" clearance, four with "Patchy" clearance and five "Control" plots.

2.3. Bird surveys

Density and diversity of breeding birds in the experimental plots were estimated by territory mapping. Surveys were conducted in spring 2006–2008, 1 year before understory clearance and 2 years after. Territory mapping was done according to the standard method with repeated visits during the breeding season (Bibby et al., 2000). All sites were visited on nine occasions between 15 April and 15 June, which is the recommended time of the year for territory mapping of forest birds in southern Sweden according to the guidelines developed by the Swedish Environmental Protection Agency (1978). Visits were conducted on mornings with little wind and no precipitation, starting at about sunrise and finishing before midday. During visits the sites were slowly walked through, using alternating routes and starting points for each visit to ensure good coverage of the site. Recording time for each plot (3–5 ha) was between 30 and 60 min/visit, depending on plot size and bird activity, respectively. Birds were recorded by sound as well as sight, with a particular focus on singing males. The locations of all birds were noted on a map (scale 1:2500) for each visit. Birds flying high over the forest (mainly gulls and corvids) were not recorded. Observations for each bird species was transferred to separate species maps. After nine visits, the species maps were used to estimate the number of territories for each species by counting the clusters of observations according to the standard methods of interpreting territory maps (Swedish Environmental Protection Agency, 1978; Bibby et al., 2000). Only bird species with a terri-