

# Ground-Nesting Birds on Green Roofs in Switzerland: Preliminary Observations

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## Abstract

Bird species in Switzerland are threatened by habitat loss and fragmentation due to increasing urbanization. New research is showing that green roofs can provide food habitat for some bird species. But little research has been done on the potential of green roofs for providing nesting locations for birds, particularly ground-nesting species. This preliminary two-year study (part of a larger, multiyear project) examined the breeding success of the little ringed plover (*Charadrius dubius*) and northern lapwing (*Vanellus vanellus*) on flat green roofs in five sites in Switzerland surrounded by varied levels of development. Results show that northern lapwings have begun to breed consistently, though as of yet unsuccessfully, on some green roofs. Because the observation time was short, the available data are incomplete. Nonetheless, they show certain tendencies with regard to the habitat selection and behavior of young and adult birds—important information that can be applied to future research and green roof design.

**Key words:** Biodiversity; breeding success; green roofs; ground-nesting birds; little ringed

plover (*Charadrius dubius*); northern lapwing (*Vanellus vanellus*); urban ecology

## Introduction

Investigations of the habitat potential of flat green roofs have indicated that this technology may lead to significant gains in biodiversity. Already, numerous IUCN Red List species of spiders and beetles have been found on green flat-roof habitats in Europe (Brenneisen, 2003a). There is also evidence for the habitat potential of green roofs for endangered bird species (Brenneisen, 2003a). Until now, little consideration has been given to the ecological functions that green roofs may perform for organisms within the larger landscape. Because of their mobility, many bird species can reach green roofs in urban areas, and at least some can utilize these roofs for feeding and breeding. In a recent study, Brenneisen (2003a) found that species such as the black redstart (*Phoenicurus ochruros*), house sparrow (*Passer domesticus*), and white wagtail (*Motacilla alba*) use green roofs as food habitats for insects and seeds. The same researcher also conducted a literature search on the breeding success of birds on green

roofs and found some references to single observations but none to successful roof broods. In the studies surveyed, observation times were too short, and the data collection was not designed for systematic observation of ground-nesting birds.

Not enough attention has been given to the behavior of adult and young birds on green roofs to generate specific design guidelines. More exact investigations are required. The following preliminary report summarizes data from a long-term study of birds on green roofs, conducted at the University of Applied Sciences, in Wädenswil, Switzerland. The results focus mainly on ground-nesting bird species and their breeding success on flat roofs. The long-term study is intended to address the question: How can green-roof design (with suitable vegetated and nonvegetated sections) favor breeding success?

## Methods

We examined green roofs at five sites with previously recorded single observations of the northern lapwing (*Vanellus vanellus*) and little ringed plover (*Charadrius dubius*). The sites were located in different Swiss cantons (Aargau, Berne, Zurich, and Zoug), and their surroundings varied from urban to rural. In 2005 and 2006, use of the roof areas as breeding habitat by these two species was recorded from the end of March until the middle of July. From the time of the birds' arrival, in March, through to July, observations were made once weekly for three hours at the same time of day; during breeding,

the frequency of observation was increased. Observations were made with field glasses (10 × 36 mm), and notes were taken in standardized field books (recording habitat, behavioral, and landscape descriptions). They were primarily made from neighboring buildings with good vantage points so that the birds were not significantly disturbed.

## Study Species

The northern lapwing is a wading bird in the plover family. It is native to temperate Europe and Asia and is occasionally seen in North America. Highly migratory over most of its range, it sometimes winters further south in northern regions of Africa and India. Lowland breeders in the westernmost areas of Europe are resident (Kooiker, 1997). The northern lapwing breeds on cultivated land and in other short-vegetation habitats. It lays three to four eggs in a ground scrape, and the chicks hatch out after 27 days of brooding. The chicks leave the nest early and after 42 days are able to fly away. From the time they leave the nest (day one), they have to find their food and water by themselves. The numbers of this species have been adversely affected by intensive agricultural techniques (Kooiker, 1997). The northern lapwing settled in the extensive wetlands of Switzerland's central country decades ago. However, when these wet areas were drained for agricultural use, populations of the species rapidly decreased (Schweizerische Vogelwarte Sempach, 2006). Some populations were able to adapt to the cultural landscape by breeding in damp meadows

and fields. Unfortunately, intensive management of agricultural soil and increasing urban sprawl have led to further declines. However, now it appears that the species is shifting to the use of green flat roofs as new brood habitat.

The little ringed plover likewise belongs to the wading bird group. Native to Europe and western Asia, its natural habitat is gravel and sand banks along the edges of rivers. It nests on the ground on stones with little or no plant growth and lays three to four eggs. The chicks hatch after 25 to 27 days of brooding and leave the nest early. As with the northern lapwing chicks, little winged plover chicks are precocial and must find food and water for themselves from the day they hatch. After 24 to 27 days they are able to fly away (Schweizerische Vogelwarte Sempach, 2006). In Switzerland, the little ringed plover was driven out of its natural riverine habitats at the beginning of the last century because of watercourse corrections. The species now uses gravel pits, industrial sites, and green roofs.

Both the little ringed plover and northern lapwing are listed as endangered and have high protection priority in European biodiversity programs (see, for example, Natura 2000, and its non-EU counterpart, the Emerald Network). The little ringed plover, according to Natura 2000, needs particularly special protection measures. The northern lapwing is a priority species within the bird-protection organizations of Switzerland (e.g., SVSBirdLife Schweiz, Schweizerische Vogelwarte Sempach) (Bollmann, 2002).

## Sites

Five observation sites were chosen for the preliminary study. The choice of the sites was based on references of breeding on green roofs made by ornithologists at Schweizerische Vogelwarte Sempach and SVS/BirdLife Schweiz.

### Shoppyländ Schönbühl (Canton of Berne)

For seven years, ornithologists have observed northern lapwings on the green roof (about 8,346 square meters) of the Frischezentrum ("Freshness Centre") of the Shoppyländ shopping complex. However, only within the last year or so have clear observations been made of nesting (approximately three nests) and breeding (Schneider, 2004). The substrate on this roof is purely mineral and consists of blown clay and volcanic material 6 to 8 centimeters thick. The vegetation consists mainly of *Sedum*, moss, and certain grasses. In spring and autumn 2004, 15 cubic meters and 47 cubic meters, respectively, of composted substrate (Ricoter) were added to the existing substrate, and a thin layer of plant seed (Basler roof herb mixture) was sown (Figure 1). The goal of adding this supplementary material was to enhance the nesting-habitat potential of the roof for northern lapwings. Shoppyländ is near Lake Moos, where several northern lapwing individuals have been observed since 1990. This population, which is under pressure from development, could be a reference or source population for the settlement of the Shoppyländ flat roof.

## Steinhausen (Canton of Zoug)

The flat roof in Steinhausen is on an office building in an industrial zone (Figure 2). The building was constructed in 1993; its roof was sealed with bitumen and covered with a layer of rolled gravel. Meager vegetation was planted on a thin humus layer; it is dominated by *Sedum* species but also includes carnation plants (*Dianthus carthusianorum* L.) and moss. The gross surface of the roof is approximately 3,200 square meters. As with the Shoppyland site, natural habitat areas are in proximity to the building. They include Zuger Lake and its banks, as well as nearby agricultural fields, which for decades have been settled by a population of northern lapwings. These sites have decreased drastically in area over the decades, and the northern lapwing has had to look for other habitat—for example, green roofs (see Figure 3).

## Kaiseraugst (Canton of Aargau)

For many years, the little ringed plover has been nesting and breeding in the Ernst Frey AG gravel pit, in Kaiseraugst, which has a surface area of 95,447 square meters (Dasen, 2005). However, within the last year, most of the pit was filled in (Figure 4); only the very northeastern section of it is still open, and this area is characterized by plentiful vegetation. Flat green roofs were constructed on three modular research buildings adjacent to the pit to explore their potential as effective habitat replacements. The behavior of the little ringed plover in its secondary habitat is being observed to find out which landscape

features are particularly important to them and to measure its food-search activity radius. The green roofs were designed with reference to the habitat conditions of the bird species. They consist of a mixture of open area (with gravel and sand) and closed area with vegetation (growing on composted soil).

## Zurich–Kloten (Canton of Zurich)

Several northern lapwing individuals have been observed on two large neighboring flat green roofs in Zurich–Kloten. These surfaces measure approximately 2,000 square meters in area and are covered with eight centimeters of mineral substrate (blown clay and volcanic material) and a mix of moss and *Sedum* species. Directly adjacent to the roofs is a 74-hectare protected natural area. This area is managed as extensive long-grass meadow, an ecologically valuable grass landscape. On these urban grasslands, several northern lapwings have been nesting and breeding for many years.

## Hochdorf (Canton of Lucerne)

The company 4B, in Hochdorf, owns factory buildings with approximately 2,000 square meters of roof surface area. The substrate on the roof is gravel and crushed stone, upon which is a meager covering of moss. In 2002, a pair of little ringed plovers was observed breeding on the roof. Since then, they have returned each year.

## Results 2005

The 2005 investigations supplied us with interesting preliminary data, in particular about the northern lapwing (see Table 1 for a summary of the data). In the Shoppyland, Steinhausen, and Zurich–Kloten sites, older breeding hollows of the northern lapwing were found on all the flat green roofs. These provide evidence that the northern lapwing has returned consistently to the flat roofs over multiple seasons (ranging from 2 to 13 years) and made primary broods. In 2005, however, none of the six primary broods were successful (i.e., chicks hatched, but none survived to fledge; most died after a few days). Three secondary broods were attempted but none were successful.

During March 2005, the population of adult northern lapwings on the Shoppyland flat green roof went from three to two when one individual died. And at the beginning of April, one of the two remaining individuals was found dead on the ground, most likely attacked (from the nature of its injuries) by a bird of prey. Consequently, there were no breeding attempts in 2005.

At the Zurich–Kloten site, northern lapwings have already bred for several years in the nearby grassland. In 2005, however, six pairs of adults used the two flat green roofs to breed. The reasons why they chose this breeding habitat are still uncertain and yet to be examined. Some may have resettled on the roof after the loss of their first brood in the grassland a few hundred meters away. Although the clutches of eggs in the second brood exhibited good hatching success, no chicks survived.

Little plovers were not observed on the roofs of the three modular buildings in Kaiseraugst. Four successful broods were observed in the adjacent gravel pit. The investigation showed that the little ringed plover needs damp places and prefers uneven surfaces (Dasen, 2005). Recommendations for creating habitat for this species on flat green roofs might include designing the roofs with uneven surfaces and water-retaining substrates.

At the Hochdorf site, no breeding success was observed this year for the little ringed plover.

At the Steinhausen site, two pairs of northern lapwings were observed brooding (Figure 5). A total of six chicks hatched but did not survive very long. Unfortunately, the carcasses of the dead chicks could not be found and examined (they may have been carried off by a bird of prey). After the chicks disappeared, the adult birds disappeared too. We presume that the chicks died because of inadequate food and water.

## Results 2006

Observations were made at the same sites in 2006. A new site was also added in Rotkreuz (Canton of Zoug). At that site five pairs of northern lapwings had chicks that hatched, but the chicks died after about five days. The results of the other sites are shown in Table 2.

This year observation cameras were installed and tested for the first time at the Steinhausen and Rotkreuz sites. The goal is to use the cameras to observe the nest sites around the clock and gather more information about the development

of the young birds. As the cameras' technology and methodology need to be refined, no further information and data is provided here.

## Discussion

Ground-nesting bird species such as the little ringed plover and northern lapwing are under strong anthropogenic pressure in Switzerland, and to a lesser degree in other European countries. Rising urbanization has led to increased loss and fragmentation of their habitat (swamps, wetlands, and grassland). But these species have shown time and again that they can adapt to the changes and to the urban landscape. The little ringed plover, for example, selects gravel pits as a secondary habitat, and the northern lapwing chooses extensively managed areas of agricultural land. In recent years, both species have begun to utilize green flat roofs.

The vegetation on the green roofs in this study consists mainly of *Sedum* species and a few herbs that cover 10% to 30% of the roofs and thus constitutes very little biomass. Plant selection is limited by the kind of substrate used (blown clay and volcanic materials) and the shallow depths at which this substrate is applied. The vegetation offers almost no faunal food source (insects, spiders, and other small animals), which is particularly important for young precocial birds (such as the ground-nesting species), which are not fed by adults and must find food and water by themselves. It also offers little cover from birds of prey such as crows. Since the main aim of this project is to develop green roof technologies and systems as habitat

replacement, we will be focusing on the proper vegetation structure needed to facilitate reproductive success. As with any habitat restoration or compensation project, this structure—and the resources it provides—must be understood or the replacement habitat runs the risk of becoming an ecological sink.

Organic materials such as compost, roof garden soil, and humus, and nonorganic substrates such as blown clay, volcanic material, and lava stone can increase the water-holding capacity of green roofs and, in the case of the organic materials, contribute valuable nutrients. Besides finding their own food, young precocial birds must find their own water. However, there is little data on this topic, and experts disagree about the necessity of water sources on green roofs. There are examples of northern lapwing colonies that have had good breeding success despite the absence of water sources such as small ponds, pools, ditches, and damp mud surfaces (Kooiker, 2000). Kooiker (2000) reported breeding success by northern lapwings in extensively used meadows with short vegetation or soils without any vegetation, and a yellow-brown surface. The northern lapwing sites examined in this study corresponded partially to these requirements.

Although the data described here consist of a very small sample size, they do provide evidence that the northern lapwing and little ringed plover use green roofs as breeding habitat. The data also show that adult northern lapwings can, in some cases, permanently change their breeding sites depending upon the needs of their young. These

observations provide incentive to gather more data in connection with flat roofs and ground-nesting bird species so we can begin to design green roofs as ecologically valuable habitat for these species.

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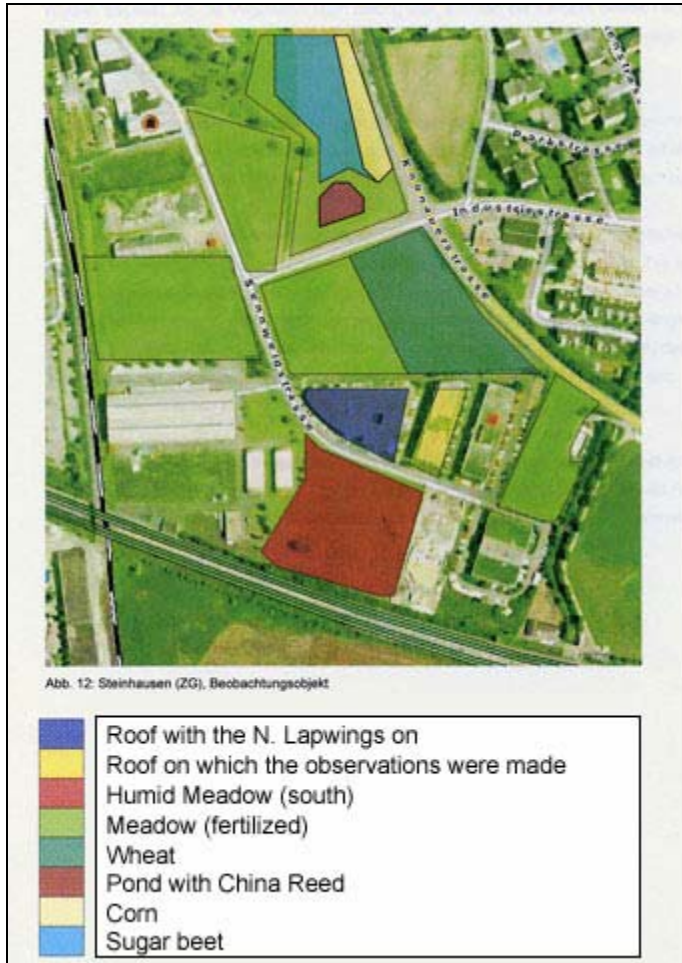
**Figure 1: Project workers add compost substrate (about 4 cm) to the topsoil of the roof at Shoppyland, Berne. (Photo by N. Baumann)**



**Figure 2: The green roof in Steinhausen, Canton Zoug. (Photo by L. Jensen and A. Kaufmann)**



**Figure 3: Aerial photo of the surroundings at the Steinhausen site, Canton Zoug, with habitat use of northern lapwings (*Vanellus vanellus*) mapped on. (Photo by L. Jensen and A. Kaufmann—© search.ch/Endoxon AG, TeleAtlas)**





**Figure 4: The gravel pit Frey AG, in Kaiseraugst, Canton Aargau. (Photo by N. Baumann)**



**Figure 5: A northern lapwing (*Vanellus vanellus*) brooding on the green roof in Steinhausen, Canton Zoug. (Photo by A. Kaufmann)**



**Table 1. Summary of results for 2005 at the five observation sites.**

<b>Sites</b>	<b>Number of breeding pairs</b>	<b>Hatchings, brooding success</b>
Steinhausen	2	4 young birds (none survived)
Shopyland	1	0
Kaiseraugst (gravel pit only)	1	4 young birds (successful)
Hochdorf	0	0
Zurich-Kloten	3	9 young birds (none survived)

**Table 2. Summary of results for 2006 at the five observation sites.**

<b>Sites</b>	<b>Number of breeding pairs</b>	<b>Hatchings, brooding success</b>
Steinhausen	1	4 young birds (none survived)
Shopyland	1	3 eggs (none hatched)
Rotkreuz	5	12 young birds (none survived)
Kaiseraugst (gravel pit only)	1	4 young birds (successful)
Hochdorf	0	0
Zurich-Kloten	no data	no data