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The restoration of the Nohlmarken nature reserve



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The Nohlmarken nature reserve in the province of Västergötland is situated 140-160 m above sea level on the south-eastern slope of the table top mountain Billingen. The little village Skultorp is just north of Nohlmarken. The reserve has an area of about 6 hectares (15 acres).

Nohlmarken is a very varied site containing acid as well as calcareous areas. There is a dry and sandy hill in the south, moist calcareous meadows in the east, a rich fen in the central part and moraines and dry calcareous grasslands in the west. Two brooks with alkaline water (pH 7.8) run through the site. There are slag-heaps of burnt alum-shale which are the remnants of old lime-works. Several power lines pass through the area.

In 1986 most of Nohlmarken was heavily overgrown and only small parts were managed. A far-reaching restoration of this valuable site was started the same year. Fourteen years later, in 2000, the site has become a largely open area with solitary trees and shrubs and the whole site is managed by mowing. The restoration has mainly been done as voluntary work by members of the local Nature Conservation Association. The reserve has a very high botanical value and is a good locality for many orchids, marsh plants and species that depend on mowing. During the fourteen years that have passed since the beginning of the restoration more than 400 species of vascular plants have been found. The flora is very varied. The most interesting parts are the moist calcareous meadows, the area under the power line in the east, the central rich fen and the dry calcareous grassland in the west. Many species found in the reserve are included in the Swedish Red Data Book.

HISTORY

In 1841 there was a redistribution of land holdings in the village of Regumatorp in the parish of Sjögerstad. According to the map that was made for the purpose, Nohlmarken consisted mainly of meadows and marshlands. A small part in the east was arable land. The meadows were mown and probably the marshes too. The map does not show whether the land was tree-covered or not but a later map, from 1878-1882, shows that a large part of the site was wooded.

It is not known at what time mowing of the site came to an end but probably this happened in the beginning of the 20th century when it started to be used as pasture. The fields that were cultivated in 1841 continued to be so until the 1940's. Then the fields became pastures and the grazing on the former meadows stopped and they were not managed for 40 years. After the grazing of the former meadows ended, they became considerably overgrown. During this period the flora was driven into small gaps in the woodland or between the willows, but parts of the moist calcareous meadows, the rich fen and the dry grassland were left relatively intact. These were able to serve as centres for recolonisation.

In 1984 the area attracted attention in connection with the Swedish Wetland Inventory. The site was highly ranked due to the species-rich moist grassland and the rich fen.

My first visit to the area was made in 1985 and it was then that the thought of restoring the site was first considered. The restoration of Nohlmarken was started the following year and this voluntary work would last for more than 10 years.

In 1986 almost the whole area west of the grazed fields was covered with trees or willows. The only open areas were a small part of the dry grassland in the west and the central rich fen. Even the area that was still grazed was quite overgrown. This was the situation when the restoration of Nohlmarken started on the 26th of July 1986.

THE RESTORATION STEP BY STEP

1986. In the first year extensive work was carried out to remove thickets and trees. More than 100 heaps of brushwood were burnt. Mowing was started in the open rich fen using a small mowing machine borrowed from another nature conservation association. In the first year over 500 hours of work was done by about 50 people.

1987. In 1987 the whole area was fenced, partly with barbed wire and partly with sheep fence. The work was done by staff from the regional forestry board and was funded by the Swedish Environmental Protection Agency. The area was divided into seven enclosures. The extensive clearing in 1986 resulted in a lot of brushwood growing up in 1987. In the enclosures grazed by sheep the brushwood was browsed and did not become a big problem. The situation was worse in the wet parts grazed by cattle and it was necessary to clear the brushwood with bush-saws. To increase the stocking rate cattle and sheep were

turned out to pasture early in the spring. However, this was not a good solution as the animals preferred to graze some plants that we wanted to protect, for example the orchids. For this reason it was decided that the most valuable areas would be grazed late in the season. Some exclosures, with an area of 10 m², were built to protect specially interesting plants. Other areas, mainly in and around the calcareous moist meadow, were mowed instead of grazed. For this purpose the association bought a small mowing machine with a width of 90 cm. This year too a lot of clearing was done.

1988. In the beginning of this year a large part of the woodland was cleared. A lot of time was spent getting rid of all the branches and twigs. An area of one hectare (approx. 2.5 acres) was mown.

1989. To make the mowing easier and more extensive a bigger and more effective mowing machine was bought. This machine worked faster than the previous one and it could cut a width of 160 cm. However, mowing was difficult because of the large number of stumps left from the clearing. A “stump grinder” was borrowed from the municipality of Skövde. This machine was designed for lawns and was very difficult to handle in the uneven ground so this work was soon abandoned.

1990. This year most of the woodland on the site was felled. After this felling the area had a much more open character. The site was managed as before, i.e. one hectare mown in the flat part, cattle grazing in

the east and sheep grazing in the rest of the area. The mowing was very time-consuming and for this reason an All Terrain Vehicle with a cart was bought. This machine exerted a very low pressure on the ground and all parts of the area could be reached without any problems. This made it much more easy to transport the hay but we still lacked a machine for collecting the hay.

1991-1992. This year a machine for hay-collecting was bought. However, the mowing was still difficult due to the large number of stumps. Something radical had to be done and around Christmas 1992 the stumps and large stones in the moist and flat part were removed with the help of an excavator. More trees were felled and substantial clearing was carried out.

During the period 1986-1992 almost 4000 hours of work were spent on the site.

1993-1996. The work in 1992 had created hollows in the ground and these had to be repaired in order to make the mowing easier. After this it was possible to mow half of the total area without any problem. In 1994 more of the site was prepared with the help of an excavator. The site became a nature reserve on the 28th of May 1996.

1997-1998. A thorough botanical inventory of the site was made in 1997. The site was divided into 24 areas, which were scrutinized twice during the growing season. The inventory took around 75 hours and more than 350 species were found.

Figure 1. Nohlmarken nature reserve consists mainly of calcareous meadows with tens of thousands of *Dactylorhiza maculata* ssp. *fuchsii*. After restoration a strong increase in the number of individuals has also been noted for i.e. *Epipactis palustris*, *Gymnadenia conopsea*, *Listera ovata*, *Linum catharticum* and *Crepis paludosa*.



Figure 2. Aerial photographs of the 6 ha in size Nohlmarken nature reserve (the boundary is marked with a black line). Grazing on the former meadow came to an end in the 1940's. In the same time the cultivated fields in east became pastures. In 1955 the meadow had been unmown and ungrazed for about 10 years and in 1986 for about 40 years. After the restoration (1998) Nohlmarken is a mowed again.

1955



1986



1998



The site was mown to an ever increasing extent. In 1998 the lands were grazed after mowing but some of the drier parts were just grazed. In the less species-rich parts mowing started as usual in August and in the most valuable parts mowing ended in October. Some unwanted plants were removed early in the season, e.g. *Rubus idaeus*, *Salix spp.*, *Populus tremula*, *Filipendula ulmaria*, *Anthriscus sylvestris* and *Mercurialis perennis*. Some more extensive clearing of the brushwood was needed, especially in the dry grassland in the west.

1999. This year the whole site was mown, mainly with mowing machines. Some edge zones, stony parts and wet areas were cut with scythes. The site was extended by felling and clearing a small wood in the north-west. In the future this area will probably be included in the nature reserve. To make public access easier some paths were covered with limestone gravel and foot bridges were built in the wet areas.

2000. In January an excavator was used in the new area to fix an ugly old limestone pit. In the reserve some irregularities were smoothed over and some remaining stones and stumps were removed. After this 90-95 % of the site could be mown with a mow-

TABLE I. THE FREQUENCY OF SOME PLANTS IN NOHLMARKEN, 1986-1999

Plants favoured by grazing or mowing	1986	1999		
<i>Ajuga pyramidalis</i>	rare	slight increase	<i>Listera ovata</i>	less common
<i>Arrhenaterum pratense</i>	quite common	constant	<i>Neottia nidus-avis</i>	5
<i>Blysmus compressus</i>	less common	constant	<i>Ophrys insectifera</i>	ca 50
<i>Cardamine pratensis</i>	less common	constant	<i>Orchis mascula</i>	not seen
<i>Carex hostiana</i>	less common	slight increase	<i>Platanthera bifolia</i>	few
<i>Carex pulicaris</i>	rare	constant	<i>Platanthera chlorantha</i>	>10
<i>Cirsium acaule</i>	quite common	increase	Introduced plants	
<i>Filipendula vulgaris</i>	rare	constant	<i>Euphrasia rostkoviana</i>	introduced
<i>Lathyrus linifolius</i>	quite common	strong increase	<i>Melampyrum cristatum</i>	introduced
<i>Nardus stricta</i>	quite common	constant	Marsh plants	
<i>Ophioglossum vulgatum</i>	quite common	increase	<i>Carex capillaris</i>	less common
<i>Polygala amarella</i>	quite common	strong increase	<i>Carex dioica</i>	less common
<i>Primula farinosa</i>	less common	slight increase	<i>Catabrosa aquatica</i>	less common
<i>Primula veris</i>	less common	increase	<i>Eriophorum latifolium</i>	quite common
<i>Pulsatilla vulgaris</i>	not seen	increase	<i>Filipendula ulmaria</i>	quite common
<i>Succisa pratensis</i>	common	increase	<i>Glyceria declinata</i>	not seen
<i>Trollius europeus</i>	less common	constant	<i>Pedicularis palustris opsiantha</i>	not seen
Species favoured by mowing			<i>Pedicularis palustris palustris</i>	less common
<i>Arnica montana</i>	less common	slight decrease	<i>Phragmites australis</i>	rare
<i>Briza media</i>	quite common	increase	Forest plants	
<i>Crepis praemorsa</i>	quite common	increase	<i>Actaea spicata</i>	less common
<i>Leontodon hispidus</i>	less common	increase	<i>Crepis paludosa</i>	quite common
<i>Linum catharticum</i>	less common	strong increase	<i>Daphne mezereum</i>	less common
<i>Parnassia palustris</i>	less common	slight increase	<i>Hepatica nobilis</i>	quite common
<i>Rhinanthus minor</i>	quite common	strong increase	<i>Mercurialis perennis</i>	quite common
<i>Rhinanthus serotinus</i>	not seen	very common	<i>Polygonatum multiflorum</i>	less common
<i>Scorzonera humilis</i>	less common	increase	Trees	
<i>Thalictrum simplex</i>	not seen	few	<i>Betula pendula/pubescens</i>	common
Orchids			<i>Picea abies</i>	quite common
<i>Corallorhiza trifida</i>	few	slight increase	<i>Pinus sylvestris</i>	less common
<i>Dactylorhiza incarnata</i>	40-50	400-500	<i>Salix myrsinifolia</i>	common
<i>Dactylorhiza incarnata cruenta</i>	not seen	>10	<i>Sorbus intermedia</i>	quite common
<i>Dactylorhiza incarnata ochroleuca</i>	not seen	5	Other plants	
<i>Dactylorhiza maculata fuchsii</i>	>1000	>10000	<i>Aquilegia vulgaris</i>	not seen
<i>Dactylorhiza traunsteineri</i>	not seen	5	<i>Centaurea jacea</i>	quite common
<i>Epipactis helleborine</i>	30-40	15	<i>Galium boreale</i>	quite common
<i>Epipactis palustris</i>	>100	>1000	<i>Lysimachia vulgaris</i>	common
<i>Gymnadenia conopsea</i>	not seen	>1000	<i>Melampyrum nemorosum</i>	not seen
<i>Gymnadenia conopsea densiflora</i>	not seen	10	<i>Origanum vulgare</i>	rare
<i>Herminium monorchis</i>	2	16	<i>Pinguicula vulgaris</i>	less common

ing machine. Some flat limestone slabs were moved from the surrounding area into the reserve in order to introduce some miniature calcareous flatrock habitats. The fences were repaired and four nature reserve signs were put up.

The future. Hopefully the whole reserve will continue to be managed as a meadow. We hope to have, in the near future, a machine that can mow and collect the hay at the same time. This would facilitate the management of Nohlmarken as well as other sites in the neighbourhood. Aftermath grazing of the whole, or parts of the site would be desirable in some years. The ground still has to be made more even to make mowing easier. Pollinating insects will be favoured by the promotion of shrubs, such as *Berberis vulgaris*, *Crataegus spp.* and *Viburnum opulus*. Another method of favouring the insects, particularly butterflies that depend on certain plants, might be to let small areas remain unmown in some years. In order to promote the bird life a large number of nesting-boxes will be put up in and around the reserve.

THE FLORA

Before the restoration. In the first inventory of 1986 approximately 240 species were found. Among these there were 11 species of orchids, including *Dactylorhiza incarnata* (40), *Dactylorhiza maculata ssp. fuchsii* (thousands), *Epipactis palustris* (hundreds), *Herminium monorchis** (2), *Neottia nidus-avis* (5) and *Ophrys insectifera* (40). Other interesting species were *Arnica montana*, *Blysmus compressus*, *Brachypodium pinnatum*, *Carex dioica*, *Carex pulicaris*, *Carex capillaris*, *Carlina vulgaris*, *Catabrosa aquatica**, *Cirsium helenoides*, *Cotoneaster intergerimus*, *Crepis praemorsa*, *Daphne mezereum*, *Eleocharis quinqueflora*, *Eleocharis uniglumis*, *Epilobium parviflorum*, *Leontodon hispidus*, *Lycopodium clavatum*, *Ophioglossum vulgare*, *Pedicularis palustris*, *Pinguicula vulgaris*, *Primula farinosa*, *Scabiosa columbaria* and *Scorzonera humilis*.

After the restoration. Several inventories have been made since 1986, the most extensive in 1997 when about 350 species were found. More than 400 species have been found in the period 1986-1999. Since 1986 the diversity has increased tremendously. A few plants have disappeared, for example *Neottia nidus-avis* which could not survive the increased sunlight which resulted from the clearing work.

Some plants have been strongly reduced in number, e.g. *Daphne mezereum*, *Maianthemum bifolium*, *Oxalis acetosella* and *Paris quadrifolia*.

Other forest plants have survived better, e.g. *Actaea spicata*, *Convallaria majalis* and *Polygonatum multiflorum*.

The light-demanding species however, have increased on the site, including a large number of species that were not seen in 1986. Some of these might have been there but in very small numbers. Other species may have persisted in the seedbank. A couple of species have been added as the area was extended, e.g. *Berula erecta*, *Cirsium oleraceum* and *Epilobium hirsutum*. Some plants, e.g. *Aquilegia vulgaris* and *Melampyrum nemorosum*, have escaped from gardens in the vicinity.

Several species have been introduced together with earth brought in from outside the area, but most of these have been temporary. New species are *Alyssum alyssoides*, *Antennaria dioica*, *Botrychium lunaria*, *Campanula cervicaria**, *Glyceria declinata*, *Dactylorhiza incarnata ssp. ochroleuca*, *Dactylorhiza incarnata ssp. cruenta*, *Dactylorhiza traunsteineri*, *Draba muralis*, *Gymnadenia conopsea*, *Hypochoeris maculata*, *Lepidium campestre*, *Lycopus europeus*, *Molinia caerulea*, *Orchis mascula*, *Polygala vulgaris*, *Pulsatilla vulgaris*, *Rhinanthus serotina*, *Sedum album*, *Thlaspi perfoliatum* and *Torilis japonica*.

In a few cases plants have been sown on the site, e.g. *Euphrasia rostkoviana ssp. rostkoviana** and *Melampyrum cristatum**. These are included in the national Red Data Book and are found in very few localities in the region. *Euphrasia rostkoviana ssp. rostkoviana* grows in around 10 sites in Västergötland and these constitute the main part of the Swedish population. Seeds have been taken from neighbouring populations and the aim has been to reduce the risk of local extinction for these species ●

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* = the species is included in the Swedish Red Data Book