THE ROLE OF BOTANIC GARDENS IN SPECIES RECOVERY: THE OBLONG WOODSIA AS A CASE STUDY

PHILIP LUSBY, ADRIAN DYER & STUART LINDSAY

A translocation experiment to reintroduce the rare fern *Woodsia ilvensis* (L.) R.Br. to former sites in England and Scotland is described. The demands of this kind of conservation work brings the work of scientists and horticulturists together. High losses of transplants are to be expected and in order to gradually build up populations in the wild, translocation programmes may have to adopt a multi-phased approach. The facilities at botanic gardens are well suited to this type of conservation work.

INTRODUCTION

One can legitimately claim that living collections within botanic gardens have always had at least an indirect conservation role by stimulating interest in plants. With the steady increase in pressure on natural and semi-natural habitats, the contribution to the conservation of plants by botanic gardens has grown accordingly. The main thrust of conservation work in botanic gardens has been mainly through *ex situ* methods which include the provision of 'safe havens' for rare and threatened plants, seed banking and cryopreservation of plant material. However, there has recently been increased interest among conservationists to use translocation to the wild of plants raised in cultivation as an approach to reintroduce species or to augment critically small populations. Botanic gardens seem well placed to make a significant contribution to this kind of work.

RECOVERY PROGRAMMES

In 1990 the report published by the Nature Conservancy Council, 'Recovery: A Proposed Programme for Britain's Protected Species' by A. Whitten, introduced an important development in species conservation. Prior to this report the main aim of nature conservation in Britain was to slow or halt the loss of species and habitats.

Philip Lusby is the Year Tutor in the School of Horticulture at the Royal Botanic Garden Edinburgh (RBGE). At the time of the Woodsia translocation project he was Head of RBGE's Scottish Rare Plant Project.

Adrian Dyer has retired from the University of Edinburgh but he is a Research Associate at RBGE and, at the time of the project, was an Honorary Fellow of the University of Edinburgh, having previously been a Senior Lecturer.

Stuart Lindsay is a Research Fellow at Harvard University. At the time of the project he was a Leverhulme Scholar working at RBGE.

The proposed Recovery Programme sought to improve the status of the most threatened plants and animals in Britain to a point where they became a self-sustaining member of their ecosystems. Costed recovery plans for each species were compiled, each plan consisting of ten sections (Whitten, 1990). One of the sub-sections, 'Translocation Requirements', was important in that for the first time in British conservation, introduction, re-introduction, and augmenting populations by translocation of plants became part of a common strategy. Conservation programmes involving re-introductions had been carried out before but only on a piecemeal basis.

Species recovery work involving translocations was further promoted by the Species Action Plans (SAP) that were written as part of the obligations of signatories of the Convention on Biological Diversity (CBD) in 1992 (Anon, 1994).

Translocation of any kind normally involves raising plants in cultivation and planting them out in the wild. Fundamental to any translocation experiment is the ability to grow the species from seed (or spores if a cryptogam). The reliance on successful propagation and cultivation of these priority species brings the expertise and experience of the horticulturist, ecologist and conservationist together. Although all these people may work within major botanic gardens they may seldom come into contact. Recovery work has provided opportunities for fruitful collaboration between scientists and horticulturists.

Recovery of the Fern Oblong Woodsia (*Woodsia ilvensis*)

As for many northern boreal and arctic-alpine plants, Britain forms the oceanic margin of the geographic distribution of *Woodsia ilvensis.* Historical evidence suggests that the fern has always been scarce and was first recognized as distinct from *Woodsia alpina* in 1785 (Lusby *et al*, 2003). The depredations of the 'Victorian Fern Craze', the mid-nineteenth century fashion for fern collecting, drastically reduced populations of many species (Allen, 1969). During the fashion there was a strong element of elitism connected with having a complete collection of British ferns and this was particularly devastating for the rarities as localities for these were ruthlessly hunted out and plundered. Only one locality in a new area has been found since this period.

The catastrophic decline of *W. ilvensis* in Britain has resulted in the fern's inclusion in various conservation priority lists, the most recent making positive intervention to restore populations by translocation a specific objective (Anon, 1998). Further, the lack of detailed knowledge of the reproductive biology of the fern stimulated research in this area.

In 1992, two research programmes, one at the University of Edinburgh funded by the Natural Environment Research Council (NERC), followed by another funded by the Leverhulme Trust and based at the Royal Botanic Garden Edinburgh, were undertaken by Stuart Lindsay and Adrian Dyer. Their research had a number of aims, including determining the current status of the fern in Britain and investigating various aspects of the population and reproductive biology of *Woodsia ilvensis.*

Lindsay and Dyer found that there were no more than a hundred clumps (not necessarily representing separate plants) left in the wild and these were distributed among five broad localities: three in Scotland, one in England and two in Wales. The English locality in Cumbria contains about 70 plants; the other populations were critically small. Lindsay and Dyer demonstrated that over 90% of *W. ilvensis* spores were viable and were also successful in raising sporelings from soil samples collected from wild population sites, thus demonstrating the existence of soil spore banks. The existence of spore banks was confirmed for a number of other fern species (Dyer and Lindsay, 1992, Dyer 1994).

Another objective of the Leverhulme project was to establish an *ex-situ* conservation collection of *W. ilvensis* to halt any further loss of British genotypes and to provide material for possible re-introduction, which was just beginning to be discussed at that time. Propagation of *W. ilvensis* from spores was initially slow and slightly problematic. At first, with little information to go on, native soil with added drainage material was used to grow-on young sporelings but this did not prove very successful.

The fern specialist at RBGE, Andrew Ensoll, was consulted and he achieved great success with the following method: spores were sown on a compost composed of one part peat and one part bark with added 'ENMAG' fertiliser. The spores and young sporelings were given 100% humidity by covering the pots with cling film and grown under a regime of 12hrs light per day using fluorescent lighting. A temperature of 18°C was maintained. Once sporelings had germinated and grown to approximately 1.5cm, they were very gradually weaned to the conditions of the open growth room by gradually reducing the humidity by slitting the cling film covering the pots. Once the sporelings were sufficiently hardened they were potted into a mixture of 40% bark, 35% John Innes Potting Compost no.1 and 25% grit. Slow release fertiliser and extra lime was added. A top-dressing of grit was applied to each pot to keep the fronds and developing spores clean. The ferns were further hardened before moving them to a shade tunnel outside. By September 1998 a conservation collection of about 2,500 young *W. ilvensis* plants in pot outdoors, representing all extant British populations, had been formed.

For each priority species for which a SAP has been written, a Steering Group is appointed to consider the practical issues of its implementation. Steering Groups consist of representatives from all relevant conservation bodies and other key experts and research workers. As Steering Groups can make decisions whether or not to carry out certain recommendations in the SAP, there is usually much negotiation before practical work is carried out. Translocations of any kind are expensive, difficult and controversial. Habitat management to improve conditions for rare plants is always the preferred option to reverse population declines. However, at sites where a species has become extinct there is no option other than reintroduction by translocation to restore a population. The decision by the Steering Group to implement the recommendation to attempt to restore populations to three former sites by translocation (Anon, 1998) was made easier from the information obtained through Lindsay and Dyer's research and the success in propagation by Ensoll.

The three sites that were chosen for re-introduction were in Teesdale in Northern England and in the Southern Uplands of Scotland. The Steering Group carefully considered the provenance of the re-introduced plants and recommendations made by the genetic guidelines for recovery programmes produced by Fleming and Sydes (1997) were also taken into account.

TRANSLOCATION OF *WOODSIA ILVENSIS*

The practical work of translocating the ferns to the re-introduction sites was carried out by a small team of horticulturists and research workers from RBGE including members of the Scottish Rare Plant Project based at the RBGE. Help was available at the Southern Upland site from staff of the National Trust for Scotland and horticulture students from Threave Gardens.

As *W. ilvensis* seemed to be palatable to grazing animals, the most suitable niches for planting were thought to be relatively inaccessible ledges and crevices. These were surprisingly difficult to locate. The size of the crevice also dictated the size of the plant. As most suitable niches were small this put a further burden on Andrew Ensoll to maintain a constant supply of young plants. Many suitable crevices were already occupied by vegetation and its removal tended to dislodge the accompanying soil. This had to be replaced when planting a fern, usually with a mixture of native soil and fern compost but this would not be stabilised until a mature root system is produced.

The well-drained, rocky habitat of *W. ilvensis* makes the establishment of young plants challenging. Lindsay and Dyer had observed that mature plants of *W. ilvensis* in Norway were particularly drought tolerant and were able to recover from a shrivelled state after a day or two of rain (Dyer *et al,* 2001). However, it is highly unlikely that young, newly planted ferns would act in the same way. It was difficult to decide whether spring or autumn planting would provide the best conditions for establishment. In spring, the conditions are becoming drier with a possibility of drought conditions before the plants establish. In early autumn, moisture levels are usually higher but the plants face the risk of loosening by frost-heave before becoming firmly rooted (Lusby *et al,* 2002). To maximise chances of successful establishment, we translocated some plants in spring/early summer and others in autumn. Where extra compost was used to plant the ferns in crevices in early summer, we added some water retentive gel. However, we were unable to conclude whether this conferred any advantage in establishment of these plants. So far the following translocations have taken place:

Teesdale site 1: 26 plants on 8 June 1999 and 38 plants on 22 June 1999.
Teesdale site 2: 50 plants on 19 September 2000.
Southern Uplands: 129 plants on 28 September1999.

Details of monitoring methods are described in Lusby *et al,* 2003.

Results

Teesdale Site 1:

Monitoring has taken place three times since planting: in June 2000, September 2000 and September 2002. Initial establishment was good as there were only four losses by June 2000 and six by September 2000 (9.5%). At least 19 plants (around 30%) were releasing spores. By September 2002, 26 plants had died (41%). At least 24 plants (38%) were shedding spores and some plants appeared vigorous.

This site with a southerly aspect was very dry in September 2002. Some plants appeared to suffer from drought. Site 2, with a northerly aspect, was much less dry and the ferns generally appeared more vigorous.

Teesdale Site 2:

By September 2002, 47 (94%) of the 50 plants had survived with 32 (64%) shedding spores. Over 30% of the plants were subjectively described as vigorous.

Southern Uplands:

By August 2000 11 plants (8.5%) had died and only a single plant had sporangia that were judged advanced enough to shed spores before winter.

No monitoring was carried out in 2001 because of access restrictions imposed following the outbreak of Foot and Mouth Disease in domestic livestock.

Discussion

It is obviously much too early to draw any real conclusions regarding success or failure of these translocation experiments with *Woodsia ilvensis*. As the aim of these translocations is to achieve a self-sustaining population of the fern at each of the sites, we clearly have a long way to go. Initial establishment of the plants was very good but, almost inevitably, there are losses with time. Given the high natural mortality of young recruits in natural plant populations (Crawley, 1986) we should perhaps expect that a very high percentage of the *Woodsia* plants to fail, leaving – if we are lucky – a very few strong individuals. This pattern has emerged in translocation experiments carried out by the Scottish Rare Plants Project, based at RBGE, for *Lychnis viscaria* (sticky catchfly). Many phases of translocations may be required to gradually build up a viable population of *W. ilvensis* and this probably applies to any other plant that is the subject of re-introduction by translocation. This approach would also gradually form a population of different aged plants, which is far more natural.

It would be understandable, but misguided, if high losses of individuals or perhaps whole cohorts of introduced plants were interpreted as utter failure of translocation as a conservation tool. However, it is inevitable that competition, and various subtle features of microsite environment that render them less than optimal for long-term colonisation, will result in high recruitment mortality. Moreover, with potentially long-lived perennial plants, recruitment does not need to be achieved very often. Thus, despite the expense in time and resources, we think it may be necessary to accept a multi-phased programme of translocations as the only realistic approach. This in turn creates a constant demand for propagation of young plants thus requiring a reliable propagation technique. It seems clear that the facilities and expertise at botanic gardens make them particularly suitable for this kind of conservation work.

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