GLOBAL RE-INTRODUCTION PERSPECTIVES

Re-introduction case-studies from around the globe

Edited by

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Cover photo: Clockwise starting from top-left:

- Formosan salmon stream, Taiwan
- Students in Madagascar with tree seedlings
- Virgin Islands boa

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Re-introduction of small cow-wheat into the Scottish Highlands, UK

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Introduction

Small cow-wheat (***Melampyrum sylvaticum***), is an annual plant of upland woodland undergoing a significant decline in the UK and restricted to 19 isolated sites in the Scottish Highlands. Six sites support less than 200 plants and only three have populations greater than 1,000 individuals. The smaller populations show little genetic diversity and the populations are genetically divergent. The species is classified as nationally scarce within the UK Red Data lists and is included in the UK Biodiversity Action Plan under Agenda 21 of the Convention on Biological Diversity. The Species Action Plan forms the rationale behind this introduction project. Although the species is abundant in parts of Europe, its boreal-montane distribution will contract under current climate change predictions. As the Scottish populations are thought to be particularly vulnerable to increased warming and drought, the genetic diversity contained within these peripheral populations is deemed important enough to protect using experimental introductions. Small cow-wheat has been introduced to five sites within the Highland Perthshire Core Forest Area. Although the species has never been formally recorded at these sites, Perthshire is thought to be within the historic range of the species and supports two of the largest UK populations.

Goals

- Goal 1: Establish, by 2010, small cow-wheat at five suitable sites in order to increase the number of individuals and populations of small cow-wheat in the UK.
- Goal 2: Ensure the new populations of small cow-wheat have greater genetic diversity than the donor populations.

Small cow wheat (*Melampyrum sylvaticum*)

Kynachan - one of the re-introduction sites

Success Indicators

- Indicator 1: Continued survival of small cow-wheat at five introduction sites
- Indicator 2: Increased genetic diversity of individuals within introduced populations as compared with that of the donor populations from which seeds were translocated.

Project Summary

Feasibility: The feasibility of a successful re-introduction of small cow-wheat was assessed using detailed autecological and demographic studies and method trials by Dalrymple (2006, PhD Thesis, University of Aberdeen). Preliminary genetics work was performed by Sharp (2003, MSc Thesis, University of Edinburgh and Royal Botanic Gardens, Edinburgh). Small cow-wheat grows in mixed-canopy woodland dominated by native deciduous species. The species prefers cool, humid areas as evidenced by the close proximity to watercourses and reliance upon canopy shading to protect from drought at lowland sites with drier climates. Although an annual, small cow-wheat populations are generally stable. This is partly a result of density dependent mortality caused by poor dispersal resulting in seeds falling below the parent and germinating ***in situ***. Poor dispersal also means that successive range contractions during periods of drier weather cannot be countered by colonization into suitable habitat once conditions ameliorate. Populations are therefore isolated and genetic divergence between populations is evident. This re-introduction was undertaken to inform large-scale re-introductions in the future. We hope to determine the optimum size of a translocation and whether the combination of seeds from different source populations can bestow benefits through increased genetic diversity or whether the natural populations are now so divergent that outbreeding depression occurs when gene pools mix. For this reason the methods are scientifically rigorous but the re-introduction is relatively small-scale.

Implementation: Thirteen sites were identified that met the criteria for the broad habitat types and proximity to watercourses. The final five sites were selected based on visits to ascertain a closer habitat match and check that site accessibility was adequate. The sites are Upper Deil's Cauldron, Lower Deil's Cauldron, Carie, Kynachan and Rumbling Bridge. Three donor populations from which seed would be sourced were selected based on size as larger populations were shown to be able to tolerate seed removal without adverse demographic effects and were genetically more diverse. The donor populations represent three site types (lowland woodland, upland woodland and montane woodland fragment) within the habitat occupied by small cow-wheat in Scotland. Seeds were collected from 100 plants at each donor population in August 2005. Leaf tissue was also

collected to enable genetic monitoring of the re-introduction. Seeds were stored for a maximum of four days between collection and sowing. Three exclosures with outside measurements of 30 x 30 x 30 cm were used at each site to prevent seed removal. Seeds from 20 plants from each of populations A, B and C, were randomly selected by from each population and sown within each exclosure. The position and number of seeds in each grid square was recorded along with the population identifier and plant number.

Aberfeldy canopy - showing canopy conditions at one of the donor populations

Post-release monitoring: The monitoring program incorporates population counts at the life cycle stages needed to assess demographic trends (seed, seedling and reproducing adult populations) and assessment of genetic diversity. The combination of molecular and ecological techniques will determine if apparent reductions in fitness can be attributed to habitat conditions or genetic factors, further work could be undertaken to identify which aspect might be the cause. In 2006, 94 plants germinated and 29 survived to maturity across the five introduction sites. These totals mask differences between sites, Rumbling Bridge had particularly low germination at only 8% with Lower Deil's Cauldron next with 16% germination. None of these seedlings went on to survive to reproduction. The other sites had germination rates of 21 - 28% matching some natural populations. When viewed by donor population it suggests that population B (germination success only 13%) may be less fit or less well adapted to Perthshire conditions (population B is most distant from the re-introduction sites). Donor populations A and C have germination rates of 29% and 23% respectively suggesting they are more suitable donors.

However, in 2007 the germination patterns were reversed; germination at Rumbling Bridge and Lower Deil's Cauldron were higher than other sites. Most seedlings appeared to be from dormant seed sown in 2005 as plants emerged in locations where no plants had survived to maturity in 2006. Additionally, the theory that donor population B was less fit had to be reassessed when the cumulative germination of 2005 seed classified according to donor rose to 36%, 29% and 30% for populations A, B and C respectively. Therefore, after the effects of dormancy have been taken into account there are no discernable differences in site suitability or donor population fitness. Unfortunately, survival of plants into maturity is unexpectedly low. In 2007 adult plants numbered the following: Upper Deil's Cauldron - 3, Lower Deil's Cauldron - 2, Carie - 2, Kynachan - 1 and Rumbling Bridge - 0. According to estimates from natural populations we might expect survival rates of the order of 10 or more individuals based on seed numbers. The reasons for this decline are unknown but hopefully will be

determined in future years after supplementary re-introductions have occurred.

Major difficulties faced

Landowner cooperation was sometimes problematic. The landowners at certain sites were worried that the introduction of a rare plant and subsequent dispersal might affect how they would be able to manage their land in the future.

Major lessons learned

- Although germination rates were slightly lower then expected, it was the mortality post-germination which was surprisingly high. In future, re-introductions of small cow-wheat will have to translocate many more seeds to account for the unexpected mortality.
- Seed remained viable for longer than expected with many seeds germinating the second spring after sowing, this suggest that small cow-wheat could regenerate from a seed bank in the short term.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- It is too early to determine whether the introduced populations will survive.
- The methods have been shown to yield useful information for future introductions regardless of whether the introduced populations survive.