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Editorial

Recovering threatened plant species and their habitats: The need for integrated action

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A B S T R A C T

As an introduction to the Special Issue on the restoration of threatened plant species and their habitats, this editorial shows how the various papers in the issue address the range of *in situ* interventions involved in species population management and restoration of their habitat, together with examples of case studies implementing these actions. It stresses the need for integrating these various interventions. It highlights the importance of protected areas in providing a degree of protection for threatened species but also the need to complement this with actions at the species level to ensure the effective conservation and long term persistence of these species. It emphasizes that ecological restoration is a complement to, not a substitute for conservation, and that the balance of effort and allocation of resources between them is a key issue.

Earth is undergoing rapid and drastic anthropogenic change. The scale and extent of biodiversity loss and ecological degradation as a result of this human action is now widely recognized. We are losing biodiversity faster than it can recover and are not on course to meet many of the CBD's Aichi biodiversity targets by 2020. Unless drastic and concerted action is taken to limit the damage, the continuing impacts will, within the coming decades, begin to have a serious effect on the way we live and even our ability to survive in an acceptable and equitable manner. While there are many dimensions to this problem – political, social, scientific and technical – conservation biologists and practitioners must ensure that their strategies and actions are well designed and effective. The realization of the likely devastating consequences of human-induced climate warming change on the living world (Steffen et al., 2018) adds even more urgency to the need for action and is forcing us to recalibrate our conservation responses. Time is not on our side.

The aim of this Special Issue of *Plant Diversity* on restoration of threatened plant species and their habitats, is to highlight the need to employ active interventions, focusing on recovery of particular plant species and populations to limit ongoing species loss and on the restoration of entire ecosystems to repair the environmental degradation. The papers in this issue present methodological reviews of *in situ* interventions as a part of threatened species population management or restoration of their habitat, and examples of case studies implementing such interventions. The main audience for this special issue is *in situ* plant conservation practitioners, including area managers, conservation biologists and policy makers.

Protected areas are the first line of defence for biodiversity conservation and the underpinning of the conservation policy of most countries but as Heywood (2019) points out, despite the great expansion of such areas in recent decades, they are in many cases far from fulfilling their potential to conserve biodiversity. The reasons include inadequate coverage in terms of ecological representation and key biodiversity areas, lack of adequate maintenance and appropriate management, and failure to target the conservation needs of threatened species. But the greatest threat to protected areas is accelerated climate change in combination with other aspects of global change such as population growth and alterations to disturbance regimes. Protected areas have a limited ability to respond and adapt to such change, largely because of their essentially fixed nature. In addition, probably a majority of species do not occur in protected areas which has led to calls for the massive expansion of protected areas to cover up to 50% of the Earth's surface – the co-called Half Earth concept – although the desirability and feasibility of such an aspirational target have been challenged.

The conservation of threatened species *in situ* has proved challenging, with most countries placing too much emphasis on the ability of protected areas provide the necessary protection for such species without any targeted on the ground management or intervention. As Monks et al. (2019) demonstrate in their paper on the conservation and recovery of threatened species in south-west Australia, key elements of *in situ* management and recovery of such species are an understanding of the ecological factors that limit population persistence, and prioritising and managing threats. Heywood (2019) emphasizes that it is not so much presence in a protected area that matter as its persistence and recovery over time. A common failing in planning species recovery is the lack

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of a detailed threat assessment and just as there is a great diversity of threats, so there is a very wide range of corresponding management interventions (Albrecht and Long, 2019; Monks et al., 2019; Heywood et al., 2018), and like them, they may interact with each other, leading to unforeseen consequences. An increasingly common intervention in recovery programmes where populations are no longer viable and under imminent threat of extinction is population augmentation, a type of conservation translocation. Translocation may also be carried out to a new site within the known range and habitat of the species with the aim of establishing a new viable population (species reintroduction), and translocation of material to well outside the species known range and possibly outside its known habitat may also be attempted (species introduction). Although some of the procedures involved are shared between these different interventions, they are commonly conflated under the general term translocation which leads to confusion. Translocation is in fact a component of recovery and reintroduction and introduction programmes, not a free-standing action.

Translocations, whether for recovery, reintroduction or introduction, are complex procedures and have a poor recorded success rate so it is important that we obtain and share information about the issues involved, experiences and the likely causes of success or failure. The papers by Albrecht and Long (2019); Miandrimanana et al. (2019); Tojibaev et al. (2019); and Fenu et al. (2019), address a range of factors that affect the outcome of translocations.

Translocations may require considerable resources and are sometimes very costly. For population augmentation or for reintroductions large amounts of material may be needed in some cases. Sourcing the seed or other material used for the multiplication of individuals for translocation and restoration can be a serious bottleneck. It may be collected from the existing populations or more often from *ex situ* conservation material such as seed from gene banks or from living collections in botanic gardens. Chapman et al. (2019) discuss the response of the Millennium Seed Bank, Kew, to the demands for capturing, protecting and restoring plant diversity in the UK and give examples of how its seed collections and associated expertise have contributed to *in situ* species reintroduction and habitat restoration projects.

When the quantities required for translocation are high – in some cases tens of thousands – and when outplants need to be raised from the seed, or if vegetative propagules have to be multiplied, nurseries are needed for this purpose. The quantities needed may exceed the capacity of botanic gardens to grow on such material, and dedicated conservation nurseries are needed. For example, the Native Plant Biodiversity Conservation Nurseries in North Caicos and in Providenciales (Dani Sanchez et al., 2019), and the horticultural expertise acquired by them over the years in growing native plants were crucial to the successful rescue of the Caicos pine *Pinus caribaea* var. *bahamensis*.

Repairing the damage to devastated ecosystems and landscapes through various forms of ecological restoration is now recognized as an essential component of biodiversity conservation. It is highly multidisciplinary and enormously challenging and covers a wide variety of aims and approaches (CBD, 2016; Palmer et al., 2016; Aronson et al., 2017). It requires clear targets, goals, and objectives; and decisions on what target state to aim for, what methods to use, which species to use, how many and so on. Shaw (2019) discusses key factors for increasing the diversity of threatened tree species in the restoration of the *Araucaria* forest ecosystem in southern Brazil.

Volis (2019) proposes a novel approach which he calls 'conservation-orientated restoration' which involves the introduction of threatened species, especially those without undisturbed reference habitats and belonging to important functional types, into multiple suitable habitats of different degree of disturbance both inside and outside their known range. Such introduction of carefully chosen threatened species can simultaneously fulfil two tasks: increase chances of global survival for imperilled species, and help to restore a disturbed ecosystem to which the plants are introduced.

Rapidly changing climatic conditions and extreme weather events add another dimension to the challenges of restoration. As Falk (2018) states, 'Climate change is a game-changer for ecological restoration. We are having to restore into a world that does not yet exist' (see also Falk, 2017).

In view of the growing momentum for restoration, such as the commitments under the Bonn Challenge to bring over 160 million hectares of degraded land under restoration (Besseau et al., 2018), another aspect that will have to be addressed is the scaling up of our efforts as required by many of the vast restoration projects being developed or planned (Aronson et al., 2017). It will require solutions to the many technological, economic and social problems involved and need an enormous financial investment (Lamb, 2018). Given that ecological restoration is a complement to, not a substitute for conservation, the balance of effort and allocation of resources between the two approaches must be kept under review, leading to difficult choices as Heywood (2019) comments.

Conflicts of interest

The author declares no conflict of interest.

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