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COMMENTARY

Elucidating biological opportunities and constraints on assisted colonization

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Abstract

Assisted colonization is a proposed climate change adaptation strategy. Martin-Alcón et al. (*Applied Vegetation Science*, this issue) report an experiment to evaluate the efficacy of assisted colonization and identify *thermal distance* as a critical consideration. By extension, we should consider the role that *ecological distance* and *socio-political distance* play within any plan to reduce extinction risk through assisted colonization.

Testing the idea of assisting species placed at risk of extinction as a consequence of climate change has become a focal area of study over the past decade (McLachlan et al. 2007; Fig. 1). Up to this point, however, there has been a paucity of empirical work on the subject. Very few studies in this growing literature are empirical tests of the outcomes of assisted colonization experiments. Just three papers in the first 5 yr of this literature represent empirical tests of the idea (Valle-Diaz et al. 2009; Willis et al. 2009; Keel et al. 2011).

This research by Martin-Alcón et al. (2016) takes a step toward filling this void in empirical experimentation. Using two provenances, four species, open and closed forests at three elevations, they report on a 3-yr experiment examining early survival and growth for oak trees in the Iberian Peninsula. These are the kinds of experiments that are difficult and fraught with uncertainty generated by experimental peculiarities, but necessary to generate the understanding of species tolerances needed to predict the consequences of assisted migration actions. By choosing to focus on a critical life history stage for trees, the regeneration niche, they provide results that are highly useful and informative to vegetation scientists interested in learning more from provenance experiments that consider climate change adaptation strategies.

Martin-Alcón et al. (2016) found high survival across most of their trials and strong correlates of extreme cold events to explain failure. They conclude by recommending managing risk of planting failure through consideration of 'thermal migration distance', focusing on extreme weather events, rather than mean temperature and precipitation envelopes. Taking this approach envisions the risk of transplant failure. This is solid advice that emerges from these careful experiments. However, this is also an idea that is likely to generalize to most species in most systems: extreme weather events are critical to understanding survivorship and mortality. This is part of what makes this sort of experimental work both critical and difficult. Restoration ecologists are beginning to highlight the variance of outcomes one can achieve based on nuanced effects such as spatial aggregation of planted individuals (Porensky et al. 2012). Our collective experience tells us that transplanting plants into new locations fails more than it succeeds (Dalrymple et al. 2012; Guerrant 2012). Maximizing the chance of success through careful consideration of factors influencing establishment is critical to our gains in understanding.

The critical innovation of prioritizing extreme weather events as driving thermal migration distances leads to a set of corollary ideas to manage risk associated with introductions. For example, Ricciardi & Simberloff (2009) highlight the risk of assisted migration in creating weeds. This threat should be a priority consideration prior to any action. Ecological distance, however, is also useful in considering the risk of creating unwanted weed issues through assisted migration. Translocation across climatic zones that minimizes ecological distance should minimize ecological novelty of interactions and reduce the risk of introduced species becoming pest species. Similarly, sharp biogeographic breaks and dispersal barriers should provide warning signals for the potential of surprise unwanted responses of species translocated outside of native distributions.

A third, and critical vector of risk that remains unaddressed in the work of Martin-Alcón et al. (2016) is that of social acceptance. Early work in assisted migration has highlighted the outcome that society may or may not accept an assisted migration action as a socially acceptable management solution to a conservation challenge (Schwartz et al. 2012). In fact, scientists appear divided on the efficacy of assisted migration and seem to favour a high standard of evidence for direct extinction threat prior to

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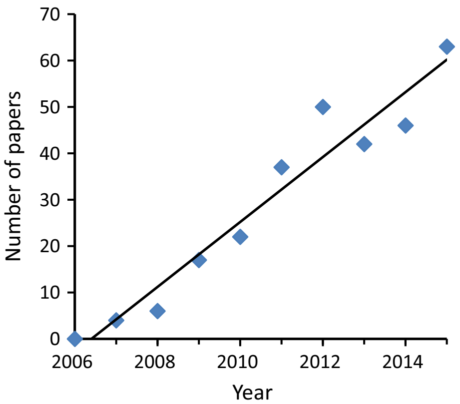

Fig. 1. The number of peer reviewed papers returned from an ISI Web of Science search of the terms ('assisted migration' or 'assisted colonization' or 'managed relocation') and ('biodiversity' or 'conservation' or 'species') and 'climate change.' Search performed on 16 Feb 2016. $r^2 = 0.94$.

engaging in this as a management strategy (Javeline et al. 2015). Yet, individuals and groups continue with *ad hoc*, unsanctioned trials (e.g. www.TorreyaGuardians.org), most of which we never hear about.

Natural resource management is conducted within a socio-political context in which people often diverge in concern for local natural values (Richardson et al. 2009). Climate change adaptation strategies such as assisted migration challenge our sense of the natural and present challenges for public policy (Hewitt et al. 2011). These challenges become an issue with respect to moving species across governmental jurisdictions, onto or off different land ownership, and into or out of ecosystems with local constituencies that place differential value on the integrity of the ecosystem with respect to bringing in previously unknown species.

Assisted colonization thus creates three distinct challenges: (1) understanding the biology of potential management actions; (2) evaluating the biological risks associated with management action; and (3) negotiating the social discord that is likely generated by most translocation proposals. If prevailing opinion on the impact of climate change on biodiversity is correct (Javeline et al. 2015), then society faces tragic choices, balancing extinction risk reduction against the risk of creating an invasive species problem and the certainty of reducing our sense of the natural. Getting out ahead of the issue through maturing our biological understanding through carefully controlled experiments such as those described by Martin-Alcón et al. (2016) is critical.

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