The importance of experimentation in translocation research

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The field of reintroduction biology is evolving into a rigorous, clearly defined scientific endeavour (Seddon, Armstrong and Maloney, 2007). Indeed, the IUCN Species Survival Commission's Reintroduction Specialist Group has evolved into the Conservation Translocation Specialist Group to better reflect the diversity of human-driven animal movements. Reflecting this move towards an improved scientific basis for translocation science, Lloyd, Hostetter, Jackson *et al.* (2019) have produced an excellent experimental assessment of how coexisting alongside wild conspecifics can improve the survivorship of the endangered Vancouver Island marmot *Marmota vancouverensis* when they ultimately found new populations. Conducting experimentation as part of translocations is incredibly challenging due to the small sample (population) sizes often used, the limited number of replicated sites that can be used, the difficulty in finding control sites, the challenges of working at an appropriate scale for the results to be relevant more broadly, and the limited funding available that is often directed to the translocation process rather than monitoring and research. Despite these hurdles, Lloyd *et al.* (2019) illustrate how such experimentation is possible, and how valuable it is.

Some interesting results leap out. Lloyd *et al.* (2019) find that translocating captive-bred marmots to sites where they coexist with wild-born marmots before founding new populations yields much higher population establishment and growth potential. This knowledge is obviously important because of the historical low success rate of translocations relying on captive-bred animals (Fischer and Lindenmayer, 2000, Griffith, Scott, Carpenter *et al.*, 1989). We have known for some time that captive-bred individuals of some species can be bonded with wild individuals. For example, the African wild dog *Lycaon pictus* metapopulation managers in South Africa often successfully infuse captive-bred individuals with wild-born individuals in soft release enclosures so that the former become adept at surviving in the wild (Davies-Mostert, Mills and Macdonald, 2009, Davies-Mostert, Mills and Macdonald, 2015, Somers, Becker, Druce *et al.*, 2016). Indeed, this leads on to consideration of additional experiments that could occur – for example, could an alternative to translocating captive-bred animals into the wild and then on to new sites (i.e., the stepping-stone approach) be simplified using a single wild-born animal to train captive-bred animals before release in a pre-release enclosure?

The inter-annual variation in survivorship (Fig. 4 in Lloyd *et al.*, 2019) intimates some interesting behavioural ecology of marmots, and perhaps other reintroduced populations. The initial increase in survivorship may suggest a period of learning occurred as marmots discovered better habitats upon release, but the decline thereafter may suggest competition began occurring as densities increased or that predators learnt to target this increasingly abundant resource. Lots more research opportunities!

The stepping-stone approach described by Lloyd *et al.* (2019) requires confidence that the captive-bred animals that are translocated to sites alongside wild-born individuals can be readily re-trapped. For some species, this is reasonable to conclude, but other trap-averse species may never return to traps or even the site of initial capture, and hence may be very challenging to use with the stepping-stone approach. The stepping-stone approach may be more species-specific than ubiquitous because of this. It is also worth considering that the concept of 'stepping-stone' translocations could also be considered a hardening off period as part of a more robust, soft release.

I also wonder how many of the marmots at the stepping stone sites died. Assuming marmots are limited by burrows, hibernacula and/or food, the population at Mt Washington may well have been at carrying capacity. Adding 77 translocated captive-bred marmots, while only taking 52 out of this population to the 12 Strathcona Provincial Park release sites, may well have exceeded the carrying capacity at Mt Washington. Lloyd *et al.* (2019) acknowledge this point, but clearly monitoring animals at the stepping-stone site seems an important element of future studies to ensure established and secure populations are not impacted by such conservation activities. For the stepping-stone approach to work, the population size and carrying capacity of stepping-stone recipient sites should be known before the translocation begins and be monitored throughout the project.

Finally, it is heartening to see the intensive and costly efforts going towards restoring the full suite of wildlife species to Vancouver Island. Such intensive conservation activities are not ubiquitous around the world, but are becoming more and more important as the Anthropocene progresses and humanity's impact on biodiversity increases. More of these experimental translocations are necessary, and the involvement of zoos is often integral to this, as it was in this project.

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