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# Distinguishing reintroduction from recolonization with genetic testing

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A B S T R A C T

Reintroductions are a common tool for restoring lost biodiversity around the globe and across taxa. The decision to pursue a reintroduction is often based upon the success of past efforts, yet in most cases the assumption that resulting populations are the products of recolonization, is not tested. By collecting data from source populations, reintroduced populations, and natural populations adjacent to reintroductions, it is possible to evaluate the success of past reintroduction events and these data may be used to guide future conservation initiatives. We used the fisher (*Pekania pennanti*), one of North America's most commonly reintroduced species, as a model to conduct an evaluation of reintroduction success. We genotyped 147 individuals at 15 microsatellite loci to determine the genetic contribution of reintroduced individuals to an ostensibly successfully reintroduced population in central Alberta, Canada. Principle component analysis and Bayesian statistical methods converged with confidence on one result: assayed individuals were descended from adjacent native Albertan populations, not putative founders from eastern Canada. A review of fisher reintroduction literature reveals similar patterns: a large proportion of contemporary individuals appear to be the result of recolonization events. Our study has broad implications for conservation as it may imply a 1) over-confidence in past reintroductions, which might lead to significant expenditure of financial and human capital on future initiatives of modest, if any, benefit, and 2) underestimation of some species' ability to disperse and (re-)colonize, highlighting limits to our understanding of functional connectivity. Obtaining appropriate genetic samples in relation to reintroductions will help determine when future reintroduction is likely to be the best conservation initiative.

## 1. Introduction

Reintroduction – the attempt to re-establish a species in part of its indigenous range (Pavlik, 1996; IUCN, 1998; IUCN/SSC, 2013) – remains a popular management method in conservation biology after a century of use (Hayward and Somers, 2009; Seddon et al., 2014). Considerable contemplation is given to reintroductions as a conservation tool across taxa: in 2016, the Species Survival Commission Reintroduction Specialist Group of the World Conservation Union (IUCN) highlighted 52 on-going case studies encompassing invertebrates, fish, amphibians, reptiles, birds, mammals, and plants (Soorae, 2016). The number of reintroductions being conducted each year is increasing (Seddon et al., 2007), reflecting the conservation community's growing confidence in the strategy compared to other management options. Successful reintroductions are loosely defined as 'establishment of a self-sustaining population' (Seddon, 1999; but see Beck et al., 1994; Sarrazin and Barbault, 1996) and are most commonly undertaken in North America, Australia, and New Zealand (Fischer and Lindenmayer, 2000). Often less empirical examination is given to the real probability for natural recolonization. Many reintroductions are performed in systems perceived to be highly isolated; however, natural recolonization is possible in many areas that demonstrate some form of contemporary, or importantly future, functional connectivity to adjacent populations (Kareiva et al., 1990). With both landscape and climate change altering the occurrence and distribution of biodiversity (Maxwell et al., 2016) the possibility of natural recolonization should be prioritized for many mobile species (Rout et al., 2013).

Context about the dynamics of reintroduced populations may be gleaned from the invasion biology literature. Species invasions and reintroductions are characterized by initiation and expansion stages

*Abbreviations:* CLM, Cooking Lake Moraine; WW, Willmore Wilderness; NA, Northern Alberta; MB, Manitoba; ON, Ontario

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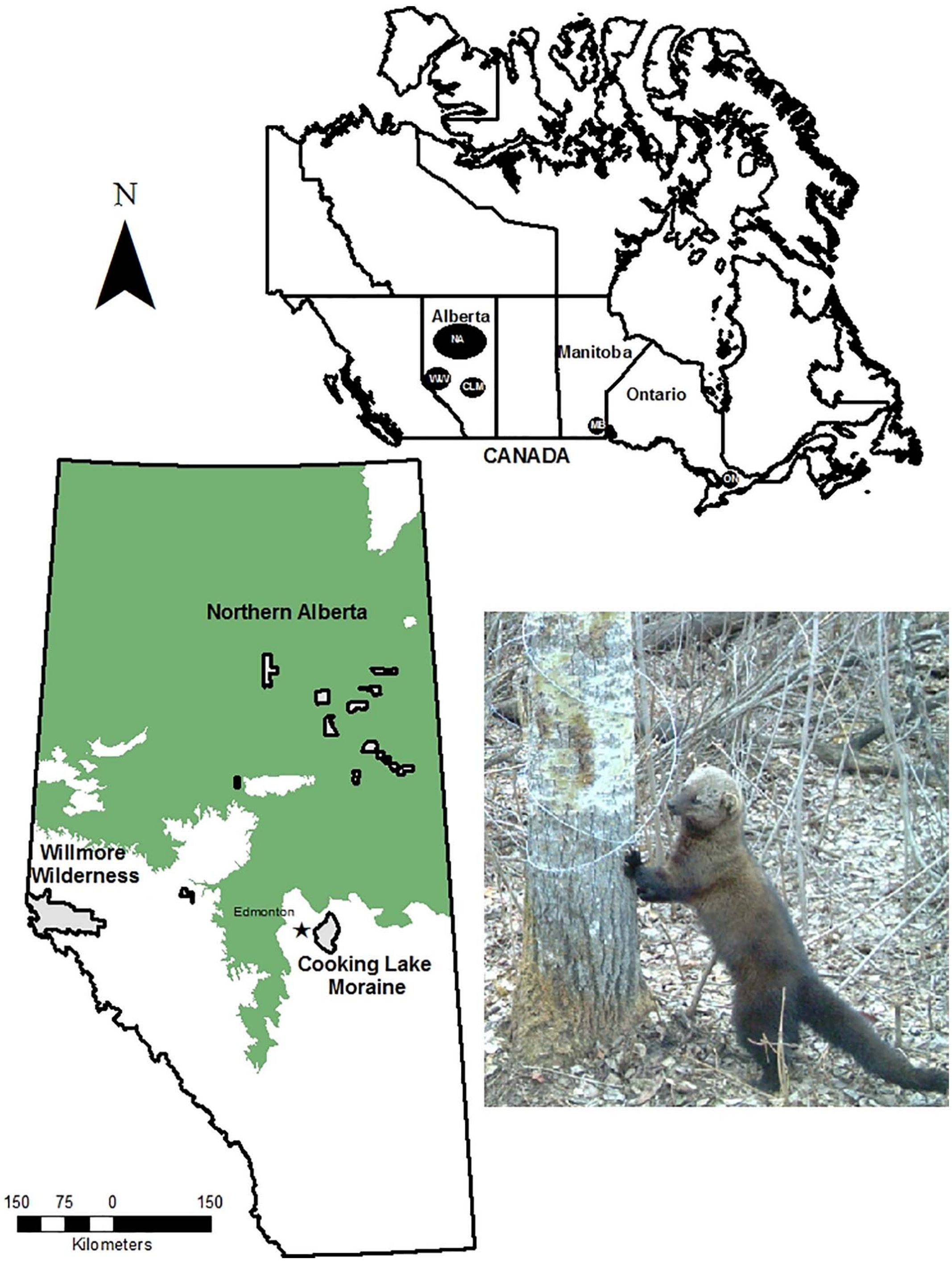


**Fig. 1.** Fisher DNA samples were collected from 64 sample sites across Alberta's Cooking Lake Moraine (CLM) and compared to four candidate source populations; two adjacent populations in Alberta (Willmore Wilderness in the Rocky Mountains and scattered trap lines throughout northern Alberta) and reintroduction source populations (Manitoba and Ontario) to assess the success of a 1990/1992 fisher reintroduction. Alberta's boreal forest is highlighted in green and a fisher is depicted at a CLM sample site. CLM = Cooking Lake Moraine, NA = northern Alberta, WW = Willmore Wilderness, MB = Manitoba, ON = Ontario. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

prior to establishment (Shigesada and Kawasaki, 1997; Armstrong and Seddon, 2007). Invasive (or exotic) species rarely establish following a single introduction (Shigesada and Kawasaki, 1997). In reintroductions, the probability of establishment can be greatly increased with planning and depends on a suite of limiting factors such as habitat availability and quality, predation, parasitism, and duration in captivity (Seddon et al., 2014). Invasion biology recognizes the 'Tens Rule' where 10% of introduced species establish and a further 10% of these spread (Jeschke and Strayer, 2005). Reintroduction biology recognizes that roughly 20% of reintroductions have been self-described as "successful" (Griffith et al., 1989; Seddon et al., 2014); when compared to the Tens Rule, one might expect this rate may be overestimated and question why more conservation efforts are not being spent on determining the best alternative action.

"Success" is a contested term in reintroduction biology. Definitions vary with project objectives, life history of the species, and the temporal scale of observation (Griffith et al., 1989; Beck et al., 1994; Sarrazin and Barbault, 1996; Seddon, 1999; Haskins, 2015; Robert et al., 2015). The