Covert rewilding: Modelling the detection of an unofficial translocation of Tasmanian devils to the Australian mainland

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Abstract
Covert rewilding is the secret and illegal translocation of species in the pursuit of conservation objectives. Recent history contains multiple covert rewilding events, frequently occurring after official permission was denied. In order to better understand the phenomenon, I formulate covert rewilding as an optimisation problem, with the goal of creating a population that is too large to be eradicated once it is detected. I then consider a hypothetical covert rewilding of Tasmanian devils Sarcophilus harrisii to the Australian mainland. Three different release locations would allow a covert devil population to remain undetected for years, by which time its size and distribution may preclude eradication. Optimal release locations also represent optimal locations for official surveillance, but a more effective approach to halting covert rewilding could be a more permissive stance towards legal rewilding.

KEYWORDS
conservation translocations, decision science, ecoterrorism, reintroduction biology, Tasmanian devils

1 INTRODUCTION

The overwhelming majority of individuals and organisations in biodiversity conservation operate strictly within the law; few consider breaking it. Traditionally, illegal conservation actions have been limited to nonviolent direct action, such as blockades and trespass (Leader & Probst 2010; Welchman, 2010). More extreme examples exist, however, including Sea Shepherd and Earth Liberation Front (involved in piracy and arson, respectively; Welchman, 2010). Illegal conservation actors – guerrilla conservationists – represent an extreme fringe, and their actions are generally condemned by mainstream actors as counterproductive. Nevertheless, guerrilla conservation is a serious issue, costing millions of dollars of damage every year across the United States alone (Jarboe, 2002).

To understand guerrilla conservation, it is important to distinguish it from other forms of illegal conduct. Unlike criminal behaviour, guerrilla conservation is philosophically motivated, and justified by altruistic arguments. In The Justification of Civil Disobedience (Rawls, 1969), John Rawls maintains that, even in a representative democracy, individuals can properly oppose legally established authority where majoritarian institutions deny justice to
a minority. Guerrilla conservation interprets civil disobedience theory from a biocentric ethical position: the environment and species have intrinsic rights (Dion, 2010), and extinction is the result of society’s systematic failure to protect those rights. Species conservation goals can thus be illegally pursued once legal avenues have been exhausted (Vanderheiden, 2016; Welchman, 2010).

Guerrilla conservation has traditionally focused on hindering the operation of natural resource industries (e.g., logging or whaling), but the popularisation of rewilding in conservation has created a new opportunity – ‘covert rewilding’. In this paper, rewilding refers to the reintroduction of extirpated native species to an ecosystem (Lorimer et al., 2015). Rewilding is ‘covert’ when it is undertaken without official sanction. Covert rewilding offers two primary attractions to guerrilla conservationists. First, species reintroduction uses natural ecological processes to return ecosystems towards their pre-industrial states (Lorimer et al., 2015). This aligns with the ‘deep ecology’ philosophy held by many guerrilla conservationists (Leader & Probst 2010). Second, because they lack numbers and resources, guerrilla conservationists are drawn to asymmetric engagements (limited actions that generate disproportionate impacts) such as tree-spiking. Covert rewilding requires minimal resources, because founder individuals may be sourced from wild populations. The hope is that natural population growth rates will then amplify small guerrilla actions into large impacts.

Although it has not attracted much attention in the conservation literature, covert rewilding has occurred repeatedly. In the United Kingdom, beavers (Castor fiber) were discovered in the Tay river catchment, after an official application to reintroduce the species was resisted by government and farmers (Gaywood, 2018). Although its provenance is not known with certainty, multiple sources believe it to be the result of covert rewilding by ‘beaver bombers’ (Werth, 2014). This is not the only covert rewilding of beavers: the Otter river population in Scotland may also be a covert rewilding (BBC 2015), and guerrilla actors released more than 100 beavers across two Belgian locations over 3 years (Verbeylen, 2003). Guerrilla conservationists have also covertly translocated populations of polecats (Mustela putorius) to Scotland (Solow, Kitchener, Roberts, & Birks, 2006), without authorisation and without being detected. Tasmanian devils (Sarcophilus harrisii) were covertly released onto Badger Island in the Australian Bass Strait in 1996 by unknown actors, where their abundance rapidly increased (DPIPWE 2011). Lynx (Lynx lynx) have been covertly released at multiple central European locations, sometimes in parallel with official reintroductions (Linnell, Breitenmoser, Breitenmoser-Wursten, Odden, & Arx, von, 2009). Conclusive evidence is hard to obtain – for obvious reasons – but the return of wild boar (Sus scrofa), goshawk (Accipiter gentilis) and eagle owls (Bubo bubo) to Britain are also suspected covert rewildings (Jones, Gow, Jones, & Campbell-Palmer, 2013).

The aim of covert rewilding is to illegally re-establish a population of an extirpated native species. Legal translocations fail for many reasons (Short, 2009), but covert rewilding faces an additional challenge – the possibility that the illegal population will be removed if discovered at an early stage, when its distribution and abundance are limited. Eradication of the Tayside beavers was seriously considered, and the Badger Island population of devils was removed to the Tasmanian mainland by the state government in 2007. A key goal of a covert rewilding is therefore to establish a population that, by the time it is discovered, is too large to eradicate. To achieve this, guerrilla conservationists could choose their introduction location to maximise growth and spread rates, and to minimise the probability of detection. Conversely, if authorities wish to halt a covert rewilding before it can expand beyond their ability to eradicate it, they must identify and surveil the most attractive covert release locations.

In this paper, I apply spatial modelling and decision science to covert rewilding, using the reintroduction of Tasmanian devils to the Australian mainland as an illustrative case study. My goal is not to advocate for or against covert rewilding, either of Tasmanian devils or more generally. Instead, I hope to offer insights into the overall feasibility of the action, and to answer questions about how a covert rewilding might proceed, from decisions about the initial introduction through to the covert population’s eventual discovery. Both proponents and opponents of covert rewilding will need to know, for example, how long it might take for a covert population to be discovered, and whether it would still be small enough for eradication to be attempted. Optimal locations also need to be identified, either as targets for surveillance or covert releases. Covert rewildings are likely to continue; a quantitative approach to these questions will offer a clearer understanding of previous and future incidents.

2 | METHODS

2.1 | Tasmanian devil case study

Tasmanian devils are the largest extant marsupial predator, a cryptic, nocturnal dasyurid with a clearly identifiable appearance and distinctive vocalisation. They are generalist predators and scavengers, found across a wide range of woodland and forest ecosystems. In the past three decades, their once-robust population has been devastated by Devil Facial Tumour Disease (DFTD), an infectious
cancer that is rapidly spreading across the species' range. Translocations to disease-free areas are the only management action that have demonstrably benefited the species' population viability (Woods et al., 2018).

There are many reasons why guerrilla conservation actors might attempt a covert devil rewilding. The species was found on the Australian mainland as recently as 3,000 years ago, and the potential ecosystem benefits of reintroduction have been discussed extensively by scientists and the public (Baker, Bode, & McCarthy, 2016; Ham, 2016; Hunter, Britz, Jones, & Letnic, 2015). Although there is community enthusiasm for a devil rewilding, the Tasmanian government has previously indicated that it does not support mainland translocations (Ham, 2016). Translocation advocates claim that the expected benefits will extend beyond the threatened devils into the wider ecosystem (Ham, 2016). Advocates also discount the arguments of opponents – both scientists and the public – who raise the potential risk of predation on threatened mainland fauna (Hunter et al., 2015), and the harm caused by removing healthy devils from the threatened Tasmanian population (Ham, 2016).

Devils are easy to catch in traps, and the species has proven to be tolerant of captivity, transport, and hard-release. The Badger Island population, for example, was trapped from wild populations, and then successfully hard-released following ferry and plane journeys (DPIPWE 2011). Devils have been released outside the main island on multiple occasions over the past century. This includes the covert translocation to Badger Island and an official translocation to Maria Island (DPIPWE 2011). It also includes three individuals of unknown provenance that have been found on the mainland, which had survived for unknown (possibly short) durations (White & Austin 2017).

2.2 Spatial population and detection model

I simulated the progress of covert rewilding actions using an age-structured spatial population model, and estimated time-to-discovery with a passive detection process. This model was adapted from a population viability analysis undertaken to support the translocation of devils to Maria Island (CBSG 2008), with additional parameter estimates from the published literature. Suitable habitat for devils on the mainland was divided into 10 × 10 km cells. The potential abundance in each cell was calculated using a habitat suitability model (Hunter et al., 2015), and the amount and type of intact vegetation (DOEE 2018). Population dynamics within each cell were based on a Leslie matrix model and nearest-neighbour dispersal. The model’s primary outputs are the abundance of devils in each cell at each time, and the total occupied area. See Supporting Information for full model details.

Rewilding involved the hard-release of 40 devils per location, the approximate number released on Maria Island. Once the covert population began to grow, a countdown to detection started. Given the species’ characteristic appearance, it might seem unlikely that a devil population on the Australian mainland could remain undetected for long, but cryptic and nocturnal animals often persist undetected alongside humans: Gilbert’s potoroo, for example, was believed extinct for two decades, despite a population being located 20 km from the Australian city of Albany. Similarly, the government was officially unaware of the reintroduction of beavers to Scotland for 7 years (Gaywood, 2018), despite the species’ recognisable appearance and penchant for flooding watercourses.

The annual probability of detection was a function of the road network and the presence of towns. A high density of roads makes detection more probable because many devil sightings are reported by motorists, often while they are scavenging roadkill (Driessen & Hocking 1992). I assumed that detection was inevitable once the spreading population arrived within 40 km of a town. The population could also be detected in any occupied cell with a constant background probability of 2.5% per year, to model chance encounters between devils and humans (e.g. hikers). The expected time until first detection depends on the location of the initial release, and on the direction and rate of spread thereafter.

The fundamental objective of a covert rewilding is to ensure that by the time the introduced population is reported, its abundance and distribution will be large enough to preclude eradication. The most obvious formulation of the objective is therefore to maximise the areal extent of the introduced population at the expected time of discovery. The objective could also be based on devil abundance, but abundance and distribution are correlated because the population spreads as it grows. Spread and detection vary considerably in space, and I therefore simulated spread and detection following a release from each cell in the landscape.

Spatial population modelling is complex and uncertain (Conlisk et al., 2013). Predictions are based on demographic and dispersal parameters that are difficult to directly measure and which vary in space, and ecological processes that propagate and magnify parameter uncertainties (growth and spread in particular; Wiegand, Revilla, & Knauer, 2004). Ecological conditions differ considerably between Tasmania and the Australian mainland, in ways that are likely to impact devil population dynamics. I therefore calculated the sensitivity of the baseline model to variation in several assumptions. First, mortal-
FIGURE 1 Covert rewilding timelines from two locations with suitable habitat, for the baseline parameter set. Each panel displays two critical factors in a covert rewilding: the decreasing probability of remaining undetected in blue, and the increasing population in orange. The population line is solid until the expected (i.e. average) detection time, and dotted afterwards. Panel a shows a release location in Wollemi National Park (32.8°S, 150.6°E). Discovery is expected after 20 years, by which time the population numbers 850. The timeline is divided into three periods: (I) The population expands undetected, far from major roads and populations. (II) Once the population expands into the road network north of the National Park, it becomes increasingly likely that the population will be noticed. (III) Once it approaches towns, detection becomes inevitable. (b) An optimal release location within Alpine National Park (37.1°S, 148.0°E). The population is expected to be discovered after 26 years numbering approximately 2,200, but before it approaches towns (note the abrupt change in detection probability after 25 years). See Supporting Information for this figure under a range of different parameter assumptions

ity rates may be increased by interactions with wild dogs, dingoes, and foxes. Second, population densities may be lower on the mainland as a result of lower prey and carrion availability. Third, background rates of detection could be higher than estimated. I therefore repeated the simulations with mortality rates that were 20% higher in all age classes, carrying capacities that were 25% lower, and background detection that was three times higher than the baseline values. Fourth, I considered the possibility of multiple simultaneous releases, rather than a single release location. Fifth, because covert rewilding may not be able to source as many individuals as an official translocation, I modelled the demographic consequences of different founder population sizes. Finally, spread rates may be different for a mainland translocation, and I therefore modelled detection using higher and lower dispersal parameter values.

3 | RESULTS

Roads and towns were common in mainland habitats that was suitable for devils, and almost all ecologically suitable release locations led to rapid detection. Figure 1 shows simulated timelines following two example covert releases. Initially, the devil population grew and spread slowly, and its probability of detection remained small. However, the species soon moved into grid cells with minor roads, then major roads, and finally a town. The probability of detection increased substantially with each event. Detection was expected in 20 years, and inevitable within 30 years.

Figure 2 shows the occupied area at the expected time-to-discovery, calculated for all release locations. A long delay did not imply a good location, because covert releases into marginal habitat resulted in slow population growth and expansion, which delayed detection but delivered small and restricted populations at the point of discovery. Nor did the best covert location maximise the population growth rate (the goal of an official rewilding project), because this could be coincident with rapid discovery. Instead, covert objectives were maximised by releases in three remote locations: two in Victoria’s Alpine National Park (NP), and one in Wollemi NP in New South Wales. These areas displayed the best combination of suitable habitat, rapid spread rates, and low detectability.

Figure 1b shows the population and detection dynamics following a release in Alpine NP. The model expects discovery to occur after 26 years, by which time the devil population would number 2,200 individuals, spread across 2,800 km². An earlier detection could easily occur, but the model estimates that there is a 95% chance that the population will remain undetected for at least 6 years (reaching 100 individuals spread across 700 km²); there is an 80% chance that the population will remain undetected for at least 22 years (1,200 individuals across 2,400 km²).
FIGURE 2 Performance of all possible Tasmanian devil covert rewilding locations in south eastern Australia, for the baseline parameter set. Map colours denote the expected distribution of the covert population at the time it is discovered (see colour bar). For example the model predicts that a covert rewilding beginning in Alpine National Park in Victoria (denoted ‘A’) will cover 2,800 km$^2$ by the time it is discovered. The two other optimal covert rewilding locations are behind Mount Tambo Conservation Reserve (‘T’) in Victoria, and in Wollemi National Park in New South Wales (‘W’). Inset panel shows the expected time before discovery (x-axis) and expected distribution upon discovery (y-axis) for each release location on the map. See Supporting Information for this figure under a range of different parameter assumptions.

Variation in the baseline parameters had an effect on the expected time to discovery, reducing or increasing it by as much as 6 years (30%); it did not change the optimal release locations. Its most noticeable effect was on the abundance of devils at the time of discovery. Covert rewilding became more challenging (i.e., detection was more rapid and abundances lower) when mortality rates were high, carrying capacity was low, background detection was more likely, and dispersal rates were high. Under pessimistic parameter values, the model predicted discovery of a population of 100 devils after 26 years. Multiple release locations made a covert rewilding more difficult, with additional populations increasing the probability of discovery. Smaller founder sizes led to longer delays before discovery, but smaller devil populations (see Supporting Information for the full sensitivity results).

4 | DISCUSSION

Conservation rewilding is broadly acknowledged to be both ambitious and risky (Lorimer et al., 2015). In most countries, jurisdiction over threatened species, and therefore the decision about whether to proceed with rewilding, rests with public servants in regulatory agencies. These decision makers are generally risk-averse (Pfeifer 2011), and anecdotal evidence suggests that applications for official rewilding are typically unsuccessful. Given these fundamentals, it is unsurprising that there are already multiple examples of covert rewilding; based on the results presented here, it is also unsurprising that some of those actions have been successful.

For Tasmanian devils, this model suggests that a covert rewilding of the Australian mainland could achieve its primary goals. In some release locations, two decades could pass before discovery, by which point a removal attempt would be expensive and challenging (both logistically and politically). As a point of comparison, the cost of removing 63 devils from the 180 km$^2$ Forestier Peninsula was estimated at AUD $676,000 (Rout, Baker, Huxtable, & Wintle, 2018). Presented with a fait accompli, and with a large and viable population of an endangered species in an inaccessible landscape, removal might not even be attempted. However, this success is predicated on the devils finding suitable conditions on the mainland. Under more challenging conditions, even a successful covert translocation would remain small in number, making removal achievable.

Although the baseline parameter estimates in the model were based on published research, and reproduced the dynamics of the Maria Island translocation, they all still
contain a high degree of uncertainty. Accurate habitat suitability models in particular are crucial for spatial population model predictions (Brichieri-Colombi & Moehrenschlager 2016), but translocated species can exhibit unexpected habitat associations (Wright, Eberhard, Hobson, Avery, &Russello, 2010). The detectability model assumed a passive survey process that focused on roads and towns, but human activities vary across the modelled landscape according to recreational and economic activities in ways that were not captured by this model. Moreover, if authorities suspect that a covert rewilding is underway, then active survey effort would elevate and alter detectability. The dispersal model is central to the predictions, yet its parameterisation is very uncertain. Individual devils have been documented moving long distances (>50 km) following translocations; if this rate of movement were ongoing, detection would be much more rapid than modelled here. The sensitivity analyses reported in the Supporting Information capture some of these uncertainties, but their main message is one of caution. The discovery timelines predicted by this model should be treated as informed guesses, not precise predictions.

One rational response to the risks of covert rewilding is additional regulation and enforcement, but this might not dissuade guerrilla conservationists. First, prosecutions may not occur: even when actors are apprehended, very few cases involving the illegal movement of wildlife in Australia lead to convictions (Alacs & Georges 2008). None followed the release of beavers or polecats into Scotland, or devils onto Badger Island. Second, punishment may not dissuade guerrilla actors. The maximum penalty for illegally translocating foxes to Tasmania, for example, was only AUD $1,000 (Saunders et al., 2006). Heavier penalties have not proven to be effective deterrents in other contexts – tree-spiking carries a maximum 40-year prison sentence in the United States.

It is therefore worth considering whether the clear and present risks of covert rewilding might be best reduced by a more permissive attitude towards official rewilding. Covert rewildings are typically preceded by unsuccessful attempts to secure official permission (Ham, 2016; Jones et al., 2013; Werth, 2014), and successive rejections of official applications could therefore be a prelude to unofficial releases. To quote a British beaver conservationist: “If we don’t do an official reintroduction, it’ll happen anyway” (Werth, 2014). There are good reasons to prefer official to covert rewildings, where the well-documented risks involved in any translocation (Ricciardi & Simberloff 2009) are compounded by limited means, and an absence of peer-review, scientific planning or oversight. In past covert rewildings, poor risk management has led to failures – often with tragic consequences for individual animals and the donor population (Linnell et al., 2009; Verbeylen, 2003) – or with the covert population being removed (DPIPWE 2011). Moreover, illegal origins can undermine public support for a population once it is discovered, and for subsequent official rewildings (Linnell et al., 2009).

The results of this paper suggest that a covert translocation of Tasmanian devils to the mainland could occur. The results could also be interpreted retrospectively. Figure 1 suggests that, if such a covert rewilding has already occurred, its existence might not yet be common knowledge – a population of devils could already be spreading across the Australian Alps. More broadly, if the lengthy detection lags predicted by this model are any indication, then the world’s ecosystems may already contain a number of successful, expanding and yet-undetected covert rewildings.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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