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Soft-Release, but Not Cool Winter Temperatures, Reduces Post-Translocation Dispersal of Jewelled Geckos

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Abstract.—Translocations are an important conservation tool, but many are unsuccessful. Soft-release translocations involve holding animals on site for a period prior to release, whereas hard-release translocations involve immediate release of animals into a new environment. Evaluating the relative impacts of hard and soft release on site fidelity of released individuals can be informative, especially when comparing between translocated and resident animals. We monitored the movement, dispersal, and home range of both translocated (hard and soft released) and resident Jewelled Geckos (*Naultinus gemmeus*) for three weeks during winter using radiotelemetry. We also monitored a hard-released group during summer and incorporated data from a previously published soft- versus hard-release translocation of Jewelled Geckos undertaken in spring. In winter, soft-released geckos dispersed less than hard-released geckos and both soft-released and resident geckos had significantly smaller home ranges than those hard released. Further, area occupied by soft-released geckos remained constant during the tracking period but increased 20-fold for hard-released geckos. Mean dispersal distances were not influenced by season or the amount of time in an enclosure prior to soft release (i.e., four months yielded similar results to nine months). Translocations employing a soft-release strategy may have value for a wide range of lizard species and could contribute to translocation success.

Translocations are an important tool used to conserve threatened species (Ewen et al., 2012; Seddon et al., 2014), including amphibians and reptiles (Germano and Bishop, 2009). Numerous species of herpetofauna are threatened globally (Gibbons et al., 2000; Böhm et al., 2013), and human intervention often is deemed necessary to prevent extinctions (Seddon et al., 2014). Human–wildlife conflict resulting from development is increasing and contributing to declines in many species of herpetofauna (Sullivan et al., 2014; Germano et al., 2015). Germano and Bishop (2009) found that reptile translocations in response to human–wildlife conflicts had higher failure rates than both conservation- and research-orientated translocations. Therefore, further research is needed to improve practices used in mitigation translocations for herpetofauna (Sullivan et al., 2014; Germano et al., 2015).

Many translocations appear unsuccessful (Griffith et al., 1989; Wolf et al., 1996; Fischer and Lindenmayer, 2000). For herpetofauna, 28% of herpetofauna translocations in the published literature failed between 1991 and 2006 and in 29% of cases outcomes were uncertain (Germano and Bishop, 2009). Furthermore, Miller et al. (2014) conducted a comprehensive review of all published and unpublished translocations of herpetofauna in New Zealand and found publication bias resulted in a gross overestimate of translocation success rates. Reported success rates were 41.7% for published studies, compared with 8.1% for all translocations (Miller et al., 2014). Publication bias against translocations with uncertain outcomes, the vast majority of projects, also was strong (50.0% and 85.1% for published and all translocations, respectively). The outcomes of many herpetofauna translocations may be uncertain, or even assumed to be failures, attributable to insufficient post-release monitoring, rather than an actual failure to establish (Germano and Bishop, 2009; Sherley et al., 2010; Bell and Herbert, 2017). Recently, a generalized framework for evaluating translocation success as a series of four time-bound stages progressing toward successful population establishment has been developed (Miller et al., 2014). Knowledge of the species' life history is used to determine how much time it will take the population to achieve each stage (Miller et al., 2014). Bell and Herbert (2017) provide an example of the framework being used to determine translocation success for a long-lived, slow breeding, New Zealand gecko species (*Hoplodactylus duvaucelii*).

Release strategy is one factor contributing to the outcomes of a translocation (Germano and Bishop, 2009). Research aimed at determining appropriate release strategies and translocation methods is important for conservation management (Clarke et al., 2002; Tuberville et al., 2005), particularly for threatened species where animals available for translocation are severely limited and losses of individuals could compromise viability of the founder population. Translocations often are categorized as either hard release or soft release (Scott and Carpenter, 1987; Bright and Morris, 1994). Hard release involves releasing animals into the new environment immediately, without any assistance such as provision of supplementary food or shelter (Richardson et al., 2014). Soft release involves a delayed release, with animals held onsite prior to release and sometimes including the provision of supplementary food or other resources (Scott and Carpenter, 1987; Bright and Morris, 1994; Clarke et al., 2002). Whether a soft release or hard release is appropriate is one of the first questions that should be asked during translocation planning (Scott and Carpenter, 1987; Richardson et al., 2014). Research on the relative impacts of hard releases and soft releases can help inform this decision-making process, and translocations provide good opportunities for such research to test theories that will inform future management (Clarke et al., 2002; Knox and Monks, 2014). Comparing movement and behavior of individuals between a natural population and a translocated group can also provide important insights on how translocated animals act compared to their wild conspecifics (Santos et al., 2009; Roe et al., 2010). The need for research on how to improve site fidelity of translocated individuals has been highlighted in recent reviews (Armstrong and Seddon, 2008; Le Gouar et al., 2012; Richardson

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et al., 2015), including for herpetofauna (Germano and Bishop, 2009). Enclosures can be constructed to restrict dispersal of translocated individuals, which may habituate animals to the release area before these structures are removed (Bright and Morris, 1994; Tuberville et al., 2005; Knox and Monks, 2014). When dispersal is not initially restricted, translocated animals may rapidly disperse large distances from the release area that may, in turn, reduce their chances of finding conspecifics for reproduction (Le Gouar et al., 2012).

Knox and Monks (2014) reviewed previous translocations of New Zealand Green Geckos (genus: *Naultinus*; see also Sherley et al., 2010). Between 1994 and 2010, nine hard releases of Green Geckos (five mitigation translocations to mainland sites and four conservation translocations to pest-mammal–free islands), yielded a total three recaptures of 155 released geckos. For these hard releases the translocations either appear to have failed, or the animals simply were not detected, attributable to the cryptic nature of green geckos and low detection probabilities (Hare et al., 2007). In contrast, two soft releases of Jewelled Geckos that used enclosures (one in 2009 and one in 2012) appear to have reduced post-release dispersal, and breeding in the release areas has been observed every year since translocation (Knox and Monks, 2014).

Our research addresses whether a soft-release strategy is beneficial for establishment of translocated Jewelled Geckos. We build upon our previous work (Knox and Monks, 2014) in which we found that a soft release (nine months in an enclosure) during spring reduced dispersal of geckos compared to a hard release. We monitored movements following hard- and soft-release translocations of Jewelled Geckos in winter and simultaneously monitored a resident (natural) population. Where appropriate, we incorporated data from our previous study from spring (Knox and Monks, 2014) and a hard-release translocation in summer that we monitored. We evaluated whether 1) mean hourly movement, home-range size, and dispersal distance differed between hard-released, soft-released, and resident geckos in winter; 2) hard-released geckos would disperse less following a winter release compared to a spring or summer release because of cooler temperatures; and 3) geckos contained in soft-release enclosures for a longer period (nine months) would disperse less than those confined for a shorter period (four months).

Materials and Methods

The Jewelled Geckos (*Naultinus gemmeus*; McCann, 1955) are moderate-sized (total length up to 160 mm), diurnal, cryptic, arboreal lizards, found only in the southeast of the South Island, New Zealand (Jewell and McQueen, 2007). It is one of nine species of the endemic genus *Naultinus* and is ranked "At Risk, Declining" according to the New Zealand Department of Conservation threat classification system (Hitchmough et al., 2016). Jewelled Geckos are long-lived, viviparous geckos, and produce a maximum of two offspring per year (Cree, 1994). The major threats to Jewelled Geckos are predation by introduced mammals and possibly birds (e.g., magpies, *Gymnorhina tibicen* and kingfishers, *Todiramphus sanctus vagans*), habitat loss or fragmentation (including fires), and illegal collection for the black market (Jewell and McQueen, 2007; Knox et al., 2012); but biologists know little about the identity or relative importance of different predator species for persistence of gecko populations.

Translocation Procedure and Initial Post-Release Monitoring.—We monitored Jewelled Geckos near Dunedin, New Zealand, at three sites unnamed to minimize the risk of illegal collection. We hard released 10 geckos into an area of *Coprosma taylorae* shrubs at site A in early January 2014. We intended to simultaneously monitor a soft-release group of 15 geckos following removal of their enclosure; however, we decided to remove this treatment from the study after some of the geckos ($N = \leq 11$) prematurely left the enclosure (possibly attributable to structural defects caused by weather). Three of these geckos were later found in habitat outside the enclosure, suggesting that the enclosure may have leaked geckos.

Within site B, we released geckos in four areas in an attempt to establish geckos in different parts of the site for conservation reasons. Further, we established separate hard-release and soft-release areas to ensure that conspecifics already at the site did not influence the behavior of subsequently released animals (Le Gouar et al., 2012). We soft-released 16 geckos into two enclosures at site B in late January 2014 (11 in a larger enclosure and five in a smaller enclosure) sourced from a population 6 km away. Then, we hard released 10 geckos into two areas at site B in late May 2014 (seven in a larger area and three in a smaller area) from the same source population. All four release areas at site B were ~30–50 m apart and contained similar habitat. We controlled for the density of geckos by ensuring both the hard- and soft-release sites had the same density of geckos upon release (one soft- and one hard-release site had 0.114 geckos/m^2 and the other soft- and hard-release site had 0.140 geckos/m^2). The sizes of the soft-release enclosures and hard-release areas differed, however (soft-release sites were 78.50 m^2 and 52.48 m^2; hard-release sites were 49.95 m^2 and 26.24 m^2), because more geckos were soft released than were hard released. Study design is described in Table 1, and key points are discussed below.

At site C (5 km from site B), 18 geckos from a resident population were studied as a comparison with the translocated group at site B. The vegetation was mainly 1–3-m high shrubs of *C. taylorae* (site A) or *Coprosma propinqua* (sites B and C), which are similar in structure and appearance to one another. Kānuka (*Kunzea robusta*) trees (4–5 m height) were of similar proportion to *C. propinqua* at the smaller hard- and soft-release sites within site B.

We undertook 12 photo-resight surveys of soft-released geckos contained inside enclosures at site B during the four months (early February to late May 2014) prior to release. These 1-h photo-resight surveys involved the identification of individual geckos based on their unique dorsal patterns (Knox et al., 2013). Surveys occurred ~10 days apart during clear weather (i.e., optimal conditions for emergence of Jewelled Geckos; Duggan, 1991) both within (45 min) and around (15 min; up to 30 m away from the boundary of) the soft-release enclosures. The photo-resight surveys provided information on movements and survival of geckos, as well as ensuring that the enclosures successfully contained geckos.

To compare movements, we simultaneously radio tracked 10 hard- and 10 soft-released geckos after the soft-release enclosures were removed. To avoid any potential bias between groups, geckos selected for radio tracking were the first to be resighted at the start of the telemetry study from within the enclosures (soft-release group) and the first found at the site from where animals were sourced (hard-release group). In addition, 18 geckos from an unmanipulated resident population were selected in the same manner and radio tracked as controls for the hard- and soft-release groups.

TABLE 1. Details of the groups of Jewelled Geckos (*Naultinus gemmeus*) monitored following translocation or in a resident population. Soft-released geckos were contained inside temporary enclosures for nine months (site A) or four months (site B) prior to release. All radio-tracking studies occurred over ~3 weeks. Note that uneven sex ratios resulted from fewer males being found at the source populations.

Site	Treatment	Translocated	Transmitters attached	No.	Sex-ratio (F:M)	Source
A	Soft-release	January 2012	September 2012	11	10:1	Knox and Monks, 2014
A	Hard-release	September 2012	September 2012	9	6:3	Knox and Monks, 2014
A	Hard-release	January 2014	January 2014	10	7:3	This study
B	Soft-release	January 2014	May 2014	10	3:2	This study
B	Hard-release	May 2014	May 2014	10	7:3	This study
C	Resident	N/A	May 2014	18	1:1	This study

Radio Tracking.—We attached 45 BD2 and 3 LB2 transmitters (0.7 g; Holohil Systems, Carp, ON, Canada) to monitor the movements of 48 Jewelled Geckos (Table 1). All transmitters weighed ≤ 7.5% of body weight of geckos (on average weighed 5.90 ± 0.11%). Transmitters were attached using an external "backpack" harness (Hoare et al., 2007a). We monitored movements of all but two geckos for ~3 weeks following transmitter attachment. The transmitter failed on one gecko after 15 days, and another individual was preyed upon after 10 days. From the latter, we took saliva swabs from the area around the transmitter and accompanying harness for DNA extraction and species identification (for method details, see Tobe and Linacre, 2008; Ramón-Laca et al., 2013). We recorded movements of radio-tracked geckos once or twice daily using a compass and tape measure from the previous sampling point (distance to the nearest centimeter and bearing).

We obtained weather data (daily low and high temperatures) for all radio-tracking periods from the closest available weather station to the sites (Musselburgh EWS 15752) using New Zealand's national climate database (CliFlo; http://cliflo.niwa.co.nz/). The CliFlo station was 15 m a.s.l. and was 16 km from site A (300 m a.s.l.), 10 km from site B (35 m a.s.l.), and 14 km from site C (50 m a.s.l.).

Statistical Analyses.—All statistical analyses were conducted in R version 3.2.0 (R Development Core Team, 2015). We fitted linear models (LMs) and linear mixed models (LMMs) in the base package and "nlme" (Pinheiro et al., 2014). For all models, we checked normality, homogeneity, and independence through inspection of the residuals (Zuur et al., 2009). We log-transformed ($x + 0.1$) data as required to meet assumptions of normality. We used a LMM to compare hourly movement (m/h) between resident geckos at site C and translocated geckos at site B, with hourly movement as the response variable and gecko ID as a random factor to account for the repeated measures of individuals. We compared home-range size of the translocated geckos at site B and the resident geckos at site C. We estimated the home range of geckos with 100% minimum convex polygons (MCP_{100}; m^2) (*mcp* function; "adehabitatHR" package; Calenge, 2006) and used LMs for comparisons where MCP_{100} was the response variable. We compared post-release dispersal, defined as the straight-line distance between release point and final recapture location, of hard- and soft-released geckos during winter with a LM using dispersal distance (m) as the response variable. We also compared post-release dispersal distance of hard-released groups from all sites among seasons (a three-level categorical variable: winter, summer, or spring) and soft-released groups between months held in enclosures (a two-level categorical, four months or nine months) with LMs where dispersal distance was the response variable.

For all models, we included the fixed effects sex (female or male), group (coded as a two-level categorical variable for comparisons of soft- or hard-released, or coded as a three-level categorical variable for comparisons of resident, soft or hard released), and the number of fixes. We report LM and LMM coefficients ± SE. For all models, we estimated pairwise comparisons between groups by adjusting the reference category; α = 0.05.

RESULTS

All 16 geckos translocated into enclosures at site B in late January 2014 were resighted following translocation and 15 of the 16 geckos were resighted during the radio-tracking period. The proportion of geckos resighted during post-release surveys ranged from 31% to 88% and averaged 53%. For each season, mean daily high and low temperatures (°C) were: winter (12.0 ± 0.4, 5.1 ± 0.4); spring (13.8 ± 0.7, 6.6 ± 0.4); and summer (17.3 ± 0.5, 10.4 ± 0.5). At site B in winter, only one of the radio-tracked 10 soft-released geckos left the previously enclosed areas, whereas all 10 hard-released geckos left their defined release areas (Fig. 1). The total area occupied by the soft-released

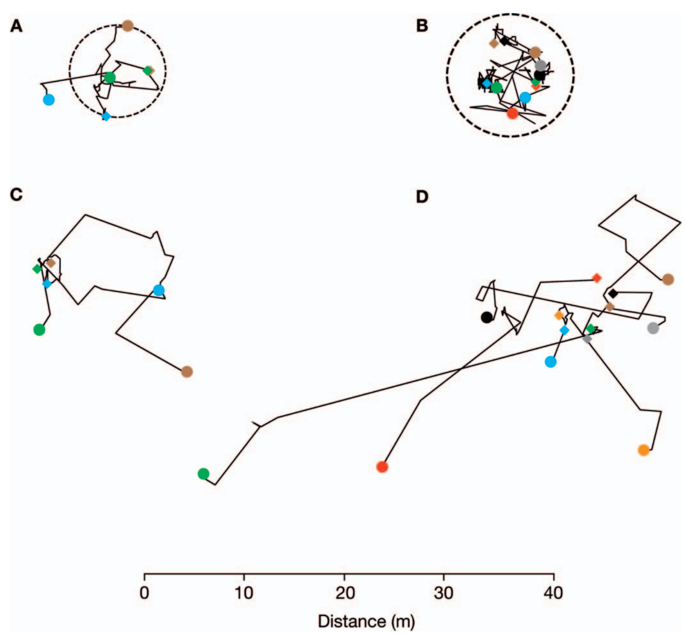

FIG. 1. Dispersal of Jewelled Geckos (*Naultinus gemmeus*) from translocated groups in New Zealand. Two groups of geckos (A and B) were soft-released (placed in temporary enclosures for 4 months prior to release) and two groups (C and D) were hard-released. Movements were monitored by radio tracking geckos over ~3 weeks. Each individual is identified by a different color combination. Smaller circles represent release positions, and larger circles represent positions at the time of transmitter removal. Lines indicate recorded movements. Soft-release enclosures are depicted by dashed circles. Sample sizes are as follows: A and C ($N = 3$), B and D ($N = 7$).

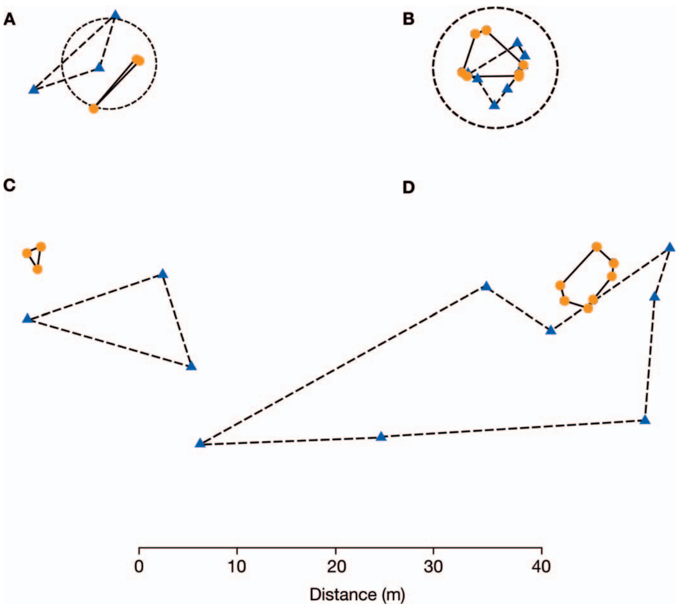

FIG. 2. Total area occupied by Jewelled Geckos (*Naultinus gemmeus*) from translocated groups in New Zealand (see Fig. 1 for information on geckos). Solid lines represent area occupied by geckos upon release, and dotted lines represent area occupied by geckos ~3 weeks after release. Positions of geckos at release are depicted by yellow circles, and the positions at the time of transmitter removal are depicted by blue triangles. Sample sizes are as follows: A and C ($N = 3$), B and D ($N = 7$).

geckos remained similar during the three-week period following the removal of the enclosure (Fig. 2; note that the area they occupied decreased slightly from 17.59 m^2 to 16.07 m^2). In comparison, hard-released geckos dispersed widely following release, effectively increasing the area they collectively occupied 20.2-fold (Fig. 2; from 20.61 m^2 to 416.39 m^2).

Mean daily movements were 0.80 ± 0.07 m for the winter soft-released geckos, 1.13 ± 0.10 m for the resident population, 1.39 ± 0.22 m for the winter hard-released geckos, and 2.79 ± 0.30 m for the summer hard-released geckos. Movement rates (mean hourly movement) were not influenced by release strategy for geckos; hard-released geckos were not significantly different from soft-released geckos, or from the resident population. Movement rates of males, however, were significantly higher than that of females (Table 2).

Mean home-range sizes (MCP_{100}) for the hard-released, soft-released, and resident geckos in winter were 59.7 ± 16.9 m^2, 14.1 ± 3.2 m^2, and 31.1 ± 7.5 m^2, respectively (Appendix 1). Soft-released geckos had significantly smaller home-range sizes than did hard-released geckos, but the difference between hard-released geckos and the resident population was not significant. Summer hard-released geckos had larger home-range sizes than did winter hard-released geckos (261.3 ± 94.1 m^2 and 59.7 ± 16.9 m^2, respectively; Appendix 1). Males had significantly larger home-range sizes than females (Table 2).

During winter, hard-released geckos dispersed significantly further than soft-released animals (Table 2). The largest recorded post-release dispersal for a hard-released gecko was 41.5 m from the release location in winter, 39.2 m in spring, and 70.1 m in summer. In contrast, the largest post-release dispersal was only 8.3 m for a soft-released gecko in winter and 16.4 m for a soft-

TABLE 2. Model estimates from linear models (LMs) and linear mixed effect models (LMMs) evaluating factors influencing movement, home range, and dispersal distance for 68 Jewelled Geckos (*Naultinus gemmeus*) radio tracked over ~3 weeks in the groups outlined in Table 1. Note that in the output presented below, the hard-released group is fitted as the reference category for release strategy comparisons of home range, movement per hour, and dispersal distance. Additionally, we ran a LM for hard-released groups with summer as the reference category and a LM for soft-released groups with nine months as the reference category. Astrerisks indicate statistical significance at $P < 0.05$.

Model/Estimate	b/SD	SE	df	*t*-value	*P*
LM Dispersal distance (m) to compare release strategies					
Intercept (hard-released)	−0.594	2.210	16	−0.269	0.792
Hard-released–soft released	−0.955	0.357	16	−2.674	0.017*
Sex	0.280	0.364	16	0.768	0.454
Number of fixes	0.172	0.128	16	1.343	0.198
LM Dispersal distance (m) to compare hard-released groups across seasons					
Intercept (summer)	1.109	1.927	24	0.576	0.570
Summer–spring	−0.133	0.345	24	−0.387	0.702
Summer–winter	0.344	0.606	24	0.568	0.575
Sex	0.883	0.301	24	2.930	0.007*
Number of fixes	0.045	0.080	24	0.559	0.581
LM Dispersal distance (m) to compare time-in-enclosure within soft-released groups					
Intercept (9 months)	0.917	1.315	20	0.697	0.494
9 months–4 months	−0.049	0.542	20	−0.090	0.929
Sex	0.510	0.503	20	1.015	0.322
Number of fixes	0.018	0.060	20	0.293	0.773
LMM Movement per hour (m/hr) to compare release strategies					
Intercept (hard-released)	−0.559	0.132	666	−4.233	<0.001*
Hard-released–resident	−0.211	0.157	34	−1.341	0.189
Hard-released–soft-released	0.066	0.180	34	0.366	0.717
Sex	0.443	0.131	34	3.386	0.002*
Residual (random factor)	1.153				
LM Home range (MCP_{100} m^2) to compare release strategies					
Intercept (Hard-released)	4.507	1.877	33	2.401	0.022*
Hard-released–resident	−0.806	0.482	33	−1.674	0.104
Hard-released–soft-released	−1.506	0.453	33	−3.327	0.002*
Sex	1.170	0.321	33	3.641	<0.001*
Number of fixes	−0.068	0.105	33	−0.650	0.520

released gecko in spring. Mean dispersal distances for the hard-released geckos in summer (16.5 ± 6.2 m) were similar to spring (14.9 ± 4.5 m) and winter (15.7 ± 3.6 m; Table 2). Mean dispersal distances were similar for soft-released geckos between winter (four months in soft-release enclosure; 4.3 ± 0.6 m) and spring (nine months in enclosure; 5.0 ± 1.5 m) (Table 2).

The one gecko preyed upon during the radio-tracking study was from the resident population. DNA analyses on saliva collected from the transmitter and harness (which had become detached from the gecko and showed signs of being chewed) identified a stoat (*Mustela erminea*) as the predator.

Discussion

Our study supports previous research by Knox and Monks (2014) that showed soft-release enclosures reduce post-release dispersal of Jewelled Geckos. We found post-release dispersal in winter was significantly lower for soft-released geckos compared to hard-released geckos. Similarly, we found home-range size was significantly smaller for soft-released geckos and the resident population compared to hard-released geckos. Furthermore, the hard-released group increased their area of occupancy 20-fold, whereas the area occupied by the soft-released group remained similar following the removal of enclosures.

In New Zealand, the Department of Conservation currently recognises 104 extant native lizard taxa, with 85% considered either "At Risk" or "Threatened," and a further 7% considered "Data Deficient" (Hitchmough et al., 2016). Conservation translocations can be used to restore populations where in situ management is not feasible (Seddon et al., 2014). Mitigation translocations are also increasingly used as a management tool for herpetofauna (Germano et al., 2015), including for *Naultinus* species (Sherley et al., 2010). Our data suggest that use of soft-release enclosures increases site fidelity of translocated Jewelled Geckos and that, after four months in an enclosure, movement patterns of translocated geckos resembled those of resident geckos. The use of enclosures may also assist Jewelled Geckos with encountering mates (Knox and Monks, 2014), although it could make them more susceptible to illegal collection (Knox et al., 2012) if the enclosure is conspicuous. High dispersal following a hard-release translocation may result in greater levels of mortality than those seen in resident populations (e.g., via predation, stress, or disease), because animals may disperse into areas of low habitat quality and, therefore, fail to find adequate resources or refugia (Calvete and Estrada, 2004; Calenge et al., 2005; Roe et al., 2010). Regardless of the mechanism, a reduction in size of the founder group can increase the loss of genetic diversity, reduce population growth rates, and diminish the probability of a population establishing (Frankham, 2005; O'Grady et al., 2006; Miller et al., 2009); hence, using techniques to minimize the loss of founders is important. Our results suggest that both the likelihood of establishment and speed of population growth may be enhanced when soft-release enclosures are used for *Naultinus* gecko translocations. Likewise, two studies with tortoises showed that soft release increased site fidelity and the likelihood of translocation success (Tuberville et al., 2005; Attum et al., 2011).

The hard release of Jewelled Geckos during winter did not affect post-release movements and dispersal compared to spring or summer hard releases. This was despite mean daily maximum and minimum temperatures in the winter radio-tracking period being ~2°C and 5°C cooler than in the spring and summer tracking periods, respectively. We also found that length of time the soft-release geckos were contained inside enclosures did not affect dispersal (this study, four months; 4.3 ± 0.6 m and Knox and Monks [2014], nine months; 5.0 ± 1.5 m). Hence, containing Jewelled Geckos in soft-release enclosures for longer than 4 months may not be necessary. In comparison, Tuberville et al. (2005) found that length of time that translocated gopher tortoises, *Gopherus polyphemus*, were contained in an enclosure was important. We must interpret our results concerning the influence of season and time inside enclosures on the movements and dispersal Jewelled Geckos with caution, because of the potentially confounding factors of site and season. As such, we suggest that further research to investigate these patterns, which have clear management implications, is warranted.

To the best of our knowledge, we provide the first confirmed record of stoat predation on New Zealand geckos. Stoats have already been identified as predators of skinks, with skinks occurring in 61 of 788 stoat scats analyzed (Cuthbert et al., 2000), and weasels have been identified as predators of Whitaker's skinks, *Oligosoma whitakeri*, and brown skinks, *Oligosoma zelandica* (Miskelly, 1997). Although concrete evidence is scant, mustelids are likely to be a major player in the suite of introduced mammals that prey on New Zealand lizards (e.g., Hoare et al., 2007b).

In conclusion, our findings support Knox and Monks (2014) who showed that a soft release reduced dispersal of translocated Jewelled Geckos and validate them at a different site, in a different season (winter as opposed to spring) and with a shorter length of time in enclosures (four months instead of nine months). We suggest that soft release be considered for future translocations of New Zealand geckos into contiguous habitat and recommend further soft-release trials with other lizard species to assess its value across a wider taxonomic range.

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APPENDIX 1. Movements of 48 Jewelled Geckos (*Naultinus gemmeus*) radio tracked for ~3 weeks in summer or winter, 2014. The 10 soft-released geckos that we radio tracked were contained inside temporary enclosures for ~4 months. The resident population was 5 km from the translocated population.

Individual	Sex	Fixes	Days	Total moved (m)	Dispersal distance (m)	Max. daily movement (m)	Home range (MCP_{100}; m^2)
Site A: Hard-release, summer							
1	F	28	25	42.2	7.3	6.9	16.5
2	F	28	25	43.5	1.7	4.9	11.8
3	M	28	25	45.8	14.0	14.2	106.6
4	F	28	25	27.3	12.2	5.9	25.9
5	F	28	25	86.1	9.1	21.3	361.0
6	M	29	26	66.1	9.6	16.3	189.8
7	F	28	24	105.8	17.0	22.6	578.9
8	F	28	24	89.5	17.8	22.2	415.6
9	M	29	23	103.1	70.1	30.9	890.1
10	F	28	21	21.2	9.3	4.1	17.1
Mean		28.2	24.3	63.1	16.8	14.9	261.3
Site B: Hard-release, winter							
1	F	17	19	31.7	6.3	10.3	62.1
2	F	17	20	10.1	3.3	4.3	4.1
3	F	17	21	21.7	7.3	6.9	17.7
4	F	18	21	41.0	28.6	12.6	80.0
5	F	17	20	33.7	12.9	16.2	57.0
6	F	17	19	13.7	6.7	6.2	14.6
7	F	17	20	22.7	13.7	7.0	33.2
8	M	17	21	44.6	21.1	9.6	181.8
9	M	20	21	49.8	41.5	33.0	108.9
10	M	19	20	23.8	15.9	12.1	37.2
Mean		17.6	20.2	29.3	15.7	11.8	59.7
Site B: Soft-release, winter							
1	F	18	22	20.4	5.5	4.1	25.9
2	F	16	21	13.7	5.9	4.3	8.4
3	F	12	22	9.8	2.8	2.9	4.1
4	F	16	20	16.7	5.0	4.1	7.9
5	F	16	22	11.5	0.5	2.0	2.1
6	F	17	22	18.7	6.8	7.8	26.5
7	M	18	22	14.2	4.3	3.9	5.6
8	M	17	22	21.3	4.2	5.2	13.9
9	M	16	22	18.5	3.7	3.7	16.0
10	M	17	22	34.6	4.1	5.8	30.1
Mean		16.3	21.7	17.9	4.3	4.4	14.1
Site C: Resident pop_n, winter							
1	F	21	20	16.4	N/A	7.9	6.0
2	F	21	20	11.4	N/A	4.9	8.2
3	F	21	21	6.6	N/A	1.2	2.9
4	F	22	22	22.2	N/A	7.5	32.9
5	F	21	20	15.3	N/A	4.4	7.9
6	F	21	20	12.9	N/A	3.1	6.3
7	F	21	20	23.6	N/A	4.6	28.6
8	F	21	21	3.8	N/A	1.2	0.8
9	F	21	20	24.1	N/A	11.5	33.2
10	M	16	15	59.1	N/A	11.7	136.1
11	M	19	18	22.4	N/A	9.4	28.4
12	M	21	21	22.2	N/A	10.0	21.3
13	M	21	21	17.3	N/A	3.6	12.1
14	M	21	21	22.0	N/A	8.0	38.1
15	M	21	21	29.9	N/A	9.6	51.1
16	M	16	15	40.2	N/A	6.7	60.2
17	M	20	19	25.1	N/A	4.1	41.7
18	M	21	20	36.4	N/A	5.9	43.4
Mean		20.3	19.7	22.8	N/A	6.4	31.1