Preliminary assessment of the release of captive-bred Gran Canaria Blue Chaffinches *Fringilla teydea polatzeki* as a reinforcement population

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**ABSTRACT**

Capsule: The endangered Gran Canaria Blue Chaffinch *Fringilla teydea polatzeki* has been bred in captivity with the aim of reinforcing wild populations. We released and monitored 26 males and 15 females between 2010 and 2012. Survival and reproductive success were similar between the reinforced population and a stable reference population, suggesting that the process could be useful for the conservation of the species.

It is widely accepted that breeding animals in captivity for reintroduction is an important management tool for recovering endangered species but there have been frequent calls for increased monitoring of reintroductions (Maunder 1992, Kleiman et al. 1994, Hein 1997, Seddon 1999, Fischer & Lindenmayer 2000) and for critical evaluation of programmes (Sarrazin & Barbault 1996, Armstrong et al. 2002). For example, reintroduced captive-bred birds often experience high post-release mortality and the survival of reintroduced captive-bred birds is dependent on the release strategies employed (Bernardo et al. 2011).

The success of a reintroduction is partly dependent on the translocation procedure and whether a ‘hard’ or ‘soft’ release strategy is used (Scott & Carpenter 1987). Soft release involves a animals being held on-site prior to a delayed release and can also include the provision of supplementary food or other resources after release (Richardson et al. 2013). According to the International Union for Conservation of Nature (IUCN 2013), animals may be held for some period at the release site to allow them to become accustomed to local conditions or enhance social group cohesion; such procedures are most likely to be useful with captive-bred animals. The propensity of reintroduced birds to move during the immediate post-release period will in part depend on soft release protocols, specifically the timing and number of release cohorts, supplementary feeding and the proximity of the soft release enclosure to freshwater sources. Captive-bred birds will be unfamiliar with the release site and this will also influence home-range establishment and site fidelity (Bernardo et al. 2011).

The Blue Chaffinch *Fringilla teydea* is a specialist passerine of thick upland Canary Island Pine *Pinus canariensis* forest on Tenerife and Gran Canaria (Canary Islands). One subspecies exists in each of these islands, although some authors have recently suggested that these represent two distinct species: the Gran Canaria Blue Chaffinch *Fringilla polatzeki* and the Tenerife Blue Chaffinch *F. teydea* (Sangster et al. 2015, Lifjeld et al. 2016). The reclassification of Gran Canaria Blue Chaffinch as a single-island endemic species would make it Europe’s rarest passerine species. Its population is very limited because the extent of pine forest on Gran Canaria is small and highly fragmented, that is why the Red Book of Birds in Spain termed the Gran Canaria subspecies as Critically Endangered (Madroño et al. 2004). A conservation strategy was initially implemented by the Canary Island Government in 1991, followed by the approval of a recovery plan in 2005. This plan includes, among other activities, the formation of at least one other population by reintroduction (Suárez et al. 2012).

The overall goal of the captive breeding programme was to decrease the risk of extinction of the Gran Canaria Blue Chaffinch by establishing a self-sustaining wild population in other pine forests. This paper reports a preliminary assessment of the three-year programme of captive-bred releases and provides information for future management actions for conservation and reintroduction of this and other passerine species.
The research was carried out in the only two pine forest regions on the island of Gran Canaria where the Blue Chaffinch breeds. The first of these was the pine forest at the Inagua Nature Reserve (3920 ha, 27°57′N 15°42′W). The population here is the island’s largest, with 121–339 birds, and has a stable population trend (Rodríguez & Moreno 2008). Carrascal & Seoane (2008) estimated the population size at 122 individuals after a fire devastated part of this pine forest in 2007. Inagua pine forest is used here as the reference population for comparison in the analysis. The second pine forest under study, Cumbre (1800 ha, 27°57′N 15°35′W), is on the summit of the island. This forest was clear-felled in the mid-nineteenth century and repopulated in the 1950s and 1960s. There are no historical data on the presence of the Blue Chaffinch at this location because when the species was discovered on Gran Canaria in 1905 this area was classified as non-forested land. It is poorly connected by vegetation cover and separated by about 4.5 km from the upper pine forest at its most narrow section (Figure 1). This second Blue Chaffinch population was discovered by Víctor Suárez in 2008, when colour-ringed birds from Inagua were observed in Cumbre pine forest and found to be breeding. Following the initial discovery, sightings were scarce in Cumbre forest: two adults were located in 2009 and three in 2010, two of these managing to successfully fledge two young. Cumbre forest is located in the centre of the island, is connected with other pine forests and, following what seems to be a natural colonization of the site, it was chosen as a highly suitable area to release captive-bred birds.

Sixteen Gran Canaria Blue Chaffinches were wild-caught in Inagua Nature Reserve and are currently used in the captive breeding programme run since 2005 (see García-del-Rey et al. 2013 for more detail of the captive breeding stock). A total of 41 Blue Chaffinches (11 in 2010, 13 in 2011 and 17 in 2012), 26 males and 15 females were reared in captivity, and released between 15 August and 15 October, 5–18 weeks after hatching to limit the period in captivity. Birds were liberated through soft release techniques, remained 14 days in groups of no more than seven in an acclimatization cage located at the release site. All the birds wore a combination of colour rings to allow individual identification at a distance. These facilities were similar to the pre-release cages at the breeding centre and birds were held in similar groups in both aviaries. These installations were watched by day to monitor bird condition and kept opened up to three months after liberation, so that individuals could use feeders that were placed inside. Furthermore, six artificial feeders were placed in the area surrounding the release cages. Feeders were suspended from branches in dense vegetation and held *P. canariensis* seeds with a mixture of other seeds. Supplementary

![Figure 1](image.png)

*Figure 1.* Map of Gran Canaria island showing the sites of the Blue Chaffinch populations at Inagua (circle) and Cumbre (triangle), where captive-bred birds were released. The extent of pine forest is marked in grey.
food was supplied throughout the winter until March. Additionally, mealworms (larvae of *Tenebrio molitor*) were provided during the holding period and for the first three weeks after liberation.

Translocation success can be determined during two phases: establishment and longer-term persistence (Armstrong *et al.* 1999). We assessed the success of the translocation programme based on two criteria: (1) short-term criteria: survival of the captive-bred birds through the first winter, by comparing the apparent survival five months after liberation of released and wild birds in the same periods and (2) long-term criteria: annual survival of adults, by comparing the apparent survival after a ten-month period for adults in the reinforced and reference populations. We also compared population trends and reproductive success between the reference and reinforced populations.

Between 16 and 41 fledglings and adults were captured by mist net and individually colour-ringed at the two sites each year. Two to three people carried out the fieldwork in the reference population from March to mid-October 2006–2011. We looked over almost the entire area of pine forests on foot and by car to find, and individually identify, marked birds. A large fire in 2007 affected of the reference population (Carrascal & Seoane 2008), consequently our database covers periods before and two years after this fire, when a significant recovery of the vegetation cover had taken place.

One or two people recorded field data in the reinforced population between 2008 and 2013 in the same way as at the reference site. Intensive monitoring in the small pine area allowed researchers to follow the entire population. Additionally, nests were locating and monitoring every 4–5 days in order to determine the number of chicks that fledged. Given the limited number of chaffinches in the Cumbre pine forest, the whole adult population and all fledglings produced each year (2010–13) could be ringed and identified in this new population.

We analysed survival using the live recaptures Cormack–Jolly–Seber model in MARK 8.1 (White & Burnham 1999) with two encounter occasions and four groups: juveniles released into reinforced population, juveniles of reference population, adults of reinforced population and adults of reference population (Supplementary Appendix 1). The data set is not extensive enough to enable the analysis of time or finer age classes in the survival analysis. Released individuals were considered to have survived their first winter if they were resighted in the two months after 15 March in the year following hatching (for the winters of 2010–11, 2011–12 and 2012–13). We compared survival against similarly collected data from the reference population but in different winters (2006–07, 2010–11). Annual survival of adults was assessed between 15 April and 15 June each year, during 2009–11 in the reference population and 2011–13 in the reinforced population.

Reproductive success was monitored in the reinforced population for comparison against similar data collected by Rodríguez & Moreno (2008) in the reference population during 1994–2004 (but excluding 2003). Reproductive success parameters were: nest success (nests that fledged at least one young), production of a second clutch (second broods and replacements) and nest productivity (number of offspring per successful nest). Statistical analyses were performed using R program (R Core Team 2014).

In total, 35 of the 41 Gran Canaria Blue Chaffinches were successfully released into the reinforced population (7 in 2010, 11 in 2011 and 17 in 2012). Another six birds were released at another date, hence are not included in this analysis. Also excluded from the analysis are six birds killed as a result of attacks by Eurasian Sparrowhawks *Accipiter nisus* while feeding in the release cages (2 in 2010, 4 in 2011). All of them died due to injuries caused by blows against the walls of the cage while trying to escape the predator. As these birds died in the cage, they were excluded from the survival analysis. Additionally, in one case, we detected wounds caused by a plastic ring in the tibio–tarsus articulation after release. This bird was captured and released after removing the colour markers on that leg.

Of the 35 individuals successfully released, 21 were detected after winter. In the same period, 46 juveniles were marked in the reference population, 24 of which survived the first winter. At the reinforced population site, 27 adults were observed and 11 of them were subsequently detected on the following year. At the reference site, 51 adults were detected and 23 of them were subsequently relocated the following year.

Winter survival probability was 0.774 (95% confidence intervals (CI) = 0.653–0.862) for released birds in the reinforced population and 0.722 (95% CI = 0.612–0.811) for wild birds in the reference population. Annual survival of adults was 0.638 (95% CI = 0.484–0.768) in the reinforced population and 0.671 (95% CI = 0.563–0.764) in the reference population.

We have reproductive success data on 24 out of the 28 monitored nests produced within the reinforced population after the first release (10 in 2011, 9 in 2012 and 9 in 2013; excludes nests abandoned before incubation). At least one chick was fledged from 79% of the nests and 41% of the breeding females attempted a second clutch (Table 1). In 46% of the nests, a single chick fledged and 54% fledged two, giving a productivity of 1.52 chicks (n = 24, sd = 0.51) per successful nest.
There were no significant differences between the percentage of successful breeders in the reinforced population and the reference population ($\chi^2 = 0.31$, df = 1, $P = 0.58$). Furthermore, the number of fledglings produced per successful nest did not differ between the two populations ($t = 0.37$, df = 29.26, $P = 0.71$).

All adults displayed breeding behaviour in the reinforced population and there was an increase in the number of adults and fledglings following releases. Despite the lack of increase in adults in 2013, the number of fledglings increased slightly from 2012 (Figure 2).

According to our assessment criteria, we consider the release of captive-bred Gran Canaria Blue Chaffinch, as a reinforcement to the Cumbre population, to be a success. The birds released had similar survival prospects, during the first winter, as those of young wild birds in the reference population. Likewise, adults at Cumbre had similar annual survival rates as those observed in the reference area at Inagua pine forest over the same period. We also found that the reproductive success measures of both populations did not differ significantly and there was an increase in the adult population and offspring production following releases of captive-bred birds.

Nevertheless, during the time the birds were held in the acclimatization cage or fed in the enclosure after release, six Blue Chaffinches died because of injuries caused by impacts against the mesh of the cage when trying to escape a predator attack. Occasionally, the supervising staff observed birds of prey in the area of the cages and on two occasions they witnessed the attack on the chaffinches acclimatizing inside. In order to prevent attacks by predators we recommend protecting the cage and reducing slightly the holding period. A reduction in the number of days of the acclimatization period would logically lower the chances of a Eurasian Sparrowhawk attack but it also could put at risk the birds’ acclimatization success. As regards the latter, some authors indicate that a 6–14-day holding period is enough for captive-bred passerine translocation (Kuehler et al. 2000, Gálvez 2012, Lagios et al. 2014).

Stacey & Taper (1992) highlight the importance of immigration to the persistence of small populations. The movement of Blue Chaffinches from one pine forest to another occurs, but individuals probably have to cross a deforested area. Therefore, we emphasize the need to connect both forests, by creating an ecological corridor through pine reforestation, in order to facilitate their movement between populations.

We recommend further monitoring of population size and reproductive success in the reinforced population, to create a longer data series which would allow us to monitor survival rates and generate estimates of population growth rate. Population viability analysis is an inexact science (Thomas 1990, Reed et al. 2003, Flather et al. 2011), but it could be considered a valid and sufficiently accurate tool for managing endangered species (Boyce 1992, Brook et al. 2000). Brook & Kikkawa (1998) conducted a population viability analysis with parameters estimated from relatively short (5 years) periods of data collection and produced very different predictions of extinction risk compared with population viability analysis based on more comprehensive ecological data spanning 15–25 years. As a guideline, population analyses provide information about the minimum number of birds that this population needs to remain viable. The information obtained will be important to design conservation strategies for the species.

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| Parameters | Reference population | Reinforced population |
|------------|----------------------|-----------------------|
| First-winter survival | 0.72 (95% CI 0.61–0.81) | 0.77 (95% CI 0.65–0.86) |
| Adult annual survival | 0.67 (95% CI 0.56–0.76) | 0.64 (95% CI 0.48–0.77) |
| Nest fledging at least one young | 70.80% | 79.17% |
| Females produced a second clutch | 33.00% | 41.18% |
| Offspring per successful nest (±sd) | 1.47 (± 0.50) | 1.52 (± 0.51) |

aData obtained from Rodríguez & Moreno (2008).
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