

**SURVIVAL, BREEDING AND MOVEMENTS OF REINTRODUCED  
ASIATIC HOUBARA (*Chlamydotis [undulata] macqueenii*) IN  
MAHAZAT AS-SAYD RESERVE, SAUDI ARABIA**

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A thesis submitted in

partial fulfilment of

the requirements for the

Degree of

Doctor of Philosophy in Zoology

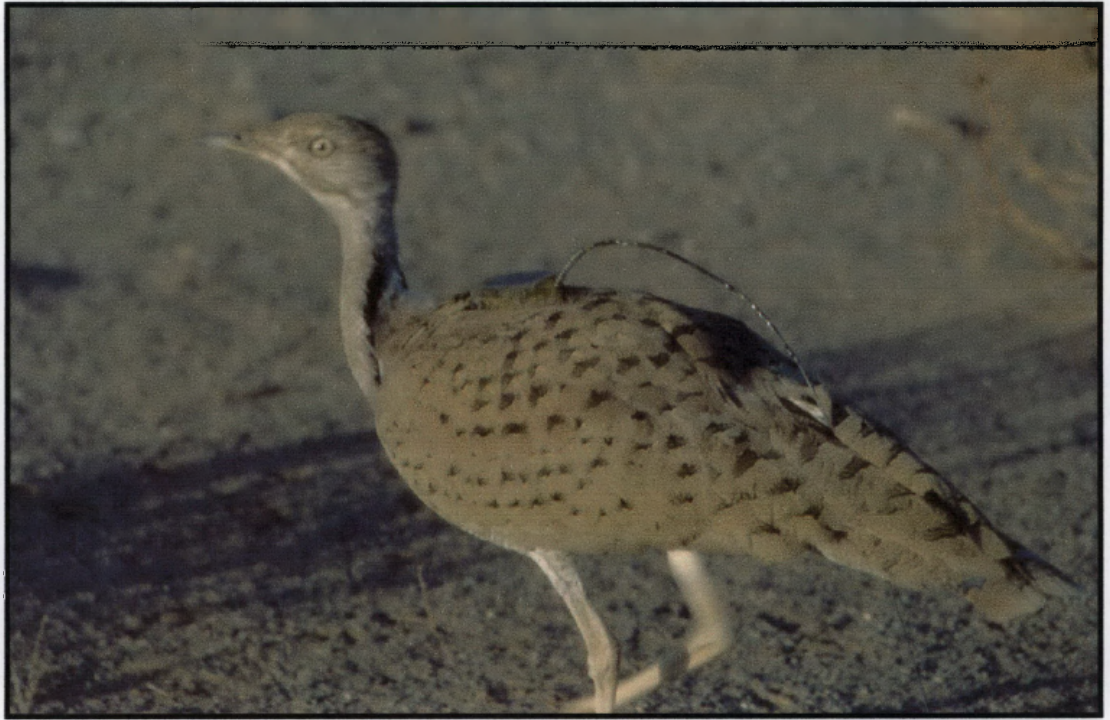
by

RICHARD F. MALONEY

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University of New England

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*Sub-adult houbara shortly after release in 1996*

## Abstract

The houbara (*Chlamydotis [u.] macqueenii*) is a desert-dwelling bustard whose ecology and behaviour is poorly known. Populations of houbara are probably in decline throughout their range. Techniques for the conservation and recovery of populations include creation of reserves and reintroduction of captive-reared sub-adults. The process of reintroduction has not been well studied for this species. Conservation biologists have tried different methods of release to test which is the most successful, but further work is required to improve release survival rates. There is also a need to consider the behaviour and ecology of reintroduced populations to ensure that they are typical of this species. In addition, reintroduced populations offer opportunities to address specific questions about houbara biology that are not easily achieved in other populations, where individuals are not individually identifiable. From 1995 to 1997, I released 152 sub-adult houbara into the 2250 km<sup>2</sup> Mahazat as-Sayd Reserve in west-central Saudi Arabia and followed their fate. In this thesis, I report on the success of releases, and on the breeding performance, nesting habitat, home range, movements, display and lekking behaviour of reintroduced houbara.

Releases were successful. In Chapter 3, I showed that 27 % of released houbara reached breeding age, and released birds generally stayed within the reserve. However, death rates were consistently high, for all years and when using two different release methods. Most deaths in the reserve (76/79) were due to predators, and 81 % of confirmed causes of death were assigned to red foxes (*Vulpes vulpes*). Half of all deaths occurred within 0.9 – 1.6 km of the release site and within 14 days of release. Translocating foxes from around the release site did not increase the distance or time to death, and previous conclusions that translocation of predators increased the distance from the release to death site for houbara were not supported over longer time periods and with larger sample sizes. Houbara were more likely to die during the first moonlit period that they were free-living in the reserve, but death rate was not related to release year, release group size, age or gender of released birds, temperature after release or rainfall prior to release. I recommend that radical changes in the release of houbara are needed to increase the number of birds being recruited each season. These changes include eradication of predators at release sites, and a greater use of portable release cages for use in sites where predator densities are naturally low, and where and when feeding conditions are optimised.

In Chapter 4, I closely monitored the outcomes for 51 breeding attempts from reintroduced houbara: including 46 nests with eggs, and calculated egg (0.88), hatching (0.35), fledging (0.27), and overall breeding success (0.083) for 15 females in this population. Only females were observed incubating and caring for young. Nest failure rates were high, mainly due to predation, but females compensated for nest loss by re-nesting. Up to three replacement clutches were laid, and two cases of double brooding were identified. Identity of predators was largely unknown: foxes took eggs from two nests, a hen harrier caught a chick, and a cat killed a fledgling. I documented many breeding parameters that have been poorly studied in this species, including egg, clutch and chick size, incubation period, start and finish dates for breeding attempts, female success, age at first nesting, and fledging period, and I compared these to data from other studies where possible.

In Chapter 5, I described vegetation and substrate characteristics at 49 nest sites, to determine the nest site requirements of reintroduced houbara. I compared the location of nests to an existing coarse scale habitat map for the reserve. For a sub-sample of 22 nests, I further compared in detail vegetation, substrate, and cover at and near each nest site to cover values and vegetation at each of 98 transects located throughout the reserve. Nests were not randomly distributed in the reserve, and were more likely to be found in the south and north east, in the presence of *Acacia spp.* trees and *Panicum turgidum* and *Ochthochloa compressa* tall grasses. No nests were found in areas of salt pan or *Haloxylon salicornicum*. Mean vegetation cover in the reserve was similar to that near to nest sites, and all plant species commonly found in the reserve were common at nest sites, except for *H. salicornicum* and *Zygophyllum simplex*. Nests were sited 4 – 60 m from dense cover, and that cover was most often sandy patches with *Acacia spp.* and tall grasses. Nests were never sited in vegetation clumps, but, with one exception, there was always some type of low growing plant, debris, or rocks near to the nest bowl. Surprisingly, nests were not clustered in the most open areas of the reserve, at sites similar to those described throughout central Asia. I suggest that houbara are very adaptable in their nesting requirements, and that nesting in areas that have trees may be a natural behaviour within the southern extremity of their range, rather than an aberrant behaviour by naive captive-reared and released birds.

I collected regular location data for all reintroduced adult houbara and used these to describe patterns of home range use in Chapter 6. Houbara have large (13000 – 16000 ha) home ranges. Male home ranges were smaller in the breeding and largest in pre-breeding seasons, whereas females had large breeding ranges and small pre-breeding ranges. Both sexes had multiple (1 – 4) cores within each range, and used most parts of their core areas. Half of all birds were site faithful to some part of core areas between seasons and years, but the level of actual home range overlap was low. Individual variation in overlap areas was high, and was similar for males and females. Home ranges were not exclusive, indicating a level of shared use of areas, but houbara were not gregarious, and were positively associated with one another on only 9.4 % of occasions. Generally, over a season, individual birds overlapped in the use of an area spatially, but not temporally. In the breeding season, associations were between sexes, whereas outside the breeding season, single-sex associations were more prevalent. I discuss four non-exclusive hypotheses for differences between sexes in home range use: mate, nest-site or food searching by females, and contraction of range by males during display.

Houbara are a lekking species, where the males give elaborate displays for the purpose of obtaining a mate, but take no part in raising young. In Chapter 7, I described in detail the pattern and timing of male display behaviours, and tested whether males differ in the intensity of their display within each season. On 100 occasions, I recorded a total of 570 displays, given by 16 of 17 adult males in the reserve. Males spent a mean of 67 secs in running displays, 2 mins 14 secs between runs, and gave 17.8 display runs per hour. During a single run males could cover up to 1.2 km (straight-line distance), and range over an area that was 2.2 km in diameter during a morning. Males displayed from daylight for 4 hrs, and for 2.5 hrs before dusk until dusk, from January to May. No displays were seen outside that period. Intensity of displaying differed between males within a season, and thus, males were providing females with an opportunity to assess male fitness by the intensity of the display.

In Chapter 8, I used location data collected during observations on houbara breeding behaviour and home range studies to test predictions about the location of male lek sites relative to females. There are several competing models that attempt to explain why males cluster at specific sites during displays. I tested three of four predictions of one of these models: the hotspot model, and showed that two predictions were supported by my data.

Male houbara display sites were most likely to be found at sites where female numbers were high, and where many female ranges overlapped, but not at sites where females spent the most time. I discuss the significance of these results based on the unpredictable nature of local movements of females, but strong female site fidelity to an overall home range area. I further suggest that males are maximising encounters with females by conspicuously displaying from the same site for long periods, rather than adopting an alternative "floater" strategy, where males would travel to a site near to a female's core home range, display to her, then move to the next female's range.

Finally, in Chapter 9, I summarise these results in the context of the value of this reintroduction project in advancing our understanding of the process of reintroduction, and of houbara survival, breeding, home range, movements and behaviour, and I make recommendations for future work on the species. Specifically, I recommend that future research focuses on quantifying breeding parameters that are limiting population growth so as to determine whether further supplementation of this reintroduction attempt is required, and on ensuring releases are conducted in sites where predators are more aggressively controlled, or where they are absent. Further, I recommend that houbara are released from more spacious cages that allow birds a greater degree of movement before release. In addition, houbara in Mahazat as-Sayd Reserve offer an excellent opportunity to examine questions on the mating and social behaviour of the species, and on lek theory: research opportunities that are greatly aided by having population of known age and gender. I recommend that researchers use this reintroduced population to further address these questions.

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