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# The restoration of the Mauritius Kestrel *Falco punctatus* population

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By 1974, the Mauritius Kestrel *Falco punctatus* had declined to only four known wild birds, including one breeding pair, as a result of habitat loss and pesticide contamination. A conservation project begun in 1973 has used many management techniques including captive breeding, supplemental feeding of wild birds, provision of nestboxes, multiple clutching, egg pulling, artificial incubation, hand rearing and release of captive-bred and captive-reared birds by hacking, fostering and predator control. A total of 331 kestrels were released in the 10 years up to the end of the 1993–1994 breeding season; one-third of these were captive bred, the rest were derived from eggs harvested from the wild. About 257 (78%) released birds survived to independence and 61% of independent juveniles survived their first winter. Although at least 71% of ringed birds attempted to breed in their first year, only 38% of the nests of first-year females successfully fledged young, averaging 1.7 per successful nest. Older females fledged young from 64% of nests, fledging an average of 2.0 per successful nest. The breeding success of hacked birds was similar to that of parent-raised kestrels, though the clutches of hacked birds tended to be larger. Annual replacement of birds holding territories averaged 17% for both sexes. By the 1993–1994 season, an estimated 56–68 pairs had established territories in the wild with a post-breeding population, including floating birds and independent young, of 222–286. Most of the kestrels were in three sub-populations, two of which were derived entirely from released birds. Mauritius Kestrels are relatively sedentary; 89% of ringed birds found nesting were less than 5 km from their release or fledging site. Since the pesticides responsible for their decline are no longer used, the number of Mauritius Kestrels should continue to rise through natural recruitment. The distribution of suitable habitat suggests that an eventual population of 500–600 kestrels on Mauritius is possible. Due to its outstanding success, the release programme for the Mauritius Kestrel ended after the 1993–1994 breeding season, though the population will continue to be monitored carefully for at least the next 5 years.

"We might abandon the Mauritius kestrel to its all-but-inevitable fate, and utilize the funds to proffer stronger support for any of the hundreds of threatened bird species that are more likely to survive".

Norman Myers
*The Sinking Ark*, 1979

The Mauritius Kestrel *Falco punctatus* is a small falcon endemic to the island of Mauritius in the western Indian Ocean. During the 1960s and 1970s it was critically endangered, and many feared that its extinction was inevitable (Brown & Amadon 1968, Myers 1979).

Prior to the arrival of settlers in the 17th century, the kestrel was probably found throughout the island. Despite forest destruction and some persecution, it was still common early this century. By 1950, it was apparently restricted to the three main mountain chains, the Moka range in the northwest, the Bambous Mountains in the east and the Black River range in the southwest (Jones 1987, Jones & Owadally 1988). By 1960 the Mauritius Kestrel was endangered (Vincent 1966), and in 1974 only four individuals were known in the wild (Temple 1977). The catastrophic decline in numbers resulted from the liberal use of pesticides, especially DDT, dieldrin and other organochlorines used to control agricultural pests and malaria-carrying mosquitoes, from 1948 until 1970 (Ricaud 1975, Mamet 1979, Cheke 1987).

A conservation project, which has included management of the free-living kestrel population, a captive breeding programme and the release of captive-bred and captive-reared birds, started in 1973.

## METHODS

### Management of the wild kestrels

To enhance productivity of the wild pairs, the following measures were taken. Eggs were taken as laid to increase the size of clutches, and whole clutches were removed to allow the pairs to relay. Such egg manipulations followed work on other kestrels (Porter & Wiemeyer 1972, Porter 1975, Bird & Lague 1982), and experiments on captive Mauritius Kestrels allowed the techniques to be perfected. The eggs harvested in this way were artificially incubated. The young were hand reared and, apart from those retained for the captive breeding programme, released mostly in areas outside the range of the original wild population. Also, some captive-bred and captive-reared nestlings were fostered in 'wild' nests.

Most Mauritius Kestrels nest in holes in cliff faces, but occasionally tree cavities are also used (Jones 1987, Jones *et al.* 1991). Where natural nest sites were in short supply, additional nestboxes were provided. Some wild pairs were supplied with mice or day-old chicks to supplement their diet in order to increase the number of fertile eggs they laid. Introduced predators—the Small Indian Mongoose *Herpestes auropunctatus* and feral Cat *Felis catus*—that prey on fledglings were trapped in the vicinity of some nests (Jones & Owadally 1988, Jones *et al.* 1991, Cade & Jones 1993).

### The captive breeding programme

In the first attempts at establishing the captive breeding programme, adult Mauritius Kestrels were trapped. Later, eggs or nestlings were removed from nests in the wild. For most of the captive breeding programme, the captive kestrels were kept in aviaries at Black River, Mauritius (Jones *et al.* 1981, 1991), where they were fed on mice and day-old chicks. The methods used in the care of captive kestrels were described in detail by Jones (1980, 1984), Jones *et al.* (1981, 1991) and Jones & Owadally (1985, 1988). Most of the eggs were artificially incubated, and the young were made available for the release programme. In 1986, three pairs of Mauritius Kestrels were sent to the World Centre for Birds of Prey in Boise, Idaho, U.S.A., and captive-bred birds have since been further distributed to a few zoos and wildlife collections (French 1993).

### Release of captive-bred and captive-reared kestrels

The release of captive-bred and captive-reared birds was intended to supplement the population in the southwest of the island and restore the numbers in the Moka and Bambous Mountains. Apart from a few full-grown first-year birds released on an offshore island, all releases were of nestling kestrels whether captive-bred or captive-reared, either through fostering in the nests of free-living pairs or by hacking (Sherrod *et al.* 1981). The basic techniques were varied to test for the best results (Jones & Owadally 1988, Jones *et al.* 1991).

To foster young, 5–18-day-old nestlings were placed in the nests of free-living kestrels that had been incubating for at least 2 weeks (incubation normally lasts 30 days) (Jones 1984, 1987). The eggs were removed for artificial incubation. In hacking, 25–34-day-old nestlings able to tear up food for themselves were installed in small groups in a nestbox at the release site. Mice or day-old chicks were provided daily while the kestrels fledged and developed flying and hunting skills. Feeding continued until the birds had become independent. All of the hacked birds and several of the fostered birds were trained to respond to a whistle and to take food from a person following their progress. Predators were trapped in the area around some of the nest sites used for fostering and at all the hack sites.

### Monitoring kestrels in the wild

Wild kestrels were located and their behaviour and breeding activity were monitored. Radio-telemetry was used to map territories and record habitat utilization. The activity of released birds, some of which were also radio-tracked, was monitored: survival, dispersal, establishment of territories and progress of breeding attempts were noted.

## RESULTS

### Management of the wild kestrels

The most successful method of increasing the productivity of wild pairs has been the harvesting of eggs as whole clutches. After the removal of the first clutch, 95% of 76 females two or more years old relaid, starting a new clutch 14 days later. The mean size of unextended first clutches was 3.4 eggs (range 1–5, $n = 96$) and of second clutches 3.3 (range 1–5, $n = 63$). There was 75% fertility of harvested eggs with 78% ($n = 315$) fertility of first clutches dropping to 59% ($n = 70$) in repeat clutches. Hatchability of 292 fertile eggs under laboratory conditions was 83%. As a result of harvesting clutches from wild birds, females laid up to four clutches in a season. Egg fitness declined in later clutches, and no fourth clutch ever included fertile eggs.

There have been mixed results from removing each egg within 24 h of laying in an attempt to increase the size of clutches. In four out of seven attempts, the clutch size was increased above five, to six eggs in two nests and eight in another two (Jones *et al.* 1991). However, in the extended clutches, egg fertility and hatchability declined.

Although supplemental feeding increased egg production and was instrumental in allowing kestrels to relay after a first brood had fledged, it did not always result in greater numbers of birds fledging and in some cases actually lowered the production of young. In the wild, young kestrels are fed primarily upon Day Geckos *Phelsuma* spp. (Jones 1987), after eating which they do not need to produce pellets. The hand-rearing work showed that chicks were unable to cope with

**Table 1.** *The numbers of Mauritius Kestrels released[1] in different parts of Mauritius*

| Season | Southwest | East | South | North | Totals |
|---|---|---|---|---|---|
| 1984–1985 | 1 (1)[2] | | | | 1 (1) |
| 1985–1986 | 4 (4) | | | | 4 (4) |
| 1986–1987 | 9 (4) | | | | 9 (4) |
| 1987–1988 | 9 (8) | 12 (10) | | | 21 (18) |
| 1988–1989 | 4 (3) | 22 (16) | | | 26 (19) |
| 1989–1990 | 14 (11) | 39 (31) | 4 (4) | | 57 (46) |
| 1990–1991 | 17 (11) | 16 (9) | 0 | 27 (21) | 60 (41) |
| 1991–1992 | 29 (22) | 21 (17) | 0 | 13 (9) | 63 (48) |
| 1992–1993 | 40 (34) | 3 (2) | 0 | 0 | 43 (36) |
| 1993–1994 | 40 (35) | 7 (5) | 0 | 0 | 47 (40) |
| Totals | 167 (133) | 120 (90) | 4 (4) | 40 (30) | 331 (257) |

[1] Six birds have been released twice after having been rescued sick or injured; five were re-released in a different area. Only the final release is counted here.

[2] The values in parentheses are the number of birds that are believed to have become independent. Where the exact figure is not known, an estimate is given.

large amounts of roughage, especially during their first week. They were less able to tolerate fur and feathers in the diet than were the European Kestrels *Falco tinnunculus* which were reared alongside Mauritius Kestrels on the same diets. During the 1990–1991 breeding season, seven free-living pairs were supplementally fed on day-old chicks and laboratory mice. The young of these all disappeared within a few days, and 5-day-old chicks fostered to two of these pairs also disappeared. It is suspected that most, if not all, of these young died from impaction of the proventriculus. A month-old chick, found dead beneath a nest, was found at post-mortem to have the proventriculus compacted with mouse fur.

Abundant potential nest holes occur in the cliffs of the mountainous southwest, and most of the kestrels there nest in cliff cavities. In the less precipitous Bambous Mountains, there are few suitable nest cavities and nestboxes have become an increasingly important part of management. Of the 105 documented nesting attempts (including repeat nestings) in the Bambous Mountains during 1988–1989 to 1993–1994, 90% were in nestboxes. Of the remaining 11, three were in holes in trees and eight in cliff cavities. In the 1993–1994 season, 49% of the 45 monitored pairs used nestboxes. Several birds returned and nested in the boxes from which they were released.

## The captive breeding programme

Between December 1973 and 1988, five adult Mauritius Kestrels, four fledglings and three nestlings were taken from the wild. Fourteen birds reared from eggs harvested from the wild were also retained to join the captive breeding programme (Jones *et al.* 1991).

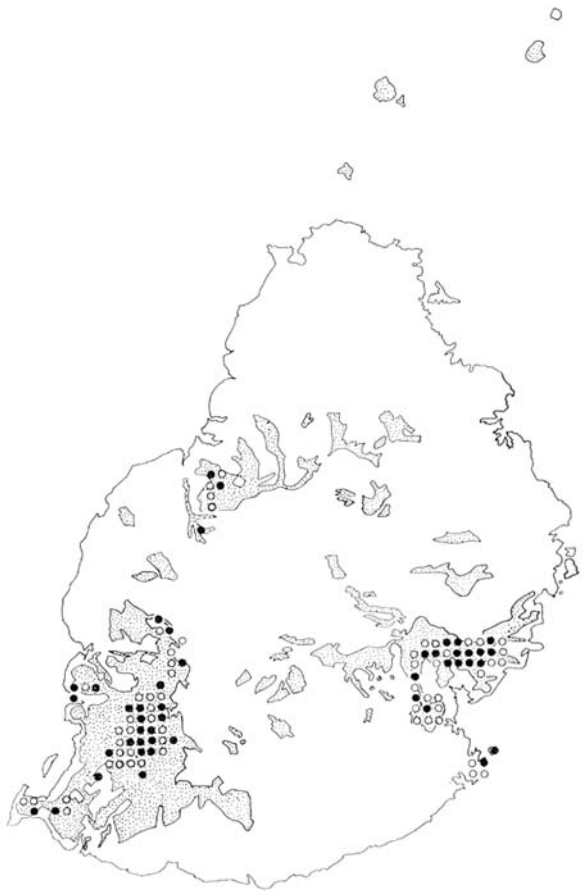

**Figure 1.** The distribution of the Mauritius Kestrel and areas of potential habitat (stippled) in 1994. Kilometre squares with territorial pairs are shown as solid circles, the open circles are where kestrels occur but are not breeding.

In captivity, Mauritius Kestrels lay clutches of one to five eggs, though three or four is normal. First clutches are laid during September–November and replacement clutches until January. Fertility of captive-laid eggs is only 38%, in part because many of the eggs were laid by single females or by females in non-copulating pairs. From 1978 to 1992, 190 fertile eggs were laid at the Government Aviary in Black River; 129 (68%) hatched, 103 (80%) were reared, mostly by hand, and 84 (82%) of the young kestrels were released into the wild.

The three pairs sent to the World Centre for Birds of Prey bred successfully, and 36 young were reared (Jones *et al.* 1991). Of these, 32 were returned to Mauritius, 25 of which were released into the wild.

## Release of captive-bred and captive-reared kestrels

The success rate of rearing young hatched from harvested eggs was significantly higher than that for young from eggs

laid in captivity. Out of 242 harvested eggs that hatched, 233 (96%) were reared, compared with 80% for captive-laid eggs ($P < 0.01$).

Between the 1984–1985 and 1993–1994 breeding seasons, 331 Mauritius Kestrels were released, and about 257 (78%) became independent (Table 1). Of these, 105 kestrels were fostered into 46 different broods of one to four individuals (with an average of 2.3); 96 (91%) fledged and of these 78 (81%)became independent. A total of 44 pairs (96%) successfully reared at least one young to fledging. Brood size at fledging in successful nests averaged 2.1.

Of the 208 fledglings hacked, about 164 (79%) became independent. Fifty groups of one to seven (mean 4.2) young kestrels were hacked. Kestrels released by this technique fledged mostly at 33–38 days old and gained their independence at 85–100 days old, most moving out of the area at an age similar to that of parent-raised birds. The kestrels were released in the three main areas of suitable habitat: southwest Mauritius, the Bambous Mountains and the Moka range (Fig. 1).

Some of the kestrels from the World Centre for Birds of Prey were already fully grown juveniles when they arrived. Eighteen were released on the 25-ha island of Ile aux Aigrettes, nearly 1 km off the southeast coast, and fed daily. Fourteen became independent (Jones *et al.* 1991).

The project to release captive-bred and captive-reared young was wound up at the end of the 1993–1994 breeding season because it was judged that the free-living population had recovered. Mauritius Kestrels were again breeding in the three mountain chains where they had existed prior to the use of organochlorines, and the annual rate of natural recruitment was exceeding mortality.

## Monitoring kestrels in the wild

### *Population*

The population of kestrels in southwest Mauritius, in and around the Black River Gorges, increased steadily in the second half of the 1980s, owing largely to careful management (Jones *et al.* 1991, Cade & Jones 1993). In all, 167 kestrels have since been released in this area (Table 1), and in the 1993–1994 breeding season there were at least 29 territorial pairs. Of these, 16 (53%) or more included at least one released bird as a member of the pair. In the seven seasons since 1987, 124 kestrels have been released in the Bambous Mountains and surrounding areas in the southeast. In the 1993–1994 season, there was a minimum of 24 breeding pairs in this area. During the 1990–1991 and 1991–1992 breeding seasons, 40 birds were hacked in the Moka range and 30 of them became independent. At least three territorial pairs were recorded there in 1993–1994.

At the end of the 1993–1994 breeding season, the known free-living population was 56 territorial pairs, with possibly as many as 68. Single birds were located in, or on the periphery of, several territories, and the number of non-breeding birds was estimated to be 40–70. The total number of independent young was 23 hacked birds, 17 fostered birds and a natural production of 30–40, giving a total post-breeding population of 222–286 birds. It is estimated that 180–200 (*c.* 70–80%) of these birds were released birds or their progeny. The population growth, together with the number of birds released, is shown in Figure 2, and a record of known territory-holding pairs each season is given in Figure 3.

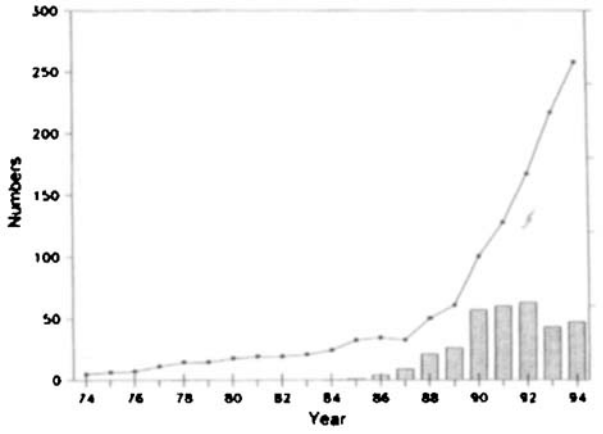


**Figure 2.** Post-breeding population estimate for the Mauritius Kestrel (continuous line) together with the number of birds released annually (histogram).

### *Habitat*

Several of the released birds have shown behaviour strikingly different from that of wild Mauritius Kestrels, with greater versatility in habitat selection, hunting behaviour and choice of prey (Jones *et al.* 1991, Cade & Jones 1993). Historical records on the kestrel indicate that it was originally restricted to forest habitat (Jones & Owadally 1985, Jones 1987). Field work in the early 1980s suggested that the kestrels were obligate forest dwellers, with the most successful breeding birds being found in the best areas of native forest (Temple 1981, 1986, Jones & Owadally 1985). At the time, it was felt that the kestrel was tied to good forest because it fed largely upon the endemic Day Geckos (Jones 1987), but subsequent studies showed that it could exploit other prey species (Jones & Owadally 1988). Many kestrel species are highly adaptable and live in a wide range of habitats, including built-up areas (Cade 1982). In an attempt to encourage the expression of this versatility in the Mauritius Kestrel, birds were released in a range of habitat types, many of which were alien to the species (Table 2).

The first releases were in good-quality native lowland forest, which was thought to be typical kestrel habitat. Subsequently, as an experiment, kestrels were released in exotic lowland savannah. The kestrels showed great versatility in this more open habitat and expressed behaviour which had not been seen previously. They perched on fence posts and

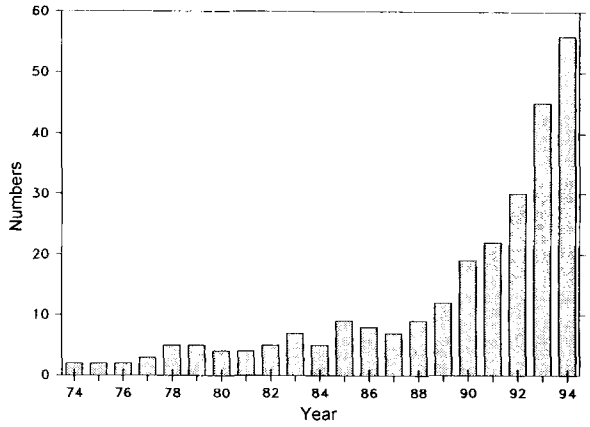


**Figure 3.** The number of territorial pairs of Mauritius Kestrels recorded each breeding season 1973–1993.

pounced on insects, they chased and caught introduced passerines, House Shrews *Suncus murinus* and Agama Lizards *Calotes versicolor*, as well as Day Geckos (Jones & Owadally 1988). In the following year, a group of four kestrels was hacked from a tower in the middle of an open field in exotic *Acacia* savannah. All these birds reached independence.

Many of the freed kestrels in the east of Mauritius, attracted by established pairs, have moved into areas of degraded and fragmented forest. Kestrels released on the island of Ile aux Aigrettes flew across to the mainland and hunted in gardens in the suburbs of Mahébourg, and there are two pairs living and breeding in the village of Black River. These are the first records of suburban Mauritius Kestrels.

### *Dispersal*

Although Mauritius Kestrels typically do not move very far from where they fledge, they are strongly attracted to established pairs. Over one-third (34%) ($n = 83$) were relocated within 1 km of their release/nest site, and 89% were within 5 km (Fig. 4). All records of more than 5 km were of birds that had been hacked in unoccupied areas, and the distance recorded is how far they had to travel to reach an established population. No kestrel from the Black River Gorges area has yet been recorded outside the gorges. Clustering of territories has always been a feature of the released birds and of the kestrels in the Black River Gorges.

### *Size of territories*

Based on the spacing between nest sites and observations of foraging males, Jones (1987) suggested that territories in the Black River Gorges during the breeding season covered 0.8–1.4 km² with a mean of about 1 km². A radio-telemetry study during the 1984–1985 breeding season of four territorial birds gave territory sizes of 0.45–0.75 km² with a mean of 0.60 km² (Jones 1987). In the eastern population, nest-site spacing during the 1992–1993 breeding season suggested a mean territory size of 1.0 ± 0.76 km² ($n = 16$) and, in the southwestern population, 1.8 ± 1.62 km² ($n = 19$). During the 1993–1994 season, the territories in the eastern population were mapped by repeated observations of the birds, all of which were colour-ringed. The mean territory size was 0.51 ± 0.14 km² ($n = 19$).

Territory boundaries typically follow ridge lines or the contours and are usually well defined during the breeding season. Provided the same birds are present, territory boundaries show little change from one year to the next. Birds rarely move to new territories. In the eastern group in 63 pair/years, only one male and two females have moved. The birds moved to adjacent territories following failed breeding attempts.

### *Age at first breeding*

Overall, 70% ($n = 84$) of the kestrels were discovered breeding when 1 year old. This is likely to be an underestimate

**Table 2.** *The numbers of Mauritius Kestrels hacked*[1] *in different habitats*

| Habitat | 1985–1986 | 1986–1987 | 1987–1988 | 1988–1989 | 1989–1990 | 1990–1991 | 1991–1992 | 1992–1993 | 1993–1994 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| Lowland forest | 4 (4) | 3 (1) | | | | | 7 (7) | | | 14 (12) |
| Exotic savanna | | 3 (1) | 4 (4) | | 6 (5) | 23 (17) | 15 (9) | | | 51 (36) |
| Secondary forest | | | 12 (10) | 5 (5) | | | | 19 (16) | | 36 (31) |
| Fragmented secondary forest | | | | 11 (8) | 18 (14) | | | 11 (8) | | 40 (30) |
| Small forested island | | | | | 7 (5) | 7 (3) | 14 (12) | | 2 (2) | 30 (22) |
| Forested river valley | | | | | 4 (4) | | | | | 4 (4) |
| Fragmented primary forest | | | | | | 6 (5) | 17 (12) | | | 23 (17) |
| Parkland/garden | | | | | | 4 (4) | | | | 4 (4) |
| Mid-altitude forest | | | | | | | | | 24 (21) | 24 (21) |
| Totals | 4 (4) | 6 (2) | 16 (14) | 16 (13) | 35 (28) | 40 (29) | 53 (40) | 30 (24) | 26 (23) | 226 (177) |

[1] The values represent the number of birds hacked followed in parentheses by the number that became independent.

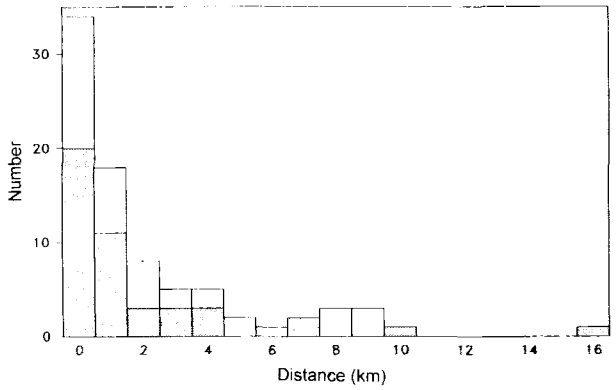


**Figure 4.** Distance moved from nest or release site to place of first breeding of 83 Mauritius Kestrels (males stippled, females open histogram).

since some of the kestrels, first found breeding when older, may have been overlooked in previous years. The average age of first recorded breeding in males was 1.3 years ($n$ = 41) and in females, 1.6 years ($n$ = 43).

*Breeding success*

Of all eggs laid in first clutches, 50% hatched and for repeat clutches, 61%. Fifty-three percent of all the young that hatched fledged. One-year-old females raised only 47% of their young, but this figure was 76% in older females for their first brood of the season. These differences are not statistically significant since the sample sizes were small. One-year-old females typically laid smaller clutches than did older birds (Table 3). Twelve percent of all pairs failed to hatch any eggs in a clutch. Excluding these, the percentages of eggs that hatched in first clutches and repeat clutches were 74% and 79%, respectively. Significantly fewer repeat nestings succeeded in fledging young ($P < 0.05$), however, and consequently the mean brood size per breeding pair was significantly smaller ($P < 0.05$). In repeat broods, only 34% of the pairs fledged one or more young (Table 3).

Although kestrels will relay if clutches are removed, none of the pairs followed fledged two broods in a season, although eight (17%) out of 48 closely monitored pairs laid again after the first brood had left the nest. Seven of these pairs were being supplementally fed, and the extra clutches were probably the result of an abundant food supply. Only two of these pairs hatched young, since most of the eggs were infertile.

Once incubation had started, only three whole clutches were lost to predators. Eggs occasionally disappeared when the clutch was being laid and the female was not sitting tight. These presumably were taken by Ship (Black) Rats *Rattus rattus*. This type of predation is hard to quantify but affected at most 5% of nesting attempts.

*Survival and mortality*

Annual survival of territorial birds, measured by recording the percentage of birds which maintained territories from one year to the next, was 83% for males ($n$ = 92) and 84% for females ($n$ = 107). Survival for the whole of the first year was 56%, if the rate of mortality is assumed to drop to the adult level during the summer months. Of the 85 birds which were released and reached independence in the eastern population up to the 1992–1993 season, 45 (53%) have subsequently been relocated in territorial pairs.

After the first week, the rate of mortality dropped off sharply, and of the 102 chicks 10 days or older that we fostered, 96 (94%) fledged. Of all the fledged kestrels that

**Table 3.** *Breeding success*[1] *of Mauritius Kestrels*

| | 1-year-old females | Older females | Repeat clutches (older females) |
|---|---|---|---|
| Percent of pairs breeding or relaying | 91% (35) | 97% (162) | 95% (66) |
| Clutch size | 3.0 ± 0.84 (25) | 3.4 ± 0.86 (96) | 3.3 ± 0.90 (63) |
| Number hatched per breeding pair | 1.8 ± 1.44 (10) | 1.7 ± 1.39 (25) | 2.0 ± 1.40 (47) |
| Number hatched per successful nest | 2.5 ± 0.96 (7) | 2.4 ± 0.93 (17) | 2.6 ± 0.98 (36) |
| Number fledged per breeding pair | 0.6 ± 1.03 (16) | 1.3 ± 1.11 (87)* | 0.7 ± 1.07 (58)* |
| Number fledged per successful nest | 1.7 ± 1.03 (6) | 2.0 ± 0.65 (56) | 2.1 ± 0.74 (20) |
| % of pairs fledging one or more young | 38% (16) | 64% (88)* | 34% (58)* |

[1] Comparisons marked * are significant, $P < 0.05$. Sample sizes are in parentheses.

did not reach independence, the cause of mortality was known for 26 (39%). For the first 2 weeks, they spent a lot of time on the ground and were particularly susceptible to predation by cats and mongooses. As they developed their hunting and flying skills, the kestrels suffered collision injuries. Death by drowning and entrapment also caused several deaths.

The little data available for adult mortality suggest that collision injuries are a major cause of death, but accidents and predation are also important.

## DISCUSSION

The Mauritius Kestrel population had increased sufficiently by early 1994 that it was likely it would expand into all suitable habitat without further releases. About 216 km$^2$ of good habitat and 80 km$^2$ of marginal habitat existed (Fig. 1). In addition, there was 133 km of linear habitat along river and stream valleys. This is about 16% of the island. Assuming a density of one pair per 1.0 km$^2$, the habitat could hold about 200–250 territories. Allowing for floating birds, a total pre-breeding season population of 600–800 birds is possible.

A population of 500 breeding birds has been suggested (Franklin 1980) as a minimum that will maintain genetic diversity within a population and may eventually allow, through mutation, for the restoration of any genetic impoverishment that the species may have developed while in its population bottleneck.

The kestrel population has apparently avoided severe genetic problems, and the only evidence of inbreeding depression is the relatively high rate of infertile eggs; otherwise breeding success and survival have been good. The percentage of infertility of 388 harvested eggs was 25% and, in all, 38% failed to hatch. In nests in the wild from which at least one young successfully hatched, egg failures were 31% and 36% for first clutches and repeat clutches, respectively. These egg failure rates were higher than those for the Seychelles Kestrel *F. araea* for which the comparable figure is 20% (Watson 1992).

The number of young fledged varies between the different age classes and nesting attempts from 0.6 to 1.3 young per breeding attempt with a mean of 1.03 for all nesting attempts (including repeat nestings). This is lower than the expected productivity of small temperate falcons (Newton 1979) but is similar to data from the Seychelles Kestrel (Watson 1992).

The rate of adult survival in the Mauritius Kestrel has been good; only 17% of territorial males and 16% of territorial females were lost each year. About 22% of released Mauritius Kestrels died before independence. But after independence about 61% survived the austral winter and 56% survived for a whole year. These figures are considerably better than those for temperate species of small falcons (Newton 1979).

In the early 1980s, some conservation organizations began to embrace the philosophies of "triage" as expounded by Myers (1979), and, as a direct consequence, some withdrew funding from the kestrel conservation project. The work on Mauritius was criticized as being too narrow and species orientated. However, this species work has provided a major incentive for habitat protection and ecological restoration work. There is no doubt that if resources had initially been directed towards habitat conservation, not as much would have been achieved. As a direct consequence of species management work, 6574 ha of native forest in the southwest of Mauritius has been designated as Mauritius' first National Park.

The project for the restoration of the Mauritius Kestrel comes under the auspices, and part funding, of the Ministry of Agriculture (National Parks and Conservation Service), Government of Mauritius. The project is supported by the Peregrine Fund, Wildlife Preservation Trusts and the Mauritian Wildlife Fund. Kestrels and biologists have been flown back and forth to the U.S.A. courtesy of Rod Hall and British Airways Assisting Nature Conservation. Air Mauritius have provided flights and help in other ways. We thank all those who have helped with the care of the captive, the release of young and the management of wild and free-living kestrels. Fuller acknowledgments are given in previous publications. This manuscript was commented upon by Malcolm Nicoll, James Groombridge, David Todd, Kirsty Swinnerton, Alan Kemp, Ian Newton, Roger Safford, Ehsan Dulloo, Greg Middleton, John Hartley and two anonymous referees.

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