# The Little Kestrel That Could

Shelley Parker

Writer's comment: When Allen Fish assigned a research paper for AVS115 (Raptor Biology), he kindly gave us the freedom to choose any diurnal raptor we wished as our subject. I knew my theme would be conservation, but I was less certain as to which of the approximately 300 diurnal raptor species to select. After much consideration, I decided it would be fun to look to the opposite side of the world and learn about a bird that I had never heard of before. This is how I met the Mauritius Kestrel from the tiny island of Mauritius in the Indian Ocean. What I didn't know until my research began was that the Mauritius Kestrel would also be a wonderful choice because its story is one of success against near extinction. Down to just 4 birds in the 1970s, there now are upwards of 800 flying free in the wild! I tried to reflect in my writing this spirit of hope and encouragement, and I am happy that others too now will get to learn a little about this kestrel, its amazing story of survival, and the fact that people can and do make a positive difference for wildlife. I want to thank Allen Fish for allowing me to gain, through his teaching style, a great knowledge and appreciation for birds of prey. Special thanks also to Ruth Gustafson at Shields Library for assisting my research, and Eric Schroeder of the University Writing Program for reviewing my work.

*—Shelley Parker*

Instructor's Comment: "We have not known a single great scientist who could not discourse freely and interestingly with a child," wrote John Steinbeck in *The Log from the Sea of Cortez.* Shelley Parker's essay on the Mauritius Kestrel—at one time, the world's most endangered raptor—achieves a friendliness and clarity that would easily hook a kindergartner (and yes, I tested this hypothesis on my son). Shelley grabs us first with the classification of kestrels worldwide, then imparts the essence of the Mauritius Kes as a forest-dwelling gecko-eater. She introduces the biologists, Stan Temple and Carl Jones, most responsible for bringing back the little island raptor from 4 individuals in the 1970s to an estimated 800 birds in the late 90s, allowing us to see Temple and Jones (their real names, Mr. Spielberg!) in a kind of "one step forward, two steps back" humanness as they pursue this goal in anything-but-linear fashion. As much as scientists aspire to be objective and methodical, passion and dogged determination are more likely to save species. And, of course, the work is never, and will never, be done. Shelley Parker's essay serves up an elegant snapshot of the reality of species conservation work, as well as a case for our collective and desperate need for more impassioned scientists on the planet.

*—Allen Fish, Avian Sciences*

On display at the American Museum of Natural History in Washington D.C. are the skeletal remains of *Raphus cucullatus*, more commonly known as the Dodo bird. First discovered by Dutch sailors on the West Indian Ocean island of Mauritius at the dawn of the 17th century, the Dodo in less than eighty years was extinct. It is possible that some were eaten by the sailors, but the primary cause of the demise was deforestation of their tropical habitat and the introduction of non-indigenous predatory species such as cats, rats, and pigs, which destroyed Dodo nests. This story is all too familiar to most of us, even today five centuries later, as we hear of new additions to the endangered species list. According to the World Conservation Union, currently 15,589 species of animals and plants worldwide are threatened with extinction (WCU 2006). We may wonder, can the example of the lost Dodo bird inspire us to fight this downward spiral of extinction? Right there on that same island of Mauritius, this question is being answered with a resounding yes!

The subject of this story is the Mauritius kestrel (*Falco punctatus*), a small raptor found only on the island of Mauritius (see Fig. 1). Among the smallest of kestrels, they average 30cm in length with weights of about 180g for females and 120g for males. Male and female plumage is the same: pale cream chest with black spots on the chest, abdomen, and flanks varying among black hearts, ovals, and arrowheads. Feathers on head, neck, wing, and tail are chestnut-brown with black streaks or bars. The tail feathers have a cream band at the end. The beak is grey with yellow skin around the nares. The eyes are large and dark brown surrounded by a pale yellow ring with

**Figure 1: The Mauritius kestrel (*Falco punctatus*).** Photo with permission from the Birds of Mauritius website <http://www.birds.mu/Endemic/Images/Kestrel2.jpg>.

a black vertical bar underneath. The feet are yellowish with dark brown talons.

**Taxonomy**

The Mauritius kestrel is one of thirteen kestrel species in the family *Falconidae* and genus *Falco* (Village 1990). For clarity, taxonomists separate *Falco* into New World and Old World species. The American kestrel (*F. sparvarius*) alone, found throughout North and South America, makes up the New World species. The remaining twelve species belong to the Old World group, which is further divided into grey and rufous morphs. Three African species are grey, and nine rufous morphs inhabit Europe, the East Indies, and Australia. Included among this latter group are three Indian Ocean species, the Seychelles kestrel (*F. araea*), Madagascar kestrel (*F. newtoni*), and the Mauritius kestrel.

What differentiates kestrels from other falcons, and how is this kestrel different from other kestrels? The answer to the first part of this question is the subject of debate; however, five basic criteria can be used (Village 1990). The first and main defining feature is hovering, a behavior used mostly to hunt. This trait, however, is not entirely diagnostic because kestrels vary in their use of hovering from extensive to none at all, such as in the Mauritius kestrel. So hovering falcons are kestrels, yet not all kestrels hover. A second distinguishing trait to consider is their short wing-to-tail ratio. With tails 60-70% of wing length, they can be thought of as falcons with short wings and long tails. A relatively short toe length is a third demarcation. Interestingly, this difference in foot structure is directly related to diet, resulting in longer toes and claws for kestrels eating bird prey (middle toe at 80-100% tarsus length) as opposed to mammal or reptile eating kestrels with shorter toes (middle toes 60-70% of tarsus length). The remaining two differences, plumage color and plumage dimorphism, hold that kestrels occur only in rufous or chestnut colors and have a higher degree of dimorphism than other falcons. These factors are even less diagnostic, however, because kestrel plumages include chestnut (as with the Mauritius kestrel), in addition to grey and rufous. Also, while plumage dimorphism is more common in kestrels than in other falconids, in several species of kestrel both sexes have a plumage typical of either the male or the female. In light of the limits inherent in the above diagnostic features, other methods can provide additional clarity. In particular, comparative DNA studies over the past few decades hold promise of providing truer, more precise criteria to define relationships among raptors.

**Hunting and Prey**

The historic closed tropical forests inhabited by Mauritius kestrels resulted in morphology different from most other kestrel species that use open forests. As a result, they more closely resemble hawks of the genus *Accipiter* with short, broad, rounded wings and long tails (Temple 1987). This is a clear example of convergent evolution between the Mauritius kestrel and accipiters.

The hunting behavior of Mauritius kestrels is also akin to that of accipiters (Temple 1987). Most kestrels attack using vertical dives or stoops initiated from an elevated perch, in flight, or in a stationary hover. Mauritius kestrels do not hover, but rather attack from horizontal flights initiated from a perch where they can conceal themselves. This sit-and-wait style includes rapid flap-flap-gliding when in pursuit of prey. Again, as with accipiters, they are well adapted to hunting in closed, tropical forest containing dense vegetation that necessitates maneuverability and short rapid flights.

In descending order of frequency, Mauritius kestrels predate geckos, birds and insects, and mammals. Far and away their most important prey are the arboreal geckos of the genus *Phelsuma*, accounting for 53% of their total diet (see Table 1). During the winter months when geckos remain hidden, Mauritius kestrels rely more upon bird prey. Quantifying this observation, Temple conducted a study between 1973 and 1976 revealing that during winter the ratio of successful attacks on birds to attacks on geckos was 1:2.1, vs. 1:3.9 the remainder of the year (Temple 1987). Since geckos are so important to their livelihood, Temple further studied this predator-prey relationship and discovered that the kestrels actually tailor their hunting schedules based upon the gecko's daily routine. He found that during morning hours geckos were still lower in the trees inside protected cracks and crevices and had a random orientation with 36% facing north, 18% east, 25% south, and 21% west. During this time, the kestrel attacks were infrequent

**Table 1: Analysis of the diet of the Mauritius Kestrel (Temple 1987)**

| Type of Prey | Number and percentage of observed attacks | Number and percentage of successful attacks | Number and percentage of items brought to nests | Estimated biomass (g) represented by known captures and percentage of total[a] | Estimated energy content (kcal) of captured prey and percentage of total[b] |
|---|---|---|---|---|---|
| Insects | 60 (16%) | 16 (27%) | 10 (10%) | 17 (1%) | 20 (1%) |
| Geckos | 240 (64%) | 31 (53%) | 75 (73%) | 864 (58%) | 1426 (53%) |
| Birds | 72 (19%) | 10 (17%) | 16 (15%) | 494 (33%) | 1037 (40%) |
| Mammals | 3 (1%) | 2 (3%) | 2 (2%) | 120 (8%) | 168 (6%) |

[a]Total of individuals captured and individuals brought to nests multiplied by estimated maximum possible mass of individuals (based on unpublished measurements by the author).
[b]Total biomass multiplied by the estimated caloric content per gram, based on conversions provided by Vitt (1978), Golley (1961), Odum et al. (1965) and Ricklefs (1967).

and initiated from similarly random positions. In the afternoon, most of the geckos were higher in trees to forage and sunbathe, and their orientation changed dramatically to 11% facing north, 7% east, 9% south, and the vast majority of 73% facing west. Not surprisingly, the frequency of kestrel attacks doubled from morning to afternoon and were initiated primarily from the east, giving them a three-fold advantage: (1) visual contact maximized with majority of geckoes facing westerly; (2) geckos illuminated by the sun behind them; and (3) geckos blinded by sunlight, allowing the kestrels to approach unseen.

## Conservation

A 1974 Cornell Lab of Ornithology newsletter reported that in January of the previous year, Dr. Stanley A. Temple left Cornell to study critically endangered birds of prey on islands in the Indian Ocean (Temple 1974). In this study, he concluded that the Seychelles kestrel was successfully adapting to human-mediated environmental changes, locating forty-nine pairs on Mahé and surrounding islets. Yet on the island of Mauritius, Temple located only seven Mauritius kestrels, making it the rarest bird in the world. The following year two of those seven birds were shot, and the breeding season yielded no surviving chicks. Temple took immediate action to intervene: he obtained approval from world leaders in conservation at the time to pull two of the remaining five kestrels from the wild in order to captively breed them. Thus, Temple, the International Council for Bird Preservation, and the Peregrine Fund began research and conservation of the Mauritius kestrel.

Historically abundant over the entire island, the Mauritius kestrel suffered a decline for a number of reasons. These reasons included shooting by islanders who thought kestrels predated on poultry, falling victim to widespread organochloride usage aimed to combat malaria, and losing forest habitats to human settlement. As a result, the kestrel became restricted to three mountain chains: the Moka range to the north, the Bambous or Grand Port range to the east, and the Black River range to the southwest (Cade and Jones 1993) (see Fig. 2).

The Black River Gorges area became the kestrel's last stronghold and this is where the first attempt to prevent their extinction took place. Between 1974 and 1975 Temple placed the sole surviving four pairs in a private aviary in Black River Gorges (MWF 2006). A year later, in 1976, the kestrels were transferred to a newly constructed Black River Captive Breeding Centre built by the Government of Mauritius with help from numerous conservation organizations, including the Wildlife Preservation Trust.

Aside from Temple, who first acted upon the threat of the bird's imminent extinction, probably the most important figure in Mauritius kestrel history is a Scottish ornithologist named Carl Jones. In 1979, Jones arrived in Mauritius as the newly appointed director of the struggling conservation effort. At that time many felt the bird should be allowed to go extinct because attempts over the past couple years to captively breed them had been dismal (Petersen 1995). In fact, years later Jones asserted "it must be stated categorically that the species survived on its own in those years in spite of captive breeding attempts" (Cade and Jones 1993).

Upon arriving in Mauritius, Jones found that of the six captive kestrels, all looked unhealthy. Sadly, within a couple of years all six died! Upon investigation, he discovered that these birds died from eating mice contaminated with DDT, dieldrin, and other organochlorines (Petersen 1995). Malaria-carrying mosquitoes are a serious threat in that part of the world, and unbeknownst to the Centre,

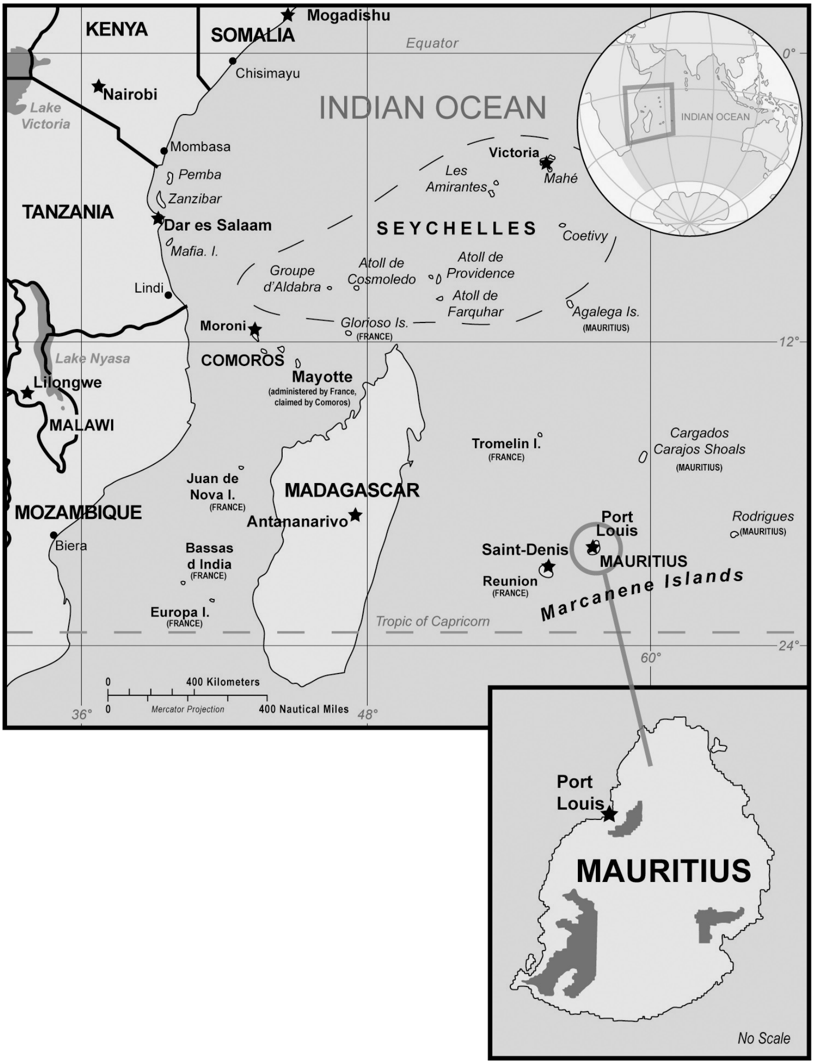


**Figure 2: Range of the Mauritius kestrel.** Adapted by John Gerlich from images at BirdLife International <www.birdlife.org> and the *CIA World Factbook.*

the wooden room where they raised mice had been sprayed over a thirty-year period with the poisons. Contamination occurred at nighttime when the mice escaped their containers and scurried along the boards, ingesting the deadly cocktail in the floor panels. And so it was that one-third of the total surviving kestrels were unwittingly killed by those very persons trying so hard to save them.

In spite of this tragedy, Jones believed the kestrel could be saved and took an impassioned approach to that end. In the first few years he was there, he journeyed alone to the mountains every day just to watch, learn, and gain an intimate understanding of this particular species. Like Jane Goodall alone with her chimpanzees in Gombe Reserve in western Tanzania, Jones, with patience and dedication, searched for an understanding of his birds on a one-to-one basis. As he explains himself, being an ornithologist and conservationist,

> [y]ou're not a physiologist studying how digestion works, you're not an ecologist studying their habitat requirements and feeding biology. You have to know your animal on a one-to-one basis, so that eventually you end up thinking like it and seeing the world through its eyes. (Petersen 1995)

The techniques Jones developed and which ultimately proved successful were derived from his intimate understanding of the Mauritius kestrel. He also incorporated methods for releasing birds of prey from the Peregrine Fund's management of the Peregrine falcon (*F. peregrinus*) (Peterson 1995). In summary, these management techniques included:

- Captive breeding
- Supplemental feeding
- Provision of nest boxes and modification of natural cavities
- Harvesting of eggs by egg-pulling and double-clutching to increase the productivity of the wild birds
- Release of captive-bred and captive-reared birds through fostering, hacking, and training of adult birds to accept food handouts until they can survive on their own
- Control of predators at release and nest-sites

(Jones 1991)

Jones and his team were the first to remove clutches from wild nests in the hopes of double clutching. This occurred during the

1981-1982 breeding season and was attempted optimistically due to success in the U.S. with the American kestrel (Jones 1985). Three eggs were pulled after six days of incubation, and, as hoped, the pair relayed. All three of these hatched and two survived. From the second clutch all hatched, but died the first day. A second kestrel pair's eggs were also taken, but they did not relay. Two of the three hatched and one survived. Years and years of this dedicated work ensued. More than two decades later, after the 1999-2000 breeding season, there were 145-200 breeding pairs and a total population of 500-800 divided into three subpopulations on mountain chains in north, east, and southwest Mauritius (BirdLife Intl 2006). The northern and eastern subpopulations consist entirely of released birds and their progeny.

In addition to his work with the kestrel, in 1984 Jones formed the Mauritius Wildlife Fund to oversee all conservation programs on the island. To date, this program has come to encompass the Pink Pigeon, the Echo Parakeet, eight songbird species, the Rodrigues Fruit Bat, five reptile species, and many endemic species of flora (MWF 2006). Supporting this work are six field stations, two endemic plant nurseries, the Captive Breeding Centre, the Gerald Durrell Endemic Wildlife Sanctuary, a Visitor's Information center, and two offices with a combined permanent staff of forty. He also helped create the country's first national park with funding from the World Bank (Petersen 1995).

In addition to captive breeding attempts on the island, kestrel pairs were also sent off to other breeding facilities. In 1986, three kestrel pairs were sent to the World Centre for Birds of Prey in Boise, Idaho (French 1993). In 1990, two pairs were sent to the Jersey Wildlife Preservation Trust in the United Kingdom (JWPT). The younger of these pairs consisted of a male hatched on Mauritius in December 1987 and a female hatched at the Boise, Idaho facility in July 1989. Their offspring hatched in 1991 and became the first successful European hatchlings for the species (French 1993).

The details of this momentous achievement began with a six-week quarantine upon arrival at JWPT. The pairs were then placed in an outdoor flight with branches and upright tree trunks for perching, and a floor covered with sand and grass. Access to an indoor heated area was provided and this was further divided into

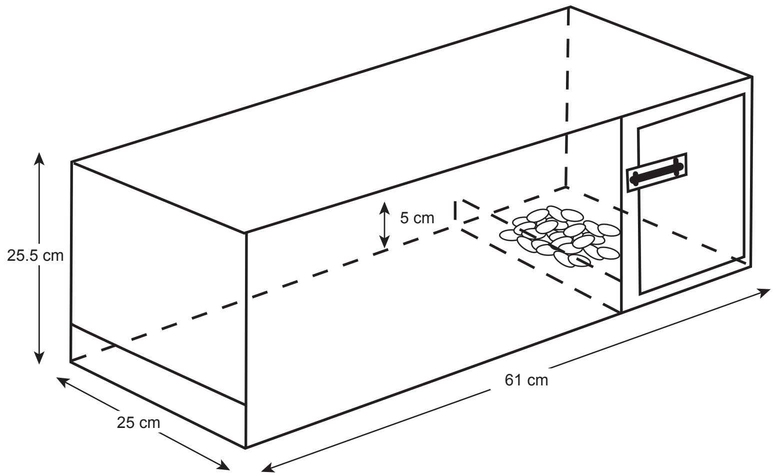


**Figure 3. Nest box. (French 1993)**

two sections for temporary separation of birds if needed. Finally, a nest box with a sand floor for the highly anticipated breeding season was added, but also used as a resting place the remainder of the year (see Fig. 3). The nest box was situated in a corner 250 cm above the floor and divided into two sections including a nesting area with an inspection door.

During the breeding season, and before winter, the pair had permanent outside access. During winter, they were shut inside at 3:00 pm. Meals consisted of three small dead white mice per day and a pinch of multi-vitamin each week. They were also fed extra portions during breeding and exceptionally cold weather. The older pair practiced courtship feeding, but the younger male during the first season was reluctant, forcing the female to snatch food away from him. Finally, he learned to pass food to her. This younger female laid a clutch of five eggs, ranging in weight from 13.5g to 17.8g. Of these five eggs, only two would produce chicks. The female did most of the incubating, and at thirty-one and thirty-three to thirty-four days, respectively, the eggs were pulled and weights recorded at 13.0g and 11.5g. These chicks were kept at 35° C and fed internal organs of white mice that were moistened in cooled boiled water. A pinch of calcium lactate was also added twice daily. On the second day, tiny fragments of mouse bone were fed with a pinch of multi-vitamin every other day. By day three, finely-chopped, skinned mouse flesh was added, and at seven days, some mouse fur.

After twelve days (51.5g and 61.1g respectively) of this hand-rearing, the older chick was returned to the parents but the younger was given to the older more experienced pair for fostering (see Fig. 4). They fledged at thirty-seven and thirty-eight days, but remained with the adults until 210 and 204 days respectively. This was a little earlier than expected but had to be done because both adult pairs were beginning to chase the young ones. At this point, they were sexed. The fate of this male/female sibling pair was to live at JWPT for a of couple years before release to Mauritius.

**Figure 4: Mauritius kestrel chicks.** Copyright Bill Burnham. Image with permission from the Peregrine Fund <www.peregrinefund.org>.

**Genetic Bottleneck**

What will determine the future success of the Mauritius kestrel population now in excess of 400 in the wild? A major factor to consider in answering this question is the genetic bottleneck the species suffered in the 1970s at their low of four individuals. Genetic comparisons with other tropical falcon species indicate a reduction in genetic diversity did occur as expected. Can the species thrive? According to Dr. Jim Groombridge at the University of Kent, the answer is yes (Groombridge et al. 2000). The possible reason he gives for this is that their productivity was only weakly affected by the bottleneck. In other words, the genes lost through the bottleneck did not include those coding for reproductive traits. Also, recovery does not need to be related to genetics, but rather to the organism's behavior. In the case of the Mauritius kestrel, since the bottleneck and subsequent conservation program, they have shown a surprising degree of flexibility in colonizing new habitats. So perhaps the sparing of genes coding for reproduction, combined with the kestrel's ability to flourish in new habitats, will enable it to overcome deleterious effects from their bottlenecking event.

Another theory proposed by Groombridge is that unrecorded nests during the time of the bottleneck provided extra DNA to help pull the species through their population recovery (Groombridge et al. 2001). To test this theory, Groombridge analyzed annual ringing data collected during the captive-breeding and reintroduction program from 1984-1994. But he also took into account the fact that Mauritius kestrels show great fidelity to their nesting sites. This means that different individuals are not equally likely to be detected, or more specifically, that banded kestrels are more likely to be observed in subsequent years. To overcome this statistical incongruity, Groombridge determined the relative frequency of ringed and unringed birds in newly established pairs and used this data. The results showed a "greater proportion of unringed birds than would be predicted from the proportion of fledglings that had been ringed in preceding year's [sic] records of fledglings" (Groombridge et al. 2001). Therefore, it is reasonable to assume that the excess unringed birds were fledged from undetected nests.

**Conclusion**

It is very fitting that the Mauritius kestrel's triumphant story unfolded on the very spot where, according to Jones, "the dawning of the modern conservation consciousness began" (Peterson 1995). Certainly, the example of the lost Dodo bird did inspire some to fight not only the kestrels' extinction, but that of all the other species now under protection on that island. The success they enjoyed in saving the Mauritius kestrel, in the face of overwhelming odds, holds an important message for the rest of us today: it is never too late for us to take action. If we decide we want to give our time, energy, and other resources, we can make a difference!

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