Ecology and Conservation of the Kagu *Rhynochetos jubatus* of New Caledonia

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To my parents for their continued support...

"Je suis pas naturaliste, je n'ai jamais aimé à m'occuper des oiseaux, je n'en ai jamais eu en ma possession ; mais celui-ci est tellement en dehors de toute la race des bipèdes emplumés, si affectueux, si intelligent, que je m'y suis attaché comme à un ami qui peuple ma solitude et qui ne manque pas un seul jour de venir, dès qu'il m'aperçoit, me souhaiter le bonjour et recevoir une caresse amicale."

Pouget 1875

Abstract

I carried out two phases of an internationally co-ordinated recovery project for the kagu *Rhynochetos jubatus* of New Caledonia between June 1991 and March 1995.

In Phase One, between June 1991 and January 1992, I established kagu abundance and distribution on Grande Terre in the first comprehensive survey of the species outside Parc Rivière Bleue, where kagu distribution was known through Yves Létocart's work there. In 177 different listening areas, I recorded a total of 491 adult kagus, including 208 pairs, in 84 of the areas, mostly in Province Sud (403 birds; 177 pairs). Low kagu numbers (1-4 birds) were recorded in 56% (n = 47) of the areas. More than nine kagus were recorded in each of 19 areas, which accounted for 57% (n = 282) of all birds. In these 19 areas, virtually all birds sang from intact forest. Kagus occurred in 'patches' over a large area of the island, but mostly in inland mountainous regions. Analyses indicated that larger numbers of kagus were likely to be found on volcanic rock types and with increasing distance from human settlements.

In Phase Two, from August 1992 to March 1995, I carried out a 32-month field-research programme at two high altitude study areas, Pic Ningua and Mt Cindoa, with the main objective of investigating if food supply was limiting annual fecundity of kagus. I found that kagu pairs probably lived on relatively fixed territories year-round where independent offspring may also be present, as was the case at Parc Rivière Bleue. At Pic Ningua, one pair nested in early December 1994, and another also probably around that time in 1993, which contrasted with the main breeding period of June-August at Parc Rivière Bleue. I recorded no breeding at Mt Cindoa, where kagus' bodyweights were generally lower than those of birds at Pic Ningua, probably due to poorer food supplies at Mt Cindoa. Kagus appeared to moult their primary feathers annually between approximately December and May, starting in close association with hot, wet conditions in the wet season, as they appeared to do at Parc Rivière Bleue. Moult may be delayed or suspended in parents feeding chicks in the wet season. After dogs *Canis familiaris* killed most of the kagus I knew at Pic Ningua (see below), remaining birds quit or extended the territories they held before the attacks. This behaviour in widowed birds may have been mostly related to a search for mates.

I found distinct seasonal patterns in kagu food supplies at high altitude closely related to seasonality in climate, especially temperature, and probably highly similar year-to-year. Food supplies peaked in the wet season and were lowest around late October when conditions were driest, and were also relatively spatially uniform in forest. It is not clear why birds do not generally use the period of peak food supplies for breeding, but it may be better for birds to moult their primary feathers at that time. Kagus were generalists in the types of the larger-sized soil and litter fauna they ate, and I recorded many new taxa not previously known to be eaten by the birds. Birds' diets were strongly influenced by seasonality in climate and food supplies, but they did not just track changing patterns in food availability. They were probably also a result of birds approaching local optima in the efficient use of available prey in response to changing environmental and physiological conditions. Birds appeared to use larger prey items when food was more abundant, and be least selective at times of greatest food scarcity in the driest periods. Birds used larvae at high frequencies in the early dry season; larvae might provide energy assimilation benefits in cold conditions.

Bodyweights of mostly non-breeding kagus at Pic Ningua and Mt Cindoa varied seasonally in close positive association with temperature and food supplies, and varied negatively with use of sheltered roosts. Bodyweights peaked at the end of the wet season around April and were lowest in the driest period of the late dry season around late October. Lack of other factors likely to be affecting the kagus' bodyweights like competition, parasites and reproduction indicated that climate and food supplies were closely linked to the seasonal variation in them. The close association between variation in temperature and kagu bodyweights and roosting behaviour appeared to be clear evidence of phenotypic adjustment in roosting behaviour for energy conservation in response to cold conditions, particularly wind chill, and food shortage.

There is little direct evidence that food supply is limiting the kagu's annual fecundity, but indirect support for this comes from, for example, the difficulty birds have in finding and capturing prey present in the soil and litter, and that they generally breed outside the period of peak food supplies and forage for long hours each day. More research is needed on whether food is limiting for aspects of kagu reproduction like egg formation and chick provisioning. Data suggest that the kagu's food supplies are independent of pair densities, thus the kagu's life history characteristics may have been strongly

influenced by selection to maximise energy resources through interaction with the environment rather than by competition. This is consistent with aspects of the kagu's life history like for example its relatively non-competitive social organisation which means that birds can devote most of their time to foraging. I propose that density-independent food limitation has played an important role in shaping annual fecundity and other life history characteristics like social organisation in tropical, and possibly south temperate, forest birds.

At Pic Ningua in 1993, I described the first documented case of multiple kagu deaths caused by dogs. Twenty kagus were found dead (15) or wounded (5; one survived) from dog attacks in four distinct episodes over a 14 week period from late April to early August. Older remains of two other birds were also found. Eighteen of the 22 birds wore radio-transmitters, and the four non-radio-tracked birds were found by chance. Dogs errant from a nearby tribal village were strongly implicated in carrying out most, if not all, of the attacks. The events on the peak showed that dogs are dangerous predators of adult kagus, and dog predation may have been important in shaping kagu distribution patterns.

Four other important implications of my study for kagu conservation management are (1) the kagu's reproductive success may be greater in low altitude compared to high altitude rainforest; (2) because the kagu's clutch size is low and invariable, and the number of successful broods per year is also low and seems to be more influenced by density-independent factor(s), birds are especially vulnerable to predation because they cannot respond to lower densities by lifting their reproductive output; (3) feral pigs *Sus scrofa* at sufficiently high densities could potentially reduce prey availability for kagus; and (4) at least two additional managed reserves like Parc Rivière Bleue protecting up to 200 kagus are required to ensure that birds remain in the wild for the long term.

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