Threatened Birds of Asia:
The BirdLife International Red Data Book

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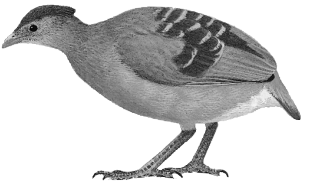
MOLUCCAN MEGAPODE
Eulipoa wallacei



Critical □ —
Endangered □ —
Vulnerable ■ A1d; A2c,d; C1

The rapid population decline of this megapode through over-exploitation is projected to continue which, combined with its small, declining and increasingly fragmented population, qualifies it for classification as Vulnerable.

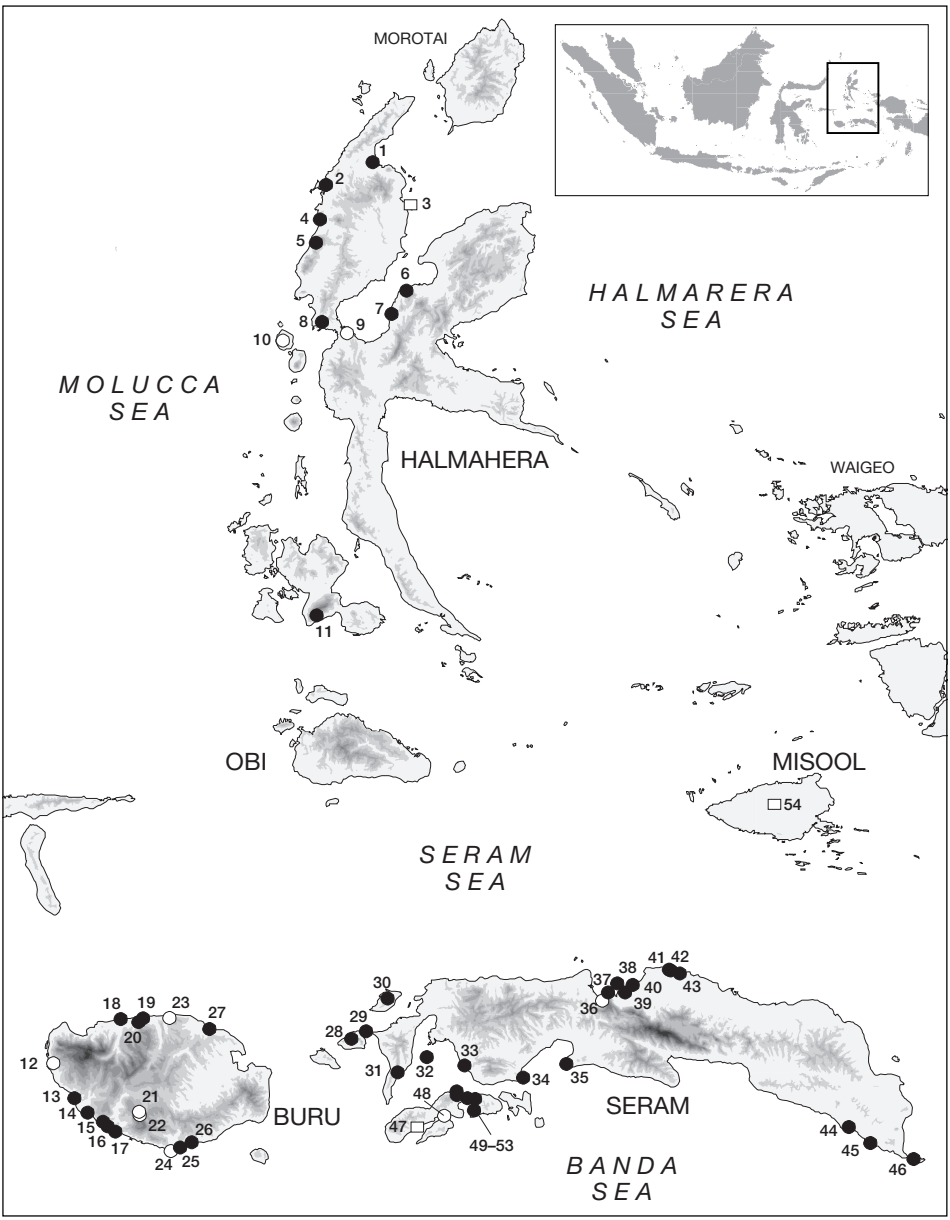
DISTRIBUTION The Moluccan Megapode (see Remarks 1) is endemic to the Moluccan Islands, central Indonesia, with the addition of Misool in eastern Indonesia. Holmes (1989) gave its range as Buru, Seram, Ambon, Bacan, Halmahera and Ternate, with one record, "perhaps as a vagrant" (see Remarks 2), from Misool, Papua (formerly Irian Jaya), thus missing Haruku. D. N. Jones *et al.* (1995) gave the same list with Haruku, but added that it may yet be found to occur on Morotai, Kasiratu, the Obi group and/or Saparua (searches in the mid-1990s found no evidence of presence on Kasiruta: Heij *et al*. 1997). It appears to have died out on Bacan, Ternate and Misool (Heij *et al*. 1997). The map shows an interesting lack of records from southern and eastern Halmahera, which may reflect a real circumstance. Records are from:

■ ***INDONESIA*** *Halmahera* **Galela** (Tiabo), August 1861 (two hatchlings, with 10 undated eggs, in RMNH), November 1994 and earlier (Dekker *et al.* 1995), this being "a major nesting ground" (Heij *et al*. 1997, Baker *et al.* 1998, Baker and Dekker 2000); **Loloda**, by local report in the 1990s (Dekker *et al.* 1995); **Pulau Miti** (Meti or Meiti island), off north-east Halmahera, a large nesting ground (attributed to de Wiljes-Hissink 1953 by Dekker *et al.* 1995 and Heij *et al*. 1997), now abandoned (Heij *et al*. 1997); **Ibu**, by local report in the 1990s (Dekker *et al.* 1995); **Gunung Gamkonora**, April/June 1931 (Heinrich 1956), 1990s (Dekker *et al.* 1995), with more than 40 nesting burrows, 1994–1995 (Heij *et al*. 1997); **Sungai Oketai**, July/September 1994 (Fuller undated); **Sungai Tolawi**, July/September 1994 (Fuller undated); **Kali Batu Putih** (not a known nesting ground record), 120 m, July 1985 (B. F. King verbally 1998, K. D. Bishop *in litt*. 2000), August 1994 (R. D. Thomas verbally 1999), mid-1999 (P. A. J. Morris *in litt*. 1999); **Dodinga**, November 1861 (specimen in RMNH);

Ternate unspecified localities, July 1875 (specimen in MCZ), and at 900 m, September 1896 (specimen in AMNH), but no longer present on the island (Heij *et al*. 1997);

Bacan **Gunung Sibela**, 1,500 m and upwards, June–July 1931 (Heinrich 1956), 410 m, October/November 1991 (Lambert 1994a), but no evidence on Bacan found by Heij *et al*. (1997);

Buru (see Remarks 3) **Fogi**, February 1912 (Stresemann 1914b); **Wa Msasi** to Wa Tawa, 20 burrows found along 2 km of sandy beach near the mouth of the Wa Naka river and unspecified numbers of burrows near Kaya Putih village, currently (Heij *et al*. 1997); **Wae Kase** (Wai Kase, Wa Kose, Wa' Kasi), currently (Heij *et al.* 1997); **Wa Bobo**, **Wa Turen** and Wa Haka (untraced), c.20 old but no fresh burrows along a coastal strip of 10 km, recently (Heij *et al*. 1997); **Wa Mala** to Ewiri, a colony of "minor importance" and "probably declining", currently (Heij *et al*. 1997); **Wa Fawel**, 1980s (D. N. Jones *et al.* 1995); **Wa Pude**, currently (Heij *et al.* 1997); **Wamlana**, currently (Heij *et al.* 1997); **Efrarat**, around 1921 (Siebers 1930); **Fakal**, February 1922 (Siebers 1930); **Wa Pati** ("Wa Pait") on the north coast (A. R. Wallace in Siebers 1930); **Waitina** estuary, around 1920 (Siebers 1930; see Threats), this presumably being the "minor" colony, "probably declining", at Wa Tina and Wa Fusi,



The distribution of Moluccan Megapode *Eulipoa wallacei*: (1) Galela; (2) Loloda; (3) Pulau Miti; (4) Ibu; (5) Gunung Gamkonora; (6) Sungai Oketai; (7) Sungai Tolawi; (8) Kali Batu Putih; (9) Dodinga; (10) Ternate; (11) Gunung Sibela; (12) Fogi; (13) Wa Msasi; (14) Wae Kase; (15) Wa Bobo; (16) Wa Turen; (17) Wa Mala; (18) Wa Fawel; (19) Wa Pude; (20) Wamlana; (21) Efrarat; (22) Fakal; (23) Wa Pati; (24) Waitina; (25) Namrole; (26) Oki; (27) Waeplau; (28) Pulau Kelang; (29) Pulau Babi; (30) Pulau Boano; (31) Iha Baru; (32) Kasa; (33) Kairatu; (34) Latu; (35) Amahai; (36) Hatu Saka; (37) Raja; (38) Sawai; (39) Hatuwe; (40) Wahai-Saleman/Saha; (41) Wahai; (42) Air Besar; (43) Labuan-Tanjung Sariputih; (44) Dawang; (45) Bitorik; (46) Kepulauan Geser; (47) Tawiri; (48) Paso; (49) Liang; (50) Tanjung Hunimua; (51) Pulau Pombo; (52) Haruku; (53) Kailolo; (54) Misool.
○ Historical (pre-1950) ● Recent (1980–present) □ Undated

currently (Heij *et al*. 1997); **Namrole** at the airstrip, "a number of old and new burrows" and birds "apparently still frequent the area", currently (Heij *et al*. 1997); **Oki** at Oki-Baru, "many" burrows along a 5 km stretch of beach, at c.40 burrows per km, currently (Heij *et al*. 1997) and at Oki-Lama, along a 5 km stretch of beach, "about 100 burrows per 1,000 m", currently (Heij *et al*. 1997); Lamalang to **Waeplau**, a 2 km beach used as a nesting ground, currently (Heij *et al.* 1997); Air Buaya (untraced), late 1995 (MKP), a minor nesting ground "likely to vanish soon", currently (Heij *et al*. 1997);

Seram **Pulau Kelang**, off the west coast, "some scattered burrows" October–November 1995 (Heij *et al*. 1997); **Pulau Babi** (Babi island), Piru bay, ten old and three freshly dug burrows, October 1994, 31 burrows including eight freshly dug, along a 200 m stretch of beach, October–November 1995 (Heij *et al*. 1997); **Pulau Boano** (Boano island, just off the west coast), old and freshly dug burrows near Strait Velntijn and Anauni village, October–November 1995 (Heij *et al*. 1997); **Iha Baru** (Elpaputih estate breeding ground on the south coast near the Tala estuary), April 1948 (de Wiljes-Hissink 1953, Dekker *et al.* 1995), two burrowing birds seen (Heij *et al*. 1997), and low-level breeding activity (including 60–70 mostly old burrows) in March 1998 (Heij 1998); **Kasa** islet in the Bay of Piru, 1890s (Martin 1894), "at least 200–250 both old and freshly dug burrows", October 1994 (Heij *et al*. 1997); **Kairatu**, 230 m, November 1991 (Dekker *et al.* 1995), small nesting ground discovered, April 1996 (Heij *et al*. 1997); **Latu**, small nesting ground, April 1996 (Heij *et al*. 1997); shoreline airstrip near **Amahai** (Iha Baru), April 1948 (de Wiljes-Hissink 1953, Dekker 1991, Dekker *et al.* 1995), still active October 1994 and April 1996 (Heij *et al*. 1997), March 1998 (Heij 1998); **Hatu Saka**, 900 m, September 1911 (Stresemann 1914a); small offshore islands off the north coast (Sapalewa [untraced], Casuari [untraced], **Raja**, **Sawai** and **Hatuwe**), all "regularly used as nesting grounds by small numbers", November 1995 (Heij *et al*. 1997); **Wahai-Saleman/Saha**, west Wahai, 76 clusters each of 2–5 burrows over 5 km of beach, November 1995 (Heij *et al*. 1997); **Wahai** area, 1990s (Heij 1995, P. Jepson *in litt.* 1995); **Air Besar**, just outside Manusela National Park, September 1987 (Bowler and Taylor 1989); **Labuan-Tanjung Sariputih**, east Wahai, "substantial" nesting population along 25 km of beach, November 1995 (Heij *et al*. 1997); **Dawang**, **Bitorik** and Kirukut (untraced), three small nesting grounds found, April 1996 (Heij *et al*. 1997); **Kepulauan Geser** (Geser islet), off south-east Seram, nesting ground found April 1996 (Heij *et al*. 1997); and, in addition, reportedly west of Wahai (Bowler and Taylor 1989), and reportedly west of Hoti, mid-1990s (Isherwood *et al*. 1997);

Ambon **Tawiri** village, breeding ground now abandoned (Heij *et al*. 1997); **Paso**, August in the 1880s (specimen in SNMB); **Liang** and **Tanjung Hunimua**, a total of 51 freshly dug burrows, November 1994 (Heij *et al*. 1997);

Haruku **Pulau Pombo** (between Haruku and Ambon, less than a mile from Kailolo), 1922 (de Wiljes-Hissink 1953) and in the 1990s (Dekker *et al.* 1995), but with little sign of use in 1996–1997 (Baker 1997c, Heij *et al*. 1997); **Haruku**, a "minor/marginal" nesting ground, currently (Heij *et al*. 1997), this evidently Dessa Haruku, 1990s (Dekker *et al.* 1995, Argeloo and Dekker 1996; see Measures Proposed); **Kailolo** (at a cape called Tanjung Maleo), since the nineteenth century (Dekker 1991, Dekker *et al.* 1995, Heij 1995, Heij *et al*. 1997; also Martin 1894, de Wiljes-Hissink 1953);

Misool unspecified locality and date (Ripley 1960), and with no evidence of persistence following a visit in February 1986 (K. D. Bishop *in litt*. 2000) and a search of the entire coastline and offshore islands in April 1997 (Heij *et al*. 1997).

POPULATION In the recent past the species has been thought to be rare on Halmahera and unlikely to survive on Ambon and Ternate (Holmes 1989), and altogether as few as 10,000 birds have been judged to exist, with this number in apparent decline, and the inherent vulnerability of the major nesting grounds suggesting that "this species may be seriously threatened with extinction" (Dekker and McGowan 1995). However, while it may be true

that the species has actually or virtually gone from Bacan—where it was rare and shy in 1931 (Heinrich 1956) and very rare in the early 1990s (Lambert 1994a)—and from Ternate and Misool (see Distribution), a conflation of neglected old and very recent evidence suggests that the threat, though real, is not yet serious. For example, two nesting grounds, at Galela and Kailolo, have been judged by far the largest of their kind, appearing to serve over half the species's global population (Dekker *et al.* 1995), but this seems to overlook the size of the site on Buru described by L. J. Toxopeus (Siebers 1930). Moreover, the persistence of many small and some large breeding grounds on Buru and Seram suggest that the species is spread sufficiently widely not to be at immediate risk.

Halmahera Local information suggests that as many as 1,000 birds may visit the nesting ground at Galela each night at the peak of the laying season, which has been taken to indicate that the catchment population for this site might be "double the size of that of Kailolo", i.e. (see below) in the region of 10,000 pairs (Dekker *et al.* 1995); Heij *et al.* (1997) estimated the egg-laying population to be 13,000–14,000 birds. However, egg-collectors at Galela were united in expressing the view that the population there is declining, having noted a sharp drop in numbers of eggs in 1985 and since 1991, the latter event related to clearance of mangrove for a banana plantation (Baker 1997c). Even so, the Galela colony was reported to yield as many as 5,000 eggs in some months, and to yield some 20,000–30,000 eggs per year (Poulsen *et al.* 1999). The nesting ground at Loloda is supposed to cater for 300–400 birds, that at Ibu for 100 birds (Dekker *et al.* 1995).

Seram The species appeared in 1911 to be rather rare (Stresemann 1914a). The Amahai nesting ground has suffered a substantial decline over recent decades, and appeared to serve only 10–20 pairs a night at the height of the egg-laying season, 1990s (Dekker 1991, Dekker *et al.* 1995). Heij *et al.* (1997) estimated less than 100 egg-laying birds using the Iha village site, and c.100 using the Tanjung Koako site. They estimated the Wahai-East egg-laying population to be between 1,800 and 2,250 birds.

Haruku Based on the assumption that individual females typically lay 10 eggs per year, and on local information indicating that as many as 40,000–50,000 eggs are taken each year from the Kailolo nesting ground, the population using this nesting ground has been put at 4,000–5,000 pairs (see Remarks 4), although the island of Haruku is too small to support such numbers permanently, suggesting that it serves populations on the adjacent islands of Seram and Ambon (Dekker 1991, Dekker *et al.* 1995). An egg taken on the island of Pombo off Haruku in 1922 may have been laid by a bird possibly if and when the island was used for roosting, and no trace of the species was found in 1948 (de Wiljes-Hissink 1953); nevertheless a tiny breeding ground was found in the 1990s but considered an overspill of the Kailolo area (Dekker *et al.* 1995). The nesting ground at Dessa Haruku is very small and used by only a small number of birds (possibly all resident on the island), although the site is strictly (but ineffectively: Baker 1997) managed along the lines of the Kailolo site (Dekker *et al.* 1995, Argeloo and Dekker 1996).

Buru In southernmost Buru a large colony of nest-clusters existed at Wa' Tina for several decades, but by 1920 only five nest-clusters remained there (Siebers 1930). The species was also reported to have disappeared from Fogi (Siebers 1930), which was presumably another colony. The species was reported as common on Buru (Collar and Andrew 1988), but this awaits confirmation (Holmes 1989).

Ambon Currently, north-east Ambon "offers only limited nesting possibilities for low numbers of birds" (Heij *et al.* 1997).

ECOLOGY ***Habitat*** The Moluccan Megapode appears to live in upland forest but to breed colonially on beaches (Stresemann 1914a, Siebers 1930, Holmes 1989), although there is inconclusive evidence that some may nest inland (see Remarks 5 and under Breeding). In general it is simply characterised as a bird of hill and mountain forest—dense evergreen

rainforest and subtropical wet moss forest—between 750 and 2,000 m, but also moving lower to enter degraded forest edge and coastal scrub (D. N. Jones *et al.* 1995). In truth, "its altitudinal distribution is not known" (Dekker and McGowan 1995) and the habitat of the species away from the breeding grounds has not been adequately documented; its presence near the coast is often only revealed by noisy crowing during the night (de Wiljes-Hissink 1953). The species was speculated to be specific to limestone habitats on Halmahera (Holmes 1989), and on Seram Stresemann (1914a) found that birds in light primary montane forest hid in small holes in the weathered limestone. Streams appear to be important at least in the breeding period, partly as corridors to the lowlands and partly as a source of water to replace the quantities used in the development of the enormous eggs (de Wiljes-Hissink 1953). Virtually the only recent records of the species away from nesting grounds are from north-east Halmahera, where in 1994 birds were found in primary forest on or near riverbanks at under 100 m elevation (Fuller undated). It appears to be less tolerant of disturbance than the Orange-footed Megapode *Megapodius reinwardt* (Bowler and Taylor 1989), and the only observation in 1991 on Bacan was in primary forest (Lambert 1994a). In one case (the airstrip in southern Seram) forest was 3 km from the breeding ground (de Wiljes-Hissink 1953). On Halmahera open sandy areas within beach forest are the preferred breeding habitat (Poulsen *et al*. 1999); it is not a bird of mangroves (Poulsen and Lambert 2000), although young birds may shelter in such habitat (see below).

Food A captive young bird ate seeds and rice but preferred insects; its behaviour was strongly nocturnal (Siebers 1930). However, the species has otherwise been assumed to be diurnal away from the nesting grounds, and to be omnivorous (D. N. Jones *et al.* 1995). Of seven adult females found dead at Tanjung Maleo, Haruku, the stomachs of six were empty, but one contained "a few hard seeds and the remains of scarab-beetles and ants" (Heij *et al*. 1997). Two bird-catchers on Halmahera independently claimed that birds eat fruit and worms (Baker 1997c).

Breeding This megapode, like the Maleo *Macrocephalon maleo*, does not build compost mounds in which to incubate its eggs, but rather utilises sun-exposed white- and black-sand beaches and similarly low-lying sandy sites for the purpose. One of the subsites at Kailolo on Haruku is an abandoned football pitch back from the beach, and scattered burrows are made elsewhere in the village, including the village graveyard (Dekker *et al.* 1995), indicating that the species is not necessarily tied to beaches (see Remarks 5), although it may well be that it profits from man-made or man-maintained clearings in areas away from beaches. There has to date been no proof that it uses geothermally heated soils.

A breeding ground is pitted with large and small funnel-shaped craters, with birds only laying in the large ones; sometimes several females will lay in the walls of one crater (de Wiljes-Hissink 1953). On Buru a major beach colony several kilometres long was characterised by low hard grasses (including *Spinifex*), high *Tacca* bushes, single or grouped *Pandanus*, *Eugenia*, and low thick-leaved shrubbery, the nests being dug in sand (to a depth of around 80 cm) between the vegetation, but covered again with such care that only the bird's footprints indicated its activity nearby, and even these were covered over with the first rain (Siebers 1930). Birds prefer to dig their nests in more open areas, tending to avoid any vegetation denser than that represented by ruderal grasses (Baker 1999). At Galela, Halmahera, the majority of eggs are laid in areas devoid of vegetation, confirming the importance of maintaining nesting grounds free of invasive weeds and grasses (Baker 1997a).

Unlike the Maleo and all other megapodes, laying always takes place at night, apparently at times of full moon (de Wiljes-Hissink 1953). However, Siebers (1930) reported that at undisturbed sites nests are dug in the late afternoon, whereas at disturbed ones they are dug under cover of darkness. Baker (1999) and Baker and Dekker (2000) found that more birds visit the nesting grounds on bright nights than during the new moon, while Heij (1995) also demonstrated a distinct link between laying and full moons in the 1994 season, although this

link was only obvious at the end of the wet and start of the dry season (September–December). It has been speculated that laying synchrony at full moon (good for adult security) might also produce hatching synchrony at new moon (good for chick security), but the incubation periods are too variable to make any confident assertion on this (Baker 1999).

Local wisdom is that eggs are also laid on moonless nights but much closer to the surface, the birds being more afraid of predation in such circumstances (Dekker *et al.* 1995). Local people at Galela indicate that snakes (probably chiefly pythons) are the major predators of adult birds (Baker 1997c, Baker and Dekker 2000). Certainly the phenomenon of shallower laying on moonless nights has been confirmed, along with the fact that sand temperatures at depths between 20 and 80 cm only vary by 1°C in the dry season but by 7°C in the wet season (Heij 1995).

Although it appears that birds on beaches are in pairs, it has not been clearly established that males accompany females to beaches, and it may be that clusters of birds are entirely composed of females showing semi-cooperative behaviour in digging (some aggression between "pairs" at burrow entrances is shown) and vigilance (Dekker *et al.* 1995). In one study, excavation was undertaken communally in seven out of 13 cases, in groups of 3–6 birds, possibly related to increased predator vigilance and reduced labour costs (Baker 1997c, 1999, Baker and Dekker 2000). L. J. Toxopeus collected only females at the site he studied, and was told by native egg-hunters that, when ready to lay, the females come down from the hilly interior to the coast, where several may be fertilised by a single male, which helps (in an unspecified way) with nest-preparation; he thought it might take the chick several days from hatching to reach the surface, as chicks dug out by villagers were unable to fly for three days (Siebers 1930). The yolk content and ratio of body to egg weight indicate that this megapode has a particularly long incubation period (Dekker *et al.* 1995), the average being 74.2 days (excluding five eggs which had an incubation period of 164 days) in a study by Heij (1995; see Remarks 6). Heij and Rompas (1997) recorded a mean egg weight on Haruku of 103 g, some 20% of adult body weight. Birds at Galela in late 1996 were found to lay similar-sized but significantly lighter eggs (mean 86 g, n = 672), the causes of which were unclear although season, diet and size differences of birds are postulated (Baker 1997c, Baker *et al.* 1998).

In the dry season hatchlings struggle towards the surface at a speed of 20 cm a day, and in the time it takes to reach the surface they lose over 12 g, some 17% of their hatching weight (69 g), representing their entire store of subcutaneous fat (Heij 1995). Typically young birds scurry off into the forest when they emerge (Heij and Rompas 1997), but this cannot be the case for birds that emerge on small offshore islands with little or no natural cover. Part of the nesting ground at Galela is a sandbank island, and by local report the young are not immediately strong enough to fly across the bay, and suffer predation from kites and monitors (see Threats below) until they are able to do so (P. Jepson *in litt.* 1995). However, they can take cover in the backing mangrove belt; when they are dug up during egg searches they are let go, but their flight feathers are still in sheath (this is what makes it difficult for them to fly), so they use the mangroves until their feathers break free (G. Baker *in litt*. 1999).

According to Kailolo villagers, egg-laying on Haruku occurs year round but with a clear peak during the dry season (September/October to April/May), an expected trend given the eggs' dependence on insolation. However, on some nights, even when the moon is full, it appears the birds are inexplicably absent (Dekker *et al.* 1995, Heij 1995). At Galela on Halmahera local informants indicate a season for egg-laying from January to July, with a peak from March to May, but even there some low-level year-round activity appears to occur (Dekker *et al.* 1995). On Bacan a gravid female was collected at the end of June at over 1,500 m, suggesting that females may leave their journeys to the coast to the very last moment (Heinrich 1956). Although it is now recognised that the birds fly considerable distances to the nesting grounds, occurrence of gravid females inland may possibly mean that there are opportunities for "egg-dumping" or that there are upland geothermal sites used by the birds.

Migration No migration is known, but nesting grounds evidently have extensive catchment areas, so that seasonal movements to nesting grounds are presumably fairly marked (it is not clear whether birds travel to and from the nesting ground, returning to a specific non-breeding home range each time they lay an egg, or remain in the vicinity of the nesting ground over the egg-laying period (which, given the estimates above of 10 eggs laid per season, and allowing 10 days between eggs, would indicate a 14-week displacement to the nesting ground hinterland). In the case of Haruku it is believed that birds fly across from Seram and Ambon (birds have been seen flying in off the sea shortly after dusk), at Galela birds are reported to fly in from the south across the Gulf of Galela from the direction of Mount Mamuwa, and at Amahai on Seram birds certainly have to fly to the nesting ground from inland forest several kilometres away (Dekker 1991, Dekker *et al.* 1995).

The value of offshore islets (see Distribution) appears to be rather high, presumably as an anti-predator mechanism, although whether such movements from larger islands have been forced by human exploitation or by pressures extending back much farther in time is not possible to judge.

THREATS ***Egg exploitation*** Around 1950 it was judged that "on the vast lonely shores of the Moluccan islands the species is not likely to suffer much from a certain amount of egg-collecting by local people" (de Wiljes-Hissink 1953). It has been suggested that any newly discovered nesting ground could be wiped out in a single season by a single collector (Holmes 1989), but in reality this is highly improbable, not only because not all eggs can be found but also because adults live for several seasons. Females have been reported to experience a period of inertia ("Ohnmachtsanfall" = fainting fit) after the exertion of laying an egg (which are so large that the stomachs of gravid females are pressed flat and contain almost nothing), and are then liable to be caught by villagers and their dogs (Siebers 1930); this circumstance appears to be confirmed by de Wiljes-Hissink (1953). The "decimation" of the nesting colony at Wa'Tina was blamed on the proximity of a populous village (Namrole on the map in Siebers 1930). According to de Wiljes-Hissink (1953), it was customary at least around 1950 for egg-harvesters to throw away rather than re-bury well-developed eggs, since they could only sell fresh ones at market. The site at Amahai, south Seram, was being exploited without the regulation of a local management system, and had decreased significantly over recent decades, and had also suffered exploitation of its sand for local road construction (Dekker 1991, Dekker *et al.* 1995). Although under Measures Taken below there is an account of the management system that controls harvesting of eggs, evidence from recent study at Kailolo suggests that the number of eggs taken doubled between 1987 and 1994 not as a result of increasing numbers of birds but as a response to increasing market demand within the developing Ambon region (Heij 1995).

Natural predators Monitor lizards *Varanus* are assumed to be nest predators (Siebers 1930). At Wa'Kasi on Buru, L. J. Toxopeus had wondered why birds only laid eggs in the beach east of the river (Siebers 1930), and it appears that west of the river the beach was backed with swamp rather than forest, and that swamp is prime habitat for monitor lizards (MKP). What was Wallace's only specimen from Buru was taken with a broken wing, as if it had been attacked in its burrow, perhaps by a rat (Wallace 1863b). Other predators include snakes, cats, pigs, dogs and Brahminy Kites *Haliastur indus* (Heij and Rompas 1997; also Baker 1997c).

Destruction of nesting grounds In the mid-1990s it was discovered that part of the Galela nesting ground on Halmahera had been sold to a banana plantation company, and although timely intervention led to local agreement to establish a reserve at the site, it is still not certain that this will happen at least without a detailed management plan (Baker 1997a,b,c). It was also discovered that egg-collectors were all over the age of 35 and had little interest in passing on their considerable skills to their children, so that in time the egg-harvesting regime

will die out; this may actually have a *negative* impact on the species, as the nesting ground is likely to become neglected and disturbed (Baker 1997c).

Habitat loss and deterioration Some deforestation has occurred in Buru's coastal lowlands, and large areas have been disturbed and selectively logged (Jepson 1993, Poulsen 1998; see Threats under Blue-fronted Lorikeet *Charmosyna toxopei*). On Seram the species appears to be less tolerant of disturbance (or disturbed forest) than the Orange-footed Megapode (J. Bowler and J. B. Taylor in Collar and Andrew 1988). On Halmahera most of the island's beach forest has been converted to coconut plantations (Poulsen *et al*. 1999), and at Kali Batu Putih around the well known site for Wallace's Standardwing *Semioptera wallacii* there has been extensive forest clearance (K. D. Bishop *in litt*. 2000). The one protected area in North Maluku (an established site for the species), on Bacan, is at risk (see Measures Taken).

MEASURES TAKEN This species has been protected under Indonesian law since 1979 (Inskipp 1986). Egg harvesting of this species for consumption is illegal (Poulsen *et al*. 1999), although clearly the law in question is never observed or enforced. In 1995 the Megapode Specialist Group outlined a project requiring implementation on this species; actions include survey of all known nesting grounds and of all islands where the species might be expected, with a detailed study at the Haruku nesting ground, seeking to determine the origin of the birds using it, the levels of exploitation involved, and relevant biological aspects such as optimal incubation conditions, thus marking the beginning of a long-term monitoring programme at the site so as to assess the levels of exploitation that the species can sustain (Dekker and McGowan 1995). This initiative was largely fulfilled through the work of Heij (1995) and Heij *et al*. (1997), with a full Indonesian-language account of the Haruku breeding grounds (Heij and Rompas 1999).

At both Kailolo and Galela there are harvesting regimes according to traditional rules which have been observed for at least 80 years, apparently without detriment to the species; indeed, the Kailolo villagers actively manage the sites by controlling invading vegetation on the tops of beaches and other areas used for nesting, to ensure maximal area for the birds to continue to lay (Dekker *et al.* 1995). The management regimes have been reported as deliberately leaving around 20% of eggs untouched (Dekker 1991) but this is apparently not the case; instead it seems that 10–15% of eggs are simply not found by the egg-harvesters (in part through their occasional diversion elsewhere, e.g. religious observances such as fasts which depress market demand, and televised world football championships), and it is from these eggs that the population continues to recruit sufficient numbers to remain in reasonable balance (Heij 1995). Nevertheless, at Galela on Halmahera the implication in Baker (1997b) is that 10% of eggs are deliberately left, and a great deal of time is spent on managing the beach vegetation; it is the deeper-laid eggs (on the moonlit nights) which are left, because they are so much more difficult to find (P. Jepson *in litt.* 1995; also Baker *et al*. 1998).

At Kailolo, the management proceeds as follows: every year at the start of the rainy season (31 March) an auction is held by which the highest bidder (who in 1994 paid the then equivalent of US$3,500) obtains the lease to harvest the eggs in the following 12 months, with 75% of the lease price going to the mosque and 25% to the village authorities, who also fix the price at which the eggs are sold (one egg US$0.15 in 1994, when 36,262 were harvested, i.e. roughly $5,500); eggs are sold locally and to other islands, with a daily inventory of numbers harvested and sold, the leaseholder employing 4–6 collectors to work at night taking the eggs and by day keeping the nesting grounds clear of vegetation and any other human disturbance (Heij 1995).

At Galela, the collection of eggs is strictly controlled by one landowner, who coordinates the activities of the other (up to 13) egg-collectors; employees are paid in eggs, taking 50% of what they collect, all claiming to leave 10% undisturbed (evidence suggests a higher percentage are left untouched) (Baker 1997a).

On Bacan, Gunung Sibela Strict Nature Reserve embraces just over 100 km^2 of lowland forest, but is under pressure from agricultural encroachment and goldmining interests (see equivalent section under White Cockatoo *Cacatua alba*).

MEASURES PROPOSED No long-term data exist on annual harvest rates, on the number of successful hatchlings from the managed populations, or on the effects of land-use changes away from the nesting grounds, so research is clearly needed to ensure that the harvesting at Kailolo and Galela can continue at its current levels (Dekker *et al.* 1995). For a clearer understanding of the species's year-round habitat and site utilisation, an intensive radio-tracking programme is essential.

One of the owners of the Galela beach nesting grounds reported that the entire "colony" was started artificially some 100 years before, when 40 eggs were brought from elsewhere on Halmahera and buried on the beach (P. Jepson *in litt.* 1995). Since all other information provided by local villagers has been vindicated by study, this item of information is well worth following up experimentally. If colonies can indeed be founded simply by burying eggs in suitable places, then it ought to be possible to establish several new colonies at propitious sites (e.g. on suitable beaches remote from human habitation) within the range of this species.

Buru Details of a proposed reserve on Buru are given under Blue-fronted Lorikeet *Charmosyna toxopei*. On Buru L. J. Toxopeus was told the local myth that this species is designated "king of the birds", on account of the large size of the eggs and the young birds' apparent lack of need to eat; from the eggs all bird species are said to have been born (Siebers 1930). This myth might be put to good use in conservation programmes for the species in the future. At Wa' Kasi (Wai Kase) the breeding ground needs to be protected or at least egg-harvesting should be managed sustainably (Poulsen 1998).

Halmahera There is a detailed recommendation for a national park embracing a total of 2,130 km^2 on Halmahera (see equivalent section under White Cockatoo). This (and to some extent the gazettement of Gunung Gamkonora as a wildlife sanctuary or recreation forest status: Purmiasa 1997) will certainly protect major areas within which the species is assumed to spend much time foraging, but it does not address nesting colony preservation; for this, conservation of appropriate remaining areas of beach forest has been judged likely to contribute more to local economies if also managed for egg collection than if converted to coconut (Poulsen *et al*. 1999). If this is true, efforts are needed to identify the most suitable areas of beach forest with existing colonies (but possibly also where colonies might be seeded) and to set up projects to develop sustainable egg harvesting systems (although a change in the law will evidently be necessary first). Heij *et al*. (1997) felt that the Galela area needed further study, and recommended a long-term project to establish the size of the *Eulipoa* population and the impact of egg-collecting on breeding success; they believed that the "plot-system" method of managing exploitation of nesting grounds "might play a key role in the survival of *Eulipoa* in the Galela area". The reasons for the abandonment of the apparently large nesting ground on the islet of Meiti off north-east Halmahera need to be investigated, with a view to its possible restoration.

Seram Heij *et al*. (1997) believed the nesting grounds at Tanjung Koako could provide nesting opportunities for an increased number of birds if (a) trespassing on the airstrip and its margins was restricted, (b) quarrying in the area ceased, and (c) the catching of adults birds was stopped. For Kasa Island, Heij *et al*. (1997) proposed the establishment of a permanently manned guard station to prevent egg-collecting and poaching, believing that this would be "an easy but rewarding task".

Haruku Management of the Kailolo nesting ground could perhaps involve a 10% hike in the price of eggs, allowing 10% of the nesting grounds to be sealed off as a no-go area for collecting, or 10% more eggs to be left unharvested; or a conservation organisation could

purchase the lease on the site and pay the salaries of the collectors (total cost US$5,000 per annum) and harvest at a lower rate than is currently done (Argeloo and Dekker 1996). Purchase of part of the site at Galela (the part that had been planned for conversion to bananas) would allow it to be managed as a nature reserve and, by protecting a key area of mangroves, would contribute general ecological benefits to the site and to the local human population (Baker 1997c). At Dessa Haruku, there is a community-help scheme funded by a Japanese agency which is seeking to manage a nesting ground; however, the planting of trees in the middle of the ground has provided perches for Brahminy Kites and is alien to the type of area selected by the megapode, and there was no enforcement of the current rule of leaving all eggs to hatch (all eggs were harvested), so entirely new management is needed at the site to make it function (Baker 1997c).

Moreover, protection of forest habitat is essential for such harvesting, and in the case of Kailolo, at least, this appears to require the conservation of habitat on other islands: the forested Gunung Salahutu in north-east Ambon appeared to be suitable for the species in 1991 (D. N. Jones *et al.* 1995), and this and other such areas (although very small by comparison with those on Halmahera and Seram) therefore need at least to be evaluated for conservation.

REMARKS (1) This distinctive species occupies its own genus *Eulipoa*; according to de Wiljes-Hissink (1953), Ogilvie-Grant erected *Eulipoa* on the basis of the relative sizes of primary and secondary feathers. Its occasional placement in *Megapodius* certainly appears inappropriate. (2) It is not clear how easily this species could wander; probably not very. However, it could easily have been taken to Misool as an egg or live captive bird. Mees (1965) described this as the most interesting case among the three Moluccan taxa found on the island, since it alone is purely Moluccan and unknown elsewhere in the Papuan region. (3) Records from the island in 1989 could have been this bird or Orange-footed Megapode *Megapodius reinwardt* (Jepson 1993). (4) This calculation does not allow for any reproductive success, since it assumes 100% human consumption of eggs laid. Given that the site has been exploited for generations, the number of pairs using the site *must* exceed ten times the number of eggs laid. In fact, since elsewhere it is reported that 20% of the eggs are left untouched (see Measures Taken), the number of pairs using the site may be 20% greater, therefore possibly as many as 6,000 rather than 5,000. (5) L. J. Toxopeus was brought an egg that had been dug out of a Forsten's Megapode *Megapodius forstenii* mound, and explained this as the result of a fertilised female whose egg-laying condition developed too fast to allow her time to reach the coast; he did not know how frequently such behaviour might occur (Siebers 1930). While this record must be treated with great caution as the eggs of the two species may not be so easy to tell apart, it may give a hint that the species at least occasionally lays eggs inland. (6) Heij (1995) clearly implied that the five eggs hatched, yet he provided no discussion or explanation of so long an incubation period or of the degree of variation (the figure of 164 must presumably be a mean, since the chances of all five eggs hatching after precisely the same extended period must be near-zero). An incubation period of up to 100 days was recorded in "captive" eggs by West *et al*. (1981).