

Until recently, this seemingly elusive motmot was extremely poorly known, despite a wide distribution from southern Mexico through to Costa Rica. A series of observations since the late 1980s have shown it to be locally not uncommon in lowland and foothill forest: however, there is still no explanation for its patchy distribution even within suitable habitat.

DISTRIBUTION The Keel-billed Motmot has been recorded at a relatively small number of localities scattered over an extensive range in Central America, generally on the Caribbean slope of southern Mexico, Belize, Guatemala, Honduras, Nicaragua and northern Costa Rica. Coordinates are taken from Binford (1989), OG (1956a,b,c, 1965, 1976), Monroe (1968).

Mexico All records of the Keel-billed Motmot are from the Isthmus de Tehuantepec eastward. Evidence from Campeche is discounted here (see Remarks 1).

Veracruz There are only two confident records: in 1948, the species was heard on a number of occasions (but never located) along the ríos Chalchijapa and Solosuchi (c.17°22'N 94°47'W, coordinates from Lowery and Dalquest 1951) near the Oaxaca border (Lowery and Dalquest 1951); it was also recorded south of San José del Carmen (in the south of the state) during the 1950s (D. A. Zimmerman *per* B. W. Miller *in litt.* 1991). Records from Ubero and Tolosa, although attributed to this state, are treated under Oaxaca; and a male (in MNHUK), collected at 90 m 30 km south-south-east of Jesús Carranza (17°26'N 95°02'W) in May 1949, was almost certainly within Oaxaca, close to route 185 near Ubero and Tolosa (Lowery and Dalquest 1951; see below).

Oaxaca The Keel-billed Motmot was twice collected at Tolosa (two specimens in AMNH, one dated December 1901). Although both Veracruz and Oaxaca states possess a town called Tolosa, Binford (1989) suggested that old records from this locality should be referred to Oaxaca and believed that these specimens were probably taken in this state (Tolosa, Oaxaca, is at 17°12'N 95°03'W, and 60 m). A male (in USNM) was taken at Ubero in December 1901 (see Remarks 2), the label suggesting that this is in Veracruz. Again, both states possess an Ubero (Uvero), but that in Oaxaca (at 17°17'N 95°01'W, and at 30 m) is almost on the Veracruz border and in close proximity both to Tolosa and the collecting locality south of Jesús Carranza (see Remarks 2). The only other record from Oaxaca is of a male (in MNHN) taken at “Chualapa” (= Santa María Chimalapa, 16°55'N 94°42'W, at c.290 m) during February 1952.

Tabasco Only one record exists, a male (in USNM) taken at Teapa in April 1900, although there is an unconfirmed report of a recent specimen from the state (S. N. G. Howell *in litt.* 1987) which, if correct, would be the first record for Mexico since 1952.

Belize Until recently there were very few records from Belize, one specimen (in BMNH) being taken “in the vicinity of Belize” [City] in January 1888. In May of the same year, the same collector (Blancaneaux) took a female (in BMNH) “near San Felipe, Riomakal”, a newer label claiming this as in Campeche, Mexico (see Remarks 1). In view of his earlier collection in Belize, it seems likely that this specimen is in fact attributable to this country, and indeed, there is a San Felipe (17°09'N 89°04'W) on the río Macal, just south of San Ignacio. A female (in CM) was taken in the Cockscombe Mountains (at 350 m) in March 1935. Since April 1988, Keel-billed Motmots have been found on the Vaca Plateau in south-western Belize, and a population has been extensively studied around the Caracol Archaeological Site, at 490 m (B. W. Miller *in litt.* 1989, 1990, Miller 1991). In January–February 1991, birds were repeatedly heard and twice seen c.20 km west of the Maya Mountains (13 km south of the Mountain Pine Ridge area, on the río Raspaculo, a continuation of the Chiquibul forest area) (S. Matola *in litt.* 1991, B. W. Miller *in litt.* 1991). A disjunct population was found to the north of Mountain Pine Ridge at Slate Creek, where two birds were heard in October 1991 (B. W. Miller *in litt.* 1991, also Miller and Miller 1992).

Guatemala The Keel-billed Motmot has been recorded from three areas: in the north (Petén) records come from Laguna Perdida, where a male (in UMMZ) was collected around 1900 (see Remarks 3), and Tikal, where one was seen and filmed in 1958 (E. P. Edwards *in litt.* 1986, 1991, Smithe 1966). Further south, Salvin (Salvin and Godman 1888-1904) believed that he saw this species near the banks of the río Chixoy not far from Santa Ana and the gorge of La Campaña, during March 1874. Santa Ana and the gorge are untraced but presumably near La Campaña (15°19'N 90°31'W), which is very close to the río Chixoy. Land (1970) referred to this sighting as from Santa Ana, Alta Verapaz, the two specimens

Threatened birds of the Americas

recorded by Boucard (1878b) from “Vera Paz” presumably being taken near here. More recently, a male (in MNHUK) was taken at El Astillero in February 1955 (apparently at c.7 m); of a number of towns by this name in Guatemala, the most likely is at 15°02'N 90°14'W. In the east, a number of birds (see Population) were recorded between 200 and 700 m on Cerro San Gil (15°40'N 88°47'W) during February 1991 (Howell and Webb 1992).

Honduras Records come from various scattered localities across the country, which from approximately west to east are: Santa Ana (15°29'N 88°03'W, at c.90 m) where two males and a female (in USNM) were taken in January and November 1890; San Pedro Montaña (a mountain range west of San Pedro Sula, which is at 15°28'N 88°01'W), where a male and female (in CM) were taken in January and February 1892 (this mountain range presumably encompasses the previous locality); the east slope of Cerro Santa Bárbara (14°53'N 88°10'W), where two males (in LSUMZ) were taken at 1,220 and 1,555 m in November 1962 and March 1963. In the vicinity of Lago Yojoa, this bird was first recorded between Taulabé (Taulevi, 14°38'N 87°59'W, at 430 m) and Lago Yojoa, where a bird was seen and one collected (in BMNH, but labelled simply “Lake of Yojoa”) in 1857 or 1858 (Taylor 1860). Subsequently the species has been taken only once at Lago Yojoa (at 760 m), this being a female (in CM) collected in June 1951.

Along the north-west coast, localities include: near Medina (15°46'N 87°54'W, 5 km south-east of Puerto Cortés), where a bird was seen at 1,500 m in October 1986 (S. Thorn *in litt.* 1991); “near Tela” (J. Clinton-Eitnien *in litt.* 1991), whence come several recent observations; Lancetilla (c.15°42'N 87°28'W), which is the (Tela river) valley running from 3 to 11 km inland of Tela, and where a male and a mated pair (in MCZ) were taken (at 365 m) during March 1928 (Peters 1929), and where birds were recorded during June 1988 and March 1991 (Howell and Webb 1992); La Ceiba (15°47'N 86°50'W), where a male (in MCZ: see Remarks 4) was collected in January 1902. In the east of the country Monroe (1968) listed a female (in UCLA) taken in January 1955 “19 km east of Jalapa, Nicaragua”, and interpreted this as 1 km east of Los Paredes (13°56'N 85°58'W), just within Honduras (see below). Records from Arenal are treated under Nicaragua. Two males (in USNM) were collected somewhere along the río Segovia (Coco) in June 1887; as this river forms much of the border between Honduras and Nicaragua, the national origin of these specimens is unknown (see below).

Nicaragua Records come from a number of localities which, from approximately north to south, are as follows: río Segovia (Coco, see above), where two males (in BMNH) were taken (apparently on the Nicaragua side) in March 1898; río Moco (14°39'N 84°17'W), near the village of Moco (untraced), 45 km west-south-west of Waspam, where a male and female (in UCLA) were taken (at 30 m) in February 1962; Eden (14°00'N 84°26'W: Huber 1932), where a female (in ANSP) was collected between 460-760 m in May 1922; and Arenal (13°48'N 85°49'W: Monroe 1968), c.25-27 km “east” (see below) of Jalapa (13°57'N 86°12'W), where two males and a female (in UCLA) were taken between 365 and 515 m in January 1955. From the coordinates it can be seen that Arenal is actually east-south-east of Jalapa, and a female taken just a few days after the Arenal specimens at “19 km east of Jalapa” is also likely to be east-south-east and therefore from Nicaragua, not “1 km east of Los Paredes” in Honduras (*contra* Monroe 1968).

Other localities include: Ocotal (apparently a municipality centred on 13°40'N 86°27'W), where two males (in AMNH) were collected in May 1908; Cum (Kum, 13°42'N 85°17'W), 45 km west-south-west of Siuna, where a female (in UCLA) was taken at 215 m in April 1962; Peña Blanca (Peñas Blancas, presumably the one north-east of Matagalpa), where a male (in AMNH) was taken in May 1909; río Tuma (precise locality along the river unknown), where a male and female (in AMNH) were taken in March-April 1909; río Grande (presumably río Grande de Matagalpa; exact locality unknown) where a male (in BMNH) was taken in February 1898; La Libertad (12°13'N 85°10'W), where a male (in BMNH) was taken in February 1892; and Chontales (a department centred on 12°05'N 85°10'W), where a specimen was taken a short time before 1872 (Salvin 1872).

Costa Rica In Costa Rica, at the southern limit of its range, the Keel-billed Motmot has been recorded from just seven localities, all on the Caribbean slope of the cordilleras (see Remarks 5). Five of these localities come from the north-west, in the cordilleras de Guanacaste and Tilarán, and are as follows:

Rincón de la Vieja (two localities on the north-north-east slopes of the volcán), 300-500 m (one specimen in MZUCR collected in November 1988: F. G. Stiles *in litt.* 1991); 4 km north-east of Dos Ríos de Upala (by the río Pizota), where two birds were seen (in 15 days of fieldwork) and a male collected (in MZUCR) during November 1987 (J. Sánchez *in litt.* 1992); La Vijagua (= Bijagua, 10°44'N 85°06'W), c.12 km north-east of Volcán Tenorio, a locality mentioned by Ridgway (1914); El Silencio de Tilarán (10°29'N 84°57'W, just to the south of Lake Arenal), where a male (in DMNH) was collected in February 1954; Peñas Blancas (a valley north of Monteverde on the Caribbean slope of the Cordillera de Tilarán, and south-east of El Silencio), where an individual apparently formed a pair-bond with a Broad-billed Motmot *Electron platyrhynchum* (Stiles and Skutch 1989, S. N. G. Howell *in litt.* 1991; see Population), and where a (questionable) sighting of a bird was recently made (Ridgley and Gwynne 1989, B. W. Miller *in litt.* 1990).

North-east of this general area, the bird has been collected (a female in MNHN) at San Carlos (in the vicinity of Villa Quebrada: the San Carlos region of eastern Alajuela province) in February 1877, representing the first Costa Rica record (Boucard 1878a, Slud 1964, F. G. Stiles *in litt.* 1992). The only other recorded locality is Isla Bonita (c.8 km north-east of Volcán Poás in the Cordillera Central) where a bird (in AMNH) was collected (date unknown).

POPULATION Almost nothing is known about the population of this elusive species, which is generally considered to be the rarest member of its family (D. A. Scott *in litt.* 1986, Miller 1991). Most observations/records have been of pairs or single birds, with normally one record per locality. The exceptions to this are recent observations in Belize, Guatemala and Honduras. The Keel-billed Motmot is apparently widespread but occurs at low density and is generally considered rare to uncommon (see Remarks 6).

Mexico The Keel-billed Motmot in Mexico is represented by 6-7 specimens, the most recent of these being taken in 1952 (see Distribution). This seemingly constitutes the last known record from the country, and indeed the species has been considered extinct there (Miller 1991), although there is a recent unconfirmed report from Tabasco (S. N. G. Howell *in litt.* 1987), and many localities remain to be checked (A. G. Navarro and A. T. Peterson *in litt.* 1991).

Belize Apparently just 2-3 specimens of this bird have been collected in Belize, the last during 1935 (see Distribution). There were a number of observations of breeding birds during the 1970s (D. Weyer *in litt.* 1989), but by 1986 the species had not been recorded for 7-8 years (B. W. Miller *in litt.* 1990). Since 1988, the Keel-billed Motmot has been regularly recorded on the Vaca Plateau (where it is considered locally abundant), and studied in detail around the Caracol Archaeological Site (also on the Vaca Plateau) (B. W. Miller *in litt.* 1989). The current estimate for the area around Caracol (in a forest plot of c.2,400 ha) is of between 17 and 24 birds during the breeding season (B. W. Miller *in litt.* 1991). A focal group of 7-8 breeding birds (in a core area of 1,600 ha) was followed at Caracol (none of which had any reproductive success), this area also supporting 18-20 Blue-crowned Motmots *Momotus momota* (B. W. Miller *in litt.* 1990). In the 1991 breeding season (in the 2,400 ha forest plot) there were 20 pairs of Blue-crowned Motmots to 2-3 pairs of Keel-billed Motmots (B. W. Miller *in litt.* 1991). Elsewhere in Belize, six or seven birds were repeatedly heard (and two seen) during January and February 1991 south of Mountain Pine Ridge: they were not at all common, being localized in one canyon area (S. Matola *in litt.* 1991, B. W. Miller *in litt.* 1991; see Distribution).

Guatemala In referring to the two specimens taken at Vera Paz (possibly the two currently in BMNH, taken during 1872 in "Guatemala" and reported by Salvin 1872), Boucard (1878b) suggested that the Keel-billed Motmot is a rare species seen generally in pairs, although this seems to be based on information taken in Costa Rica (see Boucard 1878a). The possible sighting by Salvin near Santa Ana in 1874 (see Distribution) suggests the presence of at least a small population in the Vera Paz area during the nineteenth century. The type-specimen (see Du Bus 1847: apparently the specimen in MNHN), and the one from Laguna Perdida represented the only other specimen records from Guatemala, while reports from Tikal and more recently unconfirmed reports by P. Hubbell (*in litt.* 1986) were the only records since the turn of the century until a population was found on Cerro San Gil in 1991 (see Distribution; Remarks 3, 4).

At least six to eight birds were noted (mostly calling) at Cerro San Gil at the end of February 1991, three birds (apparently two males courting a female) being seen together, and one seen near a probable nest-burrow (Howell and Webb 1992).

Honduras The collection of this species during the 1850s was noted with “much interest” (Sclater 1858), although subsequently it has been considered locally fairly common rather than rare, with as many as five birds seen and heard in June 1988 at Lancetilla and the country seemingly regarded as the species's centre of abundance (S. N. G. Howell *in litt.* 1989, 1991; see also Monroe 1968, Ridgely and Gwynne 1989). There are three main areas of abundance: (1) the San Pedro Montaña area (including Santa Ana), where five birds were taken between 1890 and 1892; (2) Lago Yojoa (including the east slope of Cerro Santa Bárbara), where four birds have been collected, three of them during the 1950s and 1960s; and (3) Tela (including the Tela–Lancetilla river valley) where three birds were taken in 1928 and whence come several recent observations (see Distribution), including that of one bird seen (three to four heard) during early June 1988 and two seen (five to six heard) in mid-March 1991 at Lancetilla (Howell and Webb 1992). In 1928, the species was regarded as “not uncommon” at Lancetilla, despite being easily overlooked (see Remarks 6; Peters 1929).

Nicaragua The Keel-billed Motmot is sparsely distributed across much of northern Nicaragua, but the population is essentially unknown as almost all localities are represented by just one or two specimens. The only exception to this is four birds collected east of Jalapa in January 1955 (see Distribution), which combined with the two taken on the río Moco in February 1962 represent the most recent records from this country.

Costa Rica In 1877 Boucard (1878a), when referring to the collection of birds at San Carlos, claimed that the Keel-billed Motmot was “rare [and] goes by pairs in the forest”, subsequent authors (e.g. Slud 1964, Stiles and Skutch 1989) also considering the bird rare. When collected at El Silencio de Tilarán in 1954, however, it was regarded as “not rare” (Slud 1964; see Distribution), and indeed most Costa Rica records come from this general area (i.e. to the north-east at Bijagua, and to the south-east at Peñas Blancas; see Distribution). Slud (1964) suggested that the Broad-billed Motmot (sympatric with Keel-billed Motmot in Costa Rica), although relatively uncommon in the area of overlap, is nevertheless commoner than the Keel-billed Motmot. The record of a bird being fed by a Broad-billed Motmot (the source of the “mixed pairing” mentioned in Stiles and Skutch 1989) in 1986 (the two were possibly seen together in 1985: S. N. G. Howell *in litt.* 1991) seems to suggest that the population is so small in Costa Rica that mates are extremely rare.

ECOLOGY The Keel-billed Motmot is a resident of lowland and foothill areas generally at altitudes of 10–760 m (see below), and exhibits no apparent seasonal variation within this range (see Distribution). Exceptions are two birds at 1,220 and 1,555 m in November 1962 and March 1963 respectively, on Cerro Santa Bárbara, and the observation at 1,500 m near Medina, Honduras (see Distribution). Almost all records come from the Caribbean slope where the bird appears to be an obligate “deep forest” (forest interior) dweller, but may possibly be a tree-fall gap specialist (B. W. Miller *in litt.* 1990, 1991). In Belize, it seems to be limited to one forest type (details unknown) (B. W. Miller *in litt.* 1990), but elsewhere the habitat has variously been described as lowland tropical rainforest, low montane rainforest (the Cerro Santa Bárbara birds were taken in the transition zone between rain- and cloud-forest) (Monroe 1968), and (in Costa Rica) the wetter portions of the subtropical zone (Slud 1964). Many descriptions suggest that the bird prefers the dense (or “heavy”) wet/humid forests, especially near streams, rivers and gullies, and where there is a dense shrub layer (Taylor 1860, Huber 1932, Slud 1964, Stiles and Skutch 1989). Singles and pairs of birds have been recorded and are generally seen perching on low branches or undergrowth (“brushwood”) close to the ground (Taylor 1860, Huber 1932, Stiles and Skutch 1989), although Peters (1929) recorded one perched high in a tree.

Foraging apparently occurs mostly at low to medium heights (Stiles and Skutch 1989), prey items including cicadas (specimen in MNHUK) and other insect species (B. W. Miller *in litt.* 1991). However, these observations at lower levels may be exceptional as birds observed by S. N. G. Howell (*in litt.* 1991) have usually stayed at mid- to upper levels (often in the canopy) where they have been seen making agile

sallies for prey (see Remarks 6). The diet apparently consists of spiders, insects (orthopterans, cicadas etc.) and the occasional anolis lizard (B. W. Miller *in litt.* 1992).

Nesting activities have only been recorded in Belize, although a female (in MNHUK) taken on 17 April in Nicaragua had an incubation patch, and birds at Cerro San Gil, Guatemala, were seen courting and near a probable nest-burrow during February 1991 (Howell and Webb 1992). In Belize, early courtship was recorded during the beginning of March, with pair bonding, copulation, egg-laying and hatching occurring by and during May (B. W. Miller *in litt.* 1990). During this time the birds give a distinct territorial vocalization (see Remarks 6) at first light (generally introducing the dawn chorus along with tinamous, forest-falcons etc.), but continuing at irregular intervals throughout the day between February and June (B. W. Miller *in litt.* 1990, S. N. G. Howell *in litt.* 1991). Around Caracol, the birds prefer the banks and mounds left by the Maya Indians for their nesting sites, and it is in these that they excavate a tunnel c.45 cm long (with a terminal chamber on the left) in which both sexes undertake the incubation of the three eggs (B. W. Miller *in litt.* 1990).

The larger Blue-crowned Motmot is very abundant around Caracol (see Population) and some antagonistic exchanges have been observed, although the two species do not appear to be in direct competition for nesting space, and niche overlap in prey items appears to be minimal (B. W. Miller *in litt.* 1990). In Nicaragua and Costa Rica, the Keel-billed Motmot is sympatric with the relatively more abundant Broad-billed Motmot (Salvin and Godman 1888-1904, Slud 1964), and in Costa Rica, an individual Keel-billed Motmot apparently formed a pair-bond with a Broad-billed Motmot, but no young were produced (Stiles and Skutch 1989).

THREATS This species occurs generally at very low densities and therefore requires large expanses of undisturbed lowland tropical forest in order to sustain a viable population. Wet lowland tropical forest is one of the most threatened habitats in Central America: in Mexico, all suitable habitat is being cleared at an alarming rate, with effectively no forest remaining in sight of the trans-isthmus highway (route 185) on the Veracruz–Oaxaca border (S. N. G. Howell *in litt.* 1987, 1991), although the Chimalapas region of Oaxaca still holds extensive undisturbed lowland forest (A. G. Navarro and A. T. Peterson *in litt.* 1991); while in Costa Rica less than 30% of wet lowland forest remains (a forest type that once covered 30% of the country: Stiles and Skutch 1989), and the area in which the species has most recently been seen is rapidly being cleared (F. G. Stiles *in litt.* 1991). The same situation obtains to a greater or lesser extent throughout the known range of the Keel-billed Motmot.

The fact that so little is known of this species's requirements means that specific threats are almost impossible to assess, but at Caracol, Belize, one pair of birds was displaced at the start of the breeding season by archaeological work, when their chosen nesting banks were removed with rubble during excavation of the Maya ruins (B. W. Miller *in litt.* 1990), this probably being the explanation for the disappearance of the species from Tikal National Park, Guatemala, where clearance of the Maya ruins was taking place when the bird was seen in 1958 (E. P. Edwards *in litt.* 1991). Only one pair out of 7-8 birds under observation at Caracol laid eggs (human disturbance at the archaeological site possibly causing this poor reproductive effort) but even these eventually failed when the young were killed in the nest burrow, apparently by fire-ants which recently spread into the clearing made by the archaeologists (B. W. Miller *in litt.* 1990). The current threats at Caracol are clearly localized but, as they affect the largest population of this species currently known, they are obviously of some concern. Caracol and the Mountain Pine Ridge locality are both within the same large forest block encompassed by the Chiquibul and Mountain Pine Ridge Forest Reserves, and are therefore set aside for timber (B. W. Miller *in litt.* 1991: see below).

MEASURES TAKEN A number of reserves and parks “protect” areas where the Keel-billed Motmot has previously been recorded, although there are very few where the species has recently been found, or for which information on remaining suitable habitat exists.

Mexico No protected area covers any of the few localities where this species has been found.

Belize The Caracol area is protected as an Archaeological Reserve (and therefore automatically a Wildlife Reserve: D. Weyer *in litt.* 1989), and some areas around it are protected at least to a degree: Mountain Pine Ridge Forest Reserve (c.500 km²) is too high and within the wrong forest type (details unknown) for this

species; Chiquibul Forest Reserve (c.1,850 km²) is being actively logged but probably harbours the bird; and the Cockscombe Basin Jaguar Reserve (460 km²) has been extensively logged and is now threatened by “slash-and-burn” agriculture, but may also support this species (*BBC Wildlife* 4 [1984]: 174-178). Almost all the areas whence come records of this species (except for Slate Creek: see below) have recently (December 1991) been designated as the Chiquibul National Park (c.108,055 ha), at the edge of which lies the Caracol site (B. W. Miller *in litt.* 1992): obviously the previous designations will now have changed, but the boundary of the new park is not known, and the degree of overlap is difficult to assess. Slate Creek is currently being established as a private reserve of c.1,400 ha (B. W. Miller *in litt.* 1992). A detailed ecological study of this bird is currently in progress at Caracol and is being followed up with research and analyses in other areas (B. W. Miller *in litt.* 1990).

Guatemala Tikal National Park once harboured the species, although its continued presence there seems to be unlikely owing to clearance around the Maya ruins (see Threats). Cerro San Gil, although an area of special protection, has been proposed (by FUNDAECO) as an ecological reserve, with boundary delimitation (for an area of c.47,400 ha) in progress during 1991 (S. N. G. Howell *in litt.* 1991, D. S. Weber *in litt.* 1992).

Honduras The Jardín Botánico Lancetilla seemingly protects the Tela river basin and contains much untouched forest (in the forest reserve), and although large numbers of people visit the gardens, few venture in the forest where the motmots occur (Cruz 1986, S. N. G. Howell *in litt.* 1991). A well used trail runs through the forest reserve (and possibly the territories of some motmots) to the village of San Francisco, but disturbance away from the path appears to be minimal (S. N. G. Howell *in litt.* 1991). Cusuco National Park protects some of the higher areas of the San Pedro Montaña region, but these may be too high for the Keel-billed Motmot, while the status of the forests (and their protection) lower down is unknown (see Cruz 1986). Similar uncertainty exists in the Santa Bárbara National Park, where although the bird has been collected at 1,220 and 1,555 m (see Distribution) these altitudes are seemingly exceptional, and in any case most of the well preserved areas of the park are above 1,800 m (Cruz 1986). Whether or not the species occurs in this protected area is unknown, and it is also unknown if it occurs in the adjacent “Reserva de Usos Múltiples Lago Yojoa” (although there appears to be limited amount of suitable habitat there: Cruz 1986). WCI's Paso Pantera project aims to link protected areas in Central America (with corridors of habitat), and this may have advantageous effects for populations of the species between Lancetilla and La Muralla Wildlife Refuge (B. W. Miller *in litt.* 1992).

Nicaragua The conservation status of this species in Nicaragua is difficult to determine owing to the imprecise nature of most distribution data. However, it appears that none of the more likely areas are currently protected.

Costa Rica The species has been recorded from Rincón de la Vieja National Park (see Distribution) although there is much habitat clearance around this park (see Threats), while Monteverde National Park apparently includes at least part of the Peñas Blancas valley (see Stiles and Skutch 1989), but whether or not the bird is to be found in the park requires further investigation. Most of Costa Rica's extensive protected areas network covers primarily montane habitats, and therefore many of the known localities for the species fall outside existing areas.

MEASURES PROPOSED The project currently in progress at Caracol is collecting data on tree species diversity, composition and forest type profiles in order to discover the precise niche and area requirements of this bird, with the long-term aim of finding (possibly by using satellite imagery) similar habitats or forest types in the rest of the species's range (B. W. Miller *in litt.* 1990). The census data already collected are to be analysed to give an indication of population viability and eventually to calculate the risk of extinction, taking into account the patchiness of distribution and fragmentation of suitable habitat (B. W. Miller *in litt.* 1990). All of these analyses will be valuable for the effective conservation of the Keel-billed Motmot, especially the identification of suitable remaining forest areas in which surveys should be concentrated in order to assess whether the species is there and, if so, the potential viability of the population: with the species producing a far-carrying call between February and June, surveys (once the

call has been learnt) would be relatively easy (S. N. G. Howell *in litt.* 1991). The Caracol area has been proposed as a World Heritage Site on the grounds of its biological and archaeological importance, as has the merging of Chiquibul National Park, Upper Bladen and Cockscombe Basin Reserves into the Maya Mountain Biosphere Reserve (560,000 ha) which would link all the southern half of the country's forests (B. W. Miller *in litt.* 1991, 1992).

Priority areas where (or near where) the species has already been recorded but where further investigation is necessary are all of the reserves mentioned above, more specifically those forests around Caracol as yet unsurveyed (including areas in the Maya Mountains in adjacent Guatemala); the areas whence come recent reports in Guatemala and Honduras; the Honduras–Nicaragua border areas, as well as the still extensive Atlantic forest areas of Nicaragua (which are largely unknown but possibly harbour significant populations; and the region around Lake Arenal, Monteverde and Rincón de la Vieja.

REMARKS (1) A female (in BMNH) was taken “near San Felipe, Riomakal” (untraced, and no country given) in May 1888, a new label on the specimen claiming this to be “San Felipe, Campeche”. There are two San Felipes in Campeche, one in the far west on the Tabasco border, and one in the south, bordering on Guatemala. However, “San Felipe, Riomakal” most probably refers to a locality along the río Macal in west-central Belize (see below) and indeed, a specimen was taken by the same collector (Blancaneaux) in January of the same year near Belize City. (2) The specimens taken at Tolosa and Ubero were collected on the same expedition (by A. E. Colburn and P. W. Shufeldt) on 21 and 27 December 1901 respectively, suggesting that the two localities are indeed in close proximity and therefore almost certainly in Oaxaca. (3) The specimen in UMMZ has recently been identified as a male; the original label has been lost but a new one, probably written by J. van Tyne, claims that “this bird was almost certainly collected at Laguna Perdida” in Petén, Guatemala (B. W. Miller *in litt.* 1990). The bird was collected by P. W. Shufeldt, and was therefore presumably taken at around the turn of the century (see Remarks 2). (4) Monroe (1968) could not find the specimen reported from La Ceiba in Bangs (1903) when he searched the MCZ collection and catalogue, but this specimen (a male) was present there in 1987 and, as reported, was collected at La Ceiba, Honduras, on 21 January 1902. (5) Stiles and Skutch (1989) suggested that this species can be found in the Cordilleras de Guanacaste and Talamanca, although this latter is a misprint for Cordillera de Tilarán (F. G. Stiles *in litt.* 1991). It is also suggested that records from further south require confirmation because of possible confusion with young Broad-billed Motmots (Stiles and Skutch 1989). (6) This bird is not easily seen, and may be readily overlooked until the observer is familiar with its voice (Peters 1929). B. W. Miller (*in litt.* 1990) claimed that there are at least five distinct calls, many of which are at very low frequency, the territorial ones being given mostly before sunrise, but also irregularly throughout the day (S. N. G. Howell *in litt.* 1991). The territorial call is very similar to that of the Broad-billed Motmot, and it is possible that this has led to the species being overlooked where these two species are sympatric (S. N. G. Howell *in litt.* 1991). The difficulty of observation (birds most often staying at mid- to upper levels in the forest), and the relatively recent discovery of a full complement of vocalizations, may help to explain the paucity of distributional records.