Confined to a small area of high, arid valleys in south-central Bolivia, where it numbers only a few thousand individuals (possibly only a thousand), this unusual macaw has suffered from capture for the cagebird industry, from persecution as a pest in peanut and maize fields, and from loss of trees within its habitat. It is the object of several concurrent projects.

DISTRIBUTION The Red-fronted Macaw is confined to south-central Bolivia, where it has been collected and sighted around the headwaters of río Yapacani and along the drainages of the río Mizque and río Grande, in western Santa Cruz, south-eastern Cochabamba and extreme northern Chuquisaca departments. There are sight records from along the río Pilcomayo drainage in Chuquisaca and immediately adjacent western Potosí department. Although only three localities of museum specimens appear to have been published before around 1990 (des Murs 1855, Bond and Meyer de Schauensee 1942-1943, Remsen *et al.* 1986), no fewer than 21 of the (at least) 29 museum specimens in existence are labelled with locality, all but one having been taken in or before 1937 (specimens in AMNH, ANSP, CM, EBD, FMNH, MNHN and UMMZ). The locality identified by des Murs (1855), "Estella", is untraced. In the following account coordinates are from OG (1955a).

Santa Cruz The species has been collected in the upper río Yapacani drainage in Santa Cruz at El Palo, 1,900 m, at 18°06'S 64°12'W (Remsen *et al.* 1986; specimen in CM), and sighted between El Trigal (1,740 m) at 18°17'S 64°09'W (whence a specimen in MNHN) and Valle Grande (2,085 m) at 18°28'S 64°06'W (Romero 1974a, Ridgely 1981a, Lanning 1982, 1991). Records from along the río Mizque drainage in Santa Cruz include (from east to west): 30 km east of Comarapa, 2,000 m, at 18°05'S 64°21'W (sighting: Nores and Yzurieta 1986); Tin-Tin, 2,150 m, at 18°01'S 64°25'W (specimens in FMNH, MNHN); Pulquina (1,690 m), at 18°06'S 64°25'W (sight records: Ridgely 1981a, Lanning 1982, 1991); and Saipina (1,475 m), at 18°06'S 64°34'W (sight records: Ridgely 1981a, Lanning 1982, 1991).

Cochabamba Records include (from east to west): Pérez (1,472 m), at 18°06'S 64°44'W (sight records: Lanning 1982); Ele-Ele, 1,525 m, at 18°06'S 64°45'W (Bond and Meyer de Schauensee 1942-1943, Lanning 1991); Pojo, 2,500 m, at 17°45'S 64°49'W (two specimens in CM); 25 km north of Aiquile, 1,800 m, at 18°00'S 65°07'W (sight records: Lanning 1982); 22 km north of Aiquile, 2,150 m at 18°02'S 65°08'W (sight record: Nores and Yzurieta 1986); Aiquile, 2,150 m, at 18°12'S 65°10'W (specimens in FMNH, UMMZ); and Mizque, 2,290 m, at 17°56'S 65°19'W (four specimens in AMNH).

Chuquisaca One specimen (in AMNH) labelled "Río Grande, 1,100 m" was evidently taken near Bella Vista, at c.18°40'S 64°17'W (see Remarks 1). Lanning (1982) reported 12 sightings along a tributary of río Grande in the north of the department, at 1,600-1,900 m near Chuqui Chuqui, at 18°50'S 65°07'W; C. Cordier (in Alderton 1985) noted the occurrence of these parrots north-west of this area, around río Caine at the headwaters of río Grande (where later they were studied by Boussekey et al. 1991a,b, 1992), and on 1 August 1989 M. Kessler (*in litt.* 1989) during a survey of only four hours found 40-50 macaws just east of Torotoro, 2,100-2,500 m, on the border of Cochabamba and Potosí departments, Torotoro being at c.18°07'S 65°46'W; this is considered the best *Schinopsis* "forest" (see Ecology) in the entire region (M. Kessler *in litt.* 1989). Lanning (1982) reported four sightings along río Pilcomayo at the eastern border of Potosí, near Uyuni, at 19°27'S 64°50'W.

Judging from the extent of habitat, Lanning (1982) estimated the range of the Red-fronted Macaw to be c.18,000 km^2 in south-east Cochabamba and adjacent parts of Santa Cruz and Chuquisaca, and c.2,000 km^2 along the río Pilcomayo in Potosí and Chuquisaca. All of the specimens from museums mentioned above were taken between 29 September and 28 December, except the singles from Trigal, collected 30 June, El Palo, collected 20 July, and Chapare, dated 21 July (but this was captive when it died). Lanning (1982) noted that the macaw is a strong flier and very mobile, and that it could probably be seen throughout its range at any time of the year, although this was doubted by Clarke and Duran Patiño (1991).

POPULATION Ridgely (1981a) estimated a total population of no more than 1,000-3,000 birds, while Lanning (1982), having found the distribution to be somewhat larger, estimated a total of 3,000-5,000 birds. This latter estimate has been recently doubted, because it was based partly on the view that the

BirdLife International (1992) Threatened Birds of the Americas.
Cambridge, UK: BirdLife International.

species moves very little within its home range, whereas modern evidence seems to be that it moves considerably; thus a census of the main area of the ríos Grande and Mizque in 1991 revealed 555-626 birds, with reports suggesting that altogether less than 1,000 persist (Clarke and Duran Patiño 1991). Half those questioned in this more recent work judged that the species was rarer than it was 8-10 years before, and a third considered it scarce or rare, with reported loss of populations at Comarapa and Pererata and a substantial decline around Trigal (Clarke and Duran Patiño 1991). In a study area of 200 ha in the río Caine, average daily sightings of 180 birds suggested a total population there of around 60 individuals (Boussekey *et al.* 1991a,b, 1992).

ECOLOGY The Red-fronted Macaw inhabits mountainous, fairly arid scrubby regions intersected with narrow gorges and wider floodplains, generally at elevations from 1,100 to 2,500 m (Ridgely 1981a, Lanning 1982, Clarke and Duran Patiño 1991; specimens in AMNH, ANSP, CM and FMNH). In western Santa Cruz department it was found in March and April in valleys with desert-like shrubby vegetation, and somewhat taller, though still dry woodland on some upper slopes and ridges, and was never seen in better developed patches of woodland (Ridgely 1981a). Lanning (1982) reported it from a mixture of scrub and semi-arid deciduous woodland. Clarke and Duran Patiño (1991) note that the lower río Grande system has been classified as temperate dry woodland, the lower río Mizque system as subtropical cactus woodland, and the upper ríos Grande and Mizque system as temperate cactus woodland; of these, they felt that the last was the most preferred habitat. Common genera of trees, usually less than 5-7 m tall, and shrubs in these woodlands are *Prosopis*, *Carica*, *Acacia*, *Mimosa*, *Gourleia*, *Schinus*, *Erythrina*, *Salix*, *Alnus* and *Dodonea* as well as balsa trees and large columnar cacti (*Cereus* spp.) (Lanning 1982, Fjeldså 1987). The study area in the río Caine was xerophytic (300-600 mm of rain per year, all between November and April) and dominated by cacti (*Cleistocactus* sp., the endemic *Lobivia caineana*, *Echinopsis* sp., *Opuntia* sp., *Quiabentia pereziensis*) plus bromeliads *Hetchia* or *Dyckia* sp. and *Tillandsia*, spiny bushes (notably *Prosopis kuntzei*) and, rarely, small trees 4-10 m tall, of which the commonest was *Schinus molle* (Boussekey *et al.* 1991a,b, 1992). At Torotoro M. Kessler (*in litt.* 1989) found the Red-fronted Macaw on the edges of irrigated fields near the river bed and very extensive *Schinopsis–Aspidosperma–Prosopis–Jacaranda* forest on the slopes (both the valley bottoms and the ridges above, at 2,500-3,000 m or more, are settled). During the day it travels alone, in pairs or small groups, rarely up to 20 individuals (Romero 1974a, Lanning 1982, Nores and Yzurieta 1986), while flocks of 30-80 birds may be seen in wide-ranging roosting flights (Ridgely 1981a). The birds are reliably reported to roost in sheer, vegetation-free cliffs, preferring those overhanging running water, adjacent to the larger rivers, higher than 40 m, and free of human disturbance (Clarke and Duran Patiño 1991), and E. Pitter and M. Bohn Christiansen (*in litt.* 1991) found two roost-sites in holes in 50 m high cliffs, although they also witnessed overnight roosting in trees near fields; for further data on daily movements, etc., see the last paragraph in this section.

In a recent survey in the río Grande, local residents identified well over twenty food-plants of the species, the four most consistently reported being two legumes (soto *Schinopsis quebracho* and algarroba *Prosopis chilensis*), a cactus (caraparí *Cereus* or *Neocardenasia* sp.) and chañara (unidentified) (Clarke and Duran Patiño 1991), confirming reports by Romero (1974a,b), Ridgely (1981a) and S. Arías (verbally 1988); a recent survey in the río Caine produced a rather different list (entirely based on local reports) consisting of *Schinus molle*, *Aspidosperma* sp., *Prosopis kuntzei* and *P. juliflora*, *Cnidoscolus* sp. and two grasses, *Tribulus* sp. and *Cenchrus* sp. (Boussekey *et al.* 1991a,b, 1992); moreover, Lanning (1991) recorded birds feeding 12 times on the fruits of *Jatropha hieronymii*, a common tree in the valleys where the species occurs, while Silva (1989a) singled out *Erythrina cristigalli* as a food-plant (presumably derived from Romero 1974b). Chewing of *Aspidosperma* leaves occurs during the resting periods, apparently for their juice (E. Pitter and M. Bohn Christiansen *in litt.* 1991). However, cultivated crops also form part of the species's diet, so that it is considered a pest by local farmers (Ridgely 1981a, Lanning 1982, E. Pitter and M. Bohn Christiansen *in litt.* 1991). Local farmers report that at the end of the breeding season (March–April) birds range into maize fields at up to 3,000 m, which are then in the main "milk" stage, and stay in these areas until groundnuts become available around May–June (Clarke and Duran Patiño 1991; also Boussekey *et al.* 1991a,b; see Threats); the same informants denied that the birds actively dig for the nuts, rather glean what have been missed during harvest or else pick over the stacks

prior to their storage (Clarke and Duran Patiño 1991), but active digging was reported in Alderton (1985) and by both R. S. Ridgely (*in litt.* 1988) and E. Pitter and M. Bohn Christiansen (*in litt.* 1991), who all noted that this was chiefly for nuts left behind after the harvest and after the fields have been ploughed, much less prior to the harvest. Once a flock of 200 birds was seen feeding in a maize field (Nores and Yzurieta 1984a, 1986), six were once observed sitting on the ground in a bean field, presumably feeding on the beans (M. Kessler *in litt.* 1989), and frequent feeding on a small grass seed (from a common weed, so that on average 14 per minute were consumed) has been noted (E. Pitter and M. Bohn Christiansen *in litt.* 1991). Apricots are occasionally taken (S. Arías verbally 1988). In October–November 1990 in the río Caine a local population of around 60 birds appeared to be feeding exclusively on some 30 ha of cultivated ground, and according to the local farmers they do so at times throughout the year; thus they follow the plough during the October groundnut sowing, seek the green shoots as they begin to appear, forage on the maturing crop in June, and glean the ungathered nuts after harvest (Boussekey *et al.* 1991a,b). In a side valley of the río Grande, 1991/1992, birds foraged mainly on the fruits of *Zizyphus mistol* in November/December, on planted corn in January/February, and fruits of *Jatropha risinifolia* from February to April (E. Pitter and M. Bohn Christiansen *in litt*. 1992). Birds drink in small groups, not going to the main river but to adjacent streams where the water flows slowly; drinking follows feeding in the morning period, lasting some 10 minutes, and occurs during the afternoon feeding session (Boussekey *et al.* 1991a,b).

Ridgely (1981a) was told by local people that the macaws nest semi-colonially on certain cliffs during September–February, and Lanning (1982, *in litt.* 1989) reported it to breed in inaccessible cavities (holes and cracks) in large sandstone cliffs during December–March, although the two closest nests he found were 200 m apart on separate cliffs (see Lanning 1991). Attempted copulation (on the ground) was witnessed twice in late October, and the earliest clutches are presumably laid in November or December; however, birds seen in November that appeared to be 6-8 months old must have hatched in March and thus represented late breeding, with eggs laid in February (Boussekey *et al.* 1991a,b). Fieldwork in 1992 strongly suggested that the breeding season is timed to coincide with maximum fruit production of wild plants, in February–March (M. Boussekey *in litt*. 1992). Romero (1974a) believed the species to be monogamous, as he always observed it in pairs; this was confirmed by Boussekey *et al.* (1991a,b, 1992), who noted that even in feeding groups a pair (sometimes with a juvenile) would always stay closer to each other than they did to the other birds. Nest-sites are in cliffs, and local reports indicate that nests are dispersed and not colonially grouped (Boussekey *et al*. 1991a,b, 1992). In one case incubation in captivity took c.26 days, and nine weeks after hatching the young could feed by themselves (DeLoach 1983); young birds fledge at about 70-73 days (Robiller *et al.* 1988). Of 26 observations (in late 1990) of pairs accompanied by immatures, 24 (92%) involved one young, one involved two and one three (Boussekey *et al.* 1991a,b); at the same site at the equivalent stage of the following year, however, pairs with two or three young were seen just as often as pairs with only one offspring, and counts of larger groups of foraging birds (up to 74) indicated that approximately one-third were first-year birds (E. Pitter and M. Bohn Christiansen *in litt.* 1991). Immatures in October–November participated little in foraging, often either sitting on the ground next to their foraging parents or remaining perched in a nearby bush (presumably they are still then being fed bill-to-bill) (Boussekey *et al.* 1991a,b).

Daily activity, October–November (1990), took the following pattern: between 05h30 and 07h00 the birds arrived from their (undiscovered) roosting cliffs, flying towards the feeding areas; between 07h30 and 10h00 they returned in the direction of the roosting cliffs, resting quietly in trees in the shade over the long midday period, though occasionally indulging in noisy social activity; between 14h30 and 17h30 they flew back again to feed; and between 17h00 and 18h30 they again returned towards the roosting cliffs (Boussekey *et al.* 1991a,b); in 1991 this pattern was repeated, except that return to forage following the midday rest period was generally delayed until 16h00 (E. Pitter and M. Bohn Christiansen *in litt.* 1991). However, in another study extending from December to March, the periods of activity were 05h30-09h30, 11h30–13h30 and 15h30–19h30 (Lanning 1991).

THREATS The Red-fronted Macaw has suffered capture for the cagebird industry and persecution by local farmers, and is now threatened by habitat destruction.

Trade Both Ridgely (1981a) and Lanning (1982) considered the capture of this species for the pet-trade a serious threat (see Remarks 2). The macaws, including both breeding adults and subadult birds, are caught with mist-nets and cannon-nets after being lured into baited fields (Ridgely 1981a). Imports into the U.S.A. went from 16 in 1977 to 82 in 1978, and 125 in the first eight months of 1979 (Nilsson and Mack 1980). In 1981 alone 300 were estimated to have been exported (see Robiller *et al.* 1988). Local people in the río Caine valley reported in 1991 that trappers from Cochabamba came every year until 1987 to capture birds (E. Pitter and M. Bohn Christiansen *in litt.* 1991); this conforms well with Robiller *et al.* (1988), who referred to "several hundred birds in trade annually in recent years", and reported seeing (in 1986) 20 wild-caught birds in a Singapore dealer's establishment, destined for the Philippines (Robiller *et al.* 1988).

Persecution Local farmers consider it a pest on their crops of maize and peanuts and kill the species by shooting it or baiting it with poisoned maize, so that around 1980 it was judged that the species would be extinct within 10 to 15 years if further hunted (D. Wells in Alderton 1985); Romero (1974b) said the birds were shot both as pests and for their tail-feathers, and also expressed concern for its security. However, neither Ridgely (1981a), Lanning (1982) nor, retrospectively, C. Cordier (in Müller-Bierl and Cordier 1991; see Remarks 2) regarded persecution by local farmers as a serious threat to the macaw, arguing that few of the farmers have firearms, a view largely confirmed in recent studies by Boussekey *et al.* (1991a,b, 1992), E. Pitter and M. Bohn Christiansen (*in litt.* 1991) and Clarke and Duran Patiño (1991), although the last, in noting that five farmers out of 24 admitted to killing birds occasionally, with nobody claiming more than two per year, regarded the overall number lost annually as of some importance if the population is as low as they judge it (see Population).

Habitat destruction Although habitat destruction was not regarded as a serious threat by Ridgely (1981a; also *in litt.* 1989) or Lanning (1982), C. Cordier (in Alderton 1985) argued that the algorroba tree, which he (and also S. Arías verbally 1988) stated to be an important food-source of these macaws (see also Ecology), is being heavily cut to make charcoal for the tin-smelting plant near the town of Oruro, and that the macaws will therefore turn to more frequent use of maize and peanuts as a food-source, this again leading to further persecution. In recent years in the main part of the range (although not in the río Caine: Boussekey *et al.* 1991a,b, 1992) the problem of habitat loss has become more acute, and is held directly to blame for the decline in numbers believed to have occurred through the 1980s: thus (1) the flood-plain valleys have lost 40% of their natural vegetation to agriculture, (2) the use of the macaw's food-plant soto (but also even various preferred cacti) as firewood to produce sugar "cake" (used in local alcohol production) entails a serious loss of food, and (3) outside the flood-plains an intensifying cattle industry is causing erosion and much habitat loss (Clarke and Duran Patiño 1991). In the río Caine, the only threat has been judged the improvements to roads that lead to the archaeological tourist site of Torotoro, 20 km to the north (Boussekey *et al.* 1991a,b), but another perception is that this area has also suffered seriously from habitat loss, with the few remaining small forested areas along the river (used by the birds in the dry season) being heavily degraded by grazing goats, charcoal extraction and firewood collection (E. Pitter and M. Bohn Christiansen *in litt.* 1991). It may therefore be no coincidence that the only locality where M. A. Carriker found it in the 1930s (Ele-Ele) was the one in which xerophytic vegetation was more abundant than anywhere else he visited (see Bond and Meyer de Schauensee 1942-1943).

Natural enemies appear chiefly to be birds of prey: an unidentified raptor, possibly a Roadside Hawk *Buteo magnirostris*, was reported to have taken a chick from the nest, and panic was witnessed amongst birds when Andean Condors *Vultur gryphus* flew close to their nests on the río Grande (Clarke and Duran Patiño 1991) and when vultures (three species), Black-chested Buzzard-eagles *Geranoaetus melanoleucus* and Crested Caracaras *Polyborus plancus* flew close while they were feeding on the ground in the río Caine valley (Boussekey *et al.* 1991a,b, E. Pitter and M. Bohn Christiansen *in litt.* 1991), while direct attacks by Peregrines *Falco peregrinus* have been witnessed (E. Pitter and M. Bohn Christiansen *in litt.* 1991).

MEASURES TAKEN The Red-fronted Macaw was placed on Appendix I of CITES in 1983 (largely in response to the study by Lanning 1982, funded by ICBP Pan American Section and NYZS), thus receiving protection against all international trade and transport (WTMU 1988), and a 1984 ban on the export of all

live animals and birds from Bolivia has now become indefinite (Clarke and Duran Patiño 1991). As an apparent consequence, trapping of birds in crop-fields, the traditional method of capture, seems genuinely to have stopped in the late 1980s (Boussekey *et al.* 1991a,b, Clarke and Duran Patiño 1991), although at Omereque on the upper río Mizque a band of smugglers was reported still to be taking 20-40 birds annually (Clarke and Duran Patiño 1991). Demand for birds in the U.S.A. apparently diminished during the 1980s owing to successful captive breeding (Clubb and Clubb 1991). Only the eight or so breeding birds on the río Zapillar exist within a protected area, namely the Amboró National Park (Clarke and Duran Patiño 1991). The study by Boussekey *et al.* (1991a,b, 1992), reported here (and now leading to a cooperative programme: see below), was undertaken in direct response to the circulation of a draft of this text in 1988. Other fieldwork is being undertaken by E. Pitter and M. Bohn Christiansen, funded by WWF-Denmark, and in early 1992 5,000 posters urging protection of the species and its habitat were made, distributed and apparently well received throughout the region (S. Arías *per* M. Bohn Christiansen *in litt*. 1992).

MEASURES PROPOSED The Red-fronted Macaw would benefit from a package of measures including site protection, elimination of trade, education campaigns, appropriate technological aid, and continuing study and monitoring. Except for the last two paragraphs, the recommendations below are based on Clarke and Duran Patiño (1991), who set out certain points in considerable detail. Some of these points will be addressed in a cooperative programme between Espace ZOOlogique (France) and Santa Cruz University, Natural History Museum and Zoo (M. Boussekey *in litt*. 1992).

Fieldwork A census in the río Grande is needed to confirm assumptions about the macaw's status there and to help plan the proposed wildlife sanctuary (see below); further study of the populations west of the main Sucre highway and in the Pilcomayo drainage is also needed.

Site protection The entire río Mizque valley (south of Saipina as far as its confluence with río Grande) and that part of the río Grande from El Oro to the main Sucre highway should be declared a wildlife sanctuary, and a minor adjustment to the limits of the Amboró National Park is needed to include the small breeding population in the río Chañawaykho.

Elimination of trade The national authorities should formally notify civic authorities and all regional corregidors (over 50 listed) to enforce the prohibition on the persecution and trapping of the macaw, with punitive action in Omereque against the trading ring in that area.

Education A small educational campaign highlighting the local and national endemism of the macaw, involving radio broadcasts, posters and videos, ought to generate considerable popular support for the species.

Appropriate aid The local sugar industry in the species's range, responsible for much tree consumption, would benefit by the introduction of fuel-efficient methods for the production not only of sugar cake but also molasses, whose addition to cattle fodder might reduce grazing pressure in the region.

Habitat conservation In the río Caine valley, a strategy and a campaign to preserve the remaining native vegetation are vital, with replanting of native trees both to provide alternative food sources for the birds and to counter the extensive soil erosion now taking place (E. Pitter and M. Bohn Christiansen *in litt.* 1991).

Captive breeding Silva (1989a) provided an indication of the surprisingly wide representation this species has in captivity, and stated that lack of protection in the wild will throw the onus of conservation onto captive breeding. However, while captive breeding has obviously greatly helped by reducing the demand for wild-caught birds, and while the development of a studbook, already established (Clubb and Clubb 1991), remains important, there is no immediate need to consider captive breeding a major option in efforts to secure the species.

REMARKS (1) The specimen labelled “río Grande, 1,100 m” was taken by on 6 November 1915 (AMNH label data) by collectors who were on the upper río Grande between Pucará and Villa Serrano on that day, and it seems likely that they obtained the specimen on the right bank of the river, in Chuquisaca department, perhaps in the vicinity of Bella Vista, at c.18°40’S 64°17’W, and certainly no more than a

two-day mule ride from Pescado (now Villa Serrano), Chuquisaca, at 19°06'S 64°22'W (A. V. Andors *in litt.* 1988).

(2) Alderton (1985) used the testimony of C. Cordier, along with published information by D. Wells (*Avicult. Bull.*, July 1981), to discredit the work of Lanning (1982), which had led to the placing of the species on Appendix I of CITES. Wells had indicated that the species was a crop pest and much persecuted by farmers (something not observed or reported by Lanning), and Alderton (1985), in criticizing Lanning for this failure, expressed frustration that "with a ban on legal trade, the only option available to the farmers is to kill the birds"; he used Cordier's information at other points to indicate apparent inadequacies in Lanning's work. It is therefore worth noting that Cordier has subsequently expressed two opinions in line with Lanning's (whether accurate or not) and made one admission that stands awkwardly against the testimony of Wells, these being that: (a) persecution by farmers did not constitute a problem for the species (Müller-Bierl and Cordier 1991); (b) intensive trapping of the birds represented a very serious threat (Robiller *et al.* 1988); and (c) depredation of crops was greatly overemphasized by dealers in order to justify their exploitation of the species (Robiller *et al.* 1988).