DISTRIBUTION, NUMBERS, AND HABITAT OF BRISTLE-THIGHED CURLEWS (*Numenius tahitiensis*) ON RANGIROA ATOLL

By ROBERT E. GILL, JR. and ROLAND L. REDMOND

ABSTRACT

We assessed the numbers, distribution, and habitat of Bristle-thighed Curlews (*Numenius tahitiensis*) on Rangiroa Atoll, Tuamotu Archipelago, during a visit in April 1988. We estimated a total of 250-350 curlews on the atoll. These birds were seen only on the southern and western rims, where they were most common on (1) saltpans within clusters of small islets and (2) narrow channels between islets that were bordered by shrubs and herb mats. The distribution of curlews on Rangiroa appeared to be determined by the distribution of humans and their commensal animals and by the availability of habitats. Given the species' relatively low numbers, low reproductive rate, and prebasic moult which, for some adults, entails a flightless period, conservation and management efforts must begin on the non-breeding grounds. These efforts should focus on reducing or eliminating potential mortality factors such as subsistence harvest, introduced predators, and contaminants. Countries throughout the species' non-breeding range are encouraged to be active in these efforts.

INTRODUCTION

The Bristle-thighed Curlew (*Numenius tahitiensis*) breeds in remote, mountainous regions of western Alaska (McCaffery & Peltola 1986, Kessel 1989, Gill *et al.* 1991) and is the only migratory shorebird confined to islands and atolls during the non-breeding season. Almost all aspects of its biology are poorly known, and only recently have studies been initiated to learn more about the species. Curlews are found on their non-breeding grounds throughout the year, but are most abundant there during the austral summer (Holyoak & Thibault 1984, Pratt *et al.* 1987). With few exceptions, information about the species during the non-breeding period is limited to accounts of its distribution (but see Lacan & Mougin 1974, Marks *et al.* 1990, Kepler *et al.*, in press).

The overall lack of knowledge about the species, its relatively small total population, and the potential for accelerated resource development on the breeding grounds prompted the US Fish and Wildlife Service to begin a comprehensive study of the Bristle-thighed Curlew in 1987, including all phases of its annual cycle. In April 1988, we visited Rangiroa Atoll to collect basic information about the status, distribution, abundance, and habitat of curlews in the Tuamotu Archipelago. Here we describe the distribution and number of curlews on Rangiroa and how they used the available habitats; we then discuss the conservation and management needs of the species on its non-breeding grounds.

STUDY AREA

Rangiroa Atoll (15°05′ S, 147°45′ W) is in the northwestern Tuamotu Archipelago. It is 80 km long and 25 km wide, and encompasses 1640 km^2,

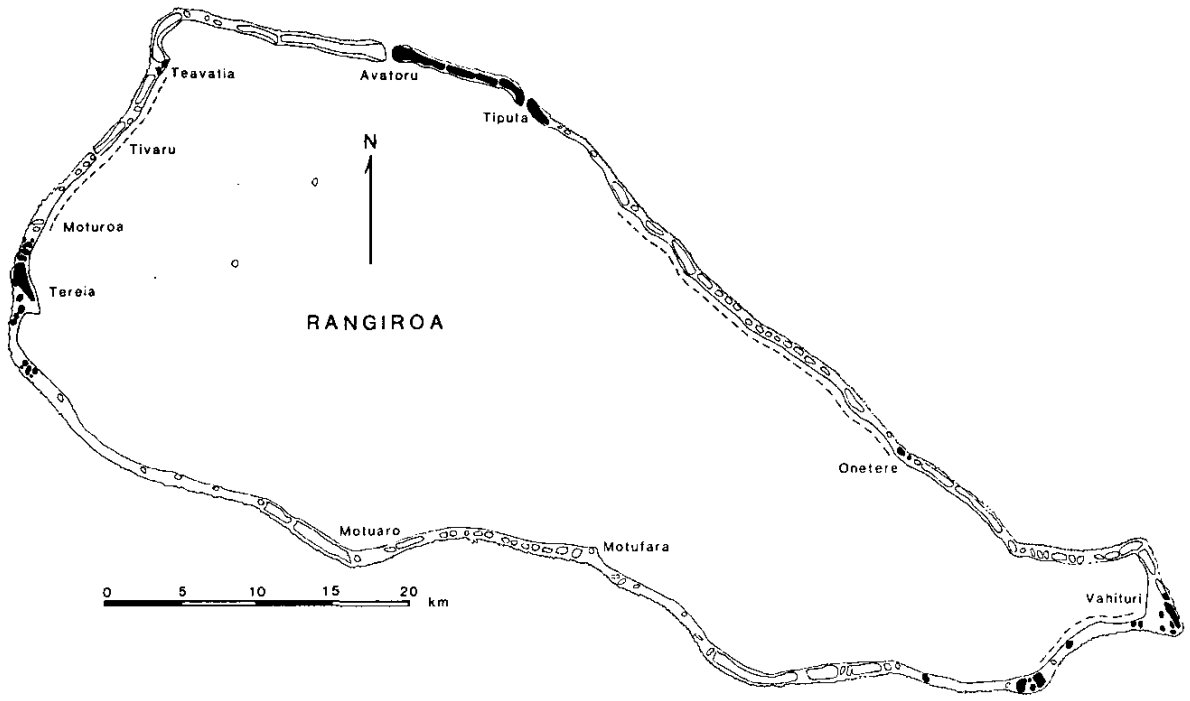

FIGURE 1 — Rangiroa Atoll showing *motu* visited (darkened) and shoreline censused (dashed line) during field work between 5 and 18 April 1988

making it the second largest open atoll in the world. The land area (43 km^2) is broken into more than 250 small islets, or *motu*, which surround a large central lagoon (1510 km^2; Figure 1). The *motu* have very little relief, and most lie only 2-3 m above high tide. The southern and eastern rims of the atoll are exposed to the trade winds, and much of this area is washed over by waves during seasonal high tides and tropical cyclones (Stoddart & Sachet 1969).

The atoll's surrounding reef and reef flat are broken by two deepwater passes along the northern rim. Most humans live in two permanent villages, Avatoru and Tiputa, adjacent to the passes. Individual *motu* are separated by narrow, shallow channels, or *hoa*. Some *hoa* are flooded daily by high tides, whereas others are inundated only during the highest spring tides or by storm-generated waves.

Landward of the reef flat is a series of narrow, older reef-rock flats and eroded terraces that extend well above most tides. Along the entire southern rim of the atoll is the *feo*, an unusual strip of ancient and intricately eroded reef rock. This formation averages 110 m in width and extends 2-3 m above the reef flat (Stoddart & Sachet 1969). In places, the *feo* is enclosed by a rock-floored reef moat that retains water during all but the lowest tides. The ocean-side beaches are composed of shingle and unconsolidated materials that rise rather steeply to the vegetated portion of the atoll. The lagoon side of the atoll is bordered by a narrow sand beach that is broken by rock along much of the northern rim but is nearly continuous along the southern rim. Many sand bars and coral heads in the lagoon become exposed at low tide. Figure 2 shows these generalized structural features of the atoll.

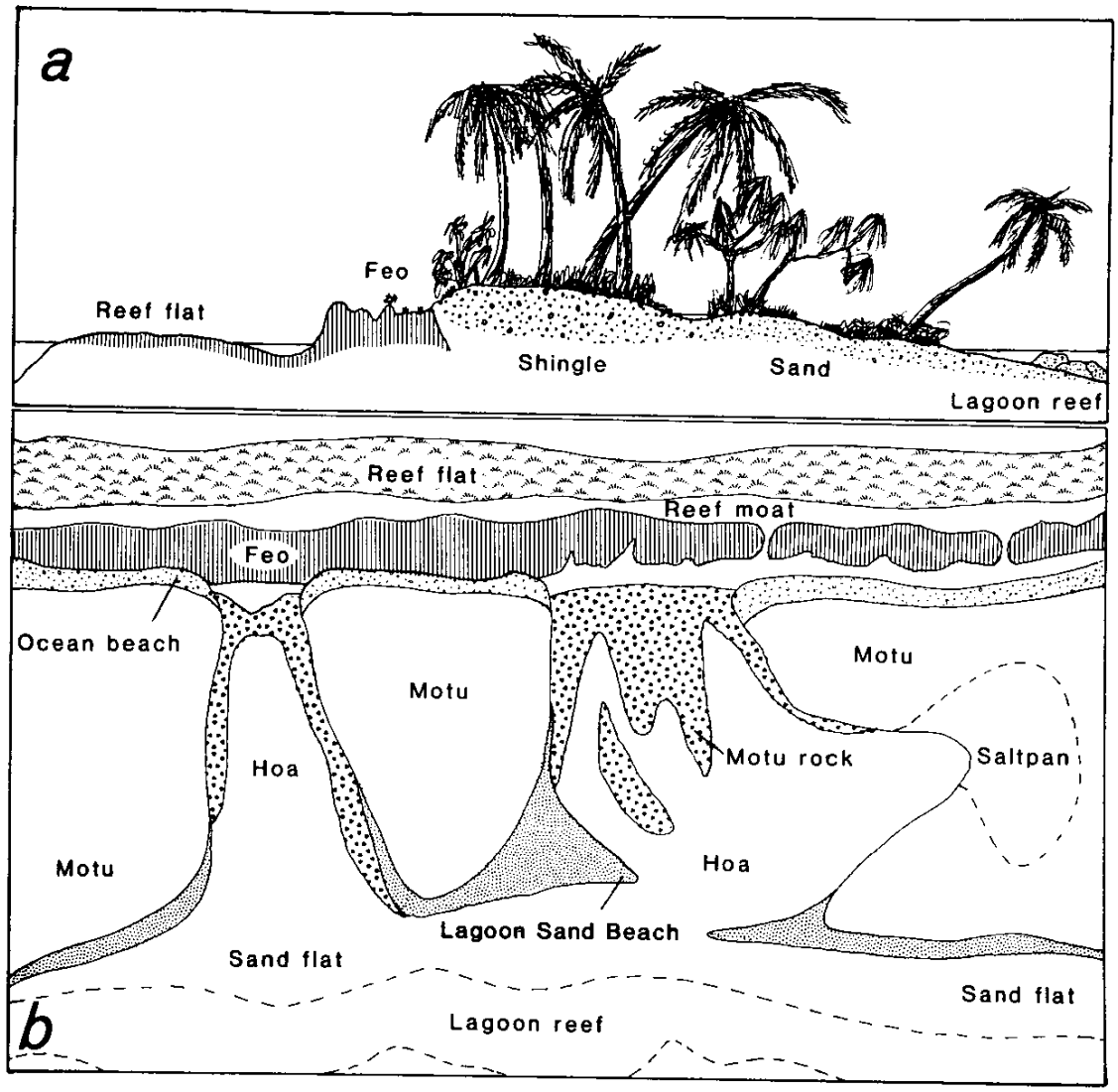

FIGURE 2 — Profile (a) and schematic overhead (b) of Rangiroa Atoll showing physiographic features and typical distribution of habitats of curlews (after Stoddart & Sachet 1969)

METHODS

We were on Rangiroa Atoll from 5 to 18 April 1988. During this time we interviewed several long-time residents of the atoll about seasonal distribution (past and present), numbers, behaviour, and subsistence use of curlews. Because we could not visit the entire atoll, we concentrated on parts that were reported to support the most curlews. We worked from Service du Cadastre maps (Papeete, Tahiti) of Rangiroa Atoll (scale 1:50,000) and Service hydrographique de la Marine (Paris) chart No. 6420 (scale 1:175,424). We measured the area of *motu* and length of shoreline from these charts with an electronic digitising planimeter.

We censused 28 named and 10 smaller, unnamed *motu* from all sections of the atoll except the central portion of the southern rim. These represented about 10 km^2 (23%) of the total land area of the atoll (Figure 1). On small *motu* (2-5 ha), we walked together or separately along the perimeter and stopped periodically to look for curlews. On larger *motu*, we usually worked

separately to obtain greater coverage. In addition to walking the perimeter, we either walked the length of the *motu* through its interior or traversed its width one or more times. We surveyed an additional 40 km (20%) of shoreline inside the atoll (Figure 1) from a small skiff. We made our daily observations between sunrise and sunset by eye, with binoculars, or with a 15-60x spotting scope. For each curlew we saw, we recorded its location, habitat, and behaviour when first seen.

We think we found most of the curlews on each *motu* that we visited. On the few *motu* where we spent more than one day or duplicated census routes, we undoubtedly counted some birds more than once. We included all observations in our analyses of behaviour and habitat use. For the population estimate, we excluded sightings of birds that we thought we recorded more than once while censusing different parts of the same or adjacent *motu*. We could not account for longer temporal or spatial movements of birds. Hence, our population estimate is based on the assumption that during our visit curlews were generally sedentary within clusters of *motu*. Lastly, we did not determine how time of day or stage of tide affected the behaviour of curlews or their use of habitats.

RESULTS

Habitats used by curlews

We identified eight habitats that Bristle-thighed Curlews used on Rangiroa Atoll. The physiography and vegetation of most of these are described more fully in Stoddart & Sachet (1969), Chevalier (1977), and Kepler & Kepler (in press).

Ocean terrace or reef flat: This habitat is along the ocean side of the atoll. It is an older reef surface, planed and locally bisected by surge channels along the outer reaches. It varies from a few hundred to several hundred metres in width and is usually composed of a reef-conglomerate of cemented corals, much of which remains exposed at high tide. Its surface ranges from relatively flat and smooth to very irregular and jagged, with boulder-size pieces of coral or conglomerate throughout.

Ocean beach: This habitat is also along the ocean side of the atoll. It is composed of unconsolidated fine to coarse sand, cobble, coral, or combinations thereof. Along the western and southeastern rims of the atoll, the beach consists of a broad steep ridge. This is clastic material, mostly coarse in texture, with some sand and much shingle thrown up against it. In most areas, *Scaevola taccada, Tournefortia argentea,* and *Guettarda speciosa* form a hedge at the crest of the beach.

Channels or *hoa:* These natural breaks in the perimeter of the atoll separate the various *motu*. Their substrates are eroded reef-rock, sand flats, conglomerate, or combinations thereof, but the narrow shores are usually sand and rock. The elevation of the substrates is highest toward the ocean and lowest toward the lagoon. Tidal channels are mostly free of vegetation except along the shoreline, whereas broader, non-tidal channels support patches of decumbent *Pemphis acidula* and *Suriana maritima.*

Lagoon sand beach: This habitat is along the lagoon side of the atoll between *hoa*. It usually consists of a narrow beach, 1-5 m wide, of coarse to fine sand.

A hedge of *Suriana maritima* grows along many of these beaches.

Lagoon coral reef: These structures of living coral or rock-reef terraces or flats become exposed at low tide along the lagoon side or in deeper *hoa*. They range in size from a fraction of a hectare to over several hectares.

Saltpan: This habitat is usually among clusters of small *motu* and varies from a fraction of a hectare to several hectares in size. Saltpans have sandy or muddy substrates that are often interspersed with patches of gravel or cobble. They are generally unvegetated or sparsely vegetated with *Heliotropium* spp. Saltpans are periodically flooded by high tides, but most are poorly drained, as indicated by the accumulation of salts on their surface.

Coconut grove: The interiors of most *motu*, especially the larger ones, contain large groves of coconut trees (*Cocos nucifera*) traditionally cultivated for copra. Groves that are still maintained for copra production are usually free of other vegetation. Poorly maintained or abandoned groves have dense understoreys that consist primarily of *Euphorbia atoto* and *Pandanus tectorius*.

Vegetated clearing: Several *motu* have clearings along their edges or occasionally within their interior. These clearings vary from a few hundred square metres to a few hectares in size and are surrounded by stands of *Pandanus* and *Pemphis*. Several of the clearings are overgrown with introduced grasses (e.g. *Cenchrus, Eragrostis, Digitaria,* or *Lepturus* spp.), suggesting that these clearings resulted from human activities.

Distribution and abundance of curlews

We recorded 66 sightings of curlews, including 32 single birds, 15 groups of two, and 19 flocks of 3-9 birds. These sightings totalled 144 birds, which we think represented about 120 individuals. About half of the curlews were at the southeastern end of the atoll near Vahituri, where curlews were on 13 of the 15 *motu* visited. The other half were along the western rim near Tereia, where curlews were on all 15 of the *motu* we visited.

No curlews were recorded either along the western rim of the atoll north of Moturoa or along the entire northeastern rim between Avatoru and Onetere. We were unable to census most of the southern rim of the atoll, but residents reported that curlews were common there, particularly on the smaller *motu* between Motuaro and Motufara. Assuming a similar habitat preference and frequency of occurrence over this area, we estimate that 250-350 curlews were on Rangiroa during our visit in April.

Habitat associations and behaviour

Among the 121 curlews for which habitat associations were recorded, 43 (36%) were using saltpans and 33 (27%) were in *hoa* between the *motu* (Table 1). Curlews were seen in moderate frequencies (6-18 birds) on ocean terraces, on lagoon sand beaches, and in vegetated clearings. In coconut groves, three curlews were observed on the ground in relatively open understorey, and three were standing on the trunks or tops of coconut trees. Only three curlews were recorded using coral reefs on the lagoon side, and no curlews were recorded using ocean beaches. However, we often saw curlews flying along ocean beaches after we had seen them on adjacent ocean terraces or in other habitats.

Only 13% of the records for which behaviour was noted (n = 139) were

TABLE 1 — The number and behaviour of Bristle-thighed Curlews recorded in each habitat during censuses of Rangiroa Atoll, 5-18 April 1988

	Behaviour when first detected					
Habitat	Feed	Stand	Flush	Fly	Unknown	Total
Saltpan	20	3	20			43
Hoa	5	17	11			33
Ocean terrace	1	5	12			18
Lagoon sand beach	3	2	7			12
Vegetated clearings	2	2	2			6
Cocos plantation	1	3	2			6
Lagoon coral reef	1		2			3
Ocean beach						0
Not recorded				18	5*	23
Total	33	32	56	18	5	144

* Birds seen by M. Putoa and H. Sanford but habitat and behaviour not noted.

of curlews in flight. Of the birds seen on the ground (n = 65), about half were standing and half feeding (Table 1). The remaining behavioural observations (n = 56) were of birds flushed from the ground. Most of the curlews seen feeding were on saltpans (60%) and in channels between *motu* (12%).

DISCUSSION

Distribution

According to long-time residents of Rangiroa, Bristle-thighed Curlews are not usually seen at any time of the year along the northern rim of the atoll from Tivaru to Vahituri. Our observations were consistent with this distribution. Several factors, including habitat, behavioural response to humans, and predation by exotic mammals, may be responsible for this pattern.

The northern and southern rims of the atoll differ somewhat in habitat. One striking feature, the *feo*, is only along the southern rim (Stoddart & Sachet 1969), but curlews probably rarely use this habitat. Saltpans, however, which curlews did use heavily, are only along the southern and western rims of the atoll (M. Putoa, pers. comm.). In addition, the southern and western rims contain almost a third more motu than the northern rim (Stoddart & Sachet 1969). This results in more *hoa*, which curlews also favoured. Reef flats are wider and the *hoa* separating the *motu* receive more tidal influence along the southern rim than along the northern rim. Thus, even though more of the land is concentrated along the northern rim, the configuration of saltpans and *hoa* along the southern rim may provide richer feeding habitats for curlews.

Probably a more important determinant of curlew distribution, however, is the presence of humans and their domesticated animals. On Rangiroa curlews were extremely wary of humans. Almost half of our observations

were of birds flushing from the ground (Table 1), often at considerable distance. Throughout the Tuamotus, residents have traditionally trapped curlews for food (Bruner 1972; Holyoak 1980; A. K. Kepler, *in litt.*) and still take a reduced subsistence harvest (M. Putoa, P. Bruner, pers. comm.). Curlews' wariness of humans may partially explain their absence along the northern rim of Rangiroa, where most people now live.

Introduced animals such as cats, dogs, and pigs may be an even stronger determinant of curlew distribution, not only on Rangiroa but throughout the birds' non-breeding range. That exotic mammals have suppressed wildlife populations and caused the extinction of endemic insular faunas is well known (Cooke *et al.* 1937, King 1973, Pascal 1980, Rauzon 1985, Hay 1986, Loope *et al.* 1988, Steadman 1989, Johnson & Stattersfield 1990, Steadman *et al.* 1990). Many of these reported extinctions were of species that nested on the ground or were flightless in a formerly predator-free environment.

Recent evidence from throughout the non-breeding range indicates that some Bristle-thighed Curlews become flightless during prebasic moult, including birds on Laysan Island (Marks *et al.* 1990), Caroline Atoll (C. Kepler, pers. comm.), and Rangiroa (H. Sanford, Sr., pers. comm.). Flightless curlews are very vulnerable to predation by cats, dogs, or pigs. Thus, it is likely that the distribution of curlews on Rangiroa and other atolls throughout the non-breeding range has been and will continue to be affected by humans and their commensal animals. Fortunately, exotic predators can be controlled and even eliminated on islands and atolls (Veitch 1985). In fact, recent eradication of feral cats on atolls in the Line Islands has resulted in the increase of several bird species there, including the Bristle-thighed Curlew (Rauzon 1985, unpubl. data; D. Forsell, C. Kepler and A. K. Kepler, pers. comm.).

Seasonal occurrence and abundance

Curlews are in French Polynesia all year, but are most common between September and April (Bruner 1972, Thibault & Thibault 1973, Holyoak 1980, Holyoak & Thibault 1984). This same pattern is reported for Rangiroa, but with one notable exception. The number of curlews there is reported to decrease between November and February (P. Bruner, M. Putoa, H. Sanford, pers. comm.). This puzzles us. The "decrease" may be a result of more secretive behaviour associated with flightlessness during moult (Marks *et al.* 1990). This would suggest, however, that the flightless period on Rangiroa occurs later or lasts much longer than either local residents believe or Marks *et al.* (1990) reported for birds at the northern edge of the non-breeding range. Alternatively, the "decrease" may reflect either seasonal shifts in regional distribution or more local changes in dispersion.

The 250-350 curlews we estimated to be on Rangiroa in April probably represent close to the peak annual number. Whether the number has changed on Rangiroa recently is not clear. Residents of the atoll were quick to suggest that the population of curlews has declined. These reports must be taken with caution, however. With the recent consolidation of villages (c. 1970), coupled with a decline in the number of people harvesting copra around the atoll, people have fewer opportunities to encounter curlews now than in the past. Nevertheless, two residents who have worked the same copra

plantations on the atoll for more than 20 years stressed that curlews seem to be less common than 15-20 years ago. At least one biologist (J-C. Thibault, *in litt.*) has indicated "a great loss" in the number of curlews throughout the Tuamotu Archipelago. It was not clear from either of these sources whether the perceived declines have occurred since 1983, when a series of tropical cyclones devastated the Tuamotus (Canby 1984) and probably affected local populations. Such reports of declining numbers, however, contrast with those from long-time residents of atolls in the northern Tuamotus, which indicate no appreciable change in 50 years (R. Lovegrove, pers. comm.). Clearly, the species' status throughout the Tuamotus and elsewhere on the non-breeding grounds needs further study.

Habitat associations and behaviour

Curlews are known to use a broad array of habitats on the non-breeding grounds (Bruner 1972, Pratt *et al.* 1987, Kepler *et al.*, in press). On Rangiroa, they were most common on clusters of small *motu* having saltpans and narrow *hoa* bordered by low shrubs and herb mats. The absence of observations of curlews standing or foraging on ocean beaches indicates that this habitat was used infrequently, at least during our visit. Curlews are known to use ocean beaches elsewhere (e.g. Caroline Atoll; Kepler *et al.*, in press). Moreover, curlews regularly use sandy beaches on Laysan Island to forage on ghost crabs (*Oxypode* sp.; J. Marks, unpubl. data). In contrast, the ocean beaches on Rangiroa are relatively rocky, especially along the southern rim where sand deposition is impeded by the *feo*, and consequently may not provide curlews with the foraging opportunities found in other habitats. Most of the curlews seen feeding, and those that flushed when first seen and were presumed to have been feeding at the time, were associated with saltpans and *hoa* (Table 1). The substrates of both of these habitats appeared to support high densities of invertebrate food, especially snails (*Neritia* sp.) and hermit crabs (*Coenobita* sp.), on which we watched curlews feed extensively at several locations.

Management

In the past, human-related activities on islands throughout the Pacific Ocean have probably altered the non-breeding distribution of the Bristle-thighed Curlew. Several activities, particularly subsistence hunting, pollution, and the introduction of predators, may continue to pose a threat to the population. Subsistence hunting of curlews and other wildlife has undoubtedly declined throughout Polynesia since the French government imposed sanctions on the possession and use of firearms. Nevertheless, even a modest harvest of curlews throughout the non-breeding range could entail the loss of a few hundred birds each year. In light of recent evidence of the species' delayed sexual maturity and extreme longevity (Marks *et al.* 1990), such a sustained loss could adversely affect the size, structure, and dynamics of the curlew population.

Pollution is probably a less serious threat to curlews now than in the recent past. Since World War II, stores of toxic chemicals, including dioxin, nerve gas, and mustard gas, have leaked into the environment at numerous military sites on islands throughout the Pacific (US Department of Interior 1986). In addition, between 1946 and 1974 hundreds of nuclear devices were exploded in the atmosphere above atolls scattered across the species'

non-breeding range (Westing 1980). These tests undoubtedly affected curlews, but we cannot assess the overall effect without knowing more about curlew migration patterns and movements during the non-breeding season. To us, the greatest threat to curlews on the non-breeding grounds is the introduction of predators capable of capturing birds during their flightless period of moult. What remains to be determined is how curlews respond to these predators. For example, do they move among atolls in search of secure places, or do they moult on islands where they become vulnerable to predation?

In 1989, the US Department of the Interior designated the Bristle-thighed Curlew as a candidate for its list of threatened and endangered species (US Department of Interior 1989). The current estimate of the species' entire breeding population is only about 7000 birds (R. Gill, C. Handel, and B. McCaffery, unpubl. data). Without historical data for comparison, however, it is not known if, and by how much, the population may have declined. Nevertheless, with the human population continuing to grow throughout the Pacific, the long-term future of curlews and many other species of island birds remains uncertain unless an effective conservation plan is developed. This plan should be developed jointly by the US, France, and New Zealand, in conjunction with less developed island nations like Kiribati and Tuvalu. For Bristle-thighed Curlews we recommend the following actions:

(1) Identify their current non-breeding distribution in relation to the distribution of introduced predators,
(2) Study their ecology in the central and southern portions of their non-breeding range, on islands with and without introduced predators,
(3) Identify predator-free islands that can be managed for curlews and other birds, and
(4) Monitor population trends of curlews in different geographical regions.

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ROBERT E. GILL, JR., *U. S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center, 1011 E. Tudor Road, Anchorage, Alaska 99503, USA;*

ROLAND L. REDMOND, *Craighead Wildlife-Wildlands Institute, 5200 Upper Miller Creek Road, Missoula, Montana 59803, USA. Present address: Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana 59812, USA*