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ORNITHOLOGY IN BELIZE SINCE 1960

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ABSTRACT.—We review ornithology in Belize, formerly British Honduras, since Russell's 1964 monograph and summarize published and unpublished reports, banding records, and museum data. Unpublished reports (gray literature) are an important source of information within the country. Since 1960, there have been numerous studies by the British Forces ornithological societies and others on avian ecology and behavior, the effects of logging on birds, the distribution of overwintering Neotropical migrants (approximately 20% of Belize's avifauna), and comparisons of avian distribution in disturbed versus undisturbed habitat. We review recent distributional records and problematic species records requiring verification and identify distributional "knowledge gaps". Although 70% of the country is still dominated by natural vegetation and 20% falls under some form of protected status, certain bird species and families are at risk from human impacts such as habitat conversion, hunting, introduced species, and in some cases, tourism. Areas for future study are suggested.

Russell (1964) provided a synopsis of ornithology in Belize through the early 1960s in his monograph: A Distributional Study of the Birds of British Honduras. In this comprehensive work he reviewed historical ornithological work in the country as far back as the 1800s. Our purpose here is not to reiterate Russell's exhaustive work, but to offer an update on ornithological study in Belize. We have divided such studies into broad categories that include ecological and behavioral studies and distributional updates. Although not strictly distributional in nature, we discuss banding records that add to our knowledge of avian distribution.

METHODS

Sources of Information.—In this paper we draw on information from many sources, including both published and unpublished literature. Unpublished reports, or "gray literature," are sometimes the only sources of information available to researchers in developing countries because scientific journals are generally costly and postal services may be unreliable. Although not critically reviewed, such unpublished resources frequently offer valuable, localized information not available otherwise. Such reports are often heavily used by government officials and decision makers. A source of such literature is BIODOC, Centro de Documentacion en Vida Silvestre, a cooperative effort between the Universidad Nacional, Costa Rica and the U.S. Fish and Wildlife Service. Research permits issued in Belize stipulate that a copy of any report resulting from such research be provided to the Forest Department, Ministry of Natural Resources. Within the active NGO community, there are three repositories for natural history information: the Belize Audubon Society being the longest standing and possibly most complete, the Belize Zoo and Tropical Education Center, and the Programme for Belize.

In the future, such reports should become more accessible to those outside the country as well as those within. The Conservation and Environmental Data System (CEDS) under the auspices of the Land Information Centre, Ministry of Natural Resources, intends to make such resources more widely available. CEDS has, as its primary mission, the development of a master catalog of such literature. Cataloging is well underway, and includes both government and NGO holdings relevant to conservation and environmental concerns within Belize. The CEDS literature resource database will be accessible via a telephone modem link allowing members to search what might be thought of as a national de-centralized library. Contact information for BIODOC and other Belizean sources are listed in the Appendix.

The country—Belize is frequently compared to Massachusetts or El Salvador in size. It extends 280 km north–south and 109 km east–west, and comprises approximately 22,960 km^2. Belize shows a mosaic of zoogeographical affinities. Northeastern Belize, including Ambergris Caye, has very strong Yucatán Peninsula affinities. Coastal areas and cayes have Caribbean affinities. The western areas extending south to the Maya Mountains divide appear to have strong Petén affinities. The coastal pine/palm savannahs resemble Honduran pine areas to the south. With over 3050 mm of rain per year (Hartshorn et al. 1984), the southern Toledo District has the highest rainfall in the country and comprises yet another distinct area. The upper elevations of the Maya Mountains are perhaps among the more unique areas in Belize. Although not considered "highlands" by Guatemalan standards, the relative elevation difference from the lowlands suggests some affinities to highlands in Guatemala (B. W. Miller and C. M. Miller 1995).

Although selectively logged for 300 years, Belize is still sparsely populated (200,000 people) with approx-

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imately 70% of its land naturally vegetated (Wilson 1995). A network of protected areas constitutes about 20% of the country. Designations ranging from Forest Reserves to Nature Reserves, offer varying levels of protection. These factors offer a fairly intact and diverse avifauna to ornithologists, with a current bird checklist numbering 546. About 20% of these birds are neotropical migrant species, and of the breeding birds, 11% are regional endemics.

ECOLOGICAL AND BEHAVIORAL STUDIES

Resident species were the subject of several studies in Belize, many in the Gallon Jug (Orange Walk District) area. Willis (1960a) studied forest flocks and Willis (1960b) focused on foraging behavior of the Red-crowned and Red-throated Ant-Tanagers (*Habia rubica* and *H. fuscicauda*), and noted some differences in habitat and foraging. Other studies were on their courtship and territorial behavior (Willis 1960c) and nesting (Willis 1961). Lancaster (1964a, b) conducted life history studies on Slaty-breasted Tinamou (*Crypturellus boucardi*) in Gallon Jug. Verner (1961) studied the nesting behavior of the Red-footed Booby (*Sula sula*) at Half Moon Caye and described the flight behavior of this species (Verner 1965).

During the 1981 Royal Air Force Ornithological Society expedition to Belize, R. D. Powell looked at hummingbird communities and defense of flowers (Jenkins, unpubl. report). Species studied included Rufous-tailed Hummingbird (*Amazilia tzacatl*), Green-breasted Mango (*Anthracothorax prevostii*), and White-bellied Emerald (*Amazilia candida*). Data on nectar production for *Hamelia patens* at the Altun Ha archaeological site were also included. B. Miller and Tilson (unpubl. data) studied the comparative behavior of the Lesser Yellow-headed Vulture (*Cathartes burrovianus*), Turkey Vulture (*Cathartes aura*) and Black Vulture (*Coragyps atratus*) at Crooked Tree in 1983. Their observations (Miller and Tilson 1985) of kleptoparistism of Limpkins (*Aramus guarauna*) by Snail Kites (*Rostrhamus sociabilis*) were erroneously attributed to Clinton-Eitniear by Weyer (1984). Clinton-Eitniear studied the King Vulture (*Sarcoramphus papa*) in Belize over several years (Clinton-Eitniear and Weyer 1982).

Kamstra (1987) conducted ecological studies in the Cockscomb Basin with emphasis on determining the status and distribution of vegetation and fauna, particularly birds. Kamstra's checklist includes 280 species, including anecdotal records from previous observers. He gives abundance based on numbers of individuals encountered during each visit, seasonal status based on Weyer and Young (1983) and habitat associations based on seven broad vegetation types defined in his report. These studies took place during the dry season (January–April) 1986, and provided the first comprehensive examination of the Cockscomb Basin.

The Scarlet Macaw (*Ara macao*) is a species of conservation concern throughout its range. Barlow and Caddick (unpubl. report) compiled sightings of the Scarlet Macaw in Belize and Mallory (1993b) undertook the first ecological study here. The latter observations suggested that this species commutes between the Cockscomb Basin and the Chiquibul forest over a low pass. She estimates that in Belize there are only 30–60 birds.

Mallory and Brokaw (1997) studied the impact of selective tree cutting on birds and tree regeneration in the Chiquibul Forest Reserve, in the southern part of the country. Selective felling harvests more tree species than normal cutting regimes in order to promote regeneration and growth of commercial species while not endangering native plants and animals at a landscape scale. They looked at the impact of selective felling logging trials and noted changes in bird populations. Mallory and Brokaw (pers. comm.) also mist-netted and censused birds in riparian and upland forests in two areas of Belize: the Rio Bravo Conservation and Management Area in northwestern Belize and the Upper Raspaculo Valley in the south-central part of the country. Results from Rio Bravo suggested that the riparian forests were richer in birds, both resident and migrant species as well as numbers of individuals. This trend held true for the Upper Raspaculo Valley although sampling effort was less.

Baker (1996) suggested that over the last 20 years, the Orange-breasted Falcon (*Falco deiroleucus*) has been extirpated from Central America from all but Guatemala and Belize. The probable result is that these populations may be disjunct from the those in South America. Baker evaluated this species in Belize and we mapped its distribution and habitat

requirements for the National Protected Areas Management Plan (B. W. Miller and C. M. Miller 1995).

Behavioral studies currently in progress in Belize include C. Miller's unpublished observations on the life history and ecology of the Keel-billed Motmot (*Electron carinatum*) in Belize and Brown's (pers. comm.) study of lek behavior and correlates of male mating success in the White-collared Manakin (*Manacus candei*) at Bermudian Landing.

In the past 10 years, a number of neotropical migrant studies were carried out; one provided by an accidental opportunity. Eighty-six neotropical migrants were found dead on board a ship anchored off the coast of Belize City after a bout of bad weather occurring 4–7 October 1973. The ship's cook froze the specimens which were later examined in Amsterdam. Roselaar (1976) discussed differences between spring and autumn mass related to migration, and ageing criteria based on these specimens. Mills and Rogers (1990, 1992) reported studies of overwintering migrants in a large citrus plantation in central Belize during the winters of 1986–1987 and 1987–1988. The numbers and proportions of overwintering migrants were higher than previously reported from any other habitat on the Yucatán peninsula, but they concluded that citrus plantations were not suitable for all migratory species. Other wintering bird studies were conducted during 1988–1989 examining understory bird populations in five nonagricultural vegetation types to determine effects of disturbance and vegetation structure on migrant habitat use (Petit et al. 1992). In February 1990 Saab and Petit (1992) studied the impact of pasture development on bird communities and found that abundance of both resident and migrant birds was nearly 70% lower in grazed pastures compared with more structurally diverse abandoned pastures.

Belize was one of seven countries sampled over six winters by Robbins and coworkers (1992). Migrants were studied in a variety of managed arboreal habitats such as pine, cacao, citrus, and shade coffee plantations and were compared with those in extensive forest and isolated forest fragments. While certain species were present in relatively large numbers, other ground-foraging migrants were rarely found in the agricultural habitats. They concluded that intensive management might severely limit neotropical migrant use of some croplands subjected to overgrazing or heavy use of agricultural chemicals. Winter habitat studies assessment, using remote sensing, was carried out for the Wood Thrush (*Hylocichla mustelina*), in the Toledo District (Rappole et al. 1994).

Kricher and Davis (1992) sampled two disturbed sites and one undisturbed moist forest site in southern Belize near a Kekchi-Maya village. They concluded that habitat mosaics, including human-disturbed areas and successional forest, are important to maximize avian species richness, particularly when such habitats are directly accessible from mature forest. Although more than half of the species utilizing successional sites were edge species, mature forest was apparently essential to much of the avian species richness of disturbed sites.

DISTRIBUTION

Our understanding of species distribution since Russell's (1964) publication comes from several sources: museum specimen records, banding data, as well as published and unpublished expedition reports. Museum based data may provide many valuable records yet to be published. Although the primary value of specimen collections is for taxonomic research, they provide valuable information for synthesis and analysis of biogeographic patterns and habitat associations (Hathway and Hoagland 1993, Murray 1993). As we developed the Belize Biodiversity Information System (http://fwie.fw.vt.edu/wes/) in cooperation with the ministry of Natural Resources, we have been repatriating museum collection data. Although not exhaustive, our museum search has turned up additional information since Russell's (1964) monograph was published (Table 1). We would appreciate information on any collections not shown.

The two largest ornithological collections are maintained at the American Museum of Natural History (AMNH) and the British Museum of Natural History (BMNH). Both have specimens from Belize, but estimates of holdings are currently not available because neither is computerized. Having had a cursory look at both collections, we believe that developing a list of specimen records for Belize

TABLE 1. Museum holdings of Belize ornithological specimens.

Museum	Number of specimens
American Museum of Natural History	undetermined
British Museum of Natural History	undetermined
California Academy of Science	1
Carnegie Museum	3424
Coe College	Russell (1964)
Cornell University	50
Field Museum, Chicago	84
Louisiana State University, Museum of Zoology	Russell (1964)
Museum of Comparative Zoology	330+ see Russell (1964)
Philadelphia Academy of Science	Russell (1964)
Pomona College	Russell (1964)
Royal Ontario Museum	1236
University of Amsterdam Zoological Museum	86
University of California, Berkeley	3
University of Kansas	35
University of Michigan Museum of Zoology	964
University of New Mexico	31
U.S. National Museum	81
Yale Peabody Museum	1
Willamette University	Russell (1964)

will entail substantial time and effort for a species-by-species search.

Substantial collections were made by the Royal Ontario Museum in 1966 and 1969 at the archaeological site Altun Ha near Rockstone Pond (Barlow et al. 1969, Barlow et al. 1970) with additional collections made in 1971 in other areas of Belize (Barlow et al. 1972).

Russell (1964) summarized collections at the Carnegie Museum made by Blake and Agostini in 1926. Five collecting expeditions were made for the museum from 1971 to 1985 (Wood and Leberman 1987) and make up the largest recent collections known. Their Belize material consists of approximately 1700 study skins, 856 alcoholics and 865 osteological specimens (Parkes, pers. comm.).

Ornithologists use banding for many research objectives ranging from tracking local and migratory movements to long term population monitoring. We present a brief summary of banding efforts which provides one index of ornithological activity in Belize. There is no repository for banding data on resident species. Consequently, we have no means of assessing total numbers of birds banded other than the data provided by Robbins (pers. comm.), who assessed wintering bird habitat associations, and our own work. Therefore, the data supplied by the Bird Banding Laboratory (BBL) includes only those migrants and resident species approved for banding with BBL supplied bands.

The number of birds banded in the early 1960s approximates that of the mid 1980s (Fig. 1). The first peak represents the efforts of a one individual, Nickell, compared to the total number banded by six researchers in the 1980s. In fact, Nickell accounts for all but 125 of the more than 12,000 birds banded during the 1960s. Nickell (1968) set up eight netting stations in Stann Creek Valley, during six successive expeditions in March and April 1960–1965. His study was the first in Belize to look at Neotropical migrants on the wintering grounds with a 37% return on 10 species he banded. After Nickell, there are no banding records until 1969. Fewer than 200 birds were banded between 1969–1972 with a hiatus until 1982. The next wave of banding activity began in the 1980s which continues at various levels to the present time.

In the Stann Creek Valley, Rogers and Odum (1966) netted birds, but apparently did not band them, as part of a study on post- and premigration changes in mass. They compared premigratory mass buildup in Belize with post migratory mass for birds netted in Panama. They suggest that fat reserves in Gray Catbirds (*Dumetella carolinensis*), Orchard Orioles (*Icterus spurius*), Indigo Buntings (*Passerina cyanea*) and Common Yellowthroats (*Geothlypis trichas*) indicated that individuals attained trans-Gulf flight capabilities at different dates. Stann Creek Valley may have been the final stop in Central America before continuing north for some species.

The British armed forces, including the Royal Air Force Ornithological Society (RAFOS), the British Army Bird Watching Society (ABWS) and Royal Air Force Kinloss (RAFK), staged five ornithological expeditions to Belize from 1981 to 1989. All included netting and some banding. In addition to compiling sight records, these expedition re-

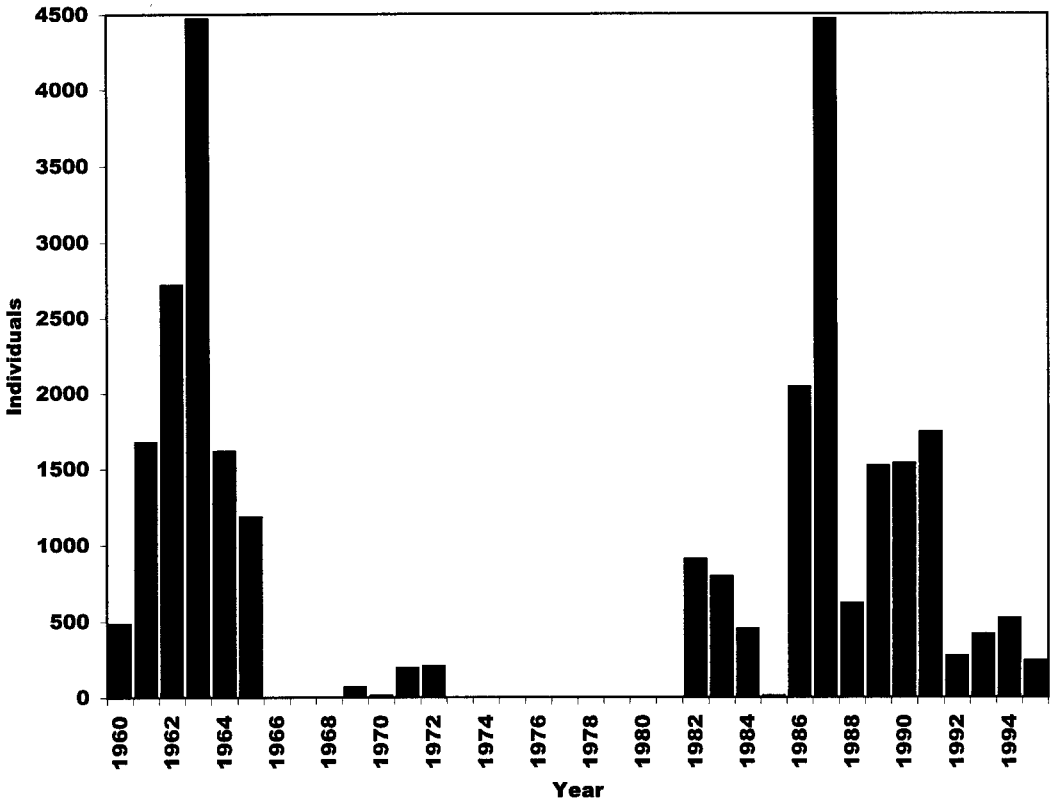

FIG. 1. Bird banding activity in Belize from 1960 to 1995 as indicated by number of Neotropical migrants banded. Data supplied by USGS-BRD Bird Banding Laboratory.

ports often included wing chord and mass for birds netted.

Jenkins (unpubl. report) compiled sight records and netting data for 107 species during the 1981 RAFOS expedition. Expedition dates were 24 February–10 April and include the following locations: Aguacate, Altun Ha, Belize City area, Big Falls Ranch, Caye Chapel, Guacamayo Bridge, Mountain Pine Ridge, Northern Lagoon, and Salamanca Camp/Jimmy Cut. Apparently they did not band any birds during this expedition although they recorded wing cord and mass for 584 birds netted. This report includes a summary of birds netted in 1979 in the Toledo District by members of the British Museum during studies of ectoparasites.

Hallchurch (1982) compiled sight records and netting data for 115 species during the 1982 ABWS expedition. He included a summary for 859 banded birds of the 1511 netted. Expedition dates were 23 February–16 March 1982 and include the following locations: Airport Camp, Altun Ha, Big Falls Ranch, Blue Creek, Toledo, and Guacamayo Bridge.

Counsell (unpubl. report) compiled sight records and netting data for 118 species during the 1986 RAFOS expedition. He included a summary of wing chord and mass for 1242 birds netted. Expedition dates were 28 February–18 March 1986 for Airport Camp, Big Falls Ranch, and Guacamayo Bridge.

We have so far been unable to locate a copy of the 1987 Royal Air Force Kinloss expedition report (Triggs 1987). However, Crease (unpubl. report) included data from that expedition showing 4375 birds netted, 2800 banded, and a total of 78 species. Crease (1990, unpubl. report) compiled sight records and netting data for 113 species during the 1989 ABWS expedition. He included a summary of wing chord and mass for 1977 birds netted. This report also includes information on recaptures of nine species of Neotropical

migrants banded by previous expeditions at Airport Camp and Big Falls Ranch. Expedition dates were 13 February–13 March 1989 and include the following locations: Airport Camp, Big Falls Ranch, Cockscomb Basin, Crooked Tree, and Guacamayo Bridge.

Wood and Adams (1985) documented the first Central American band recovery of a Blue-winged Warbler (*Vermivora pinus*). The bird was collected at First Hill along the Bladen Branch of the Monkey River and was originally banded in Kalamazoo, Michigan. Krichner and Davis (1986) studied wintering site fidelity of Neotropical migrants near Blue Creek, Toledo District, 1982–1984. They found high site fidelity in Kentucky Warblers (*Oporornis formosus*), Northern Waterthrush (*Seiurus noveboracensis*), Hooded Warblers (*Wilsonia citrina*), Gray Catbirds, and Wood Thrushes.

Published, unpublished, and gray literature provide substantial distributional information for Belize. Russell's (1964) monograph provided the basis for the first checklists for the country [Weyer and Young (1977), Weyer and Young (1983), Hartshorn et al. (1984)]. Russell (1966) also conducted follow up work in 1958, 1959 and 1963 in Belize and published distributional notes on the Black Rail (*Laterallus jamaicensis*) and Gray-breasted Crake (*Laterallus exilis*). Wood and Paulson (1988) added Couch's Kingbird (*Tyrannus couchii*) to the list of species recognized to occur in Belize. With the addition of this species, Tropical Kingbird (*T. melancholicus*) records should be reevaluated because rarely are these similar species differentiated in reports.

British military ornithological expeditions provided distributional records for select areas of Belize, many of which were related to military training exercises (Counsell and Etheridge 1986; Hallchurch 1982; Counsell, unpubl. report; Crease, unpubl. report; Jenkins, unpubl. report). In a number of cases these expeditions provided first records from remote sites such as Union Camp in the Maya Mountains. While valuable, these reports were the source of a few identification errors, some of which were perpetuated in subsequent literature. For example, the Northern Pygmy-owl (*Glaucidium gnoma*) was reported while netting and banding at the Guacamayo Bridge at the Macal River. This record was apparently accepted by Walters (1993) who published this and other records in a paper on first records for Belize. Howell (1995) refuted the validity of this and a number of other such records published by Walters (1993), e.g., Western Kingbird (*Tyrannus verticalis*), Cassin's Kingbird (*Tyrannus vociferans*), Hutton's Vireo (*Vireo huttoni*) and Western Wood-Pewee (*Contopus sordidulas*).

The Green-fronted Hummingbird (*Amazilia viridifrons*) record (Hallchurch 1982) is likely an error in identification also. Howell and Webb (1995) state that this species is resident in Mexico on the Pacific slope occurring in arid to semiarid scrub. Because the record from Blue Creek lies within a high rainfall area (Hartshorn et al. 1984), we speculate that this bird was more likely an Azure-crowned Hummingbird (*Amazilia cyanocephala*) which is similar in appearance and does occur in the area.

Another unlikely record was a Bald Eagle (*Haliaetus leucocephalus*) ". . . seen well by 10 members . . ." and ". . . another observer is familiar with the Golden Eagle (*Aquila chrysaetos*) and was able to exclude this as a possibility. . ." (Counsell, unpubl. report).

Weyer, a founding member of Belize Audubon Society, co-authored the first widely available checklists for Belize (Weyer and Young 1977, 1983; Wood et al. 1986). Weyer (1984) also presented the first records for Solitary Eagle (*Harpyhaliatus solitarius*), reported from the Macal River in the Mountain Pine Ridge Forest Reserve and included several other anecdotal reports on this species by others.

Another founding member of Belize Audubon Society and private pilot, W. F. Young undertook monitoring of Jabiru storks (*Jabiru mycteria*) in 1969 with annual aerial surveys of nesting through 1987. He provided locations of historical nesting sites (Young, pers. comm.), which we used to document that critical nesting habitat for this species fell largely outside the existing protected areas network (B. W. Miller and C. M. Miller 1995). Young also co-authored the first widely available checklist for Belize (Weyer and Young 1977, Weyer and Young 1983).

Five years (1987–1991) of study on habitat use of wintering Neotropical migrants by Robbins and Dowell contributed significantly

to the knowledge of Belize avifauna. Their work not only provided insights into habitat use by neotropical migrants but added a number of noteworthy records for Belize (Howell et al. 1992). Their 7540 species distribution records gathered throughout Belize were frequently the only records for some locations. Robbins and coworkers (1995) provided the first countrywide density distribution maps by habitat.

Brokaw and Lloyd-Evans (1987) provided the initial species list for the Bladen Nature Reserve and the first bird distribution records for that area of Belize. Mallory and Brokaw have provided records for the Rio Bravo Conservation and Management Area while working on long-term avian community ecology. In addition, Mallory (1991, 1993a) has contributed new distributional information from the upper Raspaculo River Basin in the Maya Mountains.

Parker added to the ornithological knowledge of the country during a brief study in a then little known area of the Columbia River Forest Reserve, now under logging concession. He found this area of wet forest and secondary growth unusually rich with at least 232 species representing well over 90% of the species restricted to evergreen forests in the country (Parker et al. 1993). Besides a number of wet foothill forest species [e.g., Violet Sabrewing (*Campylopterus hemileucurus*); Slaty Antwren (*Myrmotherula schisticolor*) a new country record; Speckled Mourner (*Laniocera rufescens*); and Shining Honeycreeper (*Cyanerpes lucidus*)] and a small component of montane forest species that typically occur in cloud forests [e.g., Spotted Woodcreeper (*Xiphorhynchus erythropygius*), Slate-colored Solitaire (*Myadestes unicolor*), and Common Bush-Tanager (*Chlorospingus opthalmicus*)], Parker characterized this forest as a very important staging ground for neotropical migrant passerines. Cerulean Warblers (*Dendroica cerulea*) were of particular note (Parker 1994) with more than 80 recorded in the tall hill forests.

Beginning in the mid-1980s, James used mist-netting and transects in various habitats in Belize including savannah areas, Rio Bravo Conservation and Management Area, and the Mussel Creek Drainage. He worked intensively at Bermudian Landing and recorded approximately 200 species (James, pers. comm.) during biodiversity surveys in an agricultural setting. He was also a participant in the Doyle's Delight expedition that documented higher elevation species such as Scaly-throated Foliage-gleaner (*Anabacerthia variegaticeps*), Spotted Woodcreeper, Common Bush Tanager, and Blue-hooded Euphonia (*Euphonia elegantissima*; Matola, unpubl. report). Besides Doyle's Delight, Matola has led several expeditions into remote areas of Belize over the past several years. Although primarily exploratory in nature, her observations and those of her colleagues have contributed to the ornithological knowledge of the country, particularly in the Toledo District. These areas include Dolores (Matola, unpubl. report) and the now besieged (by Malaysian loggers) Columbia River Forest Reserve where such species as the Slate-colored Solitaire, White-winged Tanager (*Piranga leucoptera*) and Common Woodnymph (*Thalurania furcata*) were notable (Matola, unpubl. report; Meadows et al., unpubl. report). An expedition into the Cockscomb Basin in 1990 included several sightings of the scarce Scarlet Macaw and secretive Agami Heron (*Agamia agami*; Matola, unpubl. report). A traverse across the Maya Mountains Divide offered distribution records in a little hunted area as well as commentary on unique vegetation types (Matola et al., unpubl. report). Matola has also co-authored a checklist for the country (Garcia et al. 1994).

McRae (unpubl. report) produced a comprehensive report for the zoological and site analysis for the National Protected Areas Management Plan, summarizing her observations of seabirds and coastal species during more than 13 years of residency on Caye Caulker. Her familiarity with Belize's barrier reef cayes and the coastal zone allowed her to pinpoint species (e.g., Wood Stork, *Mycteria americana*) and particular areas of conservation concern as well as add a new country record, the Northern Phalarope (*Phalaropus lobatus*) at Caye Rosario (McRae 1994). Her annually updated checklist for Caye Caulker provides some interesting migrant records (McRae, 1993) and may reflect trends over several years.

The Belize Audubon Society, founded in 1969, is more than a birdwatching society. BAS today functions as a leading NGO

charged by the government of Belize with management of six reserves. Its newsletter, which appears 3–4 times per year, is frequently cited. It offers conservation news, publishes field trip accounts and has served as an unofficial repository for bird records. The Belize Audubon Society also administrates two of Belize's three Christmas Bird Counts. Although the quality of the data gathered via Christmas Bird Counts (CBC) may be questionable (Arbib 1981, Bock and Root 1981), CBCs have tracked some interesting trends in Belize as the country develops. The first CBC was inaugurated in 1969 in an area near Belize City and covered 11 vegetation types including wetlands and riparian corridors along the Mussel Creek Drainage. In 1996, 21,501 birds of 181 species were counted with Tree Swallows (*Tachycineta bicolor*) and Blue-winged Teal (*Anas discors*) accounting for the high numbers (Craig 1997).

The second Belize CBC was begun in 1972 around the then new capital Belmopan, mainly in tropical forest of 12 recognized vegetation types. The count circle included a portion of the Hummingbird Highway which has undergone significant alteration over the years resulting from refugee settlement. Human settlement along the Hummingbird Highway has created a barrier between contiguous habitats (B. W. Miller and C. M. Miller 1995). Data from this CBC may track changes in relative abundance for this rapidly developing section of the country. The 1996 count recorded 4546 birds of 198 species (Craig 1997).

In 1990, the Gallon Jug CBC began in northwestern Belize on private property which contains nine vegetation types and an agricultural area surrounded by approximately 400,000 ha of tropical forest. The 1996 count resulted in 2823 birds of 217 species (Craig 1997). Combined, all three CBCs covered 26 vegetation types.

We began ornithological study in Belize in 1986 with inventory work along the Mussel Creek Drainage, a critical wetland habitat. Five years of ornithological inventories combined with other biodiversity studies at the Maya archaeological site, Caracol, led to the establishment of the Chiquibul National Park in 1991. Distribution and life history studies of the little known Keel-billed Motmot were conducted simultaneously (C. M. Miller 1991, 1994; B. W. Miller and C. M. Miller 1996). We also assisted in Robbins' wintering bird survey in 1987 and 1991, and evaluated Black Catbird (*Melanoptila glabrirostris*) populations on Caye Caulker (B. W. Miller and C. M. Miller 1991).

At the request of the Belize Audubon Society and the Forest Department, we conducted avian inventory work at many sites throughout the country deemed of conservation concern. We have produced many unpublished technical reports, popular articles and publications, and checklists (B. W. Miller and C. M. Miller 1998), broadening the knowledge of species distributions within the country. We began to evaluate avian distributions in the country (B. W. Miller and C. M. Miller 1992) as we developed a natural history database to compile distribution records across the country with emphasis on 78 areas of concern for a zoological and site analysis for the National Protected Areas Management Plan (B. W. Miller and C. M. Miller 1995).

PROBLEMATIC SPECIES REQUIRING VERIFICATION IN BELIZE

Certain species tend to appear repeatedly in lists, expedition accounts, and anecdotal reports. Their presence or absence can be difficult to verify. Howell and Webb's (1995) guide to birds of Mexico and northern Central America has clarified many questions but certain species remain problematical.

Cinnamon Teal (Anas cyanoptera).—Not shown by Howell and Webb (1995), but record from Big Falls Rice Station, along the Belize River (Counsell and Etheridge 1986).

Masked Duck (Oxyura dominica).—Not shown for Belize by Howell and Webb (1995); however, anecdotal records exist from birding groups. Recorded during the 1985 Belize City CBC.

Solitary Eagle (Harpyhaliaetus solitarius).—Not shown by Howell and Webb (1995), but many records (Weyer and Young 1983; Weyer 1984; Clinton-Eitniear 1986; Kamstra 1987; Meerman and Williams, unpubl. report) within Belize.

Swainson's Hawk (Buteo swainsoni).—Howell and Webb (1995) state this species requires verification. We have several reports of the species but lack proper documentation.

Harpy Eagle (Harpia harpyja).—Persistent

sightings occur with some regularity (Weyer 1984, Dunham 1994) although the large similar sized Crested Eagle (*Morphnus guianensis*) also has been documented in Belize and the birds may be confused by observers. Historical Harpy Eagle records were noted during a time when the Crested Eagle had not yet been documented in Belize and the available field guides either had no plates (e.g., Blake and Tibbits 1953) or did not list the Crested Eagle (Peterson and Chalif 1973). Howell and Webb (1995) show the Harpy Eagle for the southern part of the country; we believe verification is still needed.

Crested Caracara (Caracara plancus).—Not shown for Belize by Howell and Webb (1995), but isolated anecdotal reports persist in the northern part of country.

Yellow-breasted Crake (Porzana flaviventer).—One unverified record from Monkey Bay Sanctuary in the Belize District exists. Howell and Webb (1995) state that the Wood and coworkers' (1986) report requires verification.

Long-billed Dowitcher (Limnodromus scolopaceus).—Howell and Webb (1995) state "possibly Belize." There are a few recent anecdotal records for this species.

Forster's Tern (Sterna forsteri).—Only one record of this species from Ambergris Caye in 1994 from a qualified observer. Howell and Webb (1995) state there are no verified records from Belize and that it is not common in Belize as reported by Wood and coworkers (1986).

Crested Owl (Lophostrix cristata).—Added to the Belize list (B. W. Miller and C. M. Miller 1992); Parker and coworkers (1993) extended the known range.

White-throated Swift (Aeronautes saxatilis).—Several recent reports for Belize; however, Howell and Webb (1995) say that it needs confirmation. This is a species that may be confused with other Swifts.

Blue-throated Goldentail (Hylocharis eliciae).—Included by Russell (1964) as unconfirmed. Mills and Rogers (1988) mist-netted an individual in a citrus orchard off the Western Highway. Platt (unpubl. report) listed the species as "probable" during wildlife surveys in the Orange Walk District. Howell and Webb (1995) show this species in the southern part of the country only.

Paltry Tyrannulet (Zimmerius vilissimus).—Howell and Webb (1995) say this species requires verification. A record exists from Parker and coworkers (1993) and there are anecdotal records from the Rio Bravo and Gallon Jug areas in the Orange Walk District.

Cassin's Kingbird (Tyrannus vociferans).—There are a few records for Belize in the northern part of the country: Cox Lagoon and Shipstern Nature Reserve (Hunt and Tamarack, unpubl. report; Meerman 1993), as well as during the Belize City CBC in both 1985 and 1986. BBL records show three birds banded each year in 1960, 1961, and 1962, and four in 1963 and in 1985. Howell and Webb (1995) state that the species requires verification in Belize.

Warbling Vireo (Vireo gilvus).—Robbins (pers. comm.) first documented this species in Belize during wintering bird surveys January 13, 1988. Parker recorded the species in the Columbia River Forest Reserve (Parker et al. 1993). Howell and Webb (1995) do not list the species for Belize.

Orange-crowned Warbler (Vermivora celata).—Howell and Webb (1995) report that this species is possible for Belize. Records for it include Bermudian Landing (James and Bider, pers. comm.) and Crooked Tree (Counsell and Etheridge 1986). It was also reported during three CBCs: Belize City in 1976 and 1977, and Belmopan in 1983.

Tropical Parula (Parula pitiayumi).—Recorded at Columbia Forest Reserve (Parker et al. 1993); one mist-netted and photographed at Caracol (Miller and Miller, unpub. data). Howell and Webb (1995) state that the species requires verification.

Hermit Warbler (Dendroica occidentalis).—Howell and Webb (1995) show no records, but reported at Bermudian Landing (James and Bider, pers. comm.).

Blackpoll Warbler (Dendroica striata).—Although Howell and Webb (1995) do not list the species for Belize, three unverified records exist in the country: Caye Caulker (McRae 1993), Rio Bravo and Gallon Jug.

Flame-colored Tanager (Piranga bidentata).—Howell and Webb (1995) do not list it for Belize, but recently reported for the country by reliable observers (M. Meadows, pers. comm.; L. Jones, pers. comm.) near Over-the-Top, Cayo District.

Lazuli Bunting (Passerina amoena).—Howell and Webb (1995) do not list it for Belize. One record exists from a reliable observer along the Macal River, Chiquibul National Park where several individuals were seen during a four day period in 1993 (Tzib, pers. comm.).

Audubon's Oriole (Icterus graduacauda).—Not listed for Belize by Howell and Webb (1995); however, records exist for Gallon Jug and Rio Bravo, as well as Lamanai (Noble et al., pers. comm.) and the Bladen (Brokaw and Lloyd-Evans 1987). Robbins (pers. comm.) recorded two individuals in the Toledo District in January 1989.

AREAS FOR FUTURE STUDY

Since the 1960s, Belize has developed a solid conservation record. Within the past 10 years, the country has attracted increasing numbers of researchers and student groups in the natural sciences including ornithology. Even so, there is clearly still a need for additional ornithological work in Belize including baseline inventories, long term monitoring, and species specific population estimates for species of conservation concern.

We evaluated the status of the protected areas coverage for species of conservation concern and compiled data on bird distributions (B. W. Miller and C. M. Miller 1995). Many areas of the country are well known but others are less so. Ironically, many readily accessible areas are still poorly known. The allure of new discoveries in remote areas such as the Bladen Nature Reserve, the Columbia River Forest Reserve, Little Quartz Ridge and the Upper Raspaculo River Basin has attracted a number of expeditions (Brokaw and Lloyd-Evans 1987; Iremonger and Sayre 1994; Mallory, pers. comm.; Meadows et al., pers. comm.; Parker et al. 1993). Consequently, baseline data for these areas is more complete than many more accessible areas of the country.

We have mapped known species numbers by topographic quadrant (Fig. 2). These numbers reflect areas of survey activity and areas where knowledge gaps exist, and are not intended as a measure of true species richness. Quadrants with low numbers indicate areas where baseline avian inventory work is necessary for a more complete understanding of species distributional limits within Belize. There are many protected areas with scant baseline data while others have relatively abundant information. We suggest that those interested in making contributions to the ornithological knowledge of Belize contact either the Conservation Division of the Forest Department, Ministry of Natural Resources, or Belize Audubon Society (see Appendix) to inquire about current priorities. This could help eliminate duplication of effort and channel research interests into areas most needing attention.

SPECIFIC AVIAN CONSERVATION CONCERNS IN BELIZE

At the conclusion of the zoological and site analysis (B. W. Miller and C. M. Miller 1995), several species and families were considered in need of further study. Most of these face threats from habitat conversion or other human induced impacts.

The status of many of Belize's seabird colonies is unclear. McRae (1994) suggests that many may be at risk with the acceleration of coastal and offshore development bringing with it increased tourism and pollution. A comprehensive survey of the coastal and offshore islands during the nesting season would provide a better picture of the status of these species. Although habitat loss from ever-increasing development pressures on Belize's offshore islands continues to threaten seabird colonies, introduced species are another insidious threat. The introduction of *Rattus rattus* to Half Moon Caye Natural Monument (NM), 80 km east of Belize City, is such an example. Half Moon Caye NM is the site of a mixed colony of thousands of Red-footed Boobies and Magnificent Frigatebirds (*Fregata magnificens*). An early naturalist who collected in Belize's cayes (Salvin 1864) discussed the colony but did not mention the presence of *Rattus rattus,* although Verner (1961) did. A five year management plan calls for a rat eradication program and monitoring of this colony that is quite likely impacted by the rat. Another potential impact to the colony is increased tourist visitation.

The Jabiru is at risk from habitat disruption and this charismatic species is of high touristic interest. Unfortunately, the Jabiru apparently does not tolerate repeated disturbance and at

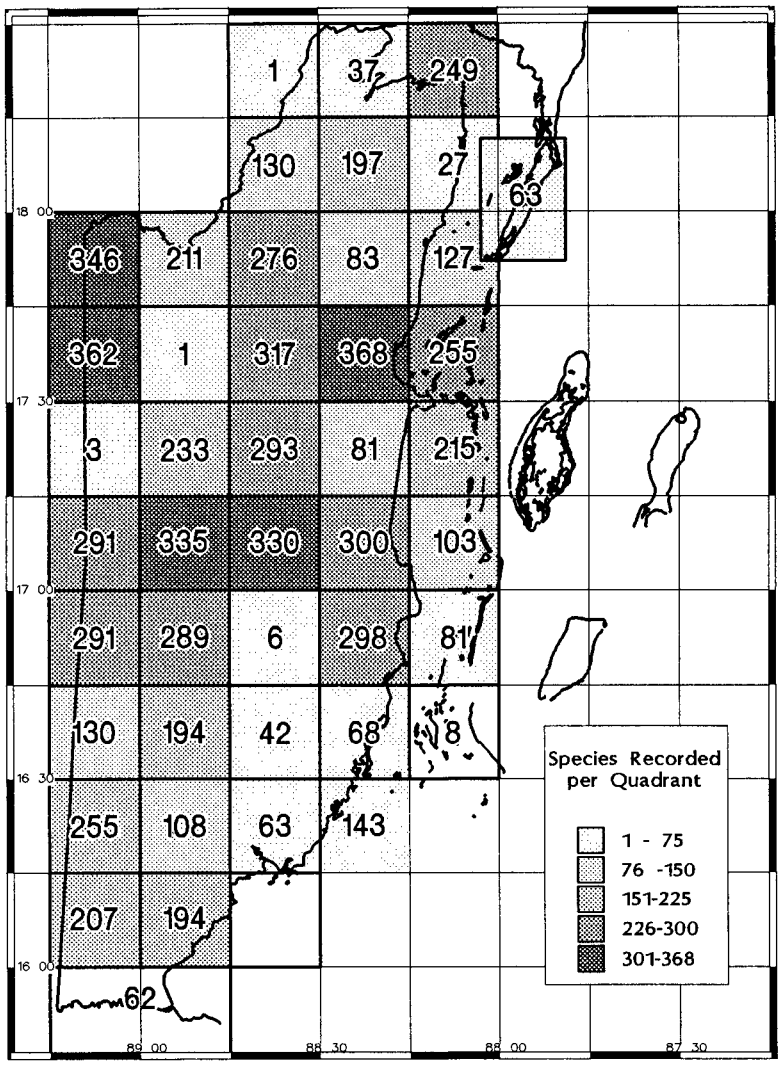

FIG. 2. Number of avian species per topographic quadrat in Belize.

least two nests failed in 1994, possibly as a result of tourist visitation. This species migrates from the Usumacinta drainage (Howell and Webb 1995) and arrives in Belize around October to nest. As marsh forests have been cleared for upland rice in the northern part of the country, the resulting shallow wetlands may provide increased foraging opportunities for the Jabiru. It may return to the same nest sites year after year, most of which are outside of the existing protected areas (B. W. Miller and C. M. Miller 1995). A monitoring program for this species would be useful.

The Crested Guan (*Penelope purpurescens*) and the Great Curassow (*Crax rubra*) are game birds legally hunted in Belize. However, there is growing concern about sustainability of this practice as well as conservation of the species. The Chief Conservation Officer has expressed interest in proposing regulations on take (R. Manzanero, pers. comm.). We suggest that population estimates and the impact of hunting on these species (see Silva and Strahl 1991) would give the Conservation Department the information it needs to impose limits and seasons on these species.

The Ocellated Turkey (*Meleagris ocellata*) is a regional endemic with one of the most restricted ranges of all gallinaceous birds in the Americas (Gonzalez et al. 1996). It has been a species of conservation concern for some time (Collar and Andrew 1988, Mountfort and Arlott 1988). Its distribution in Belize includes formally protected areas and large parcels of private land where hunting is not permitted or is at least curtailed. Because it appears locally abundant, the species was assumed to be secure and Collar and coworkers (1992) did not include it as a species of concern. Although it is not legally hunted in Belize the turkey is taken opportunistically. In a recent study in Tikal National Park, Guatemala, Gonzalez and coworkers (1996) showed that survival rates for hens ranged from 60% to 75% and poult survival was 13% during the two year study. With growing immigrant populations, subsistence hunting in Belize may have long term implications for the Ocellated Turkey. Gonzalez and coworkers (1996) found that 67% of subsistence hunters in the Tikal area hunted Ocellated Turkey. We suggest that investigation on the impact of hunting, mapping distributions, and developing country-wide population estimates for the Ocellated Turkey would provide important data for this species' management.

Parrots in the local pet trade are a matter of concern. Apparently there is some evidence that the regional endemic Yellow-headed Parrot (*Amazona oratrix belizensis*) is being exploited for foreign markets (Somerville 1997). Habitat loss is another concern. The Conservation Department has indicated interest in addressing this problem (R. Manzanero, pers. comm.) with a captive bird registering scheme for management purposes. Baseline population data for monitoring of this species and other *Amazonas* would be valuable. More than 60 Scarlet Macaws were counted by wardens near the village of Red Bank where macaws have recently been heavily poached (Saqui 1997). Conservation research for this northern Central American subspecies (Weidenfeld 1994) and other parrots is badly needed.

The Black Catbird is restricted to the east coast of the Yucatán, Cozumel Island and northeastern Belize (Phillips 1986). It is at risk because of habitat loss resulting from increased development, both in Mexico and Belize. To date, nesting in Belize is documented only from Caye Caulker (McRae, pers. comm.) and Shipstern Nature Reserve (Meerman, pers. comm.). In 1991, the species was considered under threat on Caye Caulker and by 1993 substantial habitat had been lost (B. W. Miller and C. M. Miller 1991, 1993). Anecdotal reports suggest it may nest on northern Ambergris Caye but this needs to be verified. Studies to determine its status and range beyond Caye Caulker would be useful.

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APPENDIX: SOURCES OF GRAY LITERATURE

A check to cover copy costs and postage accompanying literature requests from any of these sources would be appreciated.

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