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BREEDING BIOLOGY OF JABIRUS (*JABIRU MYCTERIA*) IN BELIZE

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ABSTRACT.—We summarized published and unpublished information on the reproductive biology and ecology of Jabirus (*Jabiru mycteria*) in Belize. From 1968 to 1987, 91 individual nests were discovered in 16 of 19 breeding seasons; 69 nests were confirmed as active. Jabiru nests were 15–30 m above ground in *Ceiba pentandra* (five nests), *Pinus caribaea* (five nests), *Tabebuia ochracea* (one nest), *Acoelorrhaphe wrightii* (one nest), and dead trees (three nests). Most nests (32 of 36) were located in northern and central Belize in isolated, tall, emergent trees (trees with crowns that stand above the surrounding canopy). Nest trees were usually surrounded by riparian forests or seasonally inundated pine-savanna wetlands situated in transitional zones where pine savannah meets coastal lowlands. Two nests were used for at least 10 years. The breeding season began with the transition from wet to dry season (November–December). Earliest eggs were observed on 12 December 1973 and latest eggs on 26 February 1987. Earliest nestlings were observed on 15 January 1970, and young were seen on nests as late as 28 May 1973. Young birds fledged 100 to 115 days after hatching but were still dependent on parents. From 1968 to 1987, a total of 44 eggs and 92 nestlings were counted. Mean clutch size was 3.14 ± 1.17 SE (range = 1–5 eggs, n = 14 nests). Hatching success for four nests during the 1972–1973 breeding season was 43.8%. For 14 years in which crude hatching success (nestlings per active nest) could be calculated, 71.6% (43 of 60) of all active nests had at least one nestling. The mean number of nestlings per nest was 2.13 ± 0.71 SE (range = 1–4 nestlings, n = 43 nests). Productivity (the number of nestlings per nest for all active nests) was 1.53. These results were similar to those of two other studies of Jabiru breeding biology conducted in Brazil and Venezuela. Jabiru populations in Belize appear to have increased since the species gained protected status in 1973. *Received 23 July 2004, accepted 4 March 2005.*

Jabirus (*Jabiru mycteria*) breed locally from southern Mexico (Campeche, Tabasco) through the lowlands of Central America and east of the Andes to northern Argentina (Bent 1926, Blake 1977, Knoder et al. 1980, Hancock et al. 1992, Antas and Nascimento 1997). They favor extensive inland and shallow wetland habitats for feeding, but prefer nearby wooded areas for roosting and nesting (Hancock et al. 1992, Stotz et al. 1996, Antas and Nascimento 1997; DW pers. obs.). Jabirus are distributed widely but are not abundant anywhere in their breeding range. They are considered regionally threatened, although not endangered (Luthin 1984, 1987; Stotz et al. 1996). In southeastern Brazil, however, they have been extirpated from the basins of the Paraiba do Sul, Tietê, and Grande rivers, and there are only a few remnant populations restricted to the São Francisco River valley in the state of Minas Gerais (Antas and Nascimento 1997:17).

Comprehensive information on numbers and population trends of Jabirus are limited, especially in Central America. Luthin (1987), however, observed Jabirus throughout their breeding range and concluded that there are three distinct populations: Central American, northern South American, and south-central South American. He suggested that research on the ecology and status of Jabirus be undertaken for each distinct population to develop a global conservation strategy for the species. DW (*in* Scott and Carbonell 1986) reported on the status of wetlands and conservation of waterbirds in Belize, referencing known Jabiru nesting areas. Recently, Frederick et al. (1997) documented previously unrecorded populations of Jabirus breeding in coastal wetlands of Nicaragua and Honduras, (Miskito Coast and La Mosquitia, respectively) during aerial strip-censuses of breeding waterbirds.

Kahl (1971, 1973), Thomas (1981, 1985), and Poveda (2003) described behavior and comparative ethology of Jabirus in Argentina, Venezuela, and Costa Rica, respectively, and Antas and Nascimento (1997) studied the

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TABLE 1. Observed egg-laying dates for the Jabiru, throughout its range.

Country	Egg-laying dates	Source
SE Mexico	Dec–Jan, Mar	Luthin 1984, Hancock et al. 1992
Belize	Dec–Feb	Hancock et al. 1992, this study
Honduras	Feb	Frederick et al. 1997
Nicaragua	Mar	Frederick et al. 1997
Costa Rica	Nov–Apr[a]	Villarreal-Orias 1988, Poveda 2003
Colombia (Rio San Jorge)	Sep–Nov	Kahl 1971, Hancock et al. 1992
Venezuela (Llanos)	Aug–Nov	Thomas 1985, González 1996a
Surinam	Aug–Oct	Spaans 1975, Hancock et al. 1992
Guyana	Aug–Oct	Hancock et al. 1992
E Brazil (Isla Mexiana)	Jul–Aug	Hancock et al. 1992, Antas and Nascimento 1997
SW Brazil (Mato Grosso)	Sep–Nov	Hancock et al. 1992, Antas and Nascimento 1997
Bolivia	Oct–Feb[a]	Dott 1984
NE Argentina (Corrientes, Chaco)	Aug–Oct	Kahl 1971, Hancock et al. 1992

[a] Breeding dates only; no egg-laying dates given.

ecology of Jabirus on the Pantanal of Brazil. Breeding and egg-laying dates have been published for some populations of Jabirus (Table 1). Breeding dates are variable across the range and seem to be influenced largely by seasonal rainfall patterns. Two published reports provide quantitative data on Jabiru breeding biology: González (1996a) and Anas and Nascimento (1997) for Venezuela and Brazil, respectively.

In Belize, the Belize Audubon Society (BAS) has published much anecdotal information on Jabiru nesting and sightings since 1969, but no comprehensive report exists for its breeding biology. From 1969 to 1987, DW and the late WFY collected information on nest locations and breeding activities of Jabirus in Belize, where the species has been officially protected since 1973. Our objective was to synthesize published and unpublished information from reliable sources and compile representative data for Jabirus in Belize. We then present an analysis of the breeding biology of Jabirus in Belize based on those sources.

METHODS

Study area.—Most Jabiru nests for our study were located in the northern and central sections of Belize (17° 10′–18° 10′ N; 89° 15′–88° 12′ W; Fig. 1). Mean monthly temperatures range from 16 to 17° C in the winter wet season and from 24 to 25° C in the summer dry season. On average, the northern coastal plains (Corozal District) receive about one-third the rainfall (1,347 mm) of the south (4,526 mm, Toledo District). Seasonal effects are greatest in the central and northern regions, where January through April or May are dry (<100 mm per month). In south-central regions, the dry season (February to April) is shorter. A minor, less rainy period usually occurs in August (Hartshorn et al. 1984, Central Statistical Office 2000).

Data sources.—Data for this study were gathered from four main sources: the unpublished field notes of DW (1968–1987), personal communications with DW from 2001 to 2003, 44 reports published in the Belize Audubon Society Bulletin from 1969 through 1987, and several letters written by WFY to Charles S. Luthin summarizing the results of nine census flights conducted between 1985 and 1986. C. S. Luthin worked for the Brehm Fund for International Bird Conservation and was chairman of the World Working Group on Storks, Ibises, and Spoonbills (WWG-SIS). We also included several recent 2003 personal observations from Belizean ornithologist, O. A. Figueroa.

Jabiru survey flights can be divided into two time periods: 1968–1981 and 1983–1987 (Table 2). Between 1968 and 1981, we confirmed 30 flights (~22.0 hr) by WFY (Young 1998). Flights were conducted in a single-engine aircraft and based out of Belize City Municipal Airport. These were low-altitude flights, often below 800 m, when nest contents were being observed. Nest locations (Appendix, Fig. 1) are approximate. To locate nest

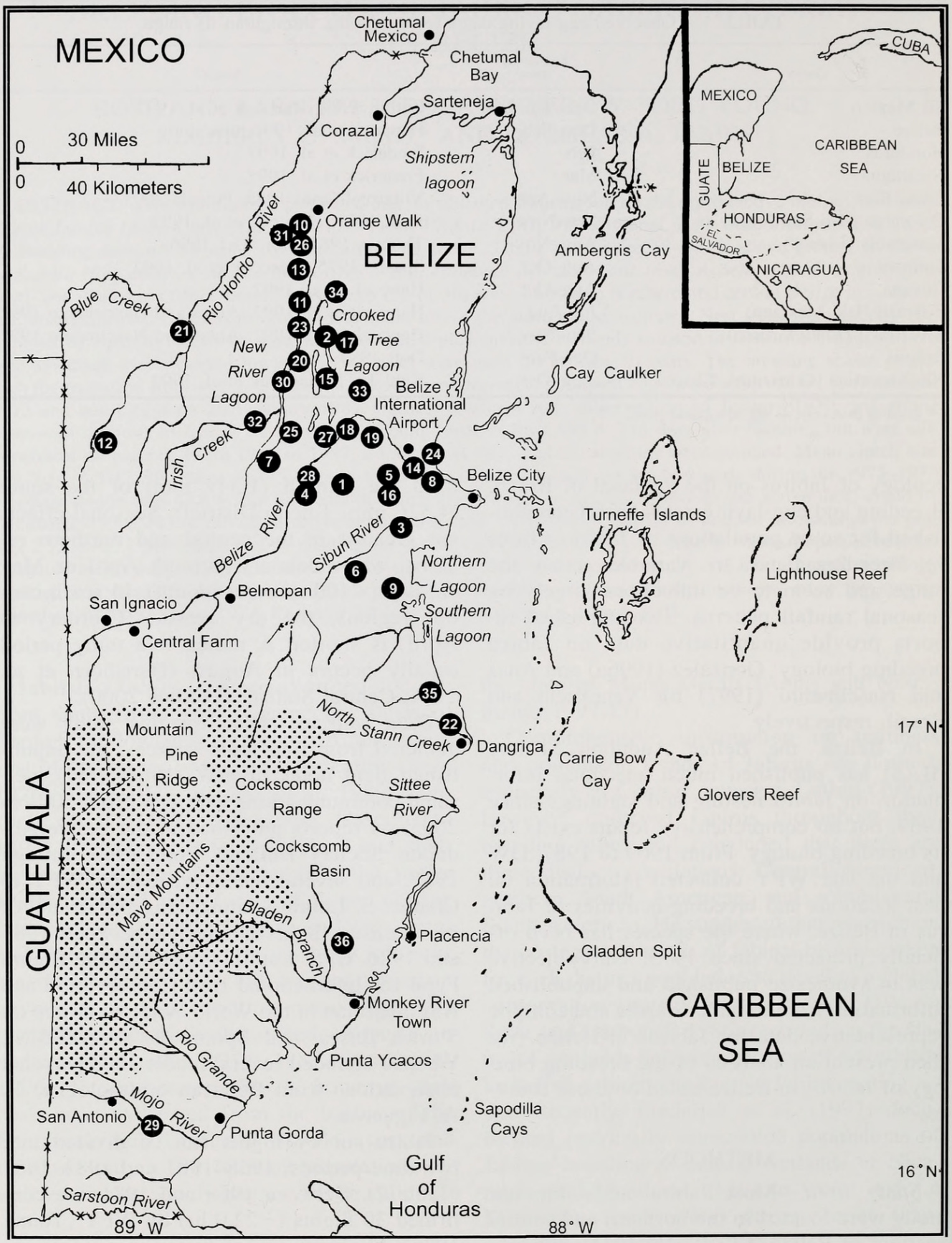

FIG. 1. Locations of 36 Jabiru nests in Belize, 1968–1987. Numbers on map refer to nesting sites listed in Appendix.

TABLE 2. Known flight dates for Jabiru surveys, 1968 to 1987[a], Belize.

Season	Flight dates
1968–1969	Mar–no specific dates reported
1969–1970	15 Nov, Dec–no specific dates reported, 15 Mar
1970–1972	No flights confirmed
1972–1973	24 Jan, 26 Jan, 2 Feb, 27 Mar
1973–1974	23 Nov, 24 Nov, 27 Nov, 6 Jan, 17 May
1974–1975	12 Nov, 16 Nov, 23 Dec, 30 Mar, 30 Apr
1975–1976	2 Dec, 22 Dec, 26 Jan, 4 Mar
1976–1977	7 Dec, 22 Dec, 26 Jan, 4 Mar
1977–1978	No flights confirmed
1978–1979	Four flights–no specific dates reported
1979–1981	Various flights–no specific dates reported
1981–1983	No flights confirmed
1983–1984[b]	25 Feb, 29 Apr–two flights each day
1984–1985[c]	30 Jan, 31 Mar, 16 Apr, 11 May, 9 Jun, 23 Jun
1985–1986[d]	17 Mar–two flights
1986–1987[e]	26 Feb, 3 Mar, 8 Mar, 13 Mar, 29 Mar

[a] Total flight time ~22.0 hr, 1968–1981.
[b] Total flight time = 11.6 hr.
[c] Total flight time = 8.95 hr.
[d] Total flight time = 6.0 hr.
[e] No flight times reported.

sites, we referred to the aerial-flight (Fig. 2) and nest-location maps developed by WFY and DW from the WWG-SIS flights (1983–1986) and DW's notes. WFY had become personally interested in Jabirus and periodically took flights to confirm nest sightings reported by charter pilots and the public. He also owned a real estate business and often located nests when flying clients. Flights between 1969 and 1981 that were not real-estate related were highly targeted and covered central and northern Belize almost exclusively. After Jabirus gained protected status in 1973, public radio announcements were made to increase awareness and to encourage reports of nest sightings and Jabirus to the BAS. Flights that were conducted between 1968 and 1982 were systematic, in that they covered areas and habitats where previous sightings had been reported.

From 1983 to 1987, 12 of 15 flights (26.6 hr) were financed by WWG-SIS and flown by J. Fuller in a Cessna 172, V3-HEJ. These flights covered predetermined routes (Fig. 2), but also included some point-to-point trapline flights within the delineated area. Flight dates for annual nest surveys between 1968 and 1987 are given in Table 2. No regular flights were documented in BAS reports for surveys before 1984.

Most flights were between November and June. Nests were most detectable early in the season when at least one adult was incubating eggs or attending young birds. Observers who often participated in these early flights were BAS members DW, M. Meadows, and B. Miller; flights after 1984 also included J. Carnegie, J. Waight, and C. S. Luthin. Observers scanned from both sides of the aircraft. They looked for nests that were known to exist in previous years and for nests reported by charter pilots and the public. When a nest was detected, the pilot would circle around the nest at lower altitude, often at only 100 m, so that observers could see nest contents with binoculars. When an adult Jabiru was sitting on a nest, the aircraft would circle until the bird stood up and allowed a clear view of nest contents. Nest size was estimated by comparing it to the size of an adult Jabiru. Nest-size estimates were made from both aircraft and vantage points on the ground. Data were available for 16 breeding seasons; no data were available for 1970–1972, 1981–1982, or 1982–1983. Flying in Belizean airspace was severely restricted during the latter two breeding seasons due to a military conflict with Guatemala.

Data analysis.—To calculate reproductive success, data were considered reliable if they

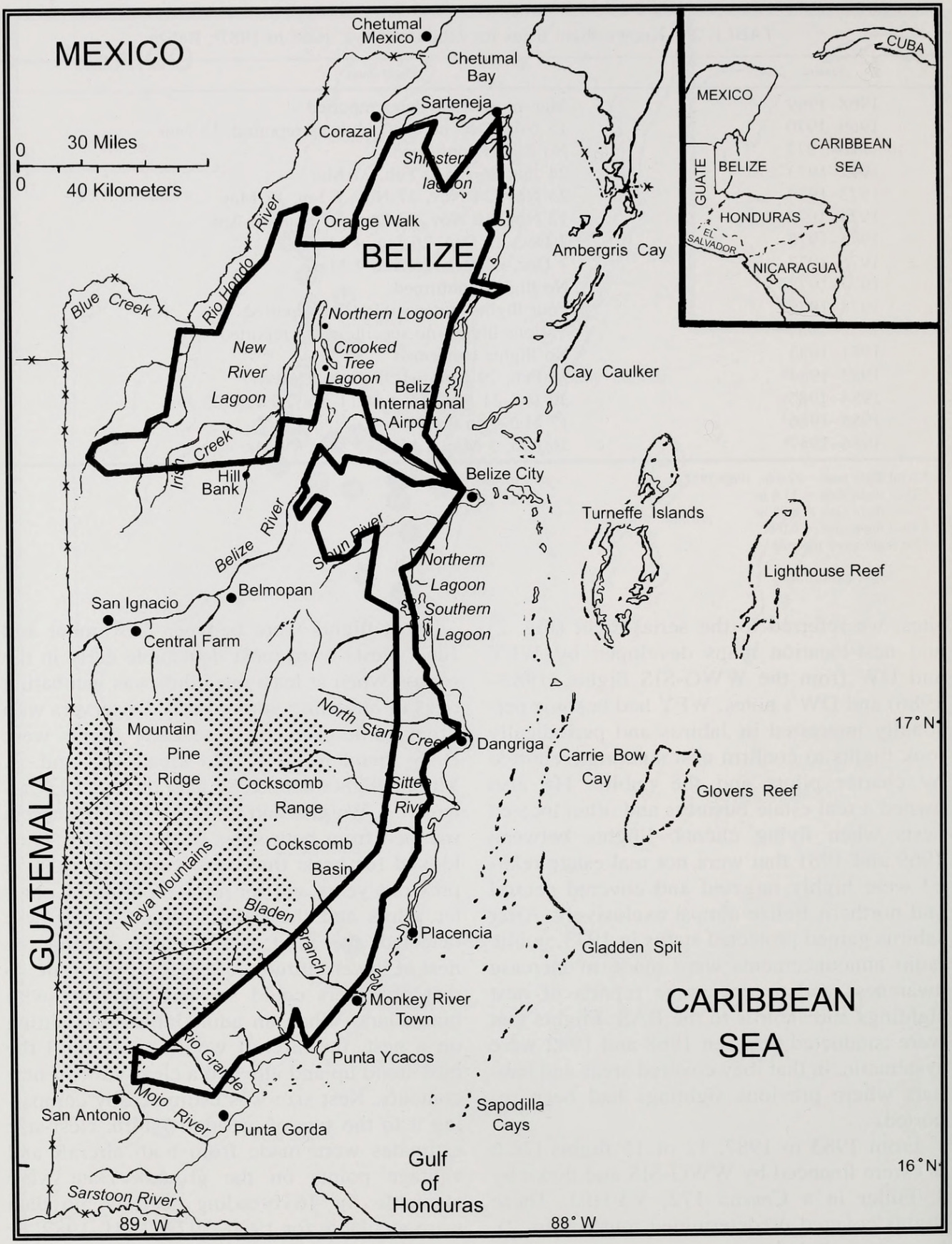

FIG. 2. Designated census routes for Jabiru nest survey flights in Belize, 1984–1987.

could be cross-referenced with BAS reports, DW's field notes, or WFY's letters. Where these data exist for breeding seasons 1968/1969 to 1986/1987, we have calculated total number of nests, active nests, eggs, nestlings, and mean clutch size. We calculated mean number of nestlings per nest for those nests with nestlings. Productivity was calculated as total number of nestlings per active nest (including nests with and without nestlings). Nests were considered to be active if adults appeared to be incubating, or if eggs or nestlings were observed in the nests. The number of young that successfully fledged could not be determined because nests were not monitored to fledging stage. Data represent the number of nestlings present at the nest.

For the 1972–1973 breeding season, we were able to calculate number of eggs that hatched (hatching success) for four nests. A crude measure of overall hatching success (1968–1987) was calculated by dividing number of nests where nestlings were observed by number of known active nests. In some years, nest data are missing; in other years, the number of nestlings observed contradicts the total number of nestlings reported by BAS, which may refer to the estimated number of young that fledged. Nest sites that could not be confirmed as either active or inactive were not included in our analysis.

RESULTS

Nest observations.—A total of 144 nest observations were made in 16 breeding seasons: 121 (84%) from aircraft and 23 (16%) from the ground. The number of observations from the ground ranged from 1 to 7 per nest and the number of observations by aircraft ranged from 1 to 16. The mean number of observations per active nest was 2.4.

Breeding behavior.—Jabirus appeared to become more numerous in Belize near the end of the rainy season (mid-November), possibly having moved from the Campeche area of Mexico (Young 1983, Miller 1991). Both males and females appear to participate in nest building, incubation, and care of young (DW pers. obs., O. A. Figueroa pers. obs.).

During both incubation and when nestlings were present, one adult often remained on the nest while the other foraged (DW pers. obs.). Defense of nests against predators or other bird species was not observed. However, breeding pairs appeared to remain in isolated breeding territories until nestlings fledged (DW pers. obs.). Jabirus may exhibit intra- and interspecific territoriality near the nest and at feeding areas (Hancock et al. 1992, González 1996b). When nestlings are about 4 weeks old, parents tend to leave them unattended for longer periods of time (O. A. Figueroa pers. obs.).

Breeding dates.—In Belize, the breeding season appears to coincide with the transition from wet to dry season (November–December). Most breeding occurs from mid-December to May. Recent observations indicate that a few nests are still active in early June (O. A. Figueroa pers. obs.). Most eggs are probably laid from December to February. Eggs seen in nests in February may have been laid during late January. Adults were observed standing on, constructing, or rebuilding nests as early as 16 November 1974. Earliest eggs were observed on 12 December 1973 and latest eggs were observed on 26 February 1987. Earliest nestlings were observed on 15 January 1970, and nestlings were observed as late as 28 May 1973. Young birds usually fledged 100–115 days after hatching (Miller 1991; DW pers. obs.), although some young fledge prior to 100 days post-hatching (O. A. Figueroa pers. obs.). Prior to finally abandoning the nest, young forage with their parents and continue to use the nest to roost. Successful Jabiru pairs are therefore involved in reproductive tasks for approximately 6–7 months.

Nest sites.—From 1968 to 1987, a total of 91 nests was discovered, of which 36 different nests were considered active in one or more years (Table 3, Appendix, Fig. 1). Each had at least one nesting attempt, yielding a total of 69 active nests over the course of 19 breeding seasons (Table 3). During the 1972–1973 breeding season, there were nine active nests and in 1986–1987 there were seven, but in most years there were five or fewer. All nests were in isolated, tall, emergent trees with one exception (Hattieville-Boom No. 1); this nest was constructed in an unusually tall group of palmetto palms (*Acoelorrhaphe wrightii*; Appendix, Fig. 1). Canopy height ranged from 10 to 30 m. We were able to identify the species of nest substrate for 12 of the 36 nests: *Ceiba pentandra* (5), *Pinus car-*

TABLE 3. Reproductive success of Jabirus in Belize during 1968–1987 breeding seasons.

Season	1968–1969	1969–1970	1970–1971	1971–1972	1972–1973	1973–1974	1974–1975	1975–1976
Total nests[a]	2	4	4	—	9	9	8	8
Active nests[b]	2	3	2	—	9	5	5	6
Nests with eggs	2	3	2	—	6	4	3	3
Mean clutch size	—	—	—	—	4.0 (4)[d]	2.5 (2)	5.0 (1)	3.0 (1)
Nests with young	2	3	2	—	7	2	3[e]	1
Mean no. young	2.0 (2)[f]	2.0 (3)	2.0 (2)	—	2.1 (7)	1.5 (2)	2.0 (3)[e]	2.0 (1)
Total young	4	6	4	—	15	3	6	2
Hatching success (%)	—	—	—	—	43.8	—	—	—
Crude hatching success	100	100	100	—	78	40	44[g]	16

[a] Total nests: active or inactive.
[b] Nests with eggs, nestlings, or incubating adults.
[c] These nests were not considered when calculating crude hatching success because no nestlings were observed in them.
[d] Number of nests where clutches were counted.
[e] Two of three nests were considered when calculating crude hatching success (the third nest was poached).
[f] Number of nests where nestlings were counted.
[g] Three nests were counted with nestlings, but one nest was destroyed before chicks fledged (that nest was not included in the calculation).

ibaea (5), *Tabebuia ochracea* (1), and palmetto palm (1). Three nests were found in unidentified dead trees. Nest trees were usually surrounded by riparian forests or seasonally inundated pine-savanna wetlands situated in transitional zones where pine savannah meets coastal lowlands; often nest trees were within seasonally flooded or permanent freshwater lagoons. The many coastal and inland lagoons in north-central and coastal areas of Belize provide nesting and foraging habitats; however, no nests were observed in mangrove-dominated areas. All nests were >1 km from mixed colonies of other bird species or other Jabiru nests.

Construction and structure of nests.—December and January appear to be the months when most nests are refurbished or new ones are built. Nests were usually 15–30 m above ground and were well supported in tree crotches. Nests often appeared deeper than wide. Nests were up to 1 m wide and 1.8 m deep, but most nests were as wide as they were deep. Each nest consisted of various sizes of sticks and other woody debris (although, to avoid disturbing the birds, no one climbed the nest trees to examine nest structures closely). Nests were continually refurbished throughout the breeding season and remained relatively flat on top (DW pers. obs.).

Several nests appeared to be used for many years. The Mucklehany Lagoon nest was discovered in 1968 and was last reported active in 1979. Two hurricanes, Francelia in 1969 and Fifi in 1974, defoliated the nest tree. New nests were subsequently built in the same tree. The Bocotora Pine Ridge nest discovered in 1973 was last reported active in 1984 (Appendix, Fig. 1).

Clutch size.—Available data from 1968 to 1987 indicated a total of 44 eggs in 14 nests. Mean clutch size was 3.14 ± 1.17 SE (range = 1–5 eggs; n = 14 nests). Most eggs were laid in January.

Hatching and nesting success.—Hatching success could be calculated only for the 1972–1973 breeding season. Four nests with eggs were visited again when young were present. Sixteen eggs produced 7 nestlings, resulting in a hatching success of 43.8%. For the 14 years that crude hatching success (nestlings per active nest) could be calculated, 71.7% (43 of 60) of all active nests had at least one nestling present. A total of 92 nestlings was counted in 60 active nests, or 1.53 nestlings per active nest. The mean number of nestlings per nest with nestlings was 2.13 ± 0.71 SE (range = 1–4 nestlings; n = 43 nests). Most young were observed in February and March.

DISCUSSION

González (1996a) reported that mean clutch size of Jabirus in Venezuela was 3.4 eggs, somewhat higher than the mean of 3.14 that we calculated in Belize. In a separate report (Young 1983), WFY and DW reported a mean clutch size of 4.1 eggs (range = 3–5 eggs; n = 19 nests) in Belize. In Brazil, Antas and Nascimento (1997) reported a clutch size of 3–4 eggs. Hatching success was calculated for

TABLE 3. Extended.

1976–1977	1977–1978	1978–1979	1979–1980	1980–1981	1981–1982	1982–1983	1983–1984	1984–1985	1985–1986	1986–1987	Totals
6	1	6	3	2	—	—	6	7	6	10	91
4	1	6[c]	3[c]	2	—	—	5	5	4	7	69 (60)
4	1	3	—	2	—	—	4	—	1	1	39
2.0 (2)	—	3.0 (1)	—	—	—	—	3.0 (1)	—	3.0 (1)	2.0 (1)	—
2	1	—	—	2	—	—	5	5	3	6	44 (43)
2.5 (5)	2.0 (1)	—	—	2.0 (2)	—	—	3.0 (5)	2.6 (5)	1.3 (3)	1.5 (6)	—
5	2	—	—	4	—	—	15	13	4	9	92
—	—	—	—	—	—	—	—	—	—	—	—
50	100	—	—	100	—	—	100	100	75	86	—

only one breeding season in Belize (43.8%) and, over a 14-year period, crude hatching success was 71.7%. Although no fledgling data were collected in Belize, 47.0 and 47.6% of active nests produced at least one chick to fledgling age for two separate years in Venezuela (González 1996a).

Overall productivity per nest was higher in Belize (1.53) compared with 0.94 and 1.00 for the 2 years in Venezuela reported by González (1996a); however, his productivity measure was based on young per active nest that fledged, so the figures are not directly comparable. The mean number of nestlings per active nest was approximately the same in Belize (2.13) as it was during both years in Venezuela (2.0 and 2.1). In Brazil, mean number of nestlings per nest varied from a peak of 1.05 in 1988 to a minimum of 0.16 in November of 1992 (Antas and Nascimento 1997). In a separate report (Young 1983), WFY and DW found mean nestlings per active nest to be 2.18 (range = 1–4; n = 22 nests) in Belize.

Based on documented reports, the main causes of the nest failures in Belize were human disturbance and nest trees being cut down by poachers (6 nests). Other nest failures were due to nest trees falling (4 nests), agricultural clearing (4 nests), and fire (1 nest). No predation was observed. Before Jabirus were officially protected in 1973, they were called "market birds" and nestlings, in particular, were hunted and their meat sold in markets. Public reports of poaching increased after the influx of refugees from Guatemala began in the early 1980s (DW pers. comm.).

As is the case in Venezuela, the breeding season for Jabirus in Belize appears to coincide with the end of seasonal rainfall. In the llanos of Venezuela, Thomas (1985) reported that breeding of Wood Storks (*Mycteria americana*), Maguari Storks (*Ciconia maguari*), and Jabirus can be understood only within the context of variations in both timing and quantity of rainfall. The breeding season began just before the rains ended (September–October in Venezuela and November–December in Belize). Jabiru breeding dates in the Pantanal of Brazil varied, but were generally between early July and mid-August, with young leaving nests between October and early December. Water levels begin to fall in the Pantanal plain in May and June. Variations were noted even within one drainage basin, Taquari, where nests in the higher-elevation areas were active earlier than nests located in lower areas of the basin (Antas and Nascimento 1997). Nestling productivity in Brazil was likely related to flood levels, as the two fish species most often fed to nestlings were found in small bodies of water during low-water periods. Many populations of storks, including Jabirus, respond to the seasonal rainfall (Campbell and Lack 1985). In Brazil, this seasonal variation is expressed as volume of rain falling at river headwaters and that falling on the plains surrounding the Pantanal. The distribution of rain during the season directly influences both the total flooded area and the speed at which water levels rise and fall (Antas and Nascimento 1997:103).

In north-central Belize, Crooked Tree Wildlife Sanctuary (CTWS), a complex of permanent and seasonal shallow, freshwater lagoons and marshes, is a critical area for migratory and non-migratory water birds, including Jabirus. Some lagoons regularly dry up by the end of the dry season (March to May). Other lagoons are as deep as 3 m and retain water year around. Most observations

indicated that by mid-June very few adult or juvenile Jabirus remained in Belize. At this time, Jabiru populations are reported to increase in the Usumacinta drainage in Mexico, where they may possibly overwinter until the next breeding season (Luthin 1984, 1987; Miller 1991; Howell and Webb 1995; DW pers. comm.); no studies have confirmed whether birds from Belize winter there. It is uncertain, but Jabirus may become more dispersed as rising water levels make major wetlands less attractive for foraging but create new foraging opportunities in more isolated areas.

Many species of storks exhibit regional movements. These are dispersal events, not true migration, and are probably related to both timing and quantity of rainfall (Campbell and Lack 1985, Thomas 1985). Jabirus begin appearing in Belize during November and December, possibly arriving from the Campeche area of Mexico (Luthin 1984, 1987; Miller 1991; Howell and Webb 1995; Frederick et al. 1997). Birds move to locations where surface water conditions appear to favor optimum feeding. In Belize, during March and April when most young have fledged, water in lagoons and marshes becomes locally concentrated. Availability of food may be the single, most important factor that regulates movements of most storks, including Jabirus. It may also influence breeding success. The lowest nestling productivity in Brazil was reported during years of lowest rain fall (Antas and Nascimento 1997). A second example is that seasonal rains dictate timing and nesting success of Wood Stork populations in Florida: up to one-half of the total Wood Stork population may not nest in years when water conditions do not provide adequate food (Campbell and Lack 1985).

The numbers of adult Jabirus aggregating in lagoons at the termination of each breeding season were always much greater than the numbers known to be nesting (DW pers. obs.). In 1969 when DW first began keeping records, she recorded a group of 14 Jabirus (composed mostly of adults) at Mexico Lagoon on mud flats in mid-May. The numbers of Jabirus congregating at CTWS has increased: 14 in May 1970; 17 in June 1971 (Weyer 1971); 23 in June 1985 (Waight 1986); and 27 in March 1987 (Craig 1987). In recent years (Waight and Beveridge 1991) at CTWS and adjacent Western Lagoon, as many as 40 and 49 Jabirus were observed in May and June 1991, respectively. In late May 1993, 50 Jabirus were observed at Northern Lagoon within CTWS (Young 1998). These observations indicate that there may be more Jabirus nesting in Belize than we report, because all nests are not equally observable (i.e., nests located inside the crowns of live trees or in lower parts of dead trees surrounded by leafy trees). These "extra" birds may represent a non-breeding group, which may be characteristic of long-lived birds that do not become reproductively active before the age of 4 years. These Jabirus could constitute a significant percentage of the population (O. A. Figueroa pers. comm.).

Most nest trees (32 of 36) were located in wetlands of northern and central Belize (Appendix, Fig. 1). This includes those in marshes along the lower New River, Crooked Tree Lagoon, Burrell Creek Lagoon, Mussel Creek, Big Falls Rice Ranch, Cox's Lagoon, and Muckelhany Lagoon. At least three nest trees were located within 1–5 km of the international airport in Ladyville, and south of the Sibun River to Northern Lagoon and Southern (Manatee) Lagoon in the Peccary Hills. Other locations include Laguna Seca, Monkey River south to Punta Ycacos Lagoon, upper Mojo River, Aguacaliente Swamp, and Mafredi Lagoon in Toledo District. DW (*in* Scott and Carbonell 1986) provided general site descriptions and status of these wetlands.

In Belize, Jabirus built nests far from other wading-bird nests. They were never observed nesting in close proximity to Wood Storks and only once, in May 1978, was a colony of Boat-billed Herons (*Cochlearius cochlearius*) observed within a few hundred meters of a Jabiru nest at Blue Creek Village nest (Appendix, Fig. 1). DW's 1985 observations in the llanos of Venezuela (Masa Guaral) and Naumburg's (*in* Kahl 1971) observations in Mato Grosso, Brazil, indicated that Jabirus nested within colonies of Wood Storks and other Ciconiiformes. González (1996a) found three Jabiru nests in the center of mixed-species colonies in Venezuela. Luthin (1984) found one Jabiru nest in a mixed-species colony in Mexico. Some nests were built in tall red mangroves (*Rhizophora mangle*) in coastal

areas of southern Mexico. In Brazil, both sexes of Jabiru have been observed defending the nest and surrounding area from other Jabirus and Wood Storks (Antas and Nascimento 1997). Inter- and intraspecific kleptoparasitism was a very common behavior during the late dry season in the llanos of Venezuela (González 1996b), and Jabirus exhibited territoriality throughout the nesting season (Kahl 1973, Thomas 1985). In Belize, DW rarely observed behavior during the breeding season that she considered territorial defense of food resources. Beginning in April, small groups of mostly adult Jabirus congregated in freshwater marshes, ponds, and lagoons where food resources may have become concentrated during the dry season (DW pers. obs.) These areas were termed "staging" areas by DW, as very few Jabirus were observed during the nonbreeding season in Belize. It is unknown—but suggested—that Jabiru populations of Central America may move seasonally between Mexico, Belize, and Guatemala (Correa and Luthin 1988; DW pers. comm.). Other reports (Ogden et al. 1988, Villarreal 1996) suggest that seasonal influxes may occur in various regions of Central America.

In Venezuela, González (1996a) reported that nestlings remained on nests from 84 to 93 days, but that fledglings remained near the nest for several weeks afterward, in many cases returning to the nest at night. In Belize, young birds remain in the nest or near the nest for 100–115 days. Successful Jabiru pairs in all three countries (Belize, Brazil, and Venezuela) are involved in reproductive tasks for approximately 7 months and may have difficulty breeding in successive years; there is, however, some evidence that Jabiru pairs may remain mated in successive seasons (Kahl 1973, Thomas 1985, González 1996a). González (1996a) indicates that less than half of all active pairs in one season are also active during the following season, and that only 25% of successful pairs are successful in a second consecutive season.

Overall, Jabiru populations may have increased in Belize since gaining protective status in 1973. In the early 1970s, the Belize Audubon Society had estimated the population to be 20–30 birds, but by 1993, the population was estimated to be 50–60 birds (Young 1998). By 2002, 102 Jabirus had been counted in the major wetlands of Belize (O. A. Figueroa pers. comm.).

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APPENDIX. Jabiru nest numbers, names, and first breeding season discovered in Belize, 1968–1987. Numbers refer to locations shown in Figure 1.

Nest No.	Nest name	Season discovered
1	Mucklehany Lagoon	1968–1969
2	Northern Lagoon	1968–1969
3	Hattieville	1969–1970
4	Mason's Farm/Cabbage Haul Swamp	1969–1970
5	Hattieville–Boom No. 1	1970–1971
6	Sibun River	1972–1973
7	Hill Bank at Dawson Creek	1972–1973
8	Perry Camp No. 1	1972–1973
9	Bocotora Pine Ridge	1972–1973
10	Orange Walk Town No. 1	1972–1973
11	Ship Yard Village	1972–1973
12	Laguna Seca	1972–1973
13	Guinea Grass	1973–1974
14	Perry Camp No. 2	1973–1974
15	Spanish Creek and Southern Lagoon	1973–1974
16	Hattieville Boom No. 2	1975–1976
17	Mexico Lagoon	1975–1976
18	Isabella Bank	1975–1976
19	Burrel Boom (Tenn Ag)	1975–1976
20	Dawson Creek	1986–1987
21	Blue Creek Village	1977–1978
22	Dandriga Nest	1978–1979
23	Back Landing	1978–1979
24	International Airport	1979–1980
25	Lemonal Nest	1979–1980
26	Orange Walk No. 2	1983–1984
27	Spanish Creek	1983–1984
28	Double Headed Cabbage	1983–1984
29	Mojo Swamp	1983–1984
30	Indian Church	1985–1986
31	San Antonio Village	1983–1984
32	Irish Creek	1986–1987
33	Black Creek House	1986–1987
34	Revenge Lagoon	1986–1987
35	Mullins River	1986–1987
36	Mango Farm–Monkey River	1986–1987