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HABITAT USE AND REPRODUCTIVE ECOLOGY OF THE OCELLATED TURKEY IN TIKAL NATIONAL PARK, GUATEMALA

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ABSTRACT.—Despite its size, color, importance as a game species, and restricted geographic range (Yucatán Peninsula, northern Belize, and northern Guatemala), little is known about the ecology of the Ocellated Turkey (*Meleagris ocellata*). Habitat use, breeding behavior, and survival based on radiotelemetry of this species were studied in Tikal National Park, Guatemala 1988–1989 and 1993–1994. Ocellated Turkeys use tall forest cover to care for their poults and forest clearings and other vegetation types during courtship and nesting. Radio-collared females traveled up to 8 km (average of 2.4 km) from the point of capture in search of nesting sites. Nesting success of eight hens was 62% and poult survival rate was 15%. The largest home range recorded for a female with poults was 12.5 km^2.

The Ocellated Turkey (*Meleagris ocellata*), one of the most spectacular birds in the Guatemalan avifauna, is an important game species that is commonly sought by subsistence hunters. The species occupies a relict geographic range that includes the Yucatán Peninsula, southern Tabasco and northeastern Chiapas in Mexico, northern Belize, and the lowlands of northern El Petén in Guatemala (Ogilvie-Grant 1893, Griscom 1932, Ridgway and Friedman 1946, Friedman et al. 1950, Leopold 1965, Lint 1977–1978, Steadman et al. 1979). This restricted range makes the species highly vulnerable to range reduction and habitat fragmentation. Since 1977, several authors have reported that populations have decreased and the species is now considered scarce in some areas, probably as a result of habitat loss, overharvest, and disease spread by domestic fowl (Lint 1977–1978, Steadman et al. 1979, Jennings 1987).

Most accounts of this species are general descriptions of occurrence and behavior. The only systematic field study on Ocellated Turkeys was performed by Steadman and coworkers (1979) during a three-week period in Tikal National Park. Biologists' lack of concern may be explained in part by the fact that the species was traditionally considered to benefit from secondary growth and forest clearings (Leopold 1965).

Information on habitat requirements of the Ocellated Turkey suggests that it uses savannas, marshlands, arid brush zones, ecotones between primary and secondary vegetation, milpas (small corn patches), forests with clearings, and other habitats. These vague descriptions suggest that the species requires a mix of forest and clearings to survive. However, it is unclear what forest and clearing types the turkeys use, in what proportion, during what times of the year, and for what activities. Without such information, it is not possible to predict the impact of extensive forest clearing on the species' population dynamics.

We studied habitat use and reproductive ecology of the Ocellated Turkey in response to the need for systematic, scientific information on a species that appears to be declining. The study consisted of two phases. The first phase was focused on habitat use and breeding behavior. The second phase was focused on habitat use by females and on population dynamics of females and poults.

STUDY AREA AND METHODS

Study area.—We studied turkeys in Tikal National Park (17° 33′ N, 89° 35′ W) in the northern part of the state of El Petén, Guatemala (Fig. 1). The Maya city of Tikal was one of the most prominent developments of the Mayan lowlands during the Classic Period (800 A.D.). Because of its archaeological and ecological importance, Tikal was decreed a national park in 1955, with an area of 576 km^2 (Acuerdo Presidencial 1955). In 1990 Tikal National Park was absorbed as one of the fully protected nuclear zones in the Maya Bio-

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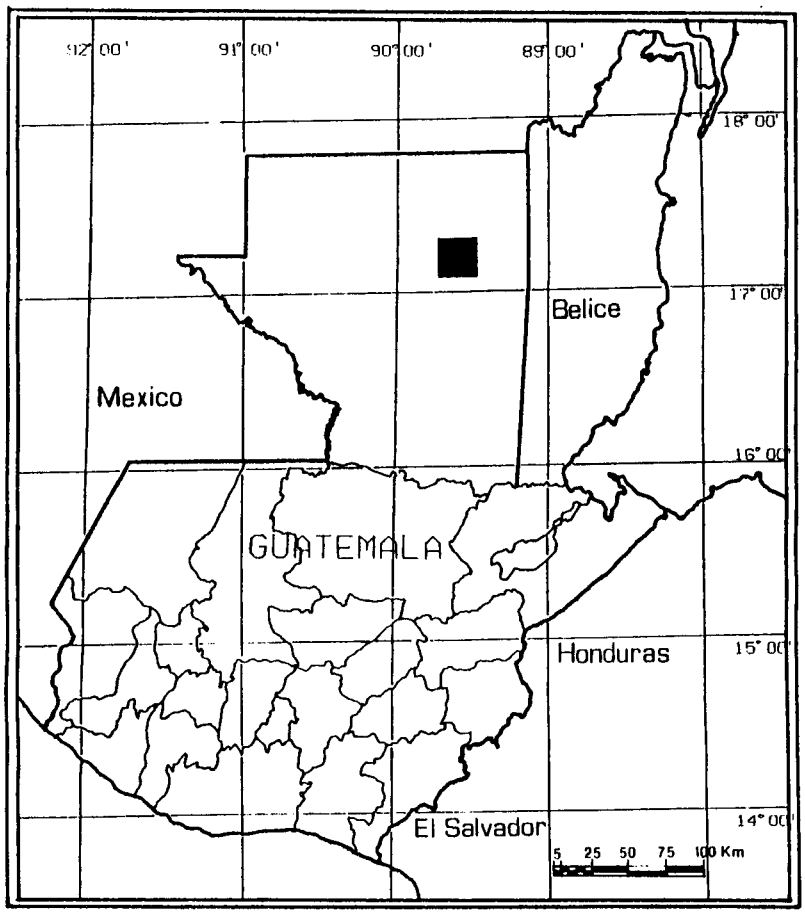

FIG. 1. Location of Tikal National Park, Guatemala.

sphere Reserve (Congreso de la República de Guatemala 1990), which protects 1.5 million ha in northern El Petén.

According to the Holdridge life-zone system, Tikal is located in warm subtropical humid forest (Instituto Geográfico Militar 1983). Temperature extremes range from 10° to 38° C. The hottest months are May and June, with daily maximums between 30° and 35° C, and minimums between 21° and 24° C. December through February are the coldest months with daily maximums between 24° and 27° C and minimums of 16° to 18° C. Temperatures as low as 2° C have been recorded. Annual precipitation is 1500–2000 mm. The rainy season usually begins in mid-May and ends in November. September and June are the rainiest months, and February and March are the driest with only 30–50 mm of rain. Heavy dawn mists during the dry season allow for green vegetation year round (National Park Service 1973).

Park topography is characterized by low undulating hills with a mean elevation of 300 m and the highest point 438 m. Soils are thin and the substrate is karstic, causing rapid runoff of surface water. Tikal has several natural depressions, locally called "bajos", or low forest, that may hold standing water during the rainy season and sometimes throughout the year. Areas that do not flood during the rainy season are known as "tall forest", and account for approximately 78% of the park area (National Park Service 1973).

Methods.—This study was divided into two phases, each with different objectives. General observations on behavior and appearance of the birds, particularly during the breeding season, were recorded throughout the project.

To provide the basic framework for habitat analyses, local expertise was utilized to define gross characteristics of the vegetation types. Five vegetation associations were identified and separated, mainly by species composition and soil hydrology.

In the first phase of the study, fifteen transects 1.2–2.0 km long were established among the different vegetation types for a total of 24.1 km. From December 1988 to July 1989 a team of four people, including MJG, walked the transects (at a speed of 1 km/hr) at

least once per month during morning hours (beginning within 1 hr of sunrise). We recorded sightings, vocalizations, and signs such as feathers and droppings, along with information on time of day, date, sex, and age (adult and yearling, if possible). We also observed and counted turkey flocks in the administrative and tourist area of Tikal monthly to obtain information on group size, age and sex composition, as well as behavior. Age and sex determination followed Smithe (1966) and Steadman and coworkers (1979). Changes in monthly composition of groups were examined with Kolmogorov-Smirnov tests ($P = 0.05$).

The second phase of the project (January 1993, to October 1994) was a study of habitat use by females and population dynamics of the species in Tikal. During January and February 1993–1995, we surveyed the administrative and ruins areas of Tikal for the occurrence of turkeys. We chose the Mundo Perdido (Lost World) ruins and the camping area as capture sites. Ocellated Turkeys were captured in Q-nets (Furman Diversified, Texas) and a custom-made drop net with a 5-cm mesh; both were baited with corn. Our trapping efforts were primarily directed toward females and restricted to a maximum of 2 hrs after daylight because high humidity combined with temperatures in excess of 25° C can cause stress and increased risk of mortality in turkeys. Measurements of weight, tail length, tarsus, and wing were taken of all captured birds prior to fitting them with harnessed backpack transmitters with a mortality/motion sensor. The radios (Mod-200 and Mod-300, Telonics, Inc., Arizona) weighed 103–130 gm and operated in the 150–151 MHz range. Expected life of the batteries was 24 months.

Following initial release, we located the radio-tagged turkeys daily with a hand-held yagi antenna and receiver ("H" antenna; Telonics, Mesa, AZ). Whenever possible, we took readings from elevated points, such as the Maya temple ruins. After poults hatched, a different female was located several times each day during peak activity hours; we also attempted direct observation. During periods of low activity each day, we located all the hens to determine their general area of activity. Radio-tracking continued through the brood rearing period or until the birds formed flocks, normally by September.

Locations were plotted on 1:25,000-scale maps. Preliminary estimates of home ranges during brood care were obtained by superimposing a grid on the minimum convex polygon enclosing female locations.

We obtained information on survival of adult females for the period from the time of trapping to the end of radio-tracking, approximately 16 weeks. Poult survival was calculated for the period from the first sighting of the brood to the end of the tracking period, approximately 12 weeks.

RESULTS

The five vegetation associations were classified as follows (González 1992): 40% of total transect in tall forest (not-flooded, ≥30 m height, clear understory), 23% in low palm forest (seasonally flooded, 20 m height, abundant vines, dense understory), 6% in low tinto forest (seasonally flooded, 15 m height, high tree density, small diameter stems), 17% in tall flooded forest (seasonally flooded, ≥30 m height, clear understory), and 14% in secondary forest (not-flooded, 20 m height, dense understory).

From December 1988 through July 1989, 163 transect counts were conducted totaling 274 km. There were no significant differences in numbers of turkeys among transects, vegetation types, or months for the duration of the study (González 1992). However, a tendency towards occurrence in tall and secondary forests was observed (González 1992, González et al. 1996).

In the administrative/tourist area of the park, the number of adult ($D = 0.328$, $P < 0.01$) and juvenile ($D = 0.426$, $P < 0.01$) females decreased significantly in the March nesting period (González 1992). Neither adult nor juvenile male numbers decreased significantly ($P > 0.05$).

During the breeding season, adult male turkeys develop stunning secondary sexual characteristics (González 1992, González et al. 1996). Adult males have a distinctive gobble and courtship display. Gobbles were first heard in early February, reached their peak in March and diminished in May. The gobble begins with several low frequency "thumps", much like the sound of a small gasoline motor starting. As the tempo of thumps increases, the typical gobble is produced.

During the display, males execute an intricate and energetic dance. They begin by tapping their feet at high speed. Then they raise and open their tail feathers in a fan, which they move from side to side. The wings vibrate as they are spread out and down, with the tips barely touching the ground. While the male moves around the female during the dance, he maneuvers his tail feathers so their dorsal surface is constantly visible to the female. Male dances have been observed from 14 February to mid-April.

Mating appears most frequent from 20 March to 10 April, although few copulations have been observed (González et al. 1996). After mating, females begin searching for nesting sites. Nests are built on the ground on

TABLE 1. Nesting, hatching, and adult female and poult survival rates of the Ocellated Turkey in Tikal, Guatemala.

Parameter	1993 (*n*)	1994 (*n*)
Radio-collared females	4	5
Nesting females	3 (75%)	5 (100%)
Females with successful nests[a]	1 (33%)	4 (75%)
Adult female survival	3 (75%)	3 (60%)
Total poults produced	5	22
Surviving poults[b]	0	4 (18%)

[a] Overall female nesting success = 62%.
[b] Overall poult survival rate = 15%.

previously cleared, well-hidden, small depressions. They are usually found in tall grass or brush, although occasionally they are located at the base of trees. Camouflage is the nest's main protection against predators.

Nests had an average of 8.8 ± 2.5 (SE; $n = 5$) cream-colored eggs mottled with brown. Incubation was 28 days. When hatched, poults are cryptically colored. Hatching (usually occurs) from the end of May to the beginning of July. However, adult females have been observed with poults still with down in September.

Young follow the hen to forest cover as soon as they hatch. This may be to avoid direct sunlight since their plumage appears conspicuous in direct light. Two weeks to a month after chicks begin hatching, females and their broods form groups in which adult females apparently share responsibility for care of the young.

Nine turkeys were captured and fitted with radio transmitters in 1993 and 1994. In March, 1995, five additional females were captured in Tikal. Table 1 shows nesting, hatching, and survival rates for adult females and poults for 1993 and 1994. The survival rate through the breeding period for adult females was 0.75 in 1993 and 0.60 in 1994 (González et al. 1996).

Of the 9 females followed through two nesting seasons, 5 lost their nests to predators. Two of these females renested. Overall, 5 of 8 hens (62%) were successful in nesting and hatching poults. Of the 27 poults produced, 4 survived to the end of the tracking season for a survival rate of 0.15. Of 5 females with broods that were tracked in 1994, 2 died 6 and 15 days after hatching their poults.

Displacement and home ranges were calculated for females captured in 1993 and 1994. The maximum distance between a trapping site and nesting site was 8 km, and the minimum was 0.2 km. The average displacement for 9 nesting attempts was 2.4 km.

The radio-collared females' home ranges averaged 0.28 km^2 (27.6 ha). The female with the largest home range covered approximately 12.5 km^2 (1247.31 ha) with her brood before forming a flock.

Females took their broods under tall forest cover. Of 61 observations of females with young, 87% were in tall forest with non-flooding soils. Analyses of aerial pictures (1:250,000) and cartographic maps (1:50,000) of the surface of Tikal National Park indicate that between 65% and 79% is considered "broadleaf tall forest" (González 1992).

DISCUSSION

Ocellated Turkeys used different vegetation types: open areas or areas with clearings during courting, breeding, and nesting, and tall forest during the rest of the year. This is in contrast to Steadman and coworkers (1979) who reported that *M. ocellata* used the forest for nesting and clearings mainly for feeding.

Habitat use by North American Wild Turkeys (*Meleagris gallopavo*) appears to be similar: forests and small clearings (Bowman et al. 1979, Everett et al. 1979, Campos et al. 1984, Towry et al. 1984, Schemnitz et al. 1985). As with the Ocellated Turkey, adult Wild Turkeys use clearings for their reproductive displays (gobble and strut; Barwick and Speake 1973).

The composition of Ocellated Turkey groups and its variation throughout the year parallels the behavior of the North American Wild Turkey as described by Latham (1976). Selection of nest sites also seems similar. Wild Turkeys will nest in open areas, such as pastures, clearings, scrub, or any type of low vegetation that adequately hides a nest (Cook 1972, Hillestad 1973, Williams et al. 1973, Latham 1976, Anonymous 1979). According to Hillestad (1973), the distance (in a straight line) from the place of mating to the nesting site for *M. gallopavo silvestris* is 2.7 km, similar to the distances between capture and nesting for Ocellated Turkeys in Tikal (2.4 km).

Habitat for broods of the Wild Turkey var-

ies. Some authors (McCabe and Flake 1985, Williams et al. 1973) report that females used forest cover for small chicks. Others have indicated that adequate habitat for poults included clearings and pastures (Hillestad and Speake 1970). Baker and coworkers (1980) found that nearly 50% of their sightings during one brooding period occurred in riparian woodland. Although most of our observations of Ocellated Turkey broods were in tall forest, they probably use other vegetation types and ecotones as they move through their home ranges. Detailed mapping of Tikal's vegetation to determine distribution of specific vegetation types identified in this study is still needed.

The survival rates of Ocellated Turkey females (0.60, 0.75) and poults (0.15) during the breeding season seem to be low. Nesting success for the Ocellated Turkey (62%) is similar to the 59–63% nesting success of Wild Turkeys in southern Florida, where several predator species were present, including skunks, raccoons, and opossums (Williams et al. 1980). According to Hickey (1955, in Williams et al. 1980), this success rate is higher than the overall nesting success of 45% reported for other galliform birds. A relatively high nesting success rate, along with the capacity to renest and the fact that yearling females nest, could partly counteract the low survival rates for hens and poults. Nevertheless, the reproductive success of Ocellated Turkeys in this study is not enough to offset mortality.

The home range calculated for the only female that had a successful brood through the end of a tracking season (12.5 km^2) was eight times as large as the spring and summer ranges of nesting Wild Turkey hens in Alabama (1.49 km^2; Hillestad 1973). Although additional information is necessary to determine the mean and variation in home ranges under differing climatic and vegetation conditions, it seems likely that this species requires large forested areas for successful reproduction.

Our results show that reproductive success of Ocellated Turkeys is low even in the moderately protected conditions within Tikal National Park. This consideration, along with rapid habitat loss and overhunting, indicate that the species could be threatened.

This bird is an important game species in an area where most animal protein is obtained by hunting. At present, prohibitions on hunting would have no effect because Guatemala lacks the necessary means for enforcement. On the basis of the results of this study, the Ocellated Turkey was included in the proposed hunting regulations for the country. The suggested hunting season is from 1 March to 30 May; subsistence hunters have a bag limit of 2 males per week, while sport hunters have a bag limit of 5 males for the season; no hunting of females is allowed. The information provided by radiotelemetry suggests that the hunting season should be shortened to 30–40 days and that the bag limits (for both types of hunters) should be reduced.

Besides hunting regulations and an educational campaign to support them, further research is needed. It is important to determine survival rates year-round and the effects of annual changes in climate, particularly precipitation, on nesting success and poult survival. This information could provide a better estimate of the turnover rate of Ocellated Turkey populations, and therefore provide the basis for adequate management programs.

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