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BREEDING ECOLOGY OF THE LEAST BITTERN IN CENTRAL FLORIDA

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Abstract.—Least Bitterns (*Ixobrychus exilis*) were found to be common residents of the littoral zone of many central Florida lakes but rare or absent at other wetlands, presumably because of lack of suitable emergent vegetation in the littoral zone. Nesting occurred most frequently in cattail (*Typha* sp., 38.2%) and bulrush (*Scirpus validus*, 52.1%). Water depth under nests averaged 107.16 ± 29.35 cm (range = 38-168 cm, n = 207 nests) but varied among lakes. Nest height above the water averaged 46.8 ± 21.2 cm (range = 5-135 cm, n = 207 nests) and was similar among lakes. Clutch size averaged 4.08 ± 0.59 eggs/nest (range = 2-5, n = 104 nests) and ranged from 3.69 ± 0.48 to 4.35 ± 0.49 among lakes and years. Number of young surviving to 2-weeks of age averaged 1.05 ± 1.62 nestlings/nest (range = 0-4) and was similar among lakes. Only 47.4% of nests survived to produce nestlings ≥2-weeks of age. Many nests failed due to wind/wave effects (24.3%) or nest abandonment (23.1%) for unknown reasons. Average hatching date was 29 May on both Lakes Kissimmee and Tohopekaliga. Significant interyear variation in mean hatch dates occurred on Lake Tohopekaliga. Because cattail appears to be an important nesting habitat for Least Bitterns and other nesting birds, lake management programs should reexamine the wildlife value of cattail and make accommodation for emergent stands of herbaceous marsh vegetation in the littoral zone of central Florida lakes.

Despite the Least Bittern having a widely distributed nesting range in North and South America (Palmer 1962, Gibbs et al. 1992), little is known about its breeding biology and habitat requirements. The species appears to be a common breeding bird in the Everglades (Frederick et al. 1990) and the littoral zone of many lakes in peninsular Florida (Rodgers pers. obs.). However, few population estimates exist for Florida because Least Bitterns are the smallest and most secretive of the herons in North America and difficult to accurately census. Despite the Least Bittern's relative abundance and general distribution, little information is available regarding the species' demographic characteristics and habitat preferences (e.g., Weller 1961, Gibbs et al. 1992, Post and Seals 1993, Post 1998), especially in Florida (Frederick et al. 1990). This lack of information resulted in the Least Bittern receiving a high "action score" (a relative measure of how much is known about a species within Florida) of 30 in the Florida Fish and Wildlife Conservation Commission's priority listing for vertebrate conservation efforts (Millsap et al. 1990).

The objective of our study was to investigate the status, nesting habitat, and demographic characteristics of Least Bitterns at several sites in central Florida. Knowledge of the population limitations, ecological specialization, and reproductive potential would help determine if this species needs specific conservation actions. Wetlands in Florida are under continuing threat of conversion or degradation from an expanding human population. Knowledge of Least Bittern nesting ecology will provide a basis for the conservation of the species and its supporting habitat in Florida.

Study Area and Methods

We surveyed the littoral zone of several lakes, impoundments, and wetlands in central Florida by airboat or canoe during February through August 1995-97 to locate nesting Least Bitterns. Surveys consisted of transects through suitable bittern habitat based on previously published studies (Weller 1961, Gibbs et al. 1992, Post and Seals 1993, Post 1998). Nest locations were mapped using a Global Positioning System unit (model NAV 5000D, Magellan Systems Corporation, San Dimas, California). Bittern nests were individually marked with numbered, colored flagging and visited every 1-2 weeks. Care was taken to reduce disturbance to the breeding bitterns by minimizing nest monitoring during pair-formation and early egg-laying periods. Nests also were visited during cooler morning and late afternoon periods and no visits occurred during inclement weather. The time (<1 minute) spent at each nest was minimized by use of two people to observe and record data, and binoculars were used to monitor nests from a distance when the nestlings were large and capable of leaving the nest.

Breeding density was estimated by counting the number of Least Bittern nests along a 2-meter wide by 50-meter transect randomly located in suitable habitat. Areas along the transect devoid of vegetation were not included in the census. Thus, the values reported herein are densities of nests per 100 m^2 of vegetation.

Study nests were monitored for standard nesting demographic variables (i.e., clutch size, nesting success, and sources of nest and nestling loss). Nest height, water depth, and nesting substrate also were measured and recorded during the early phase of nesting when the nest contained eggs. Because it was difficult to locate the highly mobile and small nestlings among the dense, nonwoody vegetation once they hatched and became mobile, nest success could only be monitored to the second week of age of the first hatchling.

Nests that failed with incomplete clutches were included in the calculation of overall nest success, but were not used to calculate clutch size. Whereas, the Mayfield method has been shown to be superior to traditional estimators of avian survival rates (Hensler and Nichols 1981), we were not always able to attain suggested minimum sample sizes (i.e., 39 nests for a minimum coefficient of variation equal to 0.05). In addition, bittern survival varies considerably during the egg laying to fledging period and would necessitate calculation for each 7-14 day period. Instead, we estimated nestling survival rates as the number of nestlings/clutch. Nestling loss was attributed to starvation when young disappeared in a sporadic pattern rather than all at once; the latter is typical of predation (Howe 1978) or nest abandonment.

Data are presented as a mean ± 1 SD. Statistical analyses were performed using the SAS System (SAS Institute Inc. 1990a, 1990b, 1990c). Analyses of reproductive and chronological variables were performed only on data sets with ≥10 nests. Prior to pairwise comparisons, data were tested for normality with the Shapiro-Wilk test using the UNIVARIATE procedure. Parametric statistics (ANOVA for mean comparisons and Fisher's protected LSD test for pair-wise comparisons) were used if the probability of Shapiro-Wilk test suggested homogeneity of variance for the variable.

Nonparametric statistics were used for clutch size and fledging success variables because the data were discrete, exhibited a small range of one to five, and often were not normally distributed. Whereas we have included the mean and one standard deviation values for clutch size and fledgling/nest rates for comparison with the literature, a Pearson chi-square test was used to analyze differences in these variables. If a chi-square test indicated a significant interlake difference among the samples, then pairwise samples of the data were compared with the Fisher's exact test. Low frequency (<10) of expected cell counts for some analyses required lumping clutch sizes into small (1 and 2-eggs), medium (3-eggs) and large (4 and 5-eggs) categories. Fledging success was analyzed for 0-fledgling, 1-fledgling, 2-fledglings, and ≥3-fledglings categories.

Hatching date was a convenient reference point for comparing breeding chronology because nest building can be variable in length, we minimized nest visitation early in pair formation to reduce disturbance, egg-laying dates were not known, and some hatching dates could be determined by back-aging nestlings. Hatching dates, defined as the week of hatching for the first egg in a nest, were grouped by one-week intervals based on visitation date and aging of nestlings. ANOVA/Fisher's protected LSD tests were run on normal or log-transformed hatching date for lake and year comparisons of breeding cycles. We assumed independence between lakes and a constant correlation within each lake.

RESULTS

Breeding density of Least Bitterns averaged 3.16 ± 2.89 nests/100 m^2 (n = 107 transects) and ranged from 0 to 12 nests/100 m^2 nests among all the wetlands we surveyed in central Florida. Few nests were located at lakes Rosalie (n = 3), Tiger (n = 1), Cypress (n = 4), and Mary Jane (n = 2) despite having relatively large amounts of emergent vegetation in the littoral zone. No nests were located at Alligator Lake (Osceola Co.), Lake Gentry (Osceola Co.), Live Oak Lake (Osceola Co.), Brick Lake (Osceola Co.), Buck Lake (Osceola Co.), Lake Hart (Orange Co.), and Lake Nona (Orange Co.). These lakes either lacked suitable cattail/bulrush nesting habitat, had a narrow littoral zone, or the littoral zone was altered due to shoreline development.

Least Bitterns nested most frequently in cattail (38.2%) and bulrush (52.1%) substrates (Table 1). Nests frequently were found in isolated "islands" of cattail and/or bulrush 75-200 m from shore in the deeper regions of the littoral zone of Lakes Kissimmee, Marion, and Tohopekaliga. These islands ranged from 25-200 m in width. Many (42.7%) bittern nests were located in colonies of Boat-tailed Grackles (*Quiscalus major*), and 2.6% of bittern nests were built on abandoned grackle nests.

Table 1. Percent use of plant species by nesting Least Bitterns on central Florida lakes.

Species[a]	Lakes				
	Cypress	Kissimmee	Marian	Tohopekaliga	Total
Buttonbush (*Cephalanthus occidentalis*)		3.4			0.5
Bulrush (*Scirpus validus*)	73.3	55.2		49.0	52.1
Cattail (*Typha* sp.)	20.0	17.2	100.0	44.1	38.2
Maidencane (*Panicum hemitomon*)	3.3	24.1		7.0	8.7
Arrowhead (*Sagittaria lancifolia*)	3.3				0.5
Number of nests	30	29	5	143	207

[a]Frequency of vegetation based on the most dominant species supporting nest structure.

Water depth beneath Least Bittern nests averaged 107.2 ± 29.3 cm (range = 38-168 cm, n = 207 nests) but significant (ANOVA, P = 0.001) differences occurred in the mean water depths among lakes (Table 2). Bitterns on Lake Cypress nested in significantly shallower water than birds on both Lakes Kissimmee (Fisher's LSD test, P = 0.0001) and Tohopekaliga (Fisher's LSD test, P = 0.0001), whereas bitterns on Tohopekaliga nested in significantly (Fisher's LSD test, P = 0.0001) shallower water than those on Lake Kissimmee. Nest height above the water averaged 46.8 ± 21.2 cm (range = 5-135 cm, n = 207 nests) and did not vary significantly (ANOVA, P = 0.61) among lakes (Table 3).

Least Bittern clutch size averaged 4.08 ± 0.59 eggs/nest (range = 2-5, n = 104 nests) and did not vary significantly (χ^2 = 1.98, P = 0.37) between Lakes Kissimmee and Tohopekaliga (Table 4). Clutch size did not vary during the breeding season at Lake Kissimmee (ordinary least squares

Table 2. Water depth (cm) beneath Least Bittern nests on central Florida lakes.

Lake	Number	Mean ± 1 SD	Range
Cypress	30	66.3 ± 16.1	38–100
Kissimmee	29	134.0 ± 27.6	65–166
Marian	5	92.2 ± 7.3	85–105
Tohopekaliga	143	110.8 ± 22.9	46–168
Total	207	107.2 ± 29.3	38–168

Table 3. Height above the water of Least Bittern nests on central Florida lakes.

Lake	Number	Mean ± 1 SD	Range
Cypress	30	49.5 ± 23.9	10–105
Kissimmee	29	43.3 ± 18.9	15–95
Marian	5	54.0 ± 15.2	40–70
Tohopekaliga	143	46.7 ± 21.3	5–135
Total	207	46.8 ± 21.2	5–135

Table 4. Clutch size of Least Bitterns nesting on central Florida lakes.

Lake	Number	Mean ± 1 SD	Range
Kissimmee	20	4.35 ± 0.49	4–5
Tohopekaliga	84	4.01 ± 0.59	2–5
Total	104	4.08 ± 0.59	2–5

regression, R^2 = 0.11, P = 0.27) but exhibited a significant seasonal decline (-1.2 eggs/100 days) at Lake Tohopekaliga (R^2 = 0.21, P = 0.002).

The number of young surviving to 2-weeks of age averaged 1.05 ± 1.62 nestlings/nest (range = 0-4, n = 104 nests) and did not vary significantly (χ^2 = 1.68, P = 0.79) between Lakes Kissimmee and Tohopekaliga (Table 5). Only 47.4% of nests survived to produce at least one 2-week old nestling (Table 6). Most bittern nesting attempts failed for

Table 5. Survivorship to 2-weeks of age for Least Bitterns nesting on central Florida lakes.

Lake	Number	Mean ± 1 Std. Dev.	Range
Kissimmee	20	1.10 ± 1.79	0–4
Tohopekaliga	84	1.04 ± 1.60	0–4
Total	104	1.05 ± 1.62	0–5

Table 6. Frequency (%) and sources of Least Bittern reproductive success and failure on central Florida lakes.

Lake[a]	Abandoned	Collapsed	Herbicided	Depredated	Successful
Kissimmee	24.1	13.8	0.0	0.0	62.1
Tohopekaliga	22.9	26.4	5.6	0.7	44.4
Total	23.1	24.3	4.6	0.6	47.4

[a]Sample sizes are given by lake in Table 4.

unknown causes before reaching the early nestling phase. However, 24.3% of nests failed because of wind-related collapse (both wind and wave action) of the nesting substrate. Herbiciding of the nesting vegetation resulted in collapse of 8 (5.6%) nests in cattail during 1997 on Lake Tohopekaliga.

Least Bitterns exhibited similar (Fisher's LSD test, $P > 0.05$) nesting chronology between Lakes Kissimmee and Tohopekaliga (Table 7). However, bitterns on Lake Tohopekaliga nested significantly (Fisher's LSD test, $P = 0.003$) earlier in 1995 (mean ± sd = 22 May ± 15.67 days, n = 26 nests) than 1996 (13 June ± 28.72 days, n = 11 nests); nesting in 1997 (30 May ± 12.88 days, n = 8 nests) was similar (Fisher's LSD test, $P > 0.05$) to both 1995 and 1996.

Discussion

Least Bitterns appear to be a common nesting species of the littoral zone of four lakes in central Florida. Bitterns were found to breed as solitary nesters and in loose colonies in regions of cattail/bulrush but not as dense as typical day herons. Kushlan (1973) considered an especially dense nesting assemblage of 11 active nests in 260 m^2 (or 4.23 nests/100 m^2) of Everglades, which is slightly greater than the average density (3.16 nests/100 m^2) we observed on all central Florida lakes. Post and Seals (1993) found low nesting densities in South Carolina that averaged 2.90 nests/ha (0.029 nests/100 m^2) with the highest density of 13 nests in a 621 m^2 cattail island. We also found bitterns nesting in colonies of Boat-tailed Grackles similar to observations reported by Bent (1926), Kushlan (1973), Post and Seals (1993), and Post (1998). The lack of bittern nests on six other Florida lakes may have been due to lack of suitable littoral habitat.

Frederick et al. (1990) concluded that dense stands of sawgrass (*Cladium jamaicencis*) and mixed sawgrass-cattail were the most important vegetative classes used by Least Bitterns in the water conservation areas (Everglades) of south Florida. Only 8.6% of sighted bitterns were flushed from dense stands of pure cattail during their study (Frederick et al. 1990:6). However, Least Bitterns were common in both pure and mixed stands of cattail and bulrush in central Florida

Table 7. Hatching dates for Least Bitterns nesting on central Florida lakes during 1995–1997.

Lake	Number	Mean ± 1 SD	Range
Kissimmee	13	29 May ± 20.68 days	2 May–11 July
Tohopekaliga	45	29 May ± 20.95 days	18 April–15 July
Total	58	29 May ± 20.91 days	18 April–15 July

lakes during our study. Bent (1926: Massachusetts and Texas) and Post (1998: South Carolina) reported bitterns commonly nested in dense growths of cattail. Weller (1961) also found frequent use of cattail and bulrush habitats by bitterns in central Iowa. Post (1998) reported the average nesting height of 41.0 cm, which is similar to the 46.8 cm average height we found in central Florida.

Weller (1961) reported the average clutch size of Least Bitterns in Iowa as 4.48 eggs, Trautman (in Palmer 1962) found an average of 4.39 from Michigan, while Post (1998) reported an average of 3.80 in South Carolina. Only the latter value is similar to the average of 4.08 eggs in our Florida study. Weller (1961) suggested Least Bittern clutch size may increase with latitude in North America, which is typical of many avian species (Klomp 1970, Koenig 1986, Schamel and Tracy 1987). However, we found no evidence that average clutch size was smaller early in the breeding season as suggested by Weller (1961). Post (1998) also found little interyear and seasonal variation in clutch size in South Carolina. Nest success in our study (46.4%) was intermediate to the 20-73% annual reproductive success reported by Weller (1961) and Gibbs et al. (1992). However, the 1.05 nestlings/nest surviving to 2 weeks in central Florida was less than the 2.93 nestlings/nest surviving to 1 week in South Carolina cited by Post (1998).

Bent (1926) cited Least Bittern egg dates for Florida ranging from 25 May to 26 June, while Palmer (1962) reported the laying season in Florida was from mid-March to early July. These ranges are similar to the hatching chronology of 18 April to 15 July we found on central Florida lakes. The average clutch completion date of 19 May reported by Post (1998) is only slightly earlier than the average hatch date of 29 May in central Florida.

We found the major sources of Least Bittern nesting failure were nest collapse (24.3%), abandonment (23.1%), with little loss attributed to predation (0.6%). These values contrast with the sources of nest collapse (32.4%), abandonment (14.7%), and predation (29.4%) identified by Post (1998). We do not know the cause of the large frequency of nest loss attributed to abandonment but these nests may have been depredated between our visits.

The loss of eight Least Bittern nests in cattail sprayed as part of the control of nuisance aquatic plants (both water hyacinth [*Eichornia crassipes*] and cattail) on Lake Tohopekaliga may be only a small portion of the actual loss of nests caused by the state sponsored herbiciding program on the lake. Once the nesting vegetation is sprayed, the plant and nest usually falls over into the water within 14 days. In addition to the bittern nests that failed when the cattail collapsed into the water, numerous nests of Boat-tailed Grackles, Red-winged Blackbirds (*Agelaius phoeniceus*), Purple Gallinule (*Porphyrula martinica*), and Common Moorhens (*Gallinula chloropus*) suffered the same fate. According to both Florida Fish and Wildlife Conservation Commission fisheries biologists and South Florida Water Management District personnel we interviewed, dense stands of cattail are considered of little value to fish and wildlife populations. Thus, large cattail islands are systematically sprayed to reduce their area of coverage. This is unfortunate because large cattail islands appear to provide more interior nesting habitat that may be less subject to wave related nest loss. Post (1998) also found cattail islands to be of considerable value to grackles and bitterns in south Carolina. Future lake management should address this dichotomy between perceived and actual wildlife value of cattail and make accommodation for the value of emergent stands of herbaceous marsh vegetation in the littoral zone of central Florida lakes.

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