# Florida Field Naturalist

PUBLISHED BY THE FLORIDA ORNITHOLOGICAL SOCIETY

VOL. 18, NO. 1 FEBRUARY 1990 PAGES 1-20

## RELATIVE ABUNDANCE AND HABITAT PREFERENCES OF LEAST BITTERNS (*IXOBRYCHUS EXILIS*) IN THE EVERGLADES

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**Abstract.**—From May through July of 1987, we encountered 607 Least Bitterns (*Ixobrychus exilis*) during 3,502 km of airboat survey in Water Conservation Area 3A of the central Everglades. Bitterns were found significantly more often along airboat trails than on canals or in open grassland, and were encountered significantly more frequently in the northeastern corner of the study area. Bitterns were most often found in association with pure sawgrass (*Cladium jamaicencis*) or mixed sawgrass/cattail (*Typha* spp.), and were rarely found in wet prairie vegetation. No preference was noted for cattail, burns, or willow (*Salix caroliniana*) ponds. The observed sex ratio was close to parity (1.04). Young appeared in large numbers after June 15. Less than three percent of the birds flushed were struck by the airboat, probably representing a minimum mortality for airboat traffic.

Least Bitterns (*Ixobrychus exilis*), the smallest and the most secretive of the North American Ardeidae, have been the subject of little quantitative research. Weller's (1961) account of the breeding biology is the only substantial contribution to date, and all quantitative studies of breeding biology have been done in the northern and western states (Beecher 1942, Kent 1951, Wood 1951, Manci and Rusch 1988). The relevance of this information to breeding biology in the southeast is unknown. Within Florida, Kushlan (1973) noted a dense nesting aggregation in the Everglades, and Bowman and Bancroft (1989) summarized nesting records occurring in the Keys.

Many authors have noted an association of Least Bitterns with cattail (*Typha* spp.), vegetated edges (summarized in Weller 1961), and nutrient-rich microhabitats (Kushlan 1973) for feeding and breeding. How-

Florida Field Naturalist 18(1): 1-9, 1990.

ever, none have demonstrated preferences for these habitat variables. Least Bitterns also are weak fliers, and may be especially vulnerable to fast-moving airboats, which are commonly used in southern marshes. The effect of airboat activity on Least Bittern populations is unknown. In this paper, we present the results of a 3-month survey of Least Bitterns flushed during regular airboat travel throughout Water Conservation Area 3A, in the central Everglades marshes of southern Florida. We include analyses of habitat and vegetational preferences, indices of abundance, and effects of airboats on Least Bittern mortality.

## METHODS

We studied Least Bitterns in Water Conservation Area 3A (WCA 3A), in Dade and Broward counties during March through July of 1987 (Fig. 1). WCA 3A is a 237,000 ha. impounded freshwater marsh, in which water level fluctuates according to a predetermined management plan. During other studies (Bennetts et al. 1988, Frederick and Collopy 1989, respectively), we regularly traversed much of the study area by airboat. Travel was along established airboat trails, through areas of undisturbed grassland and open water, and along canals during daylight hours. During airboat trips, we recorded the location, age, sex, habitat characteristics, and vegetation from which Least Bitterns flushed. We defined three major habitat types: airboat trails, open grassland, and canal edges. Density of vegetation was estimated as dense if stalks and leaves constituted greater than 50% of the areal coverage, and sparse if less than 50%. Bitterns observed in direct flight at or above 5 m above ground level were not recorded. From maps, we estimated the total distance we traveled during each trip on trails, open grassland, and canals, and traveled a total of 3,502 km during 82 boat-days. In some cases, survey routes were repeated regularly (particularly in the northeastern section of WCA3), or in other cases were followed only once. The approximate location of all survey routes is shown in Figure 1.

## RESULTS

We sighted a total of 607 individual bitterns (Table 1). Birds were rarely seen except when flushed, and nearly all birds flushed were within 2 m of the side of the boat.

Geographic and habitat preferences.—All classes of birds combined were sighted at a rate of 0.17 birds per km (Table 1). However, this rate varied dramatically with habitat. In canals, open grassland, and trails, we found 0.13, 0.04, and 0.37 birds/km, respectively. Frequency of sighting was not in proportion to the distance we traveled in any habitat (entire study area, $Chi^2$ goodness of fit = 525.16, $P << 0.001$). The highest densities within any subdivision of the study area were found on airboat trails.

The study area showed major geographic differences in densities, and can be conveniently divided into northeastern (shaded area, Fig. 1) and south-central sections. We found the highest density of bitterns in the northeastern part of the study area in all three major habitat categories. These differences were not in proportion to the distance traveled in each

of the two study area sections either when all habitat types were lumped ($Chi^2$ goodness of fit = 4,810, $P << 0.001$) or when grassland and trail sightings were examined individually ($Chi^2$ = 73.09, and 364.61, respectively, $P << 0.001$ for both). In the northeastern section, density along canals was lower than that for open grassland. The lowest densities were

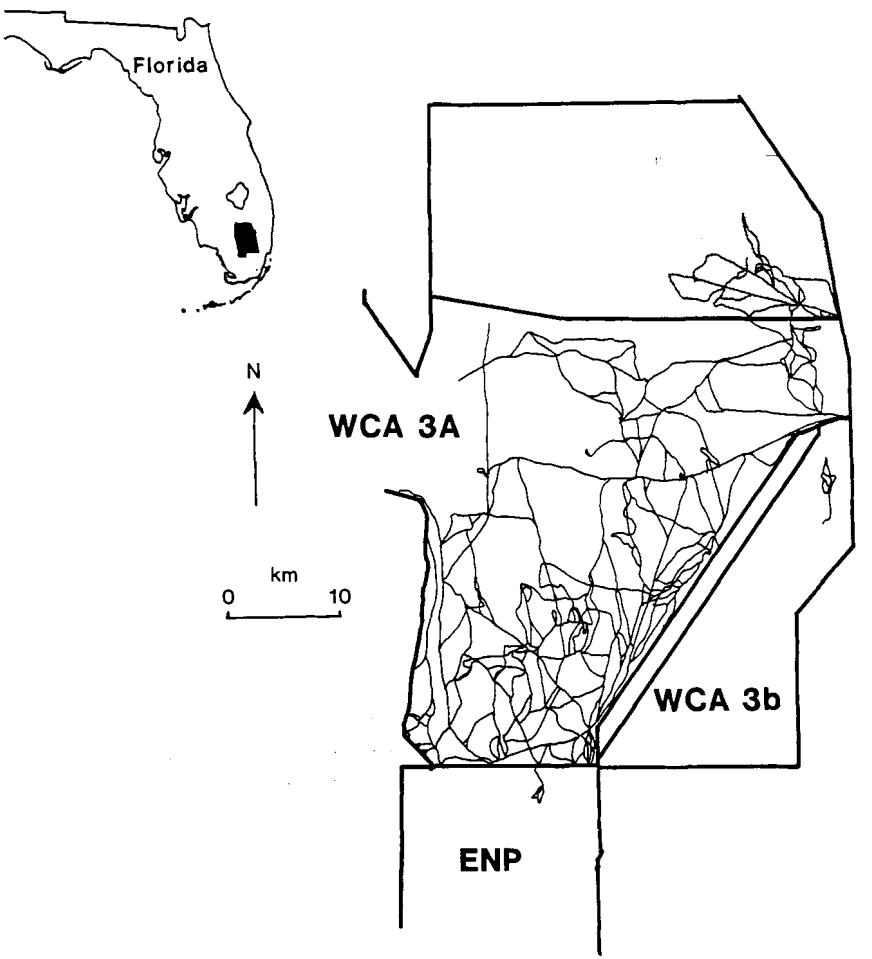


**Figure 1. Map of the study area and location within Florida, showing major canals surrounding Water Conservation Area 3A and 3B (WCA 3A, WCA 3B, respectively), and Everglades National Park (ENP). Heavy lines denote boundaries or canals; thin lines show airboat trails traveled more than once during the period of study. The northeastern part of the study area is shown shaded in gray.**

**Table 1. Summary of Least Bittern sightings in WCA 3 by geographic location, habitat type, age, and sex.**

| Study area | Males | Females | Im-matures | Un-identified | Total | Km traveled | Birds/km |
|---|---|---|---|---|---|---|---|
| Northeast | | | | | | | |
| canal | 0 | 2 | 7 | 3 | 12 | 103 | 0.11 |
| grassland | 11 | 5 | 8 | 9 | 33 | 155.4 | 0.21 |
| trails | 69 | 70 | 163 | 103 | 405 | 337.5 | 1.20 |
| other[1] | | | | 11 | 11 | | |
| total | 80 | 77 | 178 | 126 | 461 | 595.9 | 0.77 |
| Central and West | | | | | | | |
| canal | 7 | 5 | 6 | 5 | 23 | 26 | 0.08 |
| grassland | 11 | 8 | 10 | 6 | 35 | 1012 | 0.03 |
| trails | 9 | 5 | 19 | 30 | 63 | 450 | 0.13 |
| other | 6 | 3 | 4 | 12 | 25 | | |
| other | 33 | 21 | 39 | 53 | 146 | 1488 | 0.07 |
| South of Tamiami | | | | | | | |
| canal | | | | | | 0.4 | 0.00 |
| grassland | | | | | 1 | 33.1 | 0.03 |
| trails | 1 | | | | 1 | 35.1 | 0.03 |
| total | 1 | 1 | | | 1 | 69.0 | 0.03 |
| Total | | | | | | | |
| canal | 7 | 7 | 13 | 8 | 35 | 268.8 | 0.13 |
| grassland | 22 | 14 | 18 | 15 | 69 | 1959.3 | 0.04 |
| trails | 79 | 75 | 182 | 133 | 469 | 1273.3 | 0.37 |
| other | 6 | 3 | 4 | 21 | 34 | | |
| total | 114 | 99 | 217 | 177 | 607 | 3502 | 0.18 |

[1]Combined counts for burns, buttonbush heads, willow ponds, open sloughs, prairies.

found south of Tamiami Trail (US Route 41), though this latter estimate is from only 69 km of survey in a small area.

Vegetative associations.—Because we could not estimate distance traveled through vegetative subclasses within each habitat, we were unable to strictly compare numbers of birds seen relative to vegetation sampled. Our surveys did, however, frequently encompass all of the dominant vegetative types shown in Table 2, often on every trip. Our analysis of vegetation should therefore be treated as an index of occurrence rather than as a measure of vegetative preference. We most frequently observed bitterns in mixed cattail/sawgrass (29.0% of birds) though homogeneous sawgrass (22.6%) and homogeneous cattail (8.6%) also were used. Bitterns were found almost twice as often in dense as in sparse stands within all three classes of vegetation. Other vegetative classes were used relatively infrequently (combined total of 1.6%). Adult birds did not differ dramatically from the entire sample (adults, juveniles, and unidentified birds) in their patterns of vegetative association (Table 2).

Bitterns did not frequent open sloughs, rush (*Eleocharis* spp.) prairies, or mats of emergent vegetation; this was confirmed by the very low frequency of occurrence in *Eleocharis* sp., pickerel-weed (*Pontedaria cordata*), arrowhead (*Sagittaria* spp.), and maidencane (*Panicum hemitomon*). Though we regularly visited two major burn areas in the western part of the study area, and one in the northeast, we observed no dramatic increase of bitterns in burned areas, as was noted by Kushlan (1973).

Sex ratio.—Because the northeastern part of the study area was the only subdivision censused regularly prior to hatching of young, and was the most intensively and regularly censused, we chose to compare categories of age and sex only in that unit. During the entire census period, we encountered 80 males, 77 females, 178 immatures or fledglings, and 126 birds which could not be accurately identified to sex or age class (Table 1). The ratio of males to females was close to parity (1.04). Considering that we probably were more likely to identify males to sex than females (adult male plumage is easier to identify), we suspect that there existed no large departure from equal proportions among adults.

Breeding.—Large numbers of fledgling bitterns were first seen after the middle of June in the northeast (Fig. 2). Using the nesting phenology outlined by Weller (1961) and Bent (1926), this implies most nest initiations occurred following 18 May. Prior to the beginning of this fledgling period (roughly 15 June) we found adults occurring at a rate of 0.18/km (all habitats lumped), ranging from 0.27/km on airboat trails to 0.00/km on canals (Table 3). If all adults seen could be considered breeding (a generous assumption), this would result in a maximum estimate of 0.089 breeding pairs per km, peaking along airboat trails at 0.135/km. In general, we observed breeding to be less dense and to start earlier in the northern part of the study area than in the south and central parts.

Impact of airboat travel on Least Bitterns.—Of the 607 birds seen, 17 (2.8%) were struck by the airboat despite all attempts by the driver to avoid contact. Two of those struck died almost immediately, seven (41%) were alive and left the area flying (including two which had passed completely under the boat's hull), and four birds could not be located despite intensive search. Of the seven flying survivors, one flew with a dangling leg, suggesting a leg injury.

## DISCUSSION

Because we could not estimate the efficiency with which we flushed Least Bitterns, all frequency of occurrence estimates should be considered mimimums. We also were unable to estimate our efficiency at spot-

**Table 2. Sightings of Least Bitterns by vegetation type.**

| Vegetative classes[1] | All sightings | | Adults only | |
|---|---|---|---|---|
| | Birds seen | Percent of total | Birds seen | Percent of total |
| Sawgrass | | | | |
| dense, water lillies[2] | 13 | 2.1 | 4 | 1.57 |
| dense, emergent[3] | 49 | 7.7 | 13 | 6.3 |
| total dense | 90 | 14.1 | 33 | 16.0 |
| sparse, water lillies | 36 | 5.6 | 12 | 5.8 |
| sparse, emergent | 60 | 9.4 | 23 | 11.2 |
| sparse, buttonbush | 6 | 0.94 | 2 | 0.97 |
| total sparse | 54 | 8.46 | 24 | 11.7 |
| total sawgrass | 144 | 22.6 | 57 | 27.7 |
| Cattail | | | | |
| dense, water lillies | 2 | 0.31 | 0 | 0 |
| dense, emergent | 1 | 0.15 | 0 | 0 |
| total dense | 55 | 8.6 | 23 | 11.1 |
| sparse, water lillies | 4 | 0.62 | 2 | 0.97 |
| sparse, emergent | 6 | 0.90 | 2 | 1.0 |
| total sparse | 23 | 3.6 | 7 | 3.4 |
| total cattail | 78 | 12.2 | 30 | 14.6 |
| Mixed cattail/sawgrass | | | | |
| dense, water lillies | 6 | 0.94 | 3 | 1.5 |
| dense, emergent | 5 | 0.80 | 0 | 0 |
| total dense | 150 | 23.5 | 39 | 18.9 |
| sparse, water lillies | 3 | 0.47 | 1 | 0.49 |
| sparse, emergent | 21 | 3.3 | 6 | 2.9 |
| total sparse | 33 | 5.2 | 8 | 3.9 |
| total mixed cattail/ sawgrass | 183 | 28.7 | 47 | 22.8 |
| *Eleocharis* sp. mat | 2 | 0.31 | 0 | 0 |
| Buttonbush head | 3 | 0.47 | 1 | 0.49 |
| Willow head | 2 | 0.31 | 2 | 0.97 |
| Emergent, no grass | 3 | 0.47 | 1 | 0.49 |
| Total | 638 | 100.0 | 206 | 100.0 |

[1]Dominant vegetation, density, and associated species.
[2]Scientific names: sawgrass (*Cladium jamaciencis*), cattail (*Typha* spp.), water lillies (*Nyphaea odorata*), buttonbush (*Cephalanthus occidentalis*), willow (*Salix caroliniana*).
[3]Combined *Pontedaria cordata*, *Sagitaria* spp., and *Panicum hemitomon* associations.

ting birds which did attempt to flush; this could have an important effect depending on vegetation type. We suspect that the locations from which bitterns did flush were an accurate indicator of relative habitat usage, because bitterns usually freeze in place prior to flushing, and attempt

**Table 3. Estimated breeding of Least Bitterns in the northeastern section of Water Conservation Area 3A[1].**

| Habitat | Km traveled | Males | Females | Pairs/km |
|---|---|---|---|---|
| canal | 55.8 | 0 | 0 | 0 |
| grassland | 122.3 | 10 | 3 | 0.08 |
| trail | 239.9 | 31 | 34 | 0.13 |
| total | 418 | 41 | 37 | 0.10 |

[1]See shaded area in Fig. 1.

walking escape only when approached relatively slowly (Weller 1961). Because nearly all flushing occurred within 2 m of the side of the boat, we suspect bitterns either freeze beyond this distance, or (in the case of airboat trails) are unable to flush except into the open from edges because of dense vegetation. We usually did not travel within 2 m of the edges of canals, and may therefore have underestimated densities in canal edge habitat.

Bitterns were much more frequently encountered in the northeastern section of WCA 3 than in any other part. By comparison with the rest of the study area, the northeastern section can be characterized as having generally denser grasslands, a thicker underlying peat substrate, a slightly higher proportion of cattail, and a close proximity to canals bearing water with a high nutrient load. We could not determine which (if any) of these differences made the northeast more attractive to breeding

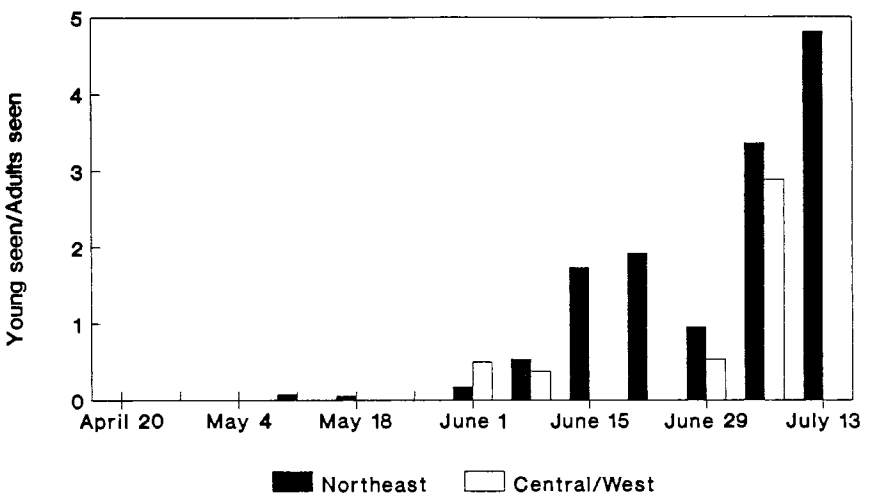


**Figure 2. Ratios of young Least Bitterns seen to adult bitterns seen in two parts of the study area as a function of time within the study period. Sightings of bitterns are grouped into 7-day periods beginning on April 20.**

bitterns. We believe that aspects of surface water dynamics (drying rate, gradient of depths, flow characteristics) in the northeast were well represented elsewhere in areas of WCA 3 censused regularly and were not responsible for the difference in bittern density. An accurate answer to this question will require a balanced manipulation of nutrients in similarly vegetated plots.

Bitterns showed an apparent preference for airboat trail edges. We hypothesize that bitterns may prefer trails because they offer both dense vegetation and a well-defined edge bordering on patches of open water. Both edges and dense vegetation have been reported as preferred nesting habitat in northern lakes (Weller 1961). Airboat trails also may be preferred because they contain relatively deep and more permanent water than the surrounding sloughs. However, even deeper and more permanent willow ponds (often surrounded in part by dense grasses) were rarely used by bitterns.

Sawgrass and mixed-sawgrass were the most important vegetative classes used by bitterns. Bitterns were flushed more frequently from dense stands than sparse and flushed rarely from stands of pure cattail. This suggests that cattail itself is not necessarily attractive to bitterns, and that sawgrass is an adequate substrate to support even relatively dense populations of Least Bitterns (Kushlan 1973). We hypothesize that bitterns show a strong association with cattail in northern lakes because cattail is one of the few tall plants growing densely in relatively deep water. In addition, it seemed clear that bitterns spent nearly all their daylight time in grass-like vegetation, rather than on open mats of emergent vegetation.

Airboat travel resulted in relatively little mortality of flushed birds (<3%). Our estimates should be taken as minimum possible mortality figures, because we were visually searching for bitterns, and making every attempt to avoid hitting them. This is probably not representative of recreational airboat traffic. We also have no estimate of damage done to nests or to birds which remained hidden. If, as adult densities suggest, nests are concentrated on edges of airboat trails, airboat damage to nests may be minimal. Airboats usually travel in the middle of trails where trails are available (particularly where vegetation is dense) because far less fuel is required.

ACKNOWLEDGMENTS

This research was supported by grants from the U.S. Army Corps of Engineers and the South Florida Water Management District. Michael W. Collopy was responsible for the initiation and organization of both grants. We thank the Florida Cooperative Research Unit at University of Florida for logistical aid. We also thank Herb W. Kale for reviewing an earlier draft of this manuscript. This is Journal series # R00439 of the Florida Experimental Station, Gainesville, Florida.

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