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Nests of American bitterns (*Botaurus lentiginosus*), marsh hawks (*Circus cyaneus*), and short-eared owls (*Asio flammeus*) are usually found in wetland habitats. Although large marshes containing dense stands of bulrushes (*Scirpus*), cattails (*Typha*), or other wetland vegetation are favored nesting cover, these birds have also been reported to nest in stands of tall, dense shrubs and grasses on the uplands (Bent 1961, 1963; Palmer 1962; Sealy 1967; Stewart 1975). During 1968–74, we regularly found upland nests of these three species while conducting duck nesting studies in planted fields of undisturbed grass-legume cover in the Dakotas (Duebbert and Lokemoen 1976). Our findings on nest densities, hatching success, site characteristics, clutch sizes, and other ecological factors are presented in this paper.

Arbib (1975) indicated that the three species discussed in the present paper, in all or a significant part of their range, currently exhibit potentially dangerous, apparently non-cyclical population declines. Our general observations in North Dakota over the past 20 years also suggest an alarming decrease in populations of these birds during the breeding season. We believe that these population declines may be correlated with the widespread destruction or degradation of essential nesting habitats as agriculture has become increasingly more intensive.

DESCRIPTION OF COVER

Nesting cover on the fields, as reported by Duebbert and Lokemoen (1976), was composed of introduced cool-season grasses and legumes, primarily smooth bromegrass (*Bromus inermis*), intermediate wheatgrass (*Agropyron intermedium*), tall wheatgrass (*A. elongatum*), alfalfa (*Medicago sativa*), and sweet clover (*Melilotus* spp.). Age of cover ranged from 2 to 8 years and the vegetation was in robust early successional stages. The cover was not hayed, grazed, burned, or tilled and its structure was tall and dense with an abundance of standing stems, intermixed with lodged and flattened residual vegetation (Figure 1). Field sizes ranged from about 15 to 65 ha. Data were collected on 10 USDA Cropland Adjustment Program (CAP) fields in Edmunds County, South Dakota, and on 7 fields of seeded cover on the Woodworth Study Area, North Dakota.

METHODS

We located nests by flushing laying or incubating birds with a 53 m cable-chain device towed between two jeeps (Higgins et al. 1969). One to three com-

Figure 1. Undisturbed grass-legume cover typical of that where upland nests of American bitterns, marsh hawks, and short-eared owls were found. (Note 30 inch reference board)

Figure 2. Upland nest of American bittern in intermediate wheatgrass-alfalfa cover.

plete searches were made of each cover plot during May, June, and July. Incubation stages for eggs were determined from techniques described by Weller (1956). Nest locations were marked with slender willows and plotted on field maps. Nest densities were calculated from the number of nests found in relation to the area searched. Hatching success was calculated by dividing the number of hatched nests by the number of nests with complete records.

RESULTS

American Bittern

Bitterns usually arrived in the vicinity of study areas during the last week of April or the first week of May. The interval between arrival and beginning of egg-laying was apparently about 30 days. Our observations on 72 nests at upland sites showed that egg-laying in 19 of 38 back-dated American bittern clutches began during the last week of May and the first week of June. The earliest egg dates for two nests were 22 May and 24 May and the latest was 3 July.

Bitterns showed a strong preference for tall, dense cover as nesting sites. Of 72 nests, 61 (85 percent) were in vegetation that was over 60 cm tall and 11 (15 percent) were in 30-60 cm inch cover. No nests were found in cover less than 30 cm tall, although such cover was available on the study areas. No nests were found in upland habitats that were annually grazed, hayed, burned, or tilled although several thousand acres of such cover were searched in North and South Dakota by biologists of the Northern Prairie Wildlife Research Center from 1968-74 (Duebbert and Kantrud 1974; Higgins 1977).

Bittern nests were generally very well concealed. Sixty-eight of 72 nests (95 percent) were classified as three-fourths or completely concealed from the side by adjacent cover. Sixty-five of 72 nests (90 percent) were classified as one-half or completely open on top. The dominant vegetation at 72 nest sites was: smooth bromegrass, 26 nests; alfalfa, 20 nests; intermediate or tall wheatgrass, 11 nests; other vegetation, 15 nests. On the Woodworth Study Area, 3 of 38 nests were in native vegetation. These included two upland nests: one in wolfberry (*Symphoricarpos occidentalis*) and one in big bluestem (*Andropogon gerardi*). One nest was in whitetop grass (*Scolochloa festucacea*) of a shallow marsh.

Hatching success was relatively high for upland nests of the American Bittern (Table 1). Of 61 nests with complete records in areas with uncontrolled predator populations, 32 (52 percent) hatched. Hatching success was higher for nests in the South Dakota CAP fields (61 percent) than for nests on the Woodworth Study Area (47 percent). On a 51-ha CAP field in South Dakota where predator control was practiced, all of six nests hatched.

Several nests were found in relatively high densities. On 30 June 1970, three nests were separated by 15 m in the 51-ha CAP field where predators were controlled. In June 1972, two successful bittern nests were separated by 25 m in a 13-ha CAP field in South Dakota. At Woodworth in 1972, five nests each were in a 10-ha field and an 11-ha field. Five additional nests were found on other smaller fields totalling 26 ha adjacent to the 10-ha and 11-ha fields. Thus, 15 American bittern nests were found on 47 ha of upland grass-legume cover located within a 0.8-km by 1.6-km block of land. Bent (1963) reported five nests in a Saskatchewan slough that was one-fourth mile (0.4 km) square. In Iowa, Provost

Table 1. Hatching success of American bittern, marsh hawk, and short-eared owl nests in fields of undisturbed grass-legume cover, 1968-74.

	American bittern	Marsh hawk	Short-eared owl
South Dakota CAP fields			
No. nests	25	21	7
No. nests complete records	23	15	6
No. hatched	14	10	6
Pct. hatched	61	67	100
Woodworth Study Area			
No. nests	38	2	6
No. nests complete records	38	2	5
No. hatched	18	0	5
Pct. hatched	47	0	100
Ulmer CAP field			
No. nests	9	4	3
No. nests complete records	6	3	3
No. hatched	6	3	3
Pct. hatched	100	100	100
Total			
No. nests	72	27	16
No. nests complete records	67	20	14
No. hatched	38	13	14
Pct. hatched	57	65	14

(1947) found three nests separated by 36 m in a 0.2-ha pond, and Middleton (1949) found two nests 18 m apart in Michigan.

In our study, two incubating birds showed extremely strong nest attachment and would not leave the nest when we approached within 1 m.

Marsh Hawk

The earliest marsh hawks usually arrived in the vicinity of the study areas during the first 2 weeks of March. Apparently there is a relatively long interval before egg-laying begins in this species. Based on records for 18 nests, initiation of egg-laying ranged from the first week of May (5 nests) to the fourth week of June (1 nest).

Marsh hawks preferred tall, dense cover as upland nesting sites. Fourteen of 27 nests (52 percent) were in cover over 60 cm tall, 11 (41 percent) were in 30-60 cm cover, and two nests were in 15-30 cm cover. Marsh hawk nests were similar to bittern nests in that they were usually well concealed from all sides and open above. Smooth bromegrass was the principal cover around 16 nests, intermediate wheatgrass surrounded eight nests, and alfalfa or sweet clover

surrounded three nests. In nest searches by NPWRC biologists on several thousand acres of annually grazed, hayed, burned, or tilled agricultural lands, two marsh hawk nests were found. One was in a 65-ha field of rye (*Secale cereale*) stubble near Roscoe, South Dakota, and the other nest was in a field of growing rye near Eureka, South Dakota.

Ten of 15 marsh hawk nests (67 percent) hatched in the South Dakota CAP fields (Table 1). All three nests hatched in 1972 on the 51-ha CAP field where predators were controlled. Two nests found at Woodworth were destroyed by predators.

Fields that ranged from 11 to 54 ha usually contained only one marsh hawk nest each year. Any field that contained a nest in one year was usually also occupied during successive years. Breckenridge (1935) noted that ground nesting hawks tend to nest at the same sites in successive years. An exception to the occurrence of one nest per field occurred only in 1972 on the field where mammalian predators were controlled during 1969-71. In that field in 1972, three marsh hawk nests were found in a triangular pattern with distances between nests of about 365 m. Young were fledged from all three nests and one pair apparently renested. A nest with three unincubated eggs found on 24 May was abandoned after disturbance. Another nest was found 75 m west of that nest on 22 June. It contained five eggs that were incubated about 20 days and subsequently five hawks were fledged from it. In Wisconsin, Errington (1930) found three pairs of marsh hawks nesting within 365 m.

Short-eared Owl

Although our total number of short-eared owl nests was small, the hatching success of this species was apparently quite high (Table 1). We found 16 nests and obtained complete nest records from 14 of these; all of 14 nests hatched. Cover at short-eared owl nests was in the 30-60 cm height range. Nests were well concealed from the sides; 12 of 16 were rated as three-fourths to totally concealed. Tops of nests were mostly open; 10 were rated as half concealed and 6 had no concealment.

One short-eared owl nest was found on annually tilled agricultural land. The nest was in the same rye stubble field near Roscoe, South Dakota, where the marsh hawk nest was found. It contained two recently hatched young when found on 30 May 1972.

A nest in the 51-ha CAP field was built in a previous year's duck nest. Urner (1923) reported a nest in a short-eared owl nest from the preceding year.

Clutch Sizes

Clutch sizes from nests of the three species we studied were similar to those reported in the literature (Table 2). Bent (1963) reported that the normal clutch size for American bitterns was three to seven eggs, usually four or five. For marsh hawks, Bent (1961) stated the most common clutch was five eggs, but four or six were frequently found. In 60 completed clutches in North Dakota, Hammond and Henry (1947) found an average of 5.05 eggs and Sealy (1967) reported a mean clutch size of 4.18 eggs for 21 upland nests near Battleford, Saskatchewan. Bent (1961) reported that clutches of short-eared owl eggs usually ranged from four to nine and the most common number was five, six, or seven.

Table 2. Clutch sizes for American bittern, marsh hawk, and short-eared owl nests in fields of undisturbed grass-legume cover, 1968-74.

Species	No. eggs								Avg.
	2	3	4	5	6	7	8	9	
American bittern (41 nests)	3	13	16	6	3	0	0	0	3.8
Marsh hawk (17 nests)	2	5	2	4	4	0	0	0	4.1
Short-eared owl (13 nests)	0	0	1	2	1	4	2	3	7.0

DISCUSSION

Breeding bird populations are closely associated with plant communities that provide habitats for successful reproduction (Lack 1933, Beecher 1942, Weller and Spatcher 1965). Previous studies have indicated that American bitterns, marsh hawks and short-eared owls traditionally nest in tall, coarse wet-meadow or marsh vegetation such as cordgrass (*Spartina* spp.), whitetop grass (*Scolochloa festucacea*), cattail (*Typha* spp.), bulrush (*Scirpus* spp.), or common reed (*Phragmites communis*). Dead vegetation remaining from previous growing seasons is apparently an important component of preferred natural nesting cover in these situations. Our study indicated that undisturbed grass-legume cover established on upland fields is also frequently selected by these species for nesting. The general physiognomy of the planted cover on cropland fields was similar to that of the above species of native vegetation. For example, intermediate wheatgrass and tall wheatgrass have a growth-form that is similar to cordgrass or whitetop grass. Even though natural wetland vegetation occurred in proximity to the fields of grass-legume cover at Woodworth, American bitterns, marsh hawks, and short-eared owls apparently preferred to nest at the upland sites. This was inferred from the fact that few nests were found in wetlands by census crews during waterfowl surveys during May-July.

Moderate to high densities of dabbling duck nests occurred in the same fields with the bitterns, marsh hawks, and short-eared owls, but female ducks or duck eggs were little affected (Duebbert and Lokemoen 1976). Another example of compatible coexistence was provided in 1972 on the 51-ha field where mammalian predators were controlled. During that year, the field contained 313 duck nests of which 281 (90 percent) hatched (H. F. Duebbert and J. T. Lokemoen, unpublished manuscript). Of the 32 nests (10 percent) which were destroyed by predators, only four losses were assigned to avian predation. During the time that ducks were nesting, there were nests of four American bitterns, three marsh hawks, and three short-eared owls in the field. Young were fledged from all 10 nests. Nesting bitterns, marsh hawks or short-eared owls also coexisted with nesting ducks in all 10 of the CAP fields studied in South Dakota (Duebbert and

Lokem[illegible] 1976) and in the fields at Woodworth. However, only minor predation by tho[illegible]pecies was noted on duck nests.

In [illegible]mmary, fields of undisturbed grass-legume vegetation established as nestin[illegible]over for ducks in the glaciated prairie region also provide essential nestin[illegible]abitat for American bitterns, marsh hawks and short-eared owls. These specie[illegible]pparently prefer to nest at upland sites in tall, dense vegetation that is not annua[illegible] mowed, grazed or burned. Nesting cover utilized by the birds was usuall[illegible]ver 45 cm tall and so dense that nests were concealed from our vision at a distan[illegible]of 1 m. Accumulation of residual vegetation for 2-5 years seemed to provi[illegible]n essential habitat component for construction and concealment of nests. In ad[illegible]on to the data reported in this paper, we have found nests of the three speci[illegible]n other fields of similar cover at widely scattered locations in the Dakotas. We c[illegible]clude that managed plots of grass-legume vegetation can provide essential nesti[illegible]cover for both non-game and game species where natural habitats have been [illegible]stroyed by intensified agricultural activities such as drainage, burning and tillag[illegible]f wetlands, overgrazing of grasslands, and conversion of native prairie to crop[illegible]d.

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