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COMPARISON OF HABITAT ATTRIBUTES AT SITES OF STABLE AND DECLINING LONG-BILLED CURLEW POPULATIONS

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ABSTRACT.—Long-billed curlew populations were studied in the upper Green River Basin of Wyoming. Sites were selected where curlew populations appear constant in numbers and declining in numbers. Results show that while few habitat differences were found between the two areas, disturbances such as grazing and dragging during nesting reduced productivity. Nest failures were also correlated with field fertilization and early season grazing. Within each area curlews nested successfully on field sites that were elevated and had adequate grass cover but not tall grass.

Before 1870 long-billed curlews (*Numenius americanus*) nested in relatively high numbers on prairielike habitats across North America (Audubon 1960, Palmer 1967, Johnsgard 1981). However, extensive hunting virtually exterminated the species from the eastern United States in the last third of the nineteenth century (Bent 1962). Their numbers continued to decline across the continent during the first 30 years of this century (Bent 1962). In addition to market hunting, many authors have cited plowing and heavy grazing of nesting habitat as causes for this decline (Oberholser 1918, Wolfe 1931, Sugden 1933, Yocum 1956, Johnsgard 1981).

During the 1930s, hunting pressure was reduced and efforts were made to reduce grassland grazing pressure on curlew populations (Yocum 1956). Long-billed curlews might have explored newly created "artificial" habitat (annual grasslands and irrigated lands) while native prairies were destroyed during that time period (Pampush 1980, Bicak et al. 1982).

Long-billed curlews have four essential nesting habitat requirements in the northwestern United States: (1) short grass (less than 30 cm tall), (2) bare ground components, (3) shade, and (4) abundant vertebrate prey (Pampush 1980). Bicak et al. (1982) and Allen (1980) presumed that a preference for large, open vistas and unobstructed forage dictated a need for short vegetation profile. An association with moist sites or water access has been documented (King 1978), but nests have also been found far from water and in generally arid sites (Bicak et al. 1982).

Our objective was to compare habitat characteristics and land-use activities between areas with stable and declining numbers of long-billed curlews to determine if habitat factors could be responsible for declines.

STUDY AREAS

Two study sites were selected in the upper Green River Basin of Wyoming. The Horse Creek site is eight miles west of Daniel near State Highway 354. This two-mile-long area is south of Myrna and Highway 354 and is bounded on the south and west by Horse Creek and Bridger National Forest. Sagebrush (*Artemisia tridentata*) and aspen (*Populus tremuloides*) cover the ridges and also encircle the flats except on the eastern outlet. This 3,000-ha area slopes from 2,315-m elevation in the west to 2,270 m in the east.

The second site, the New Fork study area, is located between Cora and Pinedale. The 2,000-ha New Fork site is bounded on three sides by sagebrush-covered hills. The elevation drops 8.7 m per km from 2,225 m in the north to 2,190 m in the south.

The climate of the upper Green River Basin is classified as continental steppe (Brown 1980). Annual precipitation ranges from 24 to 40 cm per year with 27–62% falling between April and September. Snow falls regularly from September to May, and heavy mountain accumulations provide summer irrigation water. Summers are short and cool, with the average growing season being 70 to 80 days (U.S. Department of Agriculture 1978).

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The vegetation in the upper Green River is principally sagebrush, with willow (*Salix* spp.) and sedge (*Carex* spp.) dominating sloughs in the weathered sites (Vale 1975). These sagebrush flats were converted to flood-irrigated hay meadows from the time of the first homesteads in 1892 to as late as 1960. After brush removal, some meadows were hand-seeded with timothy (*Phleum pratense*) and redtop (*Agrostis palustris*), while others were left in native graminoids. By the 1940s alsike clover (*Trifolium hybridium*) and reeds canary grass (*Phalarius arundinaceae*) had replaced redtop in mixed plantings with timothy.

Native plants have reinvaded many of the fields. The dominant invaders include wire grass (*Juncus balticus*) and some rush and mountain timothy (*Phleum alpinum*) (Hitchcock 1921). Many cultivated meadows are the result of conversion, beginning around 1960. These fields are thoroughly plowed, leveled, and then seeded with timothy, alsike clover, milkvetch (*Astragalus* spp.), meadow foxtail (*Alopecurus pratensis*), alfalfa (*Medicago sativa*), and other grasses. Cultivated meadows are fertilized annually with nitrogen or ammonium nitrate. In the 1970s some native meadows were also fertilized, but this activity has declined markedly since 1978 because of high costs. Approximately 90% of the total hectarage at Horse Creek and 83% at New Fork are hay meadows. The percentage of potential long-billed curlew nesting habitat is thus very similar at the two sites.

Sheep, cows, and hogs have been raised historically on both study sites, but current livestock are entirely beef cattle. From November to May cattle are confined to feed grounds near four ranches on Horse Creek Flat. After calving in April, herds are gradually shifted through a series of fields beginning in mid-May or June. Some fields in this flat are used solely for summer pasture. Many of the summer-pastured cattle come from other wintering grounds near the North Fork study site. The remaining cattle are moved to summer range off the flat. Hay is cut (once annually) from nonsummer-pastured fields starting at the end of July and continuing through August or September.

Meadow dragging is a land-use practice which affects ground-nesting birds. This is done in the spring to break up manure piles left by fall- and winter-pastured cattle. Drags can be anything from tree branches or scrap metal tied behind a large log to modern harrows. Dragging has declined since the mid-1960s because of fuel and labor costs and a decrease in haying.

Both sites are irrigated. At New Fork, water flow is regulated by a large upstream dam. Spring irrigation water is not released until 1–10 June, leaving fields dry in May. The water is shut off for 7–10 days before haying. Horse Creek has not been dammed. Fields are flooded as soon as the snow melts (usually mid-May), and water continues to saturate the meadows until mid-July in most years. Both areas are underlain by gravel beds up to 9 m deep. These beds fill with water so that the hay crops are irrigated constantly from below, in addition to surface flow.

METHODS

Preliminary observations were made in May–August 1981. During this time we became familiar with principal use areas and behavior patterns of curlews. Field sites were then selected. Field data were collected 5 May–20 August 1982.

POPULATION INDICES.—Long-billed curlews were counted 5 May–19 July 1981 and 1982 using roadside surveys on prescribed routes in each study area. A modified version of the Breeding Bird Survey (Robbins et al. 1986) was used to sample the greatest number of birds over a greater distance. Survey results were converted to number of birds seen per kilometer of road surveyed. Twenty-two surveys were completed at Horse Creek and 18 at New Fork in 1982. Curlew locations by sex were marked on a 1:24,000 topographic map. Long-billed curlews were sexed by bill length (Allen 1980).

HABITAT DATA.—Native and cultivated fields were sampled at both study areas. Timing and level of grazing pressure based on numbers of cattle were recorded so that comparisons could be made with curlew use. Each of the 65 hay fields was divided into four 200-m-wide strips, and parallel transects were run down the center of each strip. Preselected random points were located by pacing along transects with only one point per 80-m interval. Thus, one random point was selected from each 200 × 80-m block of the field.

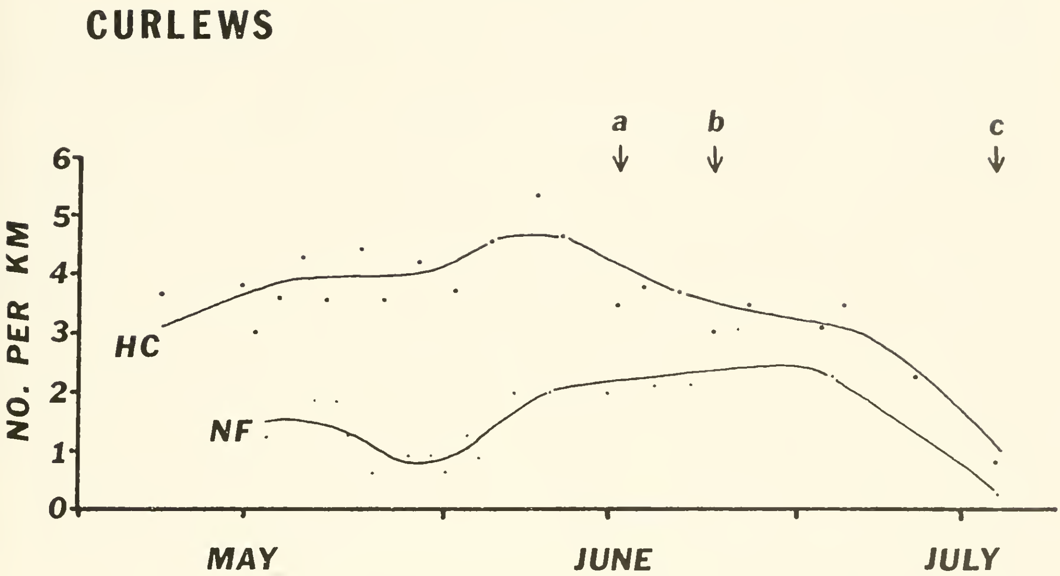

Fig. 1. Number of long-billed curlews seen per kilometer surveyed, 5 May–19 July 1982; a = date of first hatch at Horse Creek, b = hatch at New Fork, c = last hatch at Horse Creek.

Specific habitat variables were measured as follows: visual obstruction or "effective height" (Robel et al. 1970) of hay was estimated against a 5-cm-diameter Robel pole marked with alternating black and white 2.5-cm bands. Measurements were taken 1.5 m away from the pole and aligned with the east-west or north-south transect. The approximate eye level for curlews is 30 cm above the ground (Redmond et al. 1981). This was mimicked by kneeling until the observer's eyes were even with a 30-cm-tall stick. The lowest 2.5-cm band visible on the Robel pole from this vantage point was then recorded as the effective height.

From the same position, the within-meadow microtopography was estimated visually by comparing the height of the ground at a random point to the ground 5 m beyond (Skeel 1976). If the sample point was approximately 2.5 cm above the surrounding ground, or less, it was classed as level. Drops of 2.5 cm or more below the background usually represented the canal or swale. Small, medium, and large hummocks were defined as sample points 2–10, 11–20, and greater than 20 cm above the surrounding ground.

Vegetation and bare ground cover were placed in one of seven cover classes with the aid of a 20 × 50-cm Daubenmier frame (Daubenmier 1959). These classes of cover were grasses, sedges, rushes, forbs, mosses, bare ground, and litter. Soil moisture measurements were grouped into three categories for analysis: (1) wet, or standing water, (2) damp, and (3) dry. In May the distance to the nearest cow manure pile greater than 2.5 cm in diameter was measured with the Robel pole.

Field boundaries and size of vegetation communities were estimated from aerial photos. Land-use data were determined from aerial photos and verified in the field. Interviews with ranchers indicated dates of dragging, fertilizing, and flooding as well as cattle movement.

NESTING HABITAT.—Nest searches were concentrated in fields where male curlews had been observed displaying in 1983 (Allen 1980). Defensive and disturbed birds were also used as clues for finding nests. Once nests were located, habitat information was collected after chicks had hatched. The following data were collected: horizontal cover by grass or sedge, rushes, forbs, and bare ground around the nest; height of nest; distance from nest to nearest canal, road, building, willow bushes, and manure pile; hay field type; and material used in nest construction. Nesting habitat was then analyzed in four ways. First, a group of 18 nests was compared randomly to available habitat and hay meadows. Second, comparisons were made between individual nests and habitat data from the fields in which they were located. Third, comparisons were made between successful and failed nest sites. Comparisons were also made between nest fields and non-nest or avoided fields.

Starting in June, nests were monitored through hatching. Every three to seven days the incubating bird was flushed so that eggs could be checked for signs of hatching. Otherwise, nests were observed from a distance of 10 to 100 m to confirm the presence of an incubating curlew. Disturbance to nesting birds was minimized by walking directly to the nest from the same direction and staying within the nest field or site of the curlew as briefly as possible. A few paradichlorobenzene crystals were scattered after the observer's trail to discourage scent-tracking predators (Redmond 1986). Flushing distance, distraction-display response to other birds, and time of day were noted on each visit.

DATA ANALYSIS.—Data were analyzed with SPSS Batch System: Statistical Packages for the Social Sciences (Nie et al. 1975). The programs used were BREAKDOWN, FREQUENCY, T-TEST, ONE-WAY (analysis of variance or AOV; stepwise and multiple) REGRESSION. All analyses of variance were one-way, and all t-tests were unpaired or unpooled. Differences between means are considered significant if probabilities were less than .05.

RESULTS

POPULATION INDICES.—Roadside counts of curlews showed significantly more birds per kilometer of road at Horse Creek, where curlew numbers increased until 10 June and then declined to 18 July. New Fork counts showed more variation but were consistently lower than Horse Creek. The highest count of birds was 4.06/km at Horse Creek and 1.45/km at New Fork (Fig. 1).

HABITAT COMPARISONS.—No vegetation differences were apparent from May surveys between cultivated and native field types. Spring grazing had repressed vegetation height to a mean of 2.38 cm in June. Ungrazed native fields averaged 4.78–5.63 cm, and cultivated hays had grown from 7.88 to 9.88 cm. Further, spring-pastured meadows were significantly shorter than both hayed only and fall-pastured meadows (all probabilities are significant if less than .05).

When all land-use types were pooled, no significant differences in vegetation height were detected between New Fork and Horse Creek in either May or June. When various types were considered separately, minor differences arose. Native hayed, pastured fields were shorter at Horse Creek than at New Fork in May (1.25 vs. 1.48 cm). Again in June, a difference between native fields at the two study sites was found. Only cultivated hay samples were consistently taller in June at Horse Creek than New Fork. Thus, vegetation height or visual obstruction differed between land-use types in the growing season (June).

Coverage by grasses, sedges, rushes, and bare ground differed between cultivated and native fields but not between study sites. Overall, ground cover in native fields averaged 24.4% grasses, 23.6% sedges, 22.7% bare ground, 9.9% rushes, 7.8% forbs, and 0.8% mosses (10.9% was unaccounted for because cover classes included a 0% but not 100%). In cultivated fields, ground coverage averaged 68.7% grasses, 10.1% forbs, 9.3% bare ground, 1.9% sedges, 0.8% rushes, and 0.4% mosses. Thus, native fields were covered by approximately equal quarters of grasses, sedges, bare ground, and all other plants, while cultivated fields were at least three-quarters grasses and about one-tenth each forbs and bare ground. Despite the planting of clover in cultivated fields, these meadows did not average significantly more forb coverage than did native fields. Coverage by grasses was significantly greater in cultivated hay fields but did not differ between study sites.

The average ground height was not significantly different in cultivated, native Horse Creek or New Fork fields. However, average height may not convey the relative "bumpiness" of fields. In casual observation, some native fields contained numerous hummocks, but all cultivated fields had been leveled.

All meadows were significantly wetter in June than May due to irrigation, but Horse Creek had even more wet ground than New

Fork when both were irrigated. Horse Creek was also significantly wetter than New Fork in May when these sites were compared. Pooled samples (May plus June) showed that Horse Creek meadows were wetter than New Fork meadows.

NESTING SUCCESS.—At Horse Creek, curlews hatched from 15 June to 12 July 1982. The one hatch seen at New Fork occurred on 24 June. The second New Fork clutch had hatched by 20 June when we visited the nest, and the third brood seen there was probably one to two weeks old on 24 June. Thus, mean hatch date on Horse Creek was 1 July, and New Fork mean hatch was 24 June.

We observed 21 long-billed curlew nests in 1982. Of the 21 nests, 3 were in cultivated hay, 1 in an unmowed slough, and 1 in an overgrazed, dry pasture. The remaining 16 curlew pairs nested in subirrigated, native hay meadows that were mowed annually. Three of these were in fields that were never pastured.

Using the Mayfield (1961, 1975) method, which compensates for unknown nest-initiation dates of failed nests, we calculated an overall nest-survival rate of 33.6%. Forty-four percent of the young survived from all Horse Creek nests, while 28.3% of non–Horse Creek nests lived. Clutch size was 3.83 with an incubation period of 28 days. Redmond and Jenni (1986) found similar results in Idaho with most females laying four eggs and incubating 28 days.

NESTING HABITAT.—Grass cover immediately around 18 nests was almost double the grass in fields generally. Nests were built in sites with less bare ground than the fields overall. Where the ground had not been leveled (native fields), nests were found on sites significantly higher than mean level ground. Average height at nest sites was 6.1 cm above the ground in a radius of 1–5 m around the nest. These heights were classed as either small hummocks or level ground. Six of the 15 nests were on hummocks (at least 2.5 cm above surrounding ground). Two of these were higher than 20 cm, while only 2 out of 320 randomly sample points were that high. Chicks hatched successfully from 5 of the 6 hummock nests (the sixth was destroyed by dragging), but 6 of the 9 level nests failed. No nests were on depressed ground (less than 2.5 cm below the surrounding ground).

Nests were found in fields that had significantly less bare ground than did the randomly sampled fields. Nests built where cattle had pastured were directly against a manure pile. Clearly, these nests were closer to conspicuous objects than could be expected from random placement.

When hatching success for 21 nests was regressed on conditions surrounding the nests, two land uses were found that predicted nest failure: grazing during incubation, and field fertilization. Nest field dragging, nest flooding, and nest height did not correlate with nest failure.

The last measure of nest habitat selection was the comparison of fields used for nesting and those not used. Three habitat traits were significantly different between these fields: percent cover by grasses, percent cover by forbs, and soil moisture. Nest fields had less grass cover (19.9%) than avoided fields (31.9%). But forbs were greater in nest fields (15.5%) than in the others (3.5%). Rush and sedge cover were not different between field types (10–24% rushes).

Nesting curlews avoided nesting in fields where only 3% of the ground surface was dry but nested in fields that were 45% dry. No difference was observed in mean visual obstruction height of vegetation in these fields. These results provided some insight into reasons for differences in curlew populations at the two study sites. Short vegetation was not common at New Fork. Human activities associated with ranging (fertilizing and dragging) were more common at New Fork than at Horse Creek.

DISCUSSION

Vertical vegetation cover is a measure of visual and foraging obstruction to ground birds such as long-billed curlews. These birds utilize areas with low vegetation profile (Bent 1962, Bicak et al. 1982, Redmond 1986). The decline of long-billed curlews parallels an increase in meadow conversion to taller cultivated fields. Curlews, however, do use cultivated fields, particularly if grazing pressure keeps vegetation low. At the Horse Creek study site, conversion to cultivated hay matched in timing and extent an increase in summer pasturing, which provides extremely short vegetation profiles.

Nest sites were analyzed to determine if curlew land-use practices, which were not apparent from the general description of hay meadows, impacted birds. Four land uses reduced the availability of preferred nest sites: seeding in cultivated fields, land leveling in cultivated fields, irrigation, and dragging. Of these, only irrigation and dragging were different between the two sites. Based on the mean placement of nests in 61% grass and 7% bare ground, cultivated hays would seem to provide good cover for curlew nests. Yet, curlews selected microsites of high-grass density rather than whole fields dense in grass. Evidence for this was threefold: (1) 50% of nests were in higher grass cover than occurred overall in their respective nest fields; (2) nest fields had lower grass cover than avoided fields (at New Fork); and (3) curlews avoided nesting in cultivated fields. Thus, while cultivated hays seemed to have increased the availability of preferred ground cover, adequate grass cover was provided by native fields.

Nesting on hummocks could have provided two advantages: better visibility (of predators), and dry nests. Nest flooding must be detrimental because curlews nested in both drier-than-average microsites and drier-than-average fields. Jenni et al. (1982) also found that curlews nested on the most xeric slopes in their study area.

Some observers have claimed that cattle-grazing is beneficial to long-billed curlews because it maintains low vegetation profiles (Sugden 1933, Timken 1969, Pampush 1980, Bicak et al. 1982). Year-long grazing was not helpful to curlews in Idaho (Redmond and Jenni 1982). In Nebraska, curlews were shown to use summer-grazed fields and avoid winter-grazed pastures (Bicak 1977).

Haying is also a mechanism used to obtain shorter vegetation; however, timing is an important factor. When cultivated fields are fertilized and hayed later in the season, harm to nests may not occur, but the birds probably avoid the fields because of taller grass during the time of nest construction (Bicak 1977).

Many authors have mentioned that curlews use agricultural lands, but only Bicak (1977) studied them on hay meadows. Uncultivated rangelands and pastures support most of the continental long-billed curlew breeding population (Johnsgard 1981, Pampush 1980). Curlews rarely nest in alfalfa, crested wheatgrass (*Agropyron cristatum*), or fallow fields (Renaud 1980, Pampush 1980, Jenni et al. 1982). Intensive cultivation and mechanical irrigation are detrimental to curlews or even preclude curlew use (Wolfe 1931, Yocum 1956, Bent 1962, Renaud 1980, Pampush 1980, Jenni et al. 1982).

Prior studies have rarely investigated water in relation to curlews. McCallum et al. (1977) reported that 41% of curlews observed on Colorado prairies were within 100 m of water. They suggested that curlews select nest sites near water, even though these sites are dry in some years (curlews are very nest-site tenacious; Redmond and Jenni 1982). Limited water sources could then explain the patchy distribution of curlews where short-grass habitat is not limiting (McCallum et al. 1977).

Wet meadows were the limiting habitat for curlews in Nebraska's Sandhills (Bicak 1977). These subirrigated meadows supply the abundant invertebrate prey required by curlew broods. As a result, wet-meadow, brood-rearing territories are more intensively defended than hillside nest territories. Other authors have suggested that moisture is required by curlews or that they readily exploit abundant foods on irrigated lands (Bent 1962, Sugden 1933, Forsythe 1970, Renaud 1980, Pampush 1980, Bicak et al. 1982).

The dominant characteristics of the irrigated lands we studied, aside from graminoid vegetation, were ubiquitous water and large insect populations (predominantly mosquitoes). These insects began emerging on 13 June 1982 at Horse Creek and were extremely numerous by 17 June.

The irrigated hay meadows used by curlews in this study correspond to Pampush's (1980) mixed-grass meadow habitat type. He found curlews on this habitat in the Upper Snake River Basin and other parts of eastern Idaho, as well as Malheur National Wildlife Refuge in Oregon. Cameron (1907) described similar curlew habitat in south central Montana where "tributary creeks . . . rise into pine hills which enclose wide parks." McCallum et al. (1977) documented curlew nesting in the "large, high altitude (over 7,500 ft [2,280 m]) unforested valley" of North Park, Colorado. Subirrigated meadows in North Park are similar to the Upper Green River Basin. Bicak (1977) and Forsythe (1972) also documented curlew use of wet pastures and hay meadows in Nebraska and Utah.

Dragging hay meadows to break up cow manure appeared to be detrimental, as this process in Wyoming occurred at about the time of nesting. Dragging has declined drastically since 1960 at Horse Creek. Prior to 1960, 75 to 85% of all meadows were dragged. Then, as ranch sizes increased (by conglomeration) and hired help decreased, Horse Creek ranchers stopped dragging their fields. Dragging declined to 44% in the 1960s and to only 8% (or four fields) by 1975. Fuel prices, shifts to cultivated hay (not grazed enough to warrant dragging), and summer pasturing have virtually eliminated this 80-year-old practice from Horse Creek. Dragging is essentially unchanged at New Fork (still 85%).

Since few fields are dragged at Horse Creek, manure piles are abundant. Curlews place their nests near manure piles, if they are available; and successful nests are slightly closer than failed nests to manure (though not significantly closer). This tendency to nest near manure has been documented (Silloway 1900, Bent 1962, Wolfe 1931, Sugden 1933, Allen 1980). Nesting near or on conspicuous objects like manure piles camouflages the curlews from aerial predators.

In summary, cultivated fields provided the preferred grass and bare ground but not hummock nest sites. (High vertical cover and fertilization could also limit cultivated-hay nesting, even though grazing and dragging disturbances were absent.) Conscribed irrigation at New Fork provided a greater area of dry soil for nests. Conversely, Horse Creek had more fields with conspicuous manure piles for nest sites and fewer dragging disturbances. As a result of availability of habitat—mixed fields with adequate, but not tall, grass cover and fields with elevated points—curlews seemed to be more successful in nesting and could thereby maintain their populations. Disturbances such as dragging during nesting could destroy nests. Grazing during incubation and field fertilization were correlated with nest failures and a declining population of curlews.

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