*The Condor* 90:782–790


# SEASONAL OCCURRENCE OF MIGRANT WHIMBRELS AND BRISTLE-THIGHED CURLEWS ON THE YUKON-KUSKOKWIM DELTA, ALASKA[1]

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*Abstract.* Migrant Whimbrels (*Numenius phaeopus*) and Bristle-thighed Curlews (*N. tahitiensis*) were recorded during five summers along coastal tundra of the Yukon-Kuskokwim Delta, Alaska. From June to September, 1975–1979, 358 flocks totalling 1,265 curlews were observed; an additional 54 flocks were identified by vocalization alone. Among the 359 flocks identified to species, 52% were of Whimbrels, 47% were of Bristle-thighed Curlews, and 1% were of both species. Flocks as large as 48 Whimbrels and 33 Bristle-thighed Curlews were recorded, but 87% of the flocks contained five or fewer birds.

During 2 years with early springs a few Whimbrels and Bristle-thighed Curlews were recorded on the delta in early June; these may have been late spring migrants, oversummering nonbreeders, or very early failed breeders. Whimbrel numbers peaked twice each summer, first in middle to late July and again in late August. These peaks probably consisted mainly of late failed breeders and of successful breeders with juveniles, respectively. The patterns of occurrence of Bristle-thighed Curlews were more complex, with up to three peaks in abundance each season, probably consisting of the following populational subclasses: (1) early failed breeders from late June to mid-July, (2) late failed breeders in late July, and (3) successful breeders and juveniles in early August. Most Bristle-thighed Curlews were gone by mid-August and Whimbrels, by early September. For both species the earliest juveniles were seen in late July in flocks with adults.

The Yukon-Kuskokwim Delta is conservatively estimated to support several thousands of both Whimbrels and Bristle-thighed Curlews. This area is considered to be particularly important for Bristle-thighed Curlews because it is the primary of only two known areas used during migration between their nesting grounds in Alaska and the first known stop on their wintering grounds in the Hawaiian Island chain, a transoceanic distance of 3,800 km. Whimbrels are more ubiquitous in their distribution and use of habitats, and their migration strategy may provide more flexibility in choice of timing and routes.

*Key words: Whimbrel; Bristle-thighed Curlew;* Numenius phaeopus; Numenius tahitiensis; *migration; Yukon-Kuskokwim Delta; Alaska.*

## INTRODUCTION

Whimbrels (*Numenius phaeopus*) and Bristle-thighed Curlews (*N. tahitiensis*) both become common in summer and fall along the coastal fringe of the Yukon-Kuskokwim Delta in Alaska (Conover 1926, Brandt 1943, Gabrielson and Lincoln 1959, Gill and Handel 1981). The timing and patterns of use of this area during migration by different components of the populations of these two species, however, are poorly understood.

Whimbrels are thought to breed sporadically along the coast of Alaska from the Kuskokwim River north and east to the Canadian border (Gabrielson and Lincoln 1959). Although nesting has never been documented along the coast of the central Yukon-Kuskokwim Delta, some Whimbrels have been recorded nesting inland near the Johnson River (Walkinshaw 1948), inland around Bethel, and in the Nulato Hills just north of the Yukon River (B. J. McCaffery, pers. comm.); other apparently breeding birds have been encountered elsewhere in the interior of the delta (Williamson 1957; C. P. Dau, pers. observ.). Some breeding also occurs in southcentral Alaska (AOU 1983).

[1] Received 4 January 1988. Final acceptance 20 July 1988.

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Breeding areas of the Bristle-thighed Curlew are even more poorly defined, but the species is known to concentrate in low, mountainous regions just north and east of the lower Yukon River (Allen 1948, Kyllingstad 1948, Allen and Kyllingstad 1949, McCaffery and Peltola 1986), and it nests uncommonly in upland areas of the northern Seward Peninsula (Kessel, in press).

In late summer and fall Whimbrels become common on coastal tundra habitats and intertidal mudflats along the Bering Sea coast from Kotzebue Sound south to Bristol Bay and the Alaska Peninsula (Connors and Risebrough 1978; Gill and Jorgensen 1979; Shields and Peyton 1979; Gill and Handel 1981; Gill et al. 1981; Kessel, in press; C. Huffman, pers. comm.). Bristle-thighed Curlews have been observed commonly in late summer and fall only in coastal vegetated habitats of the Yukon-Kuskokwim Delta (Gill and Handel 1981), although they do occur uncommonly in coastal lowlands of the Seward Peninsula (Kessel, in press).

During the course of other studies on the central Yukon-Kuskokwim Delta, we recorded all observations of Whimbrels and Bristle-thighed Curlews in order to document their timing and patterns of use. Although the area was not surveyed systematically, our methods were consistent from year to year and allow a general comparison of the two species. These data provide the first quantitative assessment of seasonal and annual variation in timing and magnitude of use of this area by migrant curlews.

## STUDY AREA

The study area was located along the Kashunuk River on the central Yukon-Kuskokwim Delta on the southwest coast of Alaska. Most observations occurred near field camps at Onumtuk and Old Chevak, about 16 and 24 km, respectively, from the coast (Fig. 1). The study area consisted of a mosaic of wet, graminoid meadows interdigitated with areas of drier upland tundra. Upland habitat was dominated by dwarf shrubs (*Salix fuscescens* and *Betula nana*) and several berry-producing species, including crowberry (*Empetrum nigrum*), mountain cranberry (*Vaccinium vitis-idaea*), and cloudberry (*Rubus chamaemorus*). More detailed descriptions of the vegetation and physiognomy of the area can be found in Mickelson (1975) and Ely and Raveling (1984).

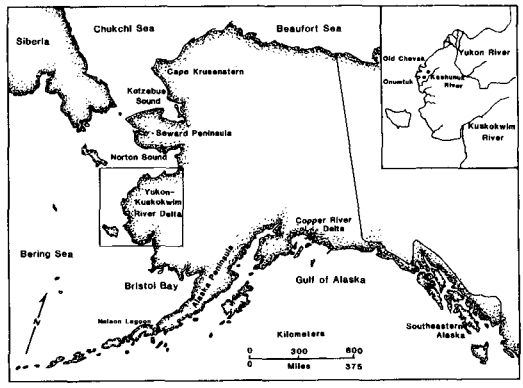


FIGURE 1. Location of study area and other sites in Alaska mentioned in the text. Studies on the Yukon-Kuskokwim River Delta were concentrated in habitats along the Kashunuk River between field camps at Old Chevak and Onumtuk.

## METHODS

### DATA COLLECTION

To determine if spring phenology was related to the timing of occurrence of curlews each year, the following spring weather conditions on the study area were monitored: (1) daily maximum and minimum temperatures, (2) dates when meadows at the Onumtuk field camp became snow-free, and (3) dates when the ice in the Kashunuk River broke up.

From one to three observers were present during the following time periods: 13 June–9 September 1975; 2 May–6 September 1976; 7 May–16 September 1977; 3 May–13 September 1978; and 27 April–17 September 1979. Observers recorded all Whimbrels and Bristle-thighed Curlews encountered during the course of other studies, generally between 06:00 and 22:00 daily. The actual duration of observation periods each day, influenced by weather and work schedules, was not recorded; a conservative estimate of 5 hr per day for each observer was used to evaluate the relative abundance of the two species each year during the period of their occurrence (3 June–10 September).

Whenever a flock of curlews was encountered, the following information was recorded: species, date, method of identification (sighting or vocalization), number of birds in flock, behavior (flying vs. feeding or roosting), and flight direction (north, south, east, or west). Occurrence of juvenile birds was sometimes but not consistently recorded. The two species were easily iden-

TABLE 1. Number of flocks of Whimbrels and Bristle-thighed Curlews observed on the Yukon-Kuskokwim Delta study area from 1975 to 1979.

| Year | Hours observation | Whimbrels | | | Bristle-thighed Curlews | | | All curlews[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Flocks | Birds | Flocks per hr | Flocks | Birds | Flocks per hr | Flocks | Birds | Flocks per hr |
| 1975 | 800 | 39 (2)[b] | 166 | 0.049 | 29 (4)[b] | 112 | 0.036 | 71[c] (6)[b] | 316 | 0.089 |
| 1976 | 1,230 | 35 (1) | 73 | 0.029 | 70 (1) | 202 | 0.057 | 124[c] (2) | 404 | 0.101 |
| 1977 | 1,310 | 43 (14) | 174 | 0.036 | 25 (10) | 28 | 0.019 | 78 (24) | 239 | 0.060 |
| 1978 | 975 | 41 (7) | 56 | 0.042 | 30 (8) | 50 | 0.031 | 83 (16) | 140 | 0.085 |
| 1979 | 1,015 | 33 (4) | 87 | 0.033 | 19 (2) | 70 | 0.019 | 56[c] (6) | 166 | 0.055 |
| | 5,330 | 191 (28) | 556 | 0.036 | 173 (25) | 462 | 0.033 | 412[c] (54) | 1,265 | 0.077 |

[a] Includes curlews unidentified to species.
[b] Number in parentheses is the number of these flocks that were identified by voice alone and for which flock size was not determined.
[c] Includes flocks that contained both Whimbrels and Bristle-thighed Curlews (1975: three flocks; 1976: one flock; 1979: one flock).

tified by vocalization or plumage characteristics. The call of the Bristle-thighed Curlew is readily distinguishable from that normally given by the Whimbrel (cf. Skeel 1978, Hayman et al. 1986), although recent observations suggest that Whimbrels nesting near Bristle-thighed Curlews may rarely give similar calls on the breeding grounds (B. J. McCaffery, pers. comm.). No Whimbrels were ever observed giving a Bristle-thighed Curlew call during this study of migrant birds, so identifications of flocks by vocalization alone were probably correct. Most identifications were made visually, and the rusty, unbarred rump of the Bristle-thighed Curlew provided a distinctive field mark (Prater et al. 1977, Hayman et al. 1986).

### STATISTICAL ANALYSIS

Data were analyzed primarily using statistical procedures available with SPSS$^x$ software (SPSS 1983). We used Chi-square analysis to: (1) test for interspecific differences in relative annual abundance by comparing the numbers of flocks of each species sighted each of the 5 years; (2) examine interannual variation in abundance for each species by comparing the number of flocks seen each year with the number expected to be seen, based on the estimated number of hours of observation each year; and (3) test for interspecific differences and seasonal changes in behavior (flying vs. feeding or roosting) and in flight direction (south vs. all other directions) within 15-day intervals. Flock sizes were also examined over 15-day intervals using analysis of variance.

Because of the uncontrolled seasonal and annual variation in observer effort, comparisons between the two species of curlews are the strongest aspects of the data and are thus emphasized here. During the 2 years in which observers left the study area in early September, the latest migration dates for Whimbrels may not have been recorded. The reader should also note that observers' efforts were concentrated along navigable waterways and on specific study plots for nesting geese and cranes. These limitations, however, should not influence significantly the general conclusions about seasonal and annual variation in the timing and relative abundance of curlews on the central Yukon-Kuskokwim Delta.

## RESULTS

### RELATIVE ABUNDANCE

From 1975 to 1979, 412 flocks of curlews were recorded on the lower Kashunuk River study area during an estimated 5,330 hr of observation (Table 1). Among the 359 flocks identified to species, 52% were composed of Whimbrels, 47% were of Bristle-thighed Curlews, and only five flocks, or about 1%, contained both species. Most (87%) of the flocks were identified visually, but 54 flocks were identified by vocalization alone (Table 1). The 358 flocks that were seen contained a total of 556 Whimbrels, 462 Bristle-thighed Curlews, and 247 unidentified curlews (Table 1). Thus, the ratio of Whimbrels to Bristle-thighed Curlews in all flocks pooled was 55:45, similar to the relative abundance of the flocks themselves (52:48).

Although over the entire 5-year study period Whimbrels only slightly outnumbered Bristle-thighed Curlews, the abundance of the two species in relation to each other varied significantly over the 5-year period ($P < 0.001$, $\chi^2 = 22.54$, df = 4). The main difference was in 1976, when twice as many flocks of Bristle-thighed Curlews as flocks of Whimbrels were recorded (Table 1). In all other years Whimbrels were more common, ranging from 34–77% higher in abundance.

TABLE 2. Earliest dates of observation of Whimbrels and Bristle-thighed Curlews in relation to spring phenology on the central Yukon-Kuskokwim Delta from 1975 to 1979.

| Year | Earliest observation dates | | Phenology | $\bar{x}$ temperatures in May (°C) | | | River ice breakup | Tundra snow-free |
|---|---|---|---|---|---|---|---|---|
| | Whimbrels | Bristle-thighed Curlews | | $n$ | Daily maximum | Daily minimum | | |
| 1975 | 4 July | 27 June | Late | 28 | 5.6 | −3.1 | 8 June | 3 June[a] |
| 1976 | 4 July | 3 July | Typical | 27 | 1.4 | −3.4 | 10 June | 24 May |
| 1977 | 6 July | 4 July | Late | 25 | 1.7 | −3.3 | 6 June | 1 June |
| 1978 | 13 June | 8 June | Early | 22 | 8.8 | 0.2 | 17 May | 13 May |
| 1979 | 5 June | 3 June | Early | 15 | 9.4 | −0.3 | 14 May | 11 May |

[a] M. R. Petersen, pers. comm.

A general picture of interannual differences in abundance for each species can be made by comparing the average number of flocks recorded per hour of observation. These comparisons must be viewed with caution since the observer effort was estimated each year. Although there was no significant interannual variation in abundance of flocks for Whimbrels ($P = 0.12$, $\chi^2 = 7.29$, df = 4), abundance varied markedly for Bristle-thighed Curlews ($P < 0.001$, $\chi^2 = 36.22$, df = 4). The number of Whimbrels recorded ranged from 0.029–0.049 flocks/hr during the five summers (Table 1). For Bristle-thighed Curlews, a pronounced discrepancy in abundance occurred in 1976, when 0.057 flocks/hour were recorded, a rate of occurrence about two to three times that of any other year of the study (Table 1).

## SEASONAL OCCURRENCE

For both Whimbrels and Bristle-thighed Curlews, the dates on which the first birds were recorded on the Yukon-Kuskokwim Delta each year were related to local spring phenology. The timing of snowmelt and river breakup during the 5 years of study (Table 2) established some of the earliest and latest records for the area (cf. Mickelson 1975, Raveling 1978, Ely and Raveling 1984). Only during 1978 and 1979, the 2 years with very early spring breakup, were Whimbrels and Bristle-thighed Curlews recorded on the delta during early June, occurring about 3 weeks earlier than the first birds recorded in years with typical or late spring phenology (Table 2).

Every year Whimbrels occurred in a bimodal pattern with the first peak occurring in middle to late July and a second peak occurring usually in late August (Fig. 2). Seasonal occurrence of Bristle-thighed Curlews was highly variable among years, with as many as three peaks occurring in any summer (Fig. 2). The earliest juveniles were recorded on 26 July for both species. Since age was not recorded consistently, the timing of occurrence of juveniles could not be distinguished from that of adults, but young birds were observed with adults in flocks of up to five birds for Whimbrels and up to 28 birds for Bristle-thighed Curlews. Dates of last departure ranged from 27 August to 10 September for Whimbrels and from 8 to 31 August for Bristle-thighed Curlews during the 5 years. There was no consistent relationship between spring phenology on the delta and median date of sighting or date of latest departure for either species.

## FLOCKING PATTERNS

Both Whimbrels and Bristle-thighed Curlews occurred predominantly in small, monospecific flocks. The two species occurred together in only five (1.4%) of 359 flocks. The average size of Whimbrel flocks was 3.4 birds (SE = 0.46, $n$ = 163, range = 1–48); for Bristle-thighed Curlews average flock size was 3.1 birds (SE = 0.39, $n$ = 148, range = 1–33). For both species, however, over half of the sightings were of single birds, and 87% of the sightings were of five or fewer birds per flock. Whimbrel flocks increased significantly in size during late August ($P < 0.05$) whereas Bristle-thighed Curlew flocks showed no significant seasonal variation in average flock size (Fig. 3).

Overall, 86% of the Whimbrel flocks and 90% of the Bristle-thighed Curlew flocks that were recorded were flying; the difference between species was not statistically significant ($P = 0.36$, $\chi^2 = 0.85$, df = 1). Because flying birds were easier to detect than those on the ground, these percentages do not reflect the actual proportion of birds flying vs. those stopping to feed or roost; however, there was no consistent pattern for either species that suggested that the proportion of birds stopping to use the area varied seasonally. Almost all flocks of Whimbrels (87%) and Bristle-

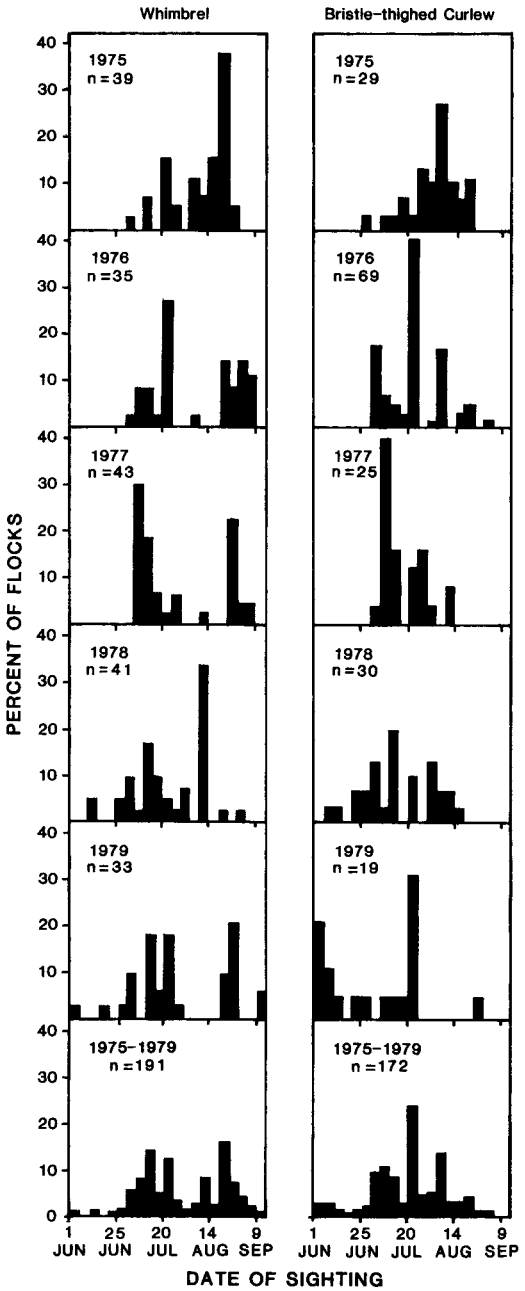


FIGURE 2. Seasonal distribution of sightings of flocks of Whimbrels and Bristle-thighed Curlews on the Yukon-Kuskokwim Delta from 1975 to 1979. Note that observers left the study area on the following dates: 9 September 1975, 6 September 1976, 16 September 1977, 13 September 1978, and 17 September 1979.

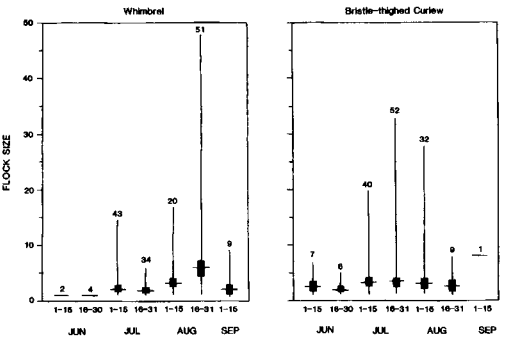


FIGURE 3. Seasonal changes in flock size of migrant Whimbrels and Bristle-thighed Curlews on the Yukon-Kuskokwim Delta from 1975 to 1979. Horizontal lines represent mean values; solid rectangles, ±1 SE; vertical lines, the ranges; and numbers above each line, the sample sizes.

thighed Curlews (84%) that were recorded flying were headed in a southerly direction, and there were no consistent seasonal changes in flight direction.

## DISCUSSION

### PATTERNS OF SEASONAL OCCURRENCE

Differences in the use of coastal habitats of the Yukon-Kuskokwim Delta by Whimbrels and Bristle-thighed Curlews can probably best be explained by differences in migration strategies, and in breeding schedules and success of the two species each year. Although little is known about reproduction of either curlew species in Alaska, we can draw some tentative inferences about what populational subclasses may be using the delta during summer.

Data on the breeding schedule of Whimbrels in Alaska are limited, with two sets of eggs recorded as early as 23 and 25 May 1951 (Gabrielson and Lincoln 1959), nesting birds found on 6 June 1946 (Walkinshaw 1948), and an adult male observed with a downy young on 9 July 1953 (Gabrielson and Lincoln 1959). Given that Whimbrels have an average incubation period of 24 days (Skeel 1983) and a fledging period of 5–6 weeks (Glutz von Blotzheim et al. 1977 cited in Johnsgard 1981), these dates are consistent with our earliest observation of a juvenile Whimbrel on the delta on 26 July.

The only data available on timing of production for Bristle-thighed Curlews are one late clutch completion date of 8–9 June 1987 (B. J. Mc-

Caffery, pers. comm.), and hatching dates for three nests: 17 June 1948 (Kyllingstad 1948), 19–23 June 1987, and 20–26 June 1987 (B. J. McCaffery, pers. comm.). If this species is similar in nesting chronology to the Whimbrel, clutches would have been completed between 24 May and 9 June and fledging would have occurred between 22 July and 13 August. These dates are again consistent with our earliest record of a juvenile Bristle-thighed Curlew on 26 July.

In light of these breeding schedules, it is possible that the few Whimbrels and Bristle-thighed Curlews that we recorded in early June of 1978 and 1979 were late spring migrants enroute to breeding grounds. However, these birds could also have been nonbreeders or very early failed breeders. Small numbers of both Bristle-thighed Curlews and Whimbrels have been reported oversummering on other areas outside their breeding range (see, e.g., Bent 1929, Stickney 1943, Bailey 1956, Gallagher 1960, Amerson 1971, Ely and Clapp 1973, Clapp and Wirtz 1975, Johnson 1977, Widrig 1979, AOU 1983).

The fact that curlews occurred on the delta in early June only during the 2 years with very early spring breakup suggests that they may have been very early failed breeders. Spring phenology on the closest known nesting area for both species, in montane habitats of the Nulato Hills 200 km to the northeast (Kyllingstad 1948, McCaffery and Peltola 1986), is influenced by the same weather systems that dictate spring phenology on the delta (B. J. McCaffery, pers. comm.). Several studies have shown how spring phenology and physical availability of habitats on the delta are closely tied to the timing of reproduction and subsequent events in the annual cycle of breeding waterfowl and shorebirds (Holmes 1971, 1972; Mickelson 1975; Dau 1976; Raveling 1978; Dau and Mickelson 1979; Handel 1982; Ely and Raveling 1984).

The occurrence of two peaks in numbers of Whimbrels on the Yukon-Kuskokwim Delta each year, separated consistently by 30–50 days (Fig. 2), indicates that there are at least two waves of migrants that pass through, and the preponderance of southward flight directions indicates a steady movement of birds south. Since both sexes incubate eggs (Skeel 1976) and both probably tend young for at least the first week (Glutz von Blotzheim et al. 1977 in Johnsgard 1981, Skeel 1978, Cramp 1983), the first wave of migrants, whose peak varied from early to late July during the 5 years, probably consisted largely of failed breeders. The timing and magnitude of the peak was probably influenced by (1) the schedule of breeding each spring as dictated by weather conditions, and (2) the timing and extent of reproductive failure each year. The second wave of migrants, which peaked from middle to late August each year, probably consisted largely of successful adults and juvenile birds.

Seasonal patterns of occurrence of Bristle-thighed Curlews were more variable and difficult to interpret. In addition to the small component of spring migrants, nonbreeders, or very early failed breeders that occurred in early June of 1978 and 1979, four other components of the Bristle-thighed Curlew population appeared to have occurred in varying proportions, comprising up to three additional peaks each year: (1) early failed breeders from late June to mid-July, (2) late failed breeders in late July, and (3) successful breeders beginning mainly in early August and overlapping with juveniles. Why there was a disproportionately high number of Bristle-thighed Curlews on the delta in 1976 cannot be readily postulated in terms of differences in either breeding schedule or success.

## IMPORTANCE OF THE YUKON-KUSKOKWIM DELTA TO CURLEWS

Although Whimbrels were recorded on the Yukon-Kuskokwim Delta usually in small, scattered flocks, the delta, because of its sheer size, may play an important role for the fall migrant population. The Yukon-Kuskokwim Delta contains over 9,250 km$^2$ of coastal tundra in its vegetated intertidal zone (King and Dau 1981). Our study area encompassed approximately 130 km$^2$, or only 1.4%, of this habitat. Given the numbers of Whimbrels we recorded each year, we conservatively estimate that a few to several thousand Whimbrels probably occur on coastal tundra of the delta each summer.

Whimbrels have been recorded in numbers as regular fall migrants in only four other areas in Alaska besides the Yukon-Kuskokwim Delta. To the north, at Cape Krusenstern on the Chukchi Sea coast, migrant Whimbrels were common during late June and July, flocking on the tundra (Connors and Risebrough 1978); on coastal tundra of the Seward Peninsula and along the lagoons and estuaries of Norton Sound, Whimbrels have been found from late June through early September, peaking in middle to late Au-

gust in numbers of less than a few thousand (Biderman et al. 1978; Shields and Peyton 1979; Woodby and Divoky 1983; Kessel, in press).

South of the Yukon-Kuskokwim Delta, two major staging areas have been identified in Alaska: Nelson Lagoon, on the northcentral Alaska Peninsula, and the Copper River Delta, in southcentral Alaska. At Nelson Lagoon, Whimbrels were recorded from early June to early September, peaking in numbers (about 4,000 birds) in middle to late July (Gill et al. 1981). Use of the Copper River Delta by summer visitants and fall migrants extended from June through early October, peaking in late July and August, with a conservatively estimated population of several thousands using the area each year (Isleib and Kessel 1973). By comparison, then, the Yukon-Kuskokwim Delta may support as many migrant Whimbrels each summer and fall as any of the traditional, known staging areas in Alaska.

Which breeding populations migrate across the Yukon-Kuskokwim Delta, how long individuals remain, and where they go after leaving the delta are not yet known. Taverner (1942) postulated that Whimbrels breeding in northern Alaska migrate through interior Alaska, across the base of the southeastern panhandle of Alaska and then across the Pacific Ocean to Vancouver Island and farther south. Birds nesting in northwestern and western Alaska may be moving to the Yukon-Kuskokwim Delta after breeding, and some component of these may be continuing south to staging areas on the Alaska Peninsula or Copper River Delta.

South of Alaska the first known stops for fall migrants are at Tofino Inlet on Vancouver Island, British Columbia (R. W. Campbell, pers. comm.), Leadbetter Point in northern Washington (Widrig 1979), and San Francisco Bay, the northernmost limit of their usual wintering area (Storer 1951; Jurek 1973; R. Gill, unpubl. data). The first fall migrants have been recorded in these three areas in late June and early July, with a peak in numbers occurring in mid-July, early August, and late August, respectively. The routes taken by migrant Whimbrels occurring on the Yukon-Kuskokwim Delta will only be able to be determined through studies of marked birds; however, availability of a number of staging areas along the migratory route may allow some flexibility in the ways of meeting the physiological requirements of migration. Direct flights from major staging areas in Alaska to British Columbia and San Francisco Bay would range from about 1,900–4,000 km in length.

In contrast to Whimbrels, Bristle-thighed Curlews are known to occur in numbers as fall migrants in only two areas of Alaska. Small numbers of curlews were found to stage on coastal lowlands of the Seward Peninsula between late June and late August (Kessel, in press), and we estimate that a few to several thousand Bristle-thighed Curlews probably occur on coastal tundra of the Yukon-Kuskokwim Delta each summer, based on calculations as used for Whimbrels. South of the delta, the birds' first possible stop during fall migration is in the leeward Hawaiian Islands, 3,800 km distant, on which the first migrants have been recorded in late July and peak numbers have been found in late August and early September (Stickney 1943, Ely and Clapp 1973, Clapp and Wirtz 1975). From there, most curlews move south to other islands in the central and south Pacific by early October, although some remain to winter on the leeward islands (Stickney 1943, Gallagher 1960, Amerson 1971, Ely and Clapp 1973, Clapp and Wirtz 1975).

Coastal tundra of the Yukon-Kuskokwim Delta, then, appears to be the most important area used by Bristle-thighed Curlews after breeding and while preparing for a long, transoceanic fall migration. Although how long individuals remain on the delta can only be accurately determined by a study of marked birds, curlews are likely to remain for up to several weeks before migrating south. Early failed breeders probably constitute most of the earliest migrants to the leeward Hawaiian Islands, remaining on the delta about 4 weeks (late June to late July); juveniles stay on the delta at most 3–4 weeks (late July to late August). How long other components of the population (nonbreeders, late failed breeders, and successful breeders) remain on the delta, and what proportion of the entire population of Bristle-thighed Curlews even uses the delta is impossible to estimate at this time.

## IMPLICATIONS OF DIFFERENT MIGRATION STRATEGIES

Although the Yukon-Kuskokwim Delta appears to be important to both species, it is one of several areas in Alaska used by Whimbrels but appears to be the primary area of only two used by Bristle-thighed Curlews before fall migration.

Because of its highly restricted breeding and

wintering distribution, the Bristle-thighed Curlew has been presented as an example of a relict species, i.e., one whose numbers or range have undergone drastic reductions (Amadon 1953). Such species tend to become more restricted geographically and ecologically because they are unable to compete with other species, and they are thus more susceptible to man-made ecological changes (Amadon 1953).

Whimbrels are much more ubiquitous than Bristle-thighed Curlews in their breeding, staging, and wintering distribution and may have greater flexibility in their ability to satisfy ecological requirements of each phase of the annual cycle. Differences between the species emphasize how urgently study of the Bristle-thighed Curlew is needed. We must determine not only its status but also any ecological requirements that may be limiting its population.

## ACKNOWLEDGMENTS

We thank Cheryl M. Boise, Craig Mickelson, Elizabeth Silberling, and Richard Wood for their assistance in recording observations of Whimbrels and Bristle-thighed Curlews. R. Wayne Campbell, Robert E. Gill, Jr., Brina Kessel, Brian J. McCaffery, and Margaret R. Petersen graciously provided unpublished information. We also thank Peter G. Connors, Lynn Fisher, Brian J. McCaffery, K. Manci, Margaret Petersen, Paul R. Schmidt, and an anonymous reviewer for constructive comments on earlier drafts of the manuscript. Robert E. Gill, Jr., is especially thanked for helpful discussions, editorial comments, and preparation of graphics. Staff of the Yukon Delta National Wildlife Refuge provided logistical support to field crews throughout the study. Their assistance is greatly appreciated.

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