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Demography, Breeding Biology and Predation of Willow Ptarmigan at Anderson River Delta, Northwest Territories

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ABSTRACT. Observations on the willow ptarmigan (*Lagopus lagopus albus*) were made during the breeding season from 1958 to 1985 at the Anderson River delta, N.W.T. Numbers of territorial males on a 65 ha study area have fluctuated between 7 and 28 over this time, with numbers peaking in 1961-62, 1969 and 1980. Peaks in ptarmigan numbers appear to be fairly synchronous over a large geographical area. Large flocks of males were observed in some years. In 1978, these males, mainly yearlings, had similar wing lengths to, but weighed slightly more than, territorial males. There appeared to be a shortage of hens in 1978, possibly caused by differential mortality during the winter. Mean clutch size ranged from 8.7 to 10.4 and mean number of fledged chicks per brood ranged from 6.3 to 6.9. Within North America clutch size of willow ptarmigan does not appear to increase with increasing latitude. As in other localities, raptors and foxes appeared to be the main predators of ptarmigan. More males than females were killed on the breeding area, but this could have been because more males were present.

Key words: willow ptarmigan, Northwest Territories, breeding, clutch size, demography, predation

RÉSUMÉ. Le lagopède des saules (*Lagopus lagopus albus*) fut observé durant les saisons nidificatrices de 1958 à 1985 au delta de la rivière Anderson, aux T. N.-O. Le nombre de mâles territoriaux dans l'aire d'étude de 65 ha fluctua entre 7 et 28 au cours de cette période, les nombres atteignant leur pointe en 1961-62, 1969 et 1980. Les pointes dans les nombres de lagopèdes semblent être synchrones sur une grande région géographique. Des volées nombreuses de mâles furent observées en certaines années. En 1978, ces mâles, la plupart âgés d'un an, avaient une longueur d'aile semblable à celle des mâles territoriaux mais pesaient un peu plus que ces derniers. Il semble y avoir eu une pénurie de femelles en 1978, peut-être entraînée par une mortalité différentielle lors de l'hiver. La couvée moyenne variait entre 8.7 et 10.4 et le nombre moyen de jeune en état de voler par nichée variait entre 6.3 et 6.9. En Amérique du Nord, la taille de la couvée du lagopède des saules ne semble pas augmenter avec la latitude. Comme ailleurs, les rapaces et les renards semblent être les principaux prédateurs du lagopède. Plus de mâles que de femelles furent tuées dans l'aire de nidification, statistique résultant peut-être du nombre plus élevé de mâles.

Mots clés: lagopède des saules, Territoires du Nord-Ouest, nidification, taille de la couvée, démographie, prédation

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INTRODUCTION

The willow ptarmigan, *Lagopus lagopus*, is a holarctic species that generally breeds in tundra and moorland habitats. The species has been divided into 16 subspecies, 7 of which are located in North America (Johnsgard, 1983). Detailed population studies have been conducted on 5 subspecies: *L. l. alleni* in Newfoundland (Bergerud, 1970); *L. l. alexandrae* in British Columbia (Weeden, 1959; Hannon, 1983; Bergerud *et al.*, 1985); *L. l. albus* in Manitoba (Martin, 1985); *L. l. scoticus* in Scotland (Jenkins *et al.*, 1963; Watson *et al.*, 1984); and *L. l. lagopus* in Norway (Myrberget *et al.*, 1982; Pedersen *et al.*, 1983).

We observed a population of *L. l. albus* during the breeding season near the Anderson River delta, Northwest Territories (69°42'N, 129°00'W; Fig. 1). Few data have been published on this subspecies in the northern part of its range. Observations have been made by TWB, incidental to other work, since 1958. In 1978 SJH worked here more intensively with a partially marked population from 17 June to 30 July. Here we present information on demography, breeding biology and predation and compare this with willow ptarmigan populations in other geographical areas.

STUDY AREA AND METHODS

The main study area was a flat 65 ha (approximately 1700 × 380 m) stretch of dwarf willow (*Salix* spp.) and birch (*Betula glandulosa*), interspersed with wet sedge and grassy areas. The west side was bordered by the Anderson River. Several islands with suitable ptarmigan breeding habitat and areas adjacent to

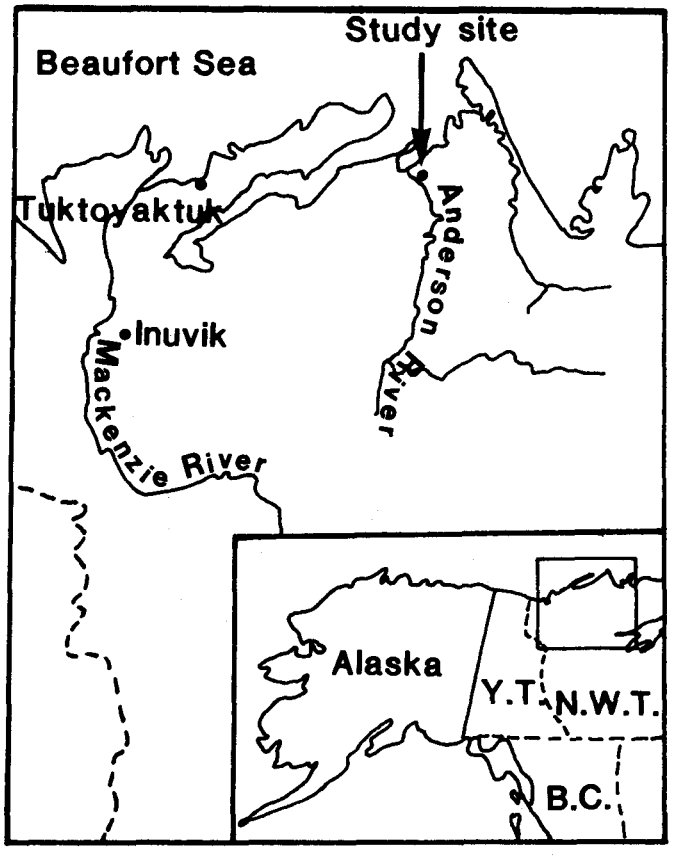

FIG. 1. Location of the study area at the Anderson River delta, Northwest Territories.

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the main study area also were searched periodically. More detailed descriptions of the area can be found in Barry (1967) and Martin and Barry (1978).

Numbers of territorial males on the main study area were determined by counting them once or twice in June from an elevated blind. The white plumage of the males was conspicuous, and they usually sat on bushes in their territories, making them easy to count. In 1978 the main study area was divided into 75 × 75 m squares and searched systematically on 26, 27 and 29 June and 3 July by walking back and forth between grid lines and marking the positions of all males on a map. Some birds were captured in nets or were noosed and individually marked with coloured plastic leg bands or spray-painted on the wings or tail, others were daubed with paint as they incubated eggs and others had distinctive plumage patterns.

Nests were located fortuitously by searching around the roosts of territorial males or by dragging a rope between two observers. Broods were located by systematic search of the area. Counts of fledged juveniles were made on and off the main study area by locating a brood, searching in the immediate area and counting all juveniles that flew.

On 1 and 2 July 1978 males from a flock found adjacent to the main study area were collected to compare age ratio, body weight and wing length with males holding territory at that time.

In 1978 all remains of dead ptarmigan were collected both on and off the main study area, and presence of scats, pellets or other signs of predators near the kills was documented. Age and sex of the remains were determined using the criteria of Bergerud *et al.* (1963) and by comparing wing lengths and lengths of rectrices and primaries to those of birds of known sex and age (unpubl. data). We attempted to identify the predator of each kill using criteria of Einarsen (1956) and Jenkins *et al.* (1964) and by comparing remains to those collected at fox (*Vulpes vulpes*) dens and raptor nests.

RESULTS

Demography

Number of males: There were approximately 19 territorial males in the main study area in 1978, a density of about 29 territorial males km^{-2}. Some very open, wet areas were not inhabited by ptarmigan. Since 1958 numbers fluctuated from 7 to 28 males (approx. 11-43 males km^{-2}; Fig. 2). Numbers peaked in 1961-62, 1969 and 1980, periods of 8 and 11 years between peaks. These density figures should only be used as an index to population change, not as absolute densities, since repeated censuses were not made and individuals usually were unmarked.

From 25 June to 24 July 1978 we observed flocks of males at the southeastern end of the study area and beyond. Prior to 2 July, flock size usually varied from 20 to 55 birds but became smaller after 2 July (6-13 birds), when broods began to appear. Flocked males were also observed during the breeding season in other years. There was a tendency for flocked males to weigh more than territorial males (flocked: $\bar{x}$ = 640 g ± 11.6 SE, N = 11; territorial: $\bar{x}$ = 602 g ± 13.5 SE, N = 10; U = 81, $p<0.06$), but wing lengths were similar (flocked: $\bar{x}$ = 204.4 mm ± 0.81 SE, N = 11; territorial: $\bar{x}$ = 206.3 mm ± 1.59 SE, N = 11; U = 81.5, $p<0.16$, two-tailed Mann Whitney U-test).

Age ratios: Territorial males were predominantly adults (27% yearlings), whereas collected flocked males were mainly yearlings (64%) in 1978, but this relationship was not statistically significant (G = 3.0, p = 0.09). Twelve territorial females, on the other hand, were predominantly yearlings in 1978 (67%); but, again, this age ratio was not significantly different from that of territorial males (G = 3.7, p = 0.06).

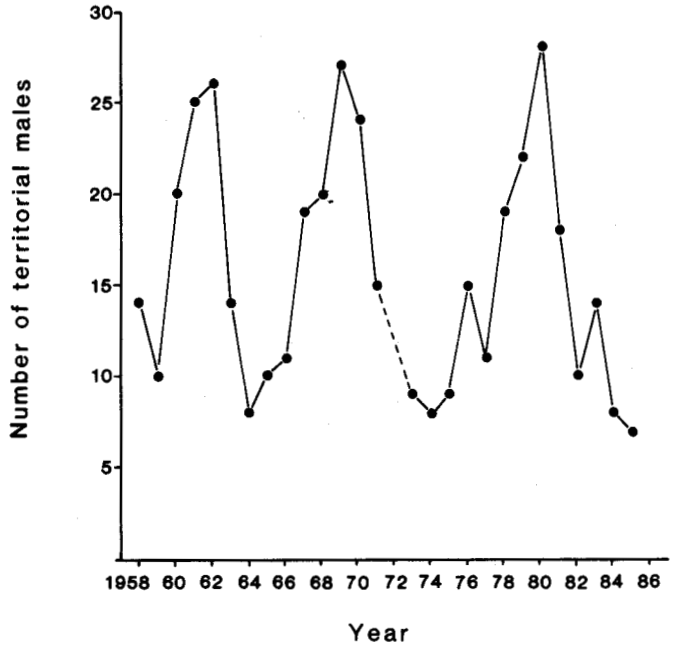

FIG. 2. Changes in the numbers of territorial male willow ptarmigan on a 65 ha study area near the Anderson River delta.

Breeding Biology

Seventy-seven nests were located over ten years and clutch size ranged from 5 to 21 eggs. Clutches of 15, 17 and 21 eggs may be the result of more than one hen laying in the same nest (Martin, 1984). Seven clutches contained fewer than 7 eggs. These latter nests were all located in 1969, a year when a snow storm interrupted incubation; they may be renests. Erikstad *et al.* (1985) found that in Norway first clutches ranged from 8 to 13 eggs and second clutches from 6 to 9 eggs. Excluding the three largest clutches, mean clutch sizes for each year in which 5 or more nests were found varied from 8.7 to 10.4 (Table 1). Of 102 eggs found in 1978, 82 hatched; however one female was killed while incubating 9 eggs; thus hatchability was 88% (82/93 eggs).

In 1978 the first brood was found on 3 July, and the first juveniles were observed flying on 17 July. Between 18 and 27 July, counts of fledged chicks were made from 14 broods, spread over a large geographical area to avoid duplication. Brood sizes ranged from 4 to 11 chicks, $\bar{x}$ = 6.9 ± 0.57 SE.

TABLE 1. Clutch sizes by year at Anderson River (mean ± SE)

Year	Mean clutch size	N
1962	9.6 ± 0.34	9
1963	9.3 ± 0.41	9
1967	9.3 ± 0.42	6
1968	10.4 ± 0.92	5
1969[a]	8.7 ± 0.26	22
1978	9.3 ± 0.40	11

[a]Probably includes several renest clutches.

In 1968 and 1969 there were sufficient sightings of fledged chicks to calculate brood sizes, and these were similar to 1978: 1968; $\bar{x} = 6.8 \pm 4.4$ SE, N = 19, range = 5-11; 1969; $\bar{x} = 6.3 \pm 0.2$ SE, N = 25, range = 3-9.

Predation

The remains of 54 ptarmigan were found in 1978 — 8 juveniles and 46 adults. Sex could not be determined for juveniles, but of adults for which sex could be determined (N = 38), 34% were females and 66% were males. Raptors were the major predators of ptarmigan at Anderson River. Of remains for which the identity of the predator could be determined (N = 32), 66% were birds of prey and 34% were mammals, presumably foxes. Over the period of this study, remains of ptarmigan have been found in nests of golden eagles (*Aquila chrysaetos*), peregrine falcons (*Falco peregrinus*) and short-eared owls (*Asio flammeus*). Gyrfalcon (*F. rusticolus*), rough-legged hawks (*Buteo lagopus*), northern harriers (*Circus cyaneus*) and goshawks (*Accipiter gentilis*) were observed hunting ptarmigan. TWB saw a parasitic jaeger (*Stercorarius parasiticus*) kill a 2-3 week old juvenile ptarmigan and another attempt to rob a ptarmigan nest: it was driven off by the male ptarmigan. Glaucous gulls (*Larus hyperboreus*) also hunted over the area and may prey on eggs or young, and a pair of ravens (*Corvus corax*) was seen carrying part of a ptarmigan carcass. Remains have also been found at the dens of red foxes and arctic foxes (*Alopex lagopus*) and in the scat of a wolf (*Canis lupus*).

DISCUSSION

Numbers of willow ptarmigan in North America appear to undergo oscillations with a period of about 8-13 yr (Williams, 1954; Keith, 1963), and the Anderson River population is no exception. Previous evidence, based on questionnaires and hunting statistics, indicated that these cycles were fairly synchronous over North America (Keith, 1963). At Anderson River, peak years preceding declines occurred in 1962, 1969 and 1980. In Newfoundland peaks occurred in 1931, 1941, 1951 and 1961 (Bergerud, 1970), and in northeastern British Columbia peaks occurred in 1962, 1971 and 1980 (Hannon, 1983; Bergerud *et al.*, 1985). These data suggest that a synchrony in ptarmigan cycles may exist over a large geographical area. Peak densities at Anderson River were much higher than in Newfoundland (1.6 pairs km^{-2}; Bergerud, 1970) but were lower than those in British Columbia (about 50 pairs km^{-2}; Hannon, 1983). The maximum recorded density of willow ptarmigan in unmanaged habitat is 88 pairs km^{-2} on an island in northern Norway (Myrberget, 1984).

Large flocks of males were an obvious feature in 1978 and in other years. Höhn (1967) also reported seeing a large flock of at least 40 adult ptarmigan at Anderson River 18-26 July 1955. He suggested that endocrine failure due to the stresses of overpopulation explained the presence of these large flocks. Watson and Moss (1979) disagreed and pointed out that these flocks probably consisted of unmated cocks and failed breeders. The flocks we observed were composed entirely of males. If flocked birds were failed breeders, we would have expected to see females as well, unless they moved elsewhere. Thus, these flocked birds were probably males that failed to obtain a territory or that previously held a territory but did not obtain a mate. Unmated territorial males usually abandon their territories during the laying period (Hannon, 1983).

Flocked males and territorial males had similar wing lengths, but flocked males weighed more at the end of incubation. Hannon and Roland (1984), working in northwestern British Columbia, found that males that replaced removed territorial males were of similar structural size to territorial males. However, there was a tendency for replacements to be lighter than residents during the last two weeks of May. Replacement males were presumably either nonterritorial or unmated males. Territorial males lose weight throughout the spring and summer until the end of incubation (Hannon and Roland, 1984). Thus unmated males and nonterritorial males appear to be able to recoup previous weight loss. This suggests that flocking behaviour may not be as energetically expensive as territoriality, at least during laying and incubation.

The higher percentage of yearlings among territorial hens than among territorial cocks at Anderson River, if biologically real, suggests differential mortality on females. This is unlikely to be occurring on the breeding range, since predation on males outweighed that of hens (see below). Female rock (*L. mutus*) and willow ptarmigan appear to migrate farther than males and spend the winter in different locations (Weeden, 1964). Mortality could be higher on females at this time. A shortage of hens during the breeding season in 1978 could explain the large number of unmated, flocked males. Excesses of males have been found in some years in red grouse (*L. l. scoticus*, Watson *et al.*, 1984) and willow ptarmigan in Newfoundland (Bergerud, 1970), Manitoba (Martin, 1985) and British Columbia (Hannon, unpubl. data).

Clutch size at the Anderson River is higher than that reported in northern British Columbia ($\bar{x} = 7.1$, range = 3-10; Hannon and Smith, 1984) and Scotland ($\bar{x} = 5.3$-8.1, range 2-15; Jenkins *et al.*, 1963) but similar to those reported from Norway ($\bar{x} = 9.8$; range 7-13; Myrberget, 1972; $\bar{x} =$ 8.8-10.5, range = 8-13; Erikstad *et al.*, 1985 [for first nests]), Manitoba ($\bar{x} = 10.8$, range = 8-14; Martin, 1985 [for first nests]) and Newfoundland ($\bar{x} = 10.2$, range = 5-13; Bergerud, 1970). Within North America clutch size of willow ptarmigan does not appear to increase with increasing latitude.

Our data cannot be used to determine the impact of predation on density of ptarmigan as they may be biased in several ways. Our collection probably underestimates the number of juveniles killed by predators, as young chicks are likely eaten whole. As well, older fledged juveniles are smaller than adults and their plumage is brown and not as obvious against the ground as the white feathers of adults killed earlier in the season. Caution also should be exercised in interpreting the sex ratio of the kill. Males could be over-represented because there were more of them on the breeding area and because, if males stay closer to the breeding areas during winter and return earlier in spring, they are available to predators on the study area for a longer period of time than are females.

Raptors appear to be the most important predators on ptarmigan in this area. Jenkins *et al.* (1964) reported that golden eagles, hen harriers (northern harriers) and foxes were the principal predators of red grouse in Scotland. Raptors and foxes each accounted for about half the predations found. In Newfoundland, raptors such as great horned owls (*Bubo virginianus*), snowy owls (*Nyctea scandiaca*) and goshawks took more ptarmigan than foxes (Bergerud, 1970).

Finally, we feel that the data presented here on the Anderson

River willow ptarmigan are useful for comparison with other subspecies of ptarmigan and other grouse species in general. The population in this area was relatively easy to work with compared to populations in other areas because of the openness of the habitat and the high density of birds. Because of its isolation, the impact of humans was low. Thus, it would be a good system with which to investigate demography of unexploited populations and the causes of population cycles.

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