MOLT OF FEMALE LESSER SCAUP IMMEDIATELY FOLLOWING BREEDING

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ABSTRACT.—The chronology, pattern, and intensity of the molt following breeding in female Lesser Scaup (*Aythya affinis*) were studied from July through October 1981-1982 and in July 1984 in southwestern Manitoba. Nonbreeding females or females that were unsuccessful breeders began molt in mid-July, but females with broods delayed molt until August. The molt-intensity index was greatest during the flightless and postflightless periods. Molt persisted at low levels through the fall migratory period. Molt scores were most variable in the preflightless period. Molting began on the head, neck, and side and progressed to the belly, upper back, and chest; the lower back was the last area to molt. Feather replacement was most rapid in the wing and capital regions. The capital region and tail were the last areas in which molt was completed in fall-migratory scaup. Molt in postbreeding females probably is influenced by the length, timing, and success of breeding efforts. Individual and geographic differences in breeding chronology, habitat conditions, and postbreeding movements may contribute to variations in molt within a population of migratory scaup. *Received 27 February 1985, accepted 16 October 1985.*

LESSER Scaup (*Aythya affinis*) are among the latest breeders of prairie-nesting waterfowl (Sowls 1955). Nesting begins in early to mid-June and the brood period may last into September (Rogers 1964, Afton 1984). As a result, female scaup may have a shorter time in which to molt before fall migration and freeze than many other female anatids.

Quantitative studies of molt in postbreeding anatids have focused on males because concentrations of molting males were available and fewer factors may influence their molt. Molt in both sexes of migrating and wintering Greater Scaup (*Aythya marila*) was quantified by Billard and Humphrey (1972); however, few studies of molt in females have addressed the molt immediately following breeding. This molt may be influenced by the time and nutrient demands of breeding, which vary among individual females according to the length, timing, and success of breeding effort. Females that do not breed or that abandon breeding efforts early in the breeding season would have more time to molt and probably enter the postbreeding period with higher nutrient and energy reserves than females that complete incubation and raise a brood.

Our study was designed to describe the chronology, pattern, and intensity of molt of female Lesser Scaup immediately following breeding. This study covers the period from July through October and includes the wing molt and early fall migration.

STUDY AREA AND METHODS

The study was conducted in the prairie pothole region near Erickson, Manitoba, 240 km west-northwest of Winnipeg and 35 km north of Minnedosa. The study area included approximately 4,700 ha near Erickson and other ponds within 32 km to the west (Austin 1983). Lesser Scaup are among the most common waterfowl species breeding in the area and are also common during postbreeding and migratory periods. Detailed descriptions of the area can be found elsewhere (Rogers 1962, Sunde and Barcia 1975, Austin 1983, Afton 1984).

Birds were collected from July through October 1981-1982 and in July 1984. Brood females were captured in early August 1981 by nightlighting (Cummings and Hewitt 1964). Feather tracts of 90 adult female Lesser Scaup were examined externally for signs of feather wear and the presence of sheathed new feathers.

Females were classified into 5 molt periods: (1) brood females; (2) preflightless birds that had completed or terminated breeding efforts; (3) flightless

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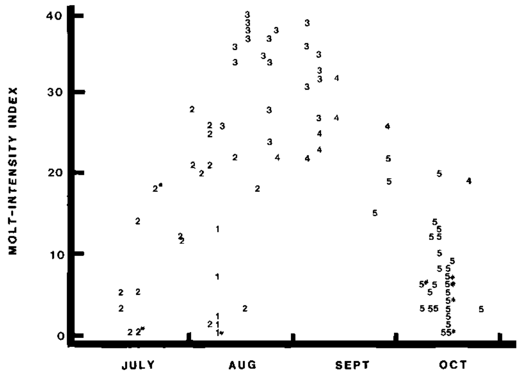

Fig. 1. Molt-intensity index scores of brood and postbreeding female Lesser Scaup by date of collection. Numbers indicate molt period: 1 = brood, 2 = preflightless, 3 = flightless, 4 = postflightless, and 5 = migratory. Numbers with asterisks represent more than one individual.

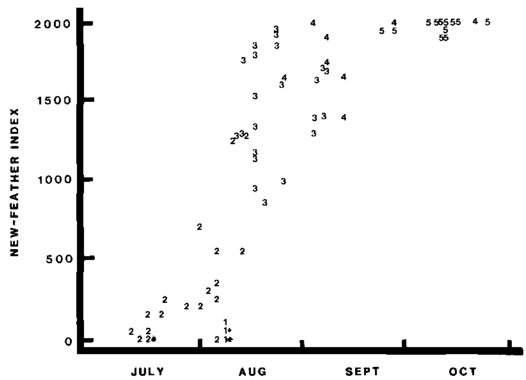

Fig. 2. New-feather index scores of brood and postbreeding female Lesser Scaup by date of collection. Numbers indicate molt period: 1 = brood, 2 = preflightless, 3 = flightless, 4 = postflightless, and 5 = migratory. Numbers with asterisks represent more than one individual.

birds with soft growing primary feathers; (4) postflightless birds with new primary feathers, capable of flight but not part of migratory flocks; and (5) migratory scaup in flocks staging or migrating through the area. Preflightless birds were distinguished from incubating females by behavioral observations (e.g. inactivity for long periods, associations with other female Lesser Scaup, absence of a mate) and, in some females, the presence of emerging feathers in the brood patch. Postflightless birds were distinguished from migratory scaup by behavioral observations (e.g. low feeding activity and restlessness) and, in some birds, the presence of soft primaries.

Molt intensity was scored for 20 feather tracts: crown, facial, chin-throat, neck, upper back, scapulars, lower back, rump, upper tail coverts, rectrices, lower tail coverts, belly, center chest, side chest, side, flank, primaries, secondaries, tertials, and wing coverts. Molt intensity in each tract was scored as 0 for no molt, 1 for light molt, and 2 for heavy molt. The percentage of new feathers for each of the 20 tracts was estimated to the nearest 10%. Tracts were then combined as 6 regions (Billard and Humphrey 1972, Bailey 1981): I, Capital (crown, facial, chin-throat, neck); II, Side and flank; III, Anterior ventral and spinal (upper back, center chest, side chest); IV, Ventral (belly); V, Posterior spinal-caudal (lower back, rump); and VI, Scapular. The Wing (remiges and wing coverts) and Tail (rectrices and tail coverts) constituted two additional regions. Intensity scores and percentage of new feathers for each region were calculated by averaging the scores for intensity and new feathers included within each region. The intensity was scored as 0 for no molt, 0.01–1.00 for light molt, and 1.01–2.00 for heavy molt.

The molt-intensity and new-feather indices for each bird were calculated by summing scores from the 20 individual tracts. A maximum molt-intensity index of 40 indicates heavy molt ("2") occurred in each of the 20 tracts, whereas a maximum new-feather index of 2,000 indicates 100% new feathers occurred in all tracts. Differences among molt periods for the molt-intensity and new-feather indices and, for each of the 8 regions, differences in molt intensity and percentage of new feathers were tested using Mann-Whitney tests (Conover 1980). Differences in molt-intensity and new-feather indices between years were also tested using Mann-Whitney tests at a significance level of 0.05.

Molt and plumage terminology.—In the terminology developed by Humphrey and Parkes (1959) and further explained by Palmer (1972), the terms "alternate" and "basic" are used to describe the two basic plumage types in the cycle of feather generations. Palmer (1972) suggested that molts are often interrupted and that molt may occur in two feather generations at once. A third plumage, called the "supplemental" plumage by Palmer (1972), is present in Oldsquaws (*Clangula hyemalis*). In female Mallards (*Anas platyrhynchos*) there may be 3 molts, or molting may occur during more of the annual cycle than previously discerned (M. Heitmeyer pers. comm). Current terminology therefore would be inadequate to describe the timing and sequences of molts and plumages in the annual cycle. To avoid possible confusion with any future changes in the terminology describing molt, we have not used the terms basic and alternate plumage in this paper.

RESULTS

When data were pooled across the 4 corresponding molt periods with each year, molt-

TABLE 1. Molt-intensity scores of 8 feather regions and molt-intensity index scores for brood and postbreeding female Lesser Scaup. Values are means ± SE.

Region	Brood	Period: Preflightless	Flightless	Postflightless	Migratory
Capital	0.3 ± 0.5	0.9 ± 0.7	1.2 ± 0.6	0.8 ± 0.6	0.5 ± 0.5
Side and flank	0.4 ± 0.5	0.8 ± 0.7	1.6 ± 0.5	1.6 ± 0.4	0.4 ± 0.5
Anterior ventral and spinal	0.2 ± 0.4	0.8 ± 0.8	1.8 ± 0.4	2.0 ± 0.0	0.4 ± 0.6
Ventral	0.0	1.0 ± 0.9	1.7 ± 0.5	1.9 ± 0.4	0.2 ± 0.6
Posterior spinal-caudal	0.1 ± 0.4	0.5 ± 0.6	1.7 ± 0.4	1.8 ± 0.4	0.3 ± 0.4
Scapular	0.0	0.8 ± 0.8	2.0 ± 0.2	1.6 ± 0.7	0.3 ± 0.5
Wing	0.0	0.0	1.9 ± 0.3	0.2 ± 0.4	0.0
Tail	0.1 ± 0.2	0.8 ± 0.8	1.7 ± 0.5	1.6 ± 0.4	0.6 ± 0.4
Molt-intensity index	3 ± 5	12 ± 10	33 ± 6	25 ± 4	7 ± 6
Sample size	8	21	23	8	37

intensity and new-feather indices did not differ between years. Within specific periods, however, differences did occur. Preflightless birds collected in 1981 had lower molt-intensity and new-feather indices than birds collected in 1982. Migratory birds collected in 1981 had lower molt-intensity scores than migrant birds in 1982. However, collection dates of individual birds also differed between years. For example, no migratory birds were collected after mid-October in 1981 because of an early freeze-up, whereas birds were collected through the end of October in 1982. Also, the average date of collections of preflightless birds in 1984 occurred 19 days earlier than collections in 1981 and 1982.

The molt-intensity (Fig. 1) and new-feather indices (Fig. 2) illustrate the general trend of molt scores over time. The figures suggest that the statistical differences between years may be due to differences in time of collection rather than to biological differences between years. Therefore, to facilitate the data analysis and to meet the purposes of this paper, we pooled the data for all three years.

Nonbreeding females or females that were unsuccessful breeders began molting in mid-July, and some brood females were molting by mid-August. The mean molt-intensity index was greatest during the flightless period and gradually declined through the postflightless and migratory periods (Table 1, Fig. 1). Molting among migrants was low in intensity, and 4 (11%) had completed the plumage and had no signs of molt. Within feather regions, the molt intensity and percentage of new feathers were most variable among birds in the preflightless period (Tables 1 and 2).

Increases in the percentage of new feathers reflected changes in the molt-intensity index. The new-feather index increased from 189 in the preflightless period to 1,485 in the flightless period, when the molt-intensity index was greatest and flight feathers were new (Table 1, Fig. 2). As the molt intensity of body feathers diminished, the rate of increase in the new-feather index also slowed. Twenty-four (67%) of 36 females in the migratory period had completed the new plumage (i.e. had all new feathers), although growth and hardening of some feathers continued in most birds.

CHRONOLOGY AND PATTERN OF MOLT

Brood period.—Four of 8 females with 2-4-week-old broods, captured 8-10 August 1981, were molting. The earliest and most intensive molt was in the Capital and Side and flank regions (Table 1, Fig. 1). Molt also occurred in the Anterior ventral and spinal, Posterior spinal-caudal, and Tail regions.

A brood female collected in early September had a molt of greater intensity and extent than the 8 brood females captured in mid-August. Molt in this late-brood female was heavy in all regions except the Posterior spinal-caudal and Wing regions, which were molting lightly. The molt-intensity index was twice that of the highest-scoring early-brood female (29 vs. 13), and the new-feather index was 2.4 times higher (290 vs. 120). Because of the marked differences in timing and stage of molt of this late brood female, these molt scores were excluded from the summary for the brood period.

Preflightless period.—Molt intensity varied greatly among birds in the preflightless period

TABLE 2. New-feather percentage scores in 8 feather regions and new-feather index scores for brood and postbreeding female Lesser Scaup. Values are means ± SE.

Region	Brood	Period			
		Preflightless	Flightless	Postflightless	Migratory
Capital	3 ± 5	11 ± 13	72 ± 74	96 ± 7	96 ± 8
Side and flank	4 ± 4	13 ± 12	66 ± 21	81 ± 21	100 ± 8
Anterior ventral and spinal	0 ± 1	8 ± 11	72 ± 25	86 ± 13	99 ± 1
Ventral	0	17 ± 17	75 ± 25	81 ± 30	100 ± 2
Posterior spinal-caudal	2 ± 0	10 ± 20	64 ± 32	77 ± 27	100 ± 1
Scapular	2 ± 1	17 ± 23	71 ± 27	90 ± 14	99 ± 2
Wing	0	0	88 ± 21	100 ± 0	100
Tail	0 ± 1	15 ± 18	71 ± 25	85 ± 14	100 ± 2
New-feather index	27 ± 45	189 ± 207	1,485 ± 337	1,780 ± 220	1,979 ± 38
Sample size	8	21	23	8	37

(Table 1). In 1984, when collections were 2-3 weeks earlier in the preflightless period than in other years, birds had lower molt-intensity scores and fewer new feathers than females collected in 1981 and 1982; three females showed no signs of molt. Remnants of brood patches were evident in 6 of 21 females. Heavy molt in the Capital region occurred in 43% of the birds. One-third of the birds were molting heavily in the Anterior ventral and spinal, Ventral, and Tail regions. Excluding the wing, molt intensity remained lowest in the Posterior spinal-caudal region.

Flightless period.—Flightless females showed all stages of remige replacement, including 1 female that had lost only her primary feathers. The new-feather index ranged from 870 to 1,930 (Table 2). Molt intensity was lowest in the Capital and Posterior spinal-caudal regions and highest in the Anterior ventral and spinal region, Spinal-scapular region, and the wing. Mean molt intensity and percentage of new feathers increased in all regions ($P < 0.01$).

The greatest increases in the percentage of new feathers occurred in the Anterior ventral and spinal region (10-72%) and the wing (0-88%). Replacement and growth of remiges followed the proximate-to-distal pattern described for Redheads (*Aythya americana;* Weller 1957, Bailey 1981).

Postflightless period.—Eight postflightless females were examined. Two postflightless females collected in late fall (29 September 1981 and 22 October 1982) were similar in molt stage to birds collected in late August and early September and thus were included in the data for this molt period. Molt intensity peaked in the Side and flank, Anterior ventral and spinal, and Posterior spinal-caudal regions, and declined in the Capital region ($P < 0.05$) when compared with the flightless condition. The plumage in all except the Capital region was more than 90% complete (Table 1).

Migratory period.—Thirty-seven females were collected from staging and migratory flocks in late September and October. Twenty-four (67%) had completed the molt (i.e. had all new feathers); 4 of these showed no signs of molt. All birds had completed the wing molt. Molt intensity declined in all regions ($P < 0.01$) except the Capital region. Continuation of the molt was greatest in the Tail region (78% of the birds) and the Capital region (65% of the birds). The latter region was the last area in which the molt was completed; the heads and necks of some birds were still flecked with the tawny, older feathers of the previous feather generation.

DISCUSSION

The pattern of molt of Lesser Scaup following breeding is similar to that of other female anatids. Molt of the contour feathers begins in brood females and is often intense before flightlessness (Weller 1957, Mendall 1958, Dement'ev et al. 1967, Bailey 1981). The head, neck, flanks, and breast are among the first areas to molt, and upper tail coverts and rectrices often molt concurrently. Down is also replaced at this time, as in Redheads (Bailey 1981). The lower back is the last area of the female to begin molt.

Remiges are lost in a short period coinciding with the peak molt intensity of body feathers. Remiges are probably lost during preening, wing-flaps, or when birds flail across the water with the wings (Hochbaum 1944). Differential growth rates cause proximal remiges to mature and harden before distal feathers and may permit birds to regain flight abilities earlier (Bailey 1981).

Molt of the contour feathers continued at high levels immediately following the flightless period and persisted at low levels through the migratory period. The majority of Lesser Scaup females showed only very light molt during October, with molt only in 1 or 2 regions. In contrast, 50% of the female Greater Scaup collected on staging and migratory areas along the Mississippi River were molting heavily in October, and 20% were molting heavily in November (Billard and Humphrey 1972). Information on the percentage of new feathers or the site of collection was not reported in that study. Whether this late fall and winter molt of Greater Scaup is the same molt as observed in Lesser Scaup is presently unknown.

The origins of the scaup that molted or staged in the Erickson area are largely unknown, and most birds that attempted to breed in the area left before the wing molt. The birds that were flightless in the area in 1982 may have come from breeding areas farther south. Few birds were present in the area during the wing molt in 1981, a relatively dry year, and overall postbreeding movements and chronology were different between years (Austin 1983).

Numerous factors probably contribute to the wide variation of molt phenomena in postbreeding Lesser Scaup. The molt of individual females following breeding may be influenced by the length, timing, and success of breeding efforts. Birds that do not breed or that terminate breeding efforts early have a longer period to molt before fall migration. Late-molting birds may delay completion of the body molt until after migration (Dement'ev et al. 1967, Billard and Humphrey 1972, Bailey 1981). Alternatively, duration of the molt may be shortened by accelerating the progression of molt in response to environmental cues (Chilgren 1978). The influence of breeding on molt chronology probably is obscured by individual and geographic variations in breeding chronology, habitat conditions, and postbreeding movements. For example, in areas of poor habitat, the postbreeding season begins 1–3 weeks earlier than under better habitat conditions (Rogers 1964, Hammell 1971, Austin 1983). The relative importance of hormonal factors, body condition, breeding success, and environmental cues in influencing molt is uncertain. Further research is needed to define the annual cycle of molts and plumages, to evaluate differences in molt relative to breeding success, and to investigate influences of environmental conditions or cues on molt phenomena.

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