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Abstract

Mallard (*Anas platyrhynchos*) populations along a 32-km roadside transect in the Alberta Parkland were observed weekly from spring to fall for 3 years, 1968–70. First Mallards arrived by mid April and reached maximum numbers by early May. Observed males, mostly flocked, outnumbered pairs by early May, indicating, as did computed hatching dates, that most females were incubating by then. The number of males declined rapidly during late May and June and few remained by July, possibly indicating a premoult migration from the region. A drought year, 1968, was characterized by a high percentage of pairs observed, as opposed to lone and flocked males, suggesting many females did not attempt to nest. In 1969, a year of excellent water conditions and warm early spring weather, populations reached maximum numbers early, with a high proportion of lone and flocked males indicating an early and almost universal initiation of nesting. In 1970 water conditions were also excellent; however, the increase in population and onset of nesting occurred more gradually. The delay was perhaps due to cool early spring weather and a higher proportion of yearling breeders. A severe summer storm probably disrupted late-season production in 1970. Three-year-average brood size decreased from 6.4 for class Ia to 4.4 for class III — a 31% decrease. A method of calculating total duckling mortality, including complete loss of broods, gave an estimate of 56% mortality from class Ia to flight stage; however, anomalies in results indicated data biases. Calculated mortality was highest in the drought year. Duckling growth rates were assessed by comparing mean observation dates for broods in different plumage classes. This method indicated a 33-day development period to flight stage, shorter than noted in other studies. Post-breeding Mallard populations decreased sharply around mid September, and counts were low for the remainder of the month. A modest re-building of numbers occurred in October, before the departure of Mallards with freeze-up in early November.

Résumé

Pendant trois ans, de 1968 à 1970, des populations de canard malard (*Anas platyrhynchos*) ont été observées le long d'un transect de 32 km en bordure d'une route située dans une savane de l'Alberta, chaque semaine, du printemps à l'automne. Les premiers canards arrivaient à la mi-avril, et l'effectif était à son maximum au début de mai. À ce moment, le nombre de mâles observés, la plupart en groupes, dépassait celui des couples, signe que la plupart des femelles couvaient alors, comme il a été calculé par les dates d'éclosion. À la fin de mai et en juin, le nombre de mâles a décliné rapidement; il en restait peu en juillet, ce qui indiquait peut-être une émigration avant la mue. L'année 1968, année de sécheresse, s'est caractérisée par un fort pourcentage du nombre de couples, comparativement à celui des mâles solitaires ou en groupes, ce qui veut dire que de nombreuses canes n'ont pas essayé de nidifier. En 1969, les conditions ont été meilleures, le printemps ayant été chaud à son début; les effectifs ont atteint leur maximum tôt et comptaient une forte proportion de mâles solitaires ou en groupes, signe d'une nidification précoce et presque générale. En 1970, les conditions étaient encore bonnes; toutefois l'accroissement des effectifs et le début de la nidification ont été plus graduels, peut-être à cause d'un début de printemps froid et d'une proportion plus élevée de géniteurs d'un an. À l'été, un gros orage a perturbé la production de fin de saison. La moyenne des couvées de trois ans a diminué de 6.4 dans la classe Ia à 4.4 dans la classe III, soit de 31%. Une méthode de calcul de la mortalité totale des canetons, y compris de l'anéantissement des couvées, a donné une estimation de 56% entre la classe Ia et le premier vol; toutefois, des anomalies dans les résultats ont laissé croire à des données erronées. La mortalité calculée a été la plus élevée pendant l'année de sécheresse. La croissance des canetons a été estimée par comparaison des moyennes des dates où les couvées étaient apparues dans différentes classes de plumage. Par cette méthode, on a calculé que le premier vol avait lieu après 33 jours, ce qui est plus précoce que ce qui a été observé dans d'autres études. Les populations de canards, après la reproduction, diminuaient brusquement autour de la mi-septembre et restaient faibles pour le reste du mois. En octobre, les effectifs se reconstituaient quelque peu, avant les migrations précédant la prise des glaces au début de novembre.

Introduction

Periodic observations along a determined route can provide considerable information on a wildlife species' life history and the effects of various environmental factors on movements, reproduction and survival. In this study, I observed Mallards during 3 years, 1968–70, at about weekly intervals from spring thaw until fall freeze-up, along a 32-km roadside route in the parkland of Alberta. I obtained data on the characteristics of spring breeding populations, and on postbreeding movements and fall egress.

I examined annual variations in production, development and mortality of young in relation to weather and habitat quality during 1968–70. In 1968 a drought resulted in scarce wetland habitat; in 1969 an excellent spring run-off filled all basins followed by generally dry weather during the nesting and brood period; in 1970 wetland conditions were excellent at the onset of breeding but seemingly adverse weather conditions occurred during the nesting period.

Dzubin (1969*a* and *b*) provides an excellent review of other studies on Mallard breeding populations, and Dzubin and Gollop (1972) give a thorough review of information on the production of Mallard young. I will therefore limit comparisons with other studies to a few of the most pertinent.

Study area and methods

The study area was located immediately east of Edmonton, Alberta, at the northwestern edge of the Aspen Parkland Life Area (Aldrich 1963). The area is mostly in cereal crops with interspersed woodland. Glacially-derived wetland basins are numerous, and in this region Mallard breeding populations occur at some of the highest densities in North America (Vermeer 1972). The survey route began at the junction of Highway 14X and 101st Avenue, at the eastern city limits of Edmonton. It proceeded along secondary roads 12.9 km east, hence 9.7 km south, hence 1.6 km west, hence 3.2 km north, hence 1.6 km west, hence 3.2 km south.

I drove the route at about weekly intervals during April through November in 1968 and 1969, and April through July in 1970. Each survey started at about 09:00 and was usually completed about noon.

Water bodies, or portions thereof, within 0.2 km of the road were included in observations. (In 1968, a few mostly hidden water bodies within 0.2 km were excluded, while observations were extended beyond 0.2 km on several lakes; however, I believe these minor variations had little effect on between-year comparability.) All observations were made at roadside from a vehicle. The water area and surrounding shoreline were scanned with the naked eye as approached, and then from a halt for several minutes or longer with binoculars and spotting scope. Mallards observed on upland or temporary puddles were included.

Through July, adult Mallards were recorded according to whether paired (with the opposite sex) or unpaired when observed, and also as lone or flocked pairs, or lone or flocked individuals — based mainly on their distance from other adult Mallards. Individuals or pairs separated by more than approximately 6 m were generally recorded as "lone". For females, the presence or absence of an accompanying brood was also noted. Young Mallards were recorded according to numerical brood size and age class (Gollop and Marshall 1954). After July, I made no attempt to separate adults from flying young or to determine sex; however, non-flying young were still recorded by brood size and age class.

Weather information is from the meteorological station at Edmonton International Airport, approximately 25 km southwest of the study area. Sizes of the 158 basins on the study area were determined using grid overlays on aerial photographs.

Results and discussion

1. Possible biases in results

In the study I interpreted changes in magnitude and composition of study area counts as representing changes in Mallard populations in the Alberta Parkland. However, several factors could have biased survey counts.

(*a*) *Sampling errors due to erratic local movements of Mallards on and off the survey area, and into and out of concealed positions* — I believe that during spring and early summer when Mallards tended to be separated into territorial pairs or small groups, sufficient samples were encountered to make unlikely large sampling errors due to local movement. During late summer and fall when Mallards tend to group in larger flocks and commonly feed in fields, there is greater likelihood local movements could cause significant variability in weekly counts. Counts of flightless broods showed moderate variability, perhaps indicating movement between on- and off-survey ponds, or from ponds to concealing surrounding upland.

(*b*) *Changing counts due to changing habitat preferences and behaviour patterns* — Upland egg laying and incubating by females obviously lowered their visibility during the spring nesting period, and observations of single males were usually treated as indicating pairs. During the flightless moult period, birds probably become more secretive and secluded. However, observations by Oring (1964) in Idaho and Hochbaum (1944) in Manitoba of flightless Mallard drakes, showed they were often in visible situations — large flocks frequenting open water out from shore.

Mallards often utilize smaller temporary potholes in spring and move to larger permanent water bodies for moulting and prior to fall migration. I think the study area was representatively composed of different wetland types. Sorensen and Isbister (1970) estimated from sample aerial photos that an average of 33% of basins in the Alberta Parkland were wet into July; the study area had 29% semi-permanent or permanent water bodies (average percentage wet into July during 1968–70). Eight per cent of basins along the study transect were 2 ha or larger, compared to an estimated 5% for the Alberta Parkland. The study area included portions of two lakes of over 40 ha.

The onset of hunting in September could have driven some Mallards from the roadside survey area to more isolated locations. However, I noted little hunting activity along the survey route and no waterfowl hunting. Most of the area was posted, and it appeared that landholders had little interest in hunting.

(*c*) *Changing visability of waterfowl due to vegetational changes* — By mid June many shallow ponds had become completely overgrown with emergent vegetation, and dense vegetation had developed around the finges of deeper ponds. I believe the developing vegetation did result in more overlooked birds, but not to the extent one might expect. In 1969, six ponds with heavy vegetation were selected for "beat-outs" after being observed from the vehicle. I attempted to locate any missed birds by walking closely around the pond yelling, clapping hands and throwing stones into the water. In 30 such beat-outs during mid June through August, I failed to locate any Mallards that had not been first seen from the vehicle. I believe Mallards generally refrain from areas with vegetation so dense as to impede movements and vision, preferring open water areas or areas with scattered vegetation.

2. General characteristics of spring breeding populations

Table 1 depicts by year the chronology of arrival of breeding pairs (lone and flocked drakes considered as indicating pairs), showing changes

Table 1
Observations of Mallard breeding populations during 1968–70 on a study area in the parkland of Alberta

	April			27 Apr–	May				June				29 Jun–	July		
	6–12	13–19	20–26	3 May	4–10	11–17	18–24	25–31	1–7	8–14	15–21	22–28	5 Jul	6–12	13–19	20–26
1968																
Lone pairs, %	100	100	38	62	21	39	32	18	37	3	10	0	33	No survey	—	0
Flocked pairs, %	0	0	42	17	21	0	14	2	18	20	13	0	0		—	0
Lone males, %	0	0	6	10	13	37	24	34	13	8	23	36	67		—	42
Flocked males, %	0	0	14	12	45	24	30	46	32	69	53	64	0		—	58
Total %	100	100	100	101	100	100	100	100	100	100	99	100	100	—	—	100
No. of indicated pairs*	1	10	50	42	62	41	50	50	38	75†	30	28	3	—	0	12
1969																
Lone pairs, %	0	52	28	38	16	12	12	23	11	0	0	0	0‡	—	—	—
Flocked pairs, %	100	20	11	3	1	0	5	0	3	7	0	0	0	—	—	—
Lone males, %	0	15	29	29	24	40	25	42	29	29	100	0	100	—	—	—
Flocked males, %	0	13	31	29	59	48	58	35	58	64	0	100	0	—	—	—
Total %	100	100	99	99	100	100	100	100	101	100	100	100	100	—	—	—
No. indicated pairs	5	60	89	58	70	60	65	26	38	14	2	16	1	0	0	0
1970																
Lone pairs, %	—	45	55	40	29	28	28	17	21	16	29	38	0	—	—	—
Flocked pairs, %	—	39	23	6	12	2	2	2	11	8	0	13	0	—	—	—
Lone males, %	—	15	14	27	27	25	40	29	21	11	29	38	5	—	—	—
Flocked males, %	—	0	7	28	33	44	31	52	46	65	43	13	95	—	—	—
Total %	—	99	99	101	101	99	101	100	99	100	101	102	100	—	—	—
No. indicated pairs	0	33	56	83	101	88	65	65	56	37	7	8	19	0	0	0
1968–70, means																
Lone pairs, %	17	54	38	44	23	25	23	18	23	6	13	6	4	—	—	0
Flocked pairs, %	83	24	23	8	11	1	6	1	11	15	10	2	0	—	—	0
Lone males, %	0	14	19	23	22	32	30	33	21	11	28	25	17	—	—	42
Flocked males, %	0	8	20	25	44	41	41	47	45	67	49	67	78	—	—	58
Total %	100	100	100	100	100	99	100	99	100	99	100	100	99	—	—	100
No. indicated pairs	2	34	65	61	78	63	60	47	44	42	13	17	8	0	0	4

*Lone and flocked males (observed without females), as well as observed pairs, are treated as indicated breeding pairs.
†Assumed to be mainly pre-moult migrants.
‡In 1969, successive counts were made on 6 and 10 July, and the 6 July count used for the 29 June–5 July period.

Table 2
Chronological distribution, expressed as percentages, of the Mallard hatch during 1968–70 on a study area in the parkland of Alberta, based on computed hatching dates of observed class Ia–Ic broods. Age classes and birth dates computed according to Gollop and Marshall (1954)

	May	28 May	June			25 June	July					No.
	21–27	–3 June	4–10	11–17	18–24	–1 July	2–8	9–15	16–22	23–29	Total %	broods
1968*	17	25	13	13	13	8	13	—	—	—	102	24
1969	19	14	8	11	6	17	19	3	—	3	100	36
1970	15	26	26	15	6	6	6	—	—	—	100	34
1968–70 total	17	21	16	13	7	11	13	1	—	1	100	94

*In 1968, observations were missed one week, and two Class I broods were assumed to have been present based on brood observations the previous week.

in the observed composition and numbers of indicated breeders through early summer. Generally, Mallards began arriving on the study area during the first half of April and a peak breeding population count was reached by early May. Counts tended to decrease slowly in the latter half of May, then drop more rapidly in June to very low levels by July. Initial observations were mainly of lone and flocked pairs; however, unpaired males quickly became common and by late April – early May outnumbered pairs. During April lone unpaired males were about as common as flocked unpaired males; however, this balance quickly shifted toward flocked males and they became the most common category through the remainder of the breeding season.

Some observed lone and flocked drakes were probably excess bachelor males. However, I believe a large majority of observed unpaired males were, or had been, mated. Unpaired males, expecially flocked males, were not commonly observed in the first weeks of Mallard ingress into the area. Most single unpaired drakes were on small potholes where I believe they were territorial and associated with a temporarily absent hen. Bellrose (1976) gives estimates of 51–53% drakes in spring Mallard populations and this probably approximates the study area ratio.

There appeared to be little early spring migration through the study area of Mallards bound for more northern breeding regions, and I believe most observed Mallards bred in the vicinity. Most pairs were observed as lone pairs on small water bodies, apparently selected as breeding territories. Observed flocked pairs were in relatively small groupings (such as two pairs or a pair and a drake), and the category had become uncommon by the end of April.

If we accept that most lone drake Mallards are territorial breeders still attached to a female engaged in egg-laying activities, while flocked drakes are indicative of females that have commenced incubating (Dzubin 1969*b*), then study area counts suggest the following pattern. Most Mallards were already mated upon arrival at their breeding area; Bellrose (1976) noted that most Mallards mate during fall and winter. Lone and flocked males increased in number very rapidly following arrival of Mallards on the study area and outnumbered observed pairs by early May. Further, flocked males outnumbered lone males by early May. I believe this indicates most females began laying and incubation soon after arriving on the area.

A rapid onset of nesting is also indicated by calculated hatching dates based on brood observations (Table 2). Mallard broods most commonly hatched during late May – early June, indicating that with an average clutch size of nine (one egg laid daily) and a 28-day incubation period (Bellrose 1976), most hens had begun egg laying during the latter half of April and were incubating by late April – early May.

Pairs continued to be commonly observed through the first half of June, and roughly half the indicated Mallard hatch occurred after early June, indicating some Mallards did not begin nesting until relatively late. However, much of this late nesting activity probably resulted from hens losing initial clutches and re-nesting. Dzubin and Gollop (1972) found in the Manitoba Parkland that two-thirds of first nesting attempts of Mallards were unsuccessful and further estimated that approximately half of these unsuccessful hens re-nested.

An interesting aspect of the study was the decline in observed males beginning about the third week in May and continuing until, by early July, males were rarely encountered. This disappearance seemed likely related to males moving to areas utilized for the eclipse moult and flight-

Table 3
Observations of female Mallards during 1968–70 on a study area in the parkland of Alberta

	April			27 Apr–	May				June				29 Jun–	July		
	6–12	13–19	20–26	3 May	4–10	11–17	18–24	25–31	1–7	8–14	15–21	22–28	5 Jul	6–12	13–19	20–26
1968																
Paired females, %	100	100	100	100	93	94	96	67	72	71	41	0	5	No survey	0	0
Single females — no brood, %*	0	0	0	0	7	6	4	20	17	4	41	90	47		71	83
Females with brood, %	0	0	0	0	0	0	0	13	10	25	18	10	47		29	17
Total %	100	100	100	100	100	100	100	100	99	100	100	100	99	—	100	100
No. females	1	10	40	33	28	17	24	15	29	24	17	29	19	—	14	18
1969																
Paired females, %	100	90	95	96	80	100	85	67	56	8	0	0	0†	0	0	0
Single females — no brood, %	0	10	5	4	20	0	15	11	0	25	43	47	32	14	31	25
Females with brood, %	0	0	0	0	0	0	0	22	44	67	57	53	68	86	69	75
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
No. females	5	48	37	25	15	7	13	9	9	12	7	15	19	14	13	4
1970																
Paired females, %	—	97	100	100	98	93	100	71	90	60	13	13	0	0	0	0
Single females — no brood, %	—	3	0	0	2	7	0	18	0	7	13	43	78	20	25	50
Females with brood, %	—	0	0	0	0	0	0	12	10	33	75	43	22	80	75	50
Total %	—	100	100	100	100	100	100	101	100	100	101	99	100	100	100	100
No. females	0	29	44	38	42	29	19	17	20	15	16	30	49	10	4	2
1968–70, means																
Paired females, %	100	93	98	99	93	94	95	68	76	53	23	5	1	0	0	0
Single females — no brood, %	0	7	2	1	7	6	5	17	9	10	30	62	61	17	48	71
Females with brood, %	0	0	0	0	0	0	0	15	16	37	48	32	38	83	52	29
Total %	100	100	100	100	100	100	100	100	101	100	101	99	100	100	100	100
No. females	2	29	40	32	28	18	19	14	19	17	13	25	29	12	10	8

*Females observed either alone or flocked, but not appearing paired with any observed male.
†In 1969, successive counts were made on 6 and 10 July, and the 6 July count was used for the 29 June–5 July period.

Figure 1 (overleaf)
Annual variation by weekly periods in observed Mallard populations in relation to water body abundance, precipitation and temperature during 1968–70 on a study area in the parkland of Alberta

less period. Hochbaum (1944) states that male Mallards begin gathering for moult on the Delta Marshes, Manitoba, by mid May and build to large concentrations by early June; some have become flightless by mid June.

Some males may have remained in the general vicinity of the study area during the moult period; however, there was possibly also a major pre-moult migration of males out of the Alberta Parkland, likely northward into the Boreal Forest Life Area. This suspicion is based not only on the disappearance of males from the study area, but also on a lack of observations of moulting concentrations in the Alberta Parkland approaching in total the approximately 400 000 males that annually breed in the region (Vermeer 1972).

On June 12, 1968, I may have witnessed a pre-moult passage of Mallards through the study area. On that date I observed 52 flocked males (and 15 flocked pairs), compared to 12 the previous week and 16 the week after. One flock, also containing pairs, took off as a group, rapidly gained altitude and disappeared from sight flying north, giving the strong impression they were migrating in that direction. Observations of pairs in these apparently migrating flocks indicated some birds — probably non-breeders — may moult in pairs.

Many other females, especially those unsuccessful in raising a brood, could also migrate separately to northern areas to moult. On 26 June 1968, flocks of six and 17 unpaired females were observed, which may have been in pre-moult migration. However, females without broods continued to be commonly seen during the summer (Table 3).

One area to which some moulting Mallards from the Alberta Parkland may migrate, is the Peace–Athabasca Delta in northeastern Alberta. Nieman and Dirschl (1973) reported an eightfold increase in adult Mallards between counts of spring breeding populations and summer moulting populations along sample transects in the delta. However, many more birds may moult on the myriad of glacial lakes and bogs throughout the Boreal Forest.

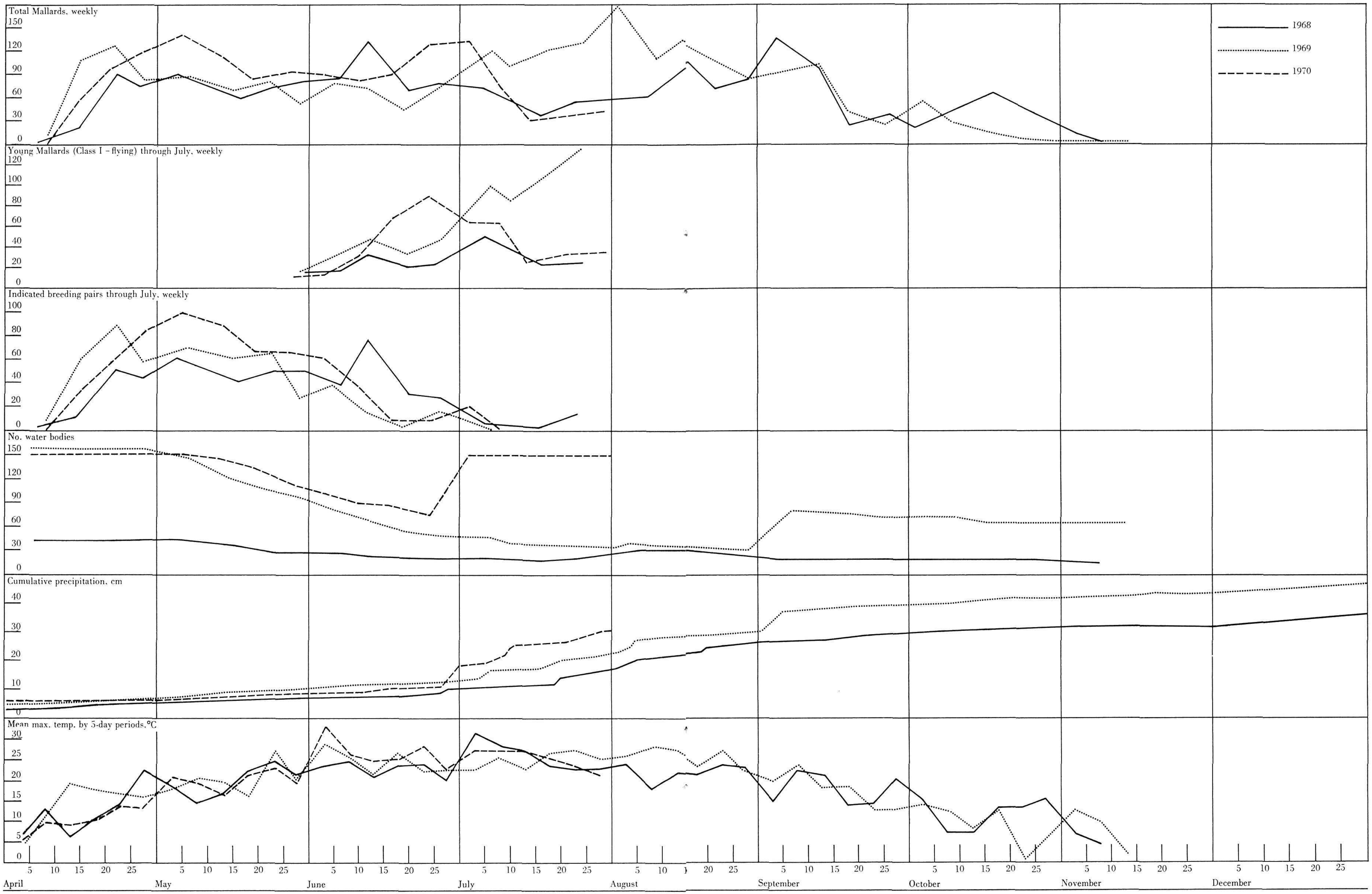
North American waterfowl sometimes migrate considerable distances to moulting areas, for example Pintail (*Anas acuta*) drakes fly to the Great Salt Lake Marshes, Utah, probably from Alberta (Bellrose 1976). Salomonsen (1968) has made a thorough review of our present knowledge of waterfowl moult migrations, with emphasis on Old World populations. He typifies adult male ducks as having a moult migration (but not most females) and suggests such migrations have survival advantage by removing a large segment of the population from food competition with parent hens and their developing young.

Dzubin (1969*b*) made periodic counts of Mallards in the grassland of southwest Saskatchewan during 1958. Mallards arrived in numbers about a week earlier than in my study and were mostly seen as pairs until late April; thereafter lone and flocked drakes became predominant. Indicated breeding pairs remained at a plateau from late April through mid May and then increased during late May – early June. However, most indicated pairs observed during late May through June were in male or mixed-sex flocks of six or larger which Dzubin considered to be made up of post breeding birds, including transients. By late June, counts of males were approximately one-quarter the number noted during early May.

3. Annual variations in spring breeding populations

Figure 1 relates annual differences in breeding populations to annual variations in temperature, precipitation and numbers of water bodies.

Figure 1


Total Mallards, weekly
Young Mallards (Class I – flying) through July, weekly
Indicated breeding pairs through July, weekly
No. water bodies
Cumulative precipitation, cm
Mean max. temp. by 5-day periods, °C
1968
1969
1970
April
May
June
July
August
September
October
November
December

In 1968, the driest conditions of the study occurred, with 73% of study-area basins dry at the onset of the breeding season. The peak count of indicated breeding pairs (62 on 4 May) was lower than in 1969 or 1970 (I believe most of the 75 indicated pairs seen on 12 June — mainly flocked males and flocked pairs — were pre-moult migrants). Indicated breeding pair counts remained high into June — longer than in the other 2 years — and a relatively high proportion of observations continued to be of lone and flocked pairs rather than lone and flocked males (Table 1). I interpret this to mean that many pairs did not attempt nesting activities — possibly waiting for rains to improve habitat conditions or for other nesting pairs to vacate territories. However, habitat conditions continued to deteriorate. Indicated breeding pairs dropped sharply in late June, apparently indicating cessation of breeding attempts. I observed fewer class I broods than in 1969 or 1970, with no indication of production after early July (Table 2). During June and July only 30% of 104 observed unpaired hens were accompanied by a brood (Table 3). In addition to drought conditions, several very cold nights occurred during the egg-laying and incubation period, with weather station readings of −8 and −11°C on 9 and 10 May, and these low temperatures could have adversely affected production.

In 1969, conditions appeared near ideal for successful breeding. A sudden upswing to warm temperatures in early April (Fig. 1) caused heavy run-off, and all study area basins were filled. Mallard indicated breeding pairs quickly reached peak numbers (89 on 22 April), and by that date over half were observed as lone and flocked males — indicative of a very rapid onset of egg laying and incubation. Many drakes appeared to desert the study area quickly as their hens began incubation and numbers of indicated breeding pairs fell quite rapidly from their late April peak. Dry weather prevailed through June and was likely conducive to good hatching success, in spite of two cold nights, with weather station readings of −6 and −4°C on 12 and 13 June, which possibly damaged some eggs. Fifty per cent more class I broods were seen than in 1968 (Table 2), and 70% of 87 unpaired hens observed in June and July were with broods (Table 3). Although many temporary basins dried up during May and June, good numbers of semi-permanent and permanent water bodies maintained adequate levels and were stabilized by increased rainfall during July. Modest numbers of lone pairs were seen through early June, and many new broods were seen in late June–early July, indicating a good re-nesting effort by hens unsuccessful in first attempts.

In 1970, water conditions were again excellent upon the spring return of Mallards; however, cool temperatures and snow cover until about 10 April apparently slowed the build-up of breeding populations compared to 1969. The peak indicated breeding pair count of 101 was not until 5 May, 2 weeks later than in 1969. There was probably also a high proportion of yearlings in 1970, resulting from good production in 1969, and yearlings may tend to arrive later on breeding areas than older birds. Lone pairs continued to be commonly seen through early June, although the proportions of unpaired drakes were not as high as in 1969. This indicates that hens did not begin nesting as soon after spring arrival as in 1969, possibly also a result of a higher proportion of yearlings. In spite of good water conditions, brood observations indicated a minimal late-season hatch in 1970 (Table 2); I believe a severe 2-day storm on 30 June – 1 July, although filing all basins, disrupted many late-nesting hens and perhaps caused considerable mortality of young broods due to exposure. Over 8 cm of rain fell; temperatures on 30 June ranged between only 8 and 14°C with high winds gusting to over 80 kmph. On the day after the storm, a study area count included 38 unpaired females without broods, the largest number seen in the study. Only four class I young were seen, compared to 39 the previous week. In 1970, 49% of 113 unpaired hens observed in June and July had broods — midway between 1968 and 1969 percentages — and the number of observed class I broods was 42% greater than 1968 and 6% less than 1969.

4. Observations of young

Table 4 shows numbers of observed Mallard broods and mean brood sizes by age class. Average brood size tended to decrease with age, although there were exceptions, apparently due to sampling variability. The 3-year-average decrease in brood size from class Ia to class III (fully-feathered and near flight) was from 6.4 to 4.4, indicating partial brood mortality of 31%. In a 4-year study in the Manitoba Parkland (Dzubin and Gollop 1972), class Ia Mallard broods averaged 6.3 and class III averaged 6.1 — only a 3% decrease. In a 4-year study in the Saskatchewan Grassland, the above authors found class Ia Mallard broods averaged 5.8, while class III averaged 4.8 — a 17% drop.

Although decreasing mean brood size with increasing age gives partial indication of duckling mortality, the loss of entire broods is not accounted for. Theoretically, with regular observations, changes by age class in total numbers of ducklings observed can provide estimates of total mortality from age class to age class. However, adjustments must be made to account for the different time spans of age classes. In Table 4, I have so adjusted numbers of observed broods in each age class to obtain total mortality estimates. These calculations suggest an average total duckling mortality of roughly 55–60% from class Ia to flight stage. However, nonsense mortality figures (increases in numbers of ducklings) were obtained for some age classes, indicating sampling errors due to changing visibility or local movements of broods or, for some age classes, variation from the time spans given in Gollop and Marshall (1954).

Results of harvest surveys and banding indicate a long-term approximately equal ratio of young to adult Mallards in fall populations prior to the onset of hunting (Bellrose 1976). Studies by Dzubin and Gollop (1972) in the Manitoba Parkland indicated that, with re-nesting, approximately 47% of Mallard hens successfully hatch a brood. Let us assume that 47% of study area hens also hatched a brood, and take my class Ia mean of 6.4 as the average number of young per hatched brood. Applying my estimated 56% mortality between class Ia and flight stage then gives a ratio of 0.6 young produced per spring-population adult, assuming about 1.1 adult drakes per hen. With the death of some adults between spring and fall — roughly estimated to be about 13% (Anderson 1975) — the calculated fall immature/adult ratio would be 0.7. Although this ratio is less than the continental average, it would be sufficient to maintain populations given Anderson's estimates of annual survival rates for Mallards banded in southwest Alberta, roughly 70% for adults and 50% for flying young.

Another means of assessing the production of flying young per adult breeder would be to assume that classes IIc–III (near flight) young were as visible as adult breeders and compare the two counts, first adjusting for the average number of times that IIc–III young would be observed. With a 20-day period for classes IIc–III (Table 4) and weekly observations, individuals would be seen an average of 2.9 times. For the 3 study years, an annual average of 80 IIc–III

Table 4
Calculations of Mallard duckling mortality based on changes in mean brood size and adjusted numbers of broods observed, by age class. Observations were missed during 1 week in 1968 (6–12 July) and in 1970 terminated on 30 July. To account for the missed observations, seven broods were added for 1968, and three for 1970, based on brood observations in the week previous to those missed

	Brood age class						
	Ia	Ib	Ic	IIa	IIb	IIc	III
	Days						
	1–6	7–12	13–18	19–25	26–35	36–45	46–55
1968							
Observed mean brood size	7.71	4.75	4.00	6.00	5.71	3.20	4.38
Number of broods observed	7	8	9	4	7	5	8
Adjusted number of broods*	7.00	6.67	7.50	2.86	3.50	2.50	4.00
Adjusted total ducklings	54	32	30	17	20	8	18
Indicated % mortality from class Ia		−41	−44	−69	−63	−85	−67
x̄ (Ib–Ic; IIa–IIb; IIc–III)		−43		−66		−76	
1969							
Observed mean brood size	6.33	6.50	5.81	7.75	4.13	5.08	3.44
Number of broods observed	6	14	16	8	16	12	9
Adjusted number of broods	6.00	11.67	13.33	5.71	8.00	6.00	4.50
Adjusted total ducklings	38	76	77	44	33	30	15
Indicated % mortality from class Ia		+100	+103	+16	−13	−21	−61
x̄ (Ib–Ic; IIa–IIb; IIc–III)		+102		+2		−41	
1970							
Observed mean brood size	5.38	5.50	6.00	5.75	6.18	4.82	5.38
Number of broods observed	8	12	14	8	11	11	8
Adjusted number of broods	8.00	10.00	11.67	5.71	5.50	5.50	4.00
Adjusted total ducklings	43	55	70	33	34	27	22
Indicated % mortality from class Ia		+28	+63	−23	−21	−37	−49
x̄ (Ib–Ic; IIa–IIb; IIc–III)		+46		−22		−43	
1968–70 totals							
Observed mean brood size	6.43	5.74	5.46	6.60	5.12	4.64	4.36
Number of broods observed	21	34	39	20	34	28	25
Adjusted number of broods	21.00	28.33	32.50	14.29	17.00	14.00	12.50
Adjusted total ducklings	135	163	177	94	87	65	55
Indicated % mortality from class Ia		+21	+31	−30	−36	−52	−59
x̄ (Ib–Ic; IIa–IIb; IIc–III)		+26		−33		−56	

*Numbers of broods observed in each age class were divided by the following factors to account for differences in the time spans of age classes (Gollop and Marshall 1954): Ia, 1.0; Ib and Ic, 1.2; IIa, 1.4; IIb, IIc, and III, 2.0 (class Ia treated as a 5-day span on assumption young would usually not be seen on first day).

Table 5
Indicated sampling errors in observations of Mallard young (1968–70 combined) based on discrepancies between expected (from previous week's observations) and actual counts of ducklings. In calculating expected counts for a weekly period, the previous week's observed young were reduced by 7% (as per indicated 1% daily mortality during 56-day flightless period). The reduced count was then split according to the proportion that would attain the following age class and inversely the proportion that would remain in the same age class; as determined by dividing 7 days (period between counts) by the age class day-span: class Ia–c, 0.39; class IIa–b, 0.41; class IIc–III, 0.35

	Observation period										
	May		June				29 June†	July			Mean %
	18–24	25–31	1–7	8–14	15–21	22–28	–5 July	6–12*	13–19*	20–26	difference‡
Class Ia–c											
Observed	0	43	61	91	98	62	91	46	29	11	—
Class IIa–b											
Expected	0	0	16	22	42	49	70	46	42	22	
Observed	0	0	0	17	25	86	60	45	19	27	
% difference	—	—	—	−23	−40	+76	−14	−2	−55	+23	33
Class IIc–III											
Expected	0	0	0	0	7	9	39	49	48	42	
Observed	0	0	0	0	0	11	54	51	34	20	
% difference	—	—	—	—	—	—	+38	+4	−29	−52	31
Flying young											
Expected	0	0	0	0	0	0	4	24	21	68	
Observed	0	0	0	0	0	0	8	5	53	128	
% difference	—	—	—	—	—	—	—	−79	+152	+88	106

*In 1968, there was no survey during the 6–12 July period, and expected and observed counts for 6–12 July and 13–19 July are based only on 1969 and 1970 observations.
†In 1969, successive counts were made on 6 and 10 July, and the 6 July count was used for the 29 June–5 July period.
‡Average of weekly percentage differences for weeks where more than 20 young were expected, disregarding sign of difference.

Table 6
Calculated mean plumage development rate for Mallards in the parkland of Alberta, based on mean observation dates of broods by plumage age class (1968–70 combined). In calculating the mean plumage development rate, I drew boundary lines midway between mean observation dates for consecutive plumage classes. I assumed that hatching occurred the same number of days before the class Ia mean observation date as was the Ia–Ib boundary after the mean and that class III contained double the number of days between the class III mean and the IIc–III boundary. Day-spans and midpoints were then determined for the seven resulting class blocks

	Age class						
	Ia	Ib	Ic	IIa	IIb	IIc	III
No. broods observed*	21	34	39	20	34	28	25
Mean observation date	16 Jun	22 Jun	26 Jun	6 Jul	7 Jul	13 Jul	15 Jul
Age class span (hatching, day 1)	1–6	7–11	12–18	19–24	25–27	28–31	32–33
Age class midpoint (hatching, day 1)	3	9	15	21	26	29	32
No. days within age class	6	5	7	6	3	4	2

*Observations were missed for 1 week in 1968 and in 1970 were terminated on 30 July. To account for these missed observations, seven broods were added in 1968 and three in 1970, based on brood observations immediately previous to those missed.

young were seen, indicating an average of 28 young produced. Averages of the three highest indicated breeding pair counts are by year (Table 1) 54, 75 and 91 — giving a 3-year average of 73 indicated pairs or roughly 146 individuals. Dividing 28 by 146 gives only 0.2 young per adult, far less than the 0.6 ratio of the first method, and probably indicates lower visibility of young compared to spring populations of adults.

My computations of total mortality from class Ia to IIc–III (Table 4) were highest for 1968, the drought year, at 76%. Further, the number of class IIc–III ducklings observed in 1968 (51) was the lowest of the 3 years. Estimated mortality from Ia to flight stage was similar in 1969 and 1970 (41 and 43%). The number of IIc–III ducklings observed was also similar for the 2 years (92 and 96).

I roughly assessed the degree of sampling variability in duckling observations by comparing actual weekly counts with expected counts based on the previous week's tally, adjusting for weekly mortality and progression of young to older age classes (Table 5). The expected and observed counts show only fair agreement: observed counts for non-flying young averaged about 30% disagreement from expected counts. This seems to indicate young commonly move on and off surveyed water bodies, or into and out of positions of concealment. Young and parent hens could spend a significant amount of time on upland, moving between ponds and perhaps feeding on terrestrial insects and maturing grain in fields surrounding ponds. Results of numerous studies of marked young, as summarized by Dzubin and Gollop (1972), show Mallard ducklings frequently make overland movements, often for no obvious reason. My expected and observed counts for flying young showed even greater disagreement than for the flightless categories, probably indicating their greater mobility.

I assessed the possibility that growth rates and time spans in age classes differed on the study area from those given by Gollop and Marshall (1954) by determining average observation dates for broods in different age classes (Table 6). With regular observations, differences in average observation dates for consecutive age classes should indicate the development period between age class midpoints. Divisions can be plotted between mean observation dates to approximate time spans in age classes.

My calculations indicated a 33-day development period to flight stage, considerably shorter than the approximately 56 days given by Gollop and Marshall based on observations of known-age broods in South Dakota. The calculated more rapid growth was concentrated in classes IIb through III. An intermediate development period was indicated in my 1969 study results by a 39-day span between first sightings of newly hatched young and flying young. In 1970, flying young were not seen until 56 days after newly-hatched young, but class III young, nearing flight, were seen at 37 days. Bellrose (1976) notes three studies in Alaska where Mallards gained flight in 40–43 days. Because my calculated 33-day period is shorter than any noted elsewhere, it is likely biased by sampling variability, or visibility or mortality differences for young born at different times of the season; however, results generally indicate somewhat more rapid development than that calculated by Gollop and Marshall for the South Dakota broods.

Observations of Mallard broods indicated a preference for more permanent, larger water bodies; 97% of observed broods were on water areas that contained water at least into August, and 71% of broods were seen on water areas of 1.2 ha or larger. In comparison, 73% of indicated territorial adult breeders (lone pairs and lone drakes) were seen on water areas wet into August, and 54% were on areas of 1.2 ha or larger. An average 26% of basins remained wet into August, and 9% were 1.2 ha or larger.

5. Late summer and fall populations

Figure 1 depicts counts of total Mallards during August through freeze-up in November for 1968 and 1969; no attempt was made to separate age and sex categories during this period. The picture is quite similar between years. In 1968, with poor production, Mallard numbers increased moderately from early August to a peak in mid August; then following a moderate drop, gradually built to a second and highest peak in early September; thereafter Mallard numbers fell sharply. A moderate build-up was again noted in mid October, but counts did not approach early September levels and then fell to only a few birds by early November.

Assuming that some adult males migrated from the parkland region to moult, it is interesting to speculate whether the population build-up in August and early September represented a return of males to the breeding area. Swathed and waste grain became available for field feeding by this time. The mid October increase perhaps represented a final movement through the region of birds from more northern areas.

In 1969, a year of good production, Mallard counts were much higher in early August than in 1968, probably composed of many young. However, the 1969 counts immediately thereafter fell sharply, perhaps indicating the departure of some young from the area. Counts modestly recovered in mid August, possibly indicating the return of some post-moult adults, then dropped slightly to a plateau through mid September. As in 1968, counts dropped drastically during the latter half of September. Although a modest increase was seen in early October, Mallards were observed in relatively low numbers through the remainder of the fall.

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