POPULATION DYNAMICS OF THE RED-TAILED HAWK (*BUTEO JAMAICENSIS*) AT ROCHESTER, ALBERTA

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THE primary objectives of this paper are to describe the dynamics of a representative population of Red-tailed Hawks in central Alberta and to evaluate current population status and trend through a life equation.

A number of studies of the Red-tailed Hawk (*Buteo jamaicensis*) have been carried out in the temperate latitudes of the United States. Fitch et al. (1946) discussed the behavior and food habits of a Red-tail population in the foothills of the California Sierra Mountains. Orians and Kuhlman (1956) and Hagar (1957) described breeding populations of Red-tailed Hawks and Great Horned Owls (*Bubo virginianus*) in Wisconsin and New York. Species composition and nesting success of raptor populations, including Red-tails, was studied in Michigan and Wyoming by Craighead and Craighead (1956). To our knowledge, no detailed investigation of Red-tailed Hawk populations on their northern breeding range has been published.

The influences of biocides and changing land use on populations of avian predators is causing increasing concern (International Council for Bird Preservation, [1964]; Hickey, 1969). To assess the effects of such environmental changes on populations, rates of reproduction and survival must be known from different segments of a species' range.

THE STUDY AREA

This investigation was conducted at the Rochester Wildlife Research Center, Rochester, Alberta. Our initial study area of 50 square miles in 1966 was enlarged to 60 square miles in 1967–69 (Figure 1). The terrain is flat to gently rolling, and the largely podsolic soils were formed on glacial till. Approximately 5 per cent of the surface is permanently covered by lakes and marshes, and the Tawatinaw River Valley which roughly bisects the study area, is the dominant topographic feature. The upland is nearly equally divided between agriculture and forest. Farmland is mainly planted to small grain and forage crops; aspen (*Populus tremuloides*) and balsam poplar (*P. balsamifera*) predominate in wooded areas. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) bogs are common on lowlands east of the Tawatinaw Valley. In the last 10 years, about 5 per cent of the uncultivated land has been burned over. The abandonment of many early farmsteads during the late 1930s has left parts of the study area in various stages of secondary succession, and much of this same ground is now being recleared for cultivation.

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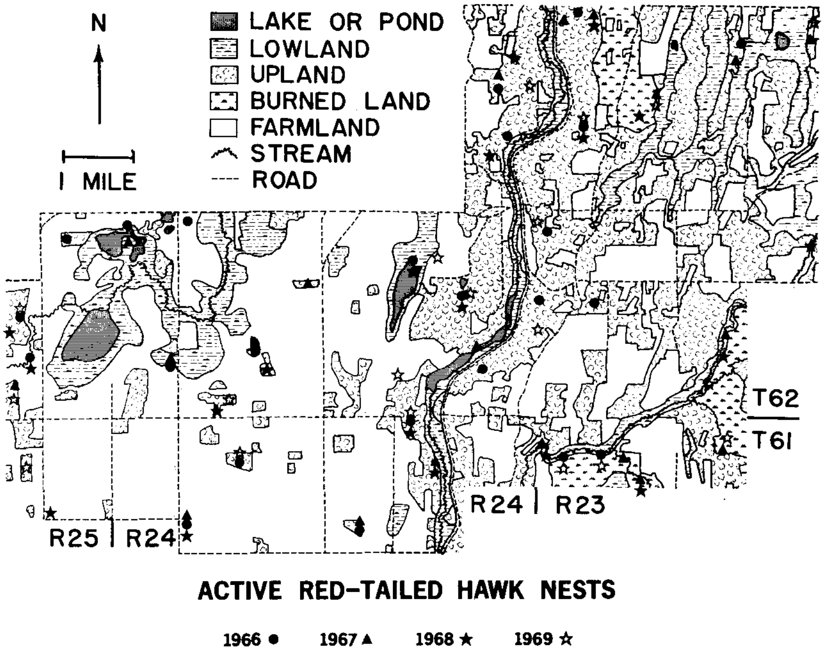

Figure 1. Distribution of active Red-tailed Hawk nests on 60-square-mile study area at Rochester, Alberta.

Methods

We employed several techniques to locate nests that we felt might be acceptable to Red-tailed Hawks. The mainly deciduous forest cover leaves many of these large nests conspicuous from early fall until late spring. Prior to the winter of 1966 we found nests by driving roads and trails, and accidentally during other field studies. During the winters of 1966–69, we also made nest searches from helicopters and fixed-wing aircraft. The main purpose of these flights was a coyote (*Canis latrans*) census, but an additional observer recorded the location of raptor nests. The aircraft flew 0.25-mile transects at a mean elevation of 350 feet. We believe we located essentially all of the large-raptor nests on the study area, for only 13 previously unknown nests were found in five helicopter flights during the winters of 1966 and 1967, and none during ground surveys in 1968. Furthermore when 9 of the 21 resident pairs of Red-tails built completely new nests in May 1969, all were located by late June. Known large-raptor nests on the study area currently total 114.

We also found 36 nests off the study area; 19 of these, in the Thorhild district 25 miles southeast of Rochester, provided information on clutch size and reproductive success during 1968 in a population undisturbed by tethering of young.

During the spring we checked study-area nests from one to three times for occupancy. The first visit was in March and early April to locate nesting Horned Owls. All inactive nests were rechecked in May and June for nesting Red-tails, Goshawks (*Accipiter gentilis*), Cooper's Hawks (*A. cooperii*), and Broad-winged Hawks (*Buteo* *platypterus*). In 1968 we revisited previously inactive nests in early May to determine the number of Red-tails incubating; a later visit to these same nests in early June established the proportion of incubating birds that successfully hatched young.

In 1966 all nest trees climbed (6) or partially climbed (1) during incubation were subsequently deserted. Therefore during 1967, 1968, and 1969 no nest trees on the study were climbed until the young had hatched. The presence of excrement ("white-wash") around the base of the nest tree proved a reliable indicator of young in the nest. Off the Rochester study area, all nests considered active were checked for eggs. We found that nests where the adults screamed and swooped as the investigators approached, or from which a bird was flushed, invariably contained eggs. Active nests were later reexamined to ascertain nestling survival rates and dates of fledging.

Nestlings were aged by comparing weights against an age-weight curve derived for known-age young.

As this study was carried out concurrently with an investigation of Red-tail food habits, 3- to 4-week-old nestling Red-tails were tethered near the base of the nest tree for approximately 3 to 4 weeks—1 to 2 weeks beyond their normal 45-day fledging period (Fitch et al., 1946). Tethering sites were visited once every 2 days to record food items brought to the young.

Eight resident adult Red-tails were live-trapped with bal-chatri cages (Berger and Mueller, 1959) and bownets (Tordoff, 1954) and color-marked during the springs of 1966–68. Trapping was most effective shortly after birds returned in spring, a period when vulnerable prey were apparently scarcest. In 1968 we also used distinct plumage patterns and/or the absence of certain flight feathers to distinguish between unmarked individuals.

Resident Red-tail pairs reacted aggressively as we approached their nests or nesting areas. With one exception the range of each pair was known to have included at least one nest that we judged suitable for Red-tail occupancy. Resident singles were never known to be associated with any large nest and were inconspicuous in their diurnal activities.

Results and Conclusions

Spring population.—The number of Red-tailed Hawks resident on the Rochester study area during the springs of 1967, 1968, and 1969 declined from 53 to 48 to 42 (Table 1). Only one bird was thought to be a yearling; it lacked the typical reddish retrices of the adult plumage. This individual was among the breeding cohort successfully fledging young in 1967. Of the resident Red-tails, 92 per cent were paired.

The mean density for Red-tails was one pair per 2.7 square miles. This compares closely with reports of one pair per 2.8 and 2.2 square miles in Wisconsin (Orians and Kuhlman, 1956) and New York (Hagar, 1957). The highest density for Red-tails was reported by Fitch et al. (1946) as one territorial pair per 0.5 square mile along the western foothills of the California Sierra Mountains.

While we determined the number of breeding pairs on the study area in 1966, we made no estimate of the total resident population. During 1967–69 approximately 80 per cent of the total population (86 per cent of the resident pairs) was known to have produced clutches. Breeding-pair

TABLE 1
COMPOSITION OF SPRING RED-TAILED HAWK POPULATION ON ROCHESTER STUDY AREA[1]

Population cohorts	Numbers 1966	1967	1968	1969
Resident pairs	?	23	22	21
Breeding (laying)	24	20	19	18
Nonbreeding (nonlaying)	?	3	3	3
Resident singles	?	7	4	0
Total resident population	?	53	48	42

[1] Size of the study area increased from 50 square miles in 1966 to 60 square miles in 1967–69.

density showed progressive decline over the 4 years—2.1, 3.0, 3.2, and 3.3 square miles per pair. For 14 per cent of the paired birds we found no active nests, and these pairs we classed as nonbreeders. Nonbreeding among resident pairs elsewhere has averaged 17 per cent, i.e. 10 per cent in Wisconsin (Orians and Kuhlman, 1956), 16 per cent in Michigan and Wyoming (Craighead and Craighead, 1956) and 26 per cent in New York (Hagar, 1957). The entire nonbreeding cohort at Rochester, including single birds, amounted to 20 per cent of the total resident population during 1967–69.

Reproductive chronology.—The Red-tailed Hawk is present on its northern breeding range in summer for about 5 to 6 months. The first ones appeared at Rochester each year during early April (Table 2), and by mid-October the last had departed. Within 1 week after arriving on the study area, pairs aggressively reacted to humans at nest sites. The birds usually occupied and added to previous nests. During 1966–68, only one breeding pair was known to have built a new nest, but in 1969, the 21 resident pairs built 9 new nests.

The first pairs began incubation during the second week in April. By backdating 32 days (Bent, 1937; Hardy, 1939) from the 2 June mean hatching date, the mean date for initiation of incubation was computed as 1 May. During any one year, the range of time over which breeding birds began incubating nests was estimated from ages of nestlings to be approximately 33 days. Thus within 3 weeks after the first Red-tails were observed, mated pairs had selected a nesting site, produced a clutch, and started incubating.

Fitch et al. (1946) record a fledging period of 45 to 46 days, which corresponds with the 44-day interval noted at Rochester. The nesting cycle from onset of apparent territoriality until fledging is thus nearly 3 months.

Clutch size.—Mean clutch size as determined from 30 complete clutches was 1.9; and as determined from numbers of 1- to 2-week-old nestlings

TABLE 2

REPRODUCTIVE CHRONOLOGY OF THE RED-TAILED HAWK AT ROCHESTER, ALBERTA

			Eggs				
			Initiation of incubation[2]		Hatching interval		
Year	First Red-tailed Hawk seen	First signs of aggressive behavior[1]	Range	Mean	Range	Mean	Calculated mean fledging date[3]
1966	7 Apr.	14 Apr.	12 Apr.–13 May	30 Apr.	14 May–14 June	1 June	16 July
1967	8 Apr.	10 Apr.	12 Apr.–26 May	4 May	14 May–27 June	5 June	20 July
1968	2 Apr.	11 Apr.	14 Apr.–11 May	25 Apr.	16 May–12 June	27 May	11 July
1969	11 Apr.	—	18 Apr.–17 May	3 May	20 May–18 June	5 June	20 July

[1] Screaming and swooping when investigator was near nest site.

[2] Hatching date estimated from nestling weights and age-weight curve of known-age nestlings. Incubation date obtained by backdating an average 32 days (Bent, 1937; Hardy, 1939) from calculated hatching date.

[3] Forty-five days after hatching (Fitch et al., 1946).

TABLE 3
RED-TAILED HAWK NESTING FAILURES BEFORE YOUNG REACHED 1 to 2 WEEKS OF AGE, 1968

Source of data	Incubated nests	Nesting failures	
		Number	Per cent
Rochester[1]	19	6	32
Other areas[2]	24	5	21
Totals	43	11	26

[1] No nest trees were climbed. Nests assumed to be active if the adults exhibited aggressive behavior when the investigator approached, and/or an adult was seen sitting on the nest. In all instances where this behavior was noted and the nest tree was climbed, a clutch was being incubated.
[2] Incubation confirmed through clutch observations.

plus unhatched eggs in 68 nests, mean clutch size was 2.1. The overall average of 2.0 ± 0.1 eggs per clutch is consistently below that summarized by Henny and Wight (1970) for the United States and southern Canada. At Rochester no significant differences were evident in mean clutch size between years, but our data indicate that active nests that failed before the young were 1 to 2 weeks old contained significantly smaller clutches (1.7 eggs/nest) than nests with continued occupancy (2.3 eggs/nest). Reduced clutch size (Lack, 1947) and probably increased frequency of nest desertion are common traits among young breeders nesting for the first time in other species, but we have no way of assessing whether this was true in our Red-tail population.

Nest desertion.—During 1968, the year for which our data are most complete, 26 per cent of the incubated nests were unsuccessful before the young reached 1 to 2 weeks of age (Table 3). This figure is close to the average (28 per cent) of rates of unsuccessful nesting noted by Fitch et al. (1946), 17 per cent; Orians and Kuhlman (1956), 26 per cent; and Hagar (1957), 41 per cent. We do not know to what extent clutches were either deserted or destroyed, or whether losses of newly hatched young were involved.

Climbing the nest tree during incubation had no obvious effect upon nest success in 1968. On the Rochester study area, 6 of the 19 nests in unclimbed trees produced no 1- to 2-week-old young; while off the study area, 5 of the 24 nests in trees that were climbed were also unsuccessful. In 1966 on the other hand, 7 of 24 nesting trees were climbed or partly climbed to determine clutch sizes, and each of these nests was subsequently deserted. As stated earlier, this experience discouraged us from further climbing during incubation.

Hagar's (1957) study in central New York suggested that interference by Great Horned Owls prompted 40 per cent of the Red-tail nest desertions

TABLE 4
NATURAL MORTALITY OF NESTLING RED-TAILED HAWKS UNTIL AGE 3–4 WEEKS

Area and year	Nests with young	Nestlings				
		Minimum hatch		3–4 weeks old		Per cent mortality
		Number	Average/nest	Number	Average/nest	
Rochester						
1966	17	29	1.7	29	1.7	0
1967	16	32	2.0	28	1.8	12
1968	13	25	1.9	19	1.5	24
1969	18	35	1.9	31	1.7	11
Other areas						
1968	15	30	2.0	28	1.9	7
Totals	79	151	1.9	135	1.7	11

before hatching; the minimum interspecific distance tolerated between nesting pairs was 350–700 yards. The same interaction may have been responsible for some desertions in the Rochester area. Five of the six nests deserted in 1968 were less than 0.5 mile from nesting Horned Owls, but there were no desertions in 1969, and two nests were within 350 and 530 yards of active Horned Owl nests.

Egg hatchability.—Of the 172 eggs from nests producing young, 4 per cent failed to hatch.

Nestling survival.—The minimum hatch was largely determined when young Red-tails were 1 to 2 weeks old; 2 to 3 weeks later another count was taken and surviving nestlings on the study area were tethered on the ground near their nest site for food-habits investigations. Mortality during this 2- to 3-week period averaged 11 per cent (Table 4). In 1968 we found remains of three nestlings at nests; in 1969 we found the remains of two nestlings. The rest during 1967–69 simply disappeared. Differences in survival rates on and off the study area (1968) were not statistically significant.

Mean initial brood size, as determined from minimum-hatch information, was 1.9 nestlings per breeding pair with young (Table 4). Yearly means ranged from 1.7 to 2.0. Subsequent rates of loss up to fledging (Tables 4 and 5) would then give an average of 1.4 young fledged per hatched clutch. This figure is identical to that computed from the data of Fitch et al. (1946) and Craighead and Craighead (1956); it is considerably below the 1.9 young reported by Orians and Kuhlman (1956) and Hagar (1957).

Study-area nestlings were tethered on the ground for an average of 3.5 weeks beginning at age 3 to 4 weeks. In assessing nestling mortality during 1966–69, the 21 tethered birds lost through handling and starvation were

TABLE 5
MORTALITY OF NESTLING RED-TAILED HAWKS FROM AGE 3–4 WEEKS UNTIL FLEDGING[1]

Year	Nests with young	Young: 3–4 weeks old	Young: Mortality factor: Predation	Young: Mortality factor: Disappeared	Young: Fledged: Number	Young: Fledged: Average/nest	Per cent mortality
Rochester							
1966	17	21	1	0	20	1.2	5
1967	16	21	0	0	21	1.3	0
1968	13	15	5	0	10	0.8	33
1969	16	29	7	1	21	1.3	28
Other areas							
1968	15	28	0	6	22	1.5	21
Totals	77	114	13	7	94	1.2	18

[1] Young dying from such unnatural causes as handling and starvation were excluded from this sample. No starvation occurred among untethered birds off the study area.

excluded from the total 3- to 4-week-old sample. Natural mortality in the form of predation (13) and disappearance (7) accounted for 18 per cent of the remaining birds both on and off the Rochester study area (Table 5).

Predation was an important factor in the loss of tethered young at Rochester during 1968 and 1969. In 1968, 5 of the 15 tethered birds (33 per cent) were either decapitated or had their skulls crushed. The tethering of young Red-tails at age 3 to 4 weeks did not appear to increase natural losses up to fledging significantly. During this same period when 33 per cent of tethered young were lost *on* the study area, 21 per cent (6) of the 28 untethered young *off* the study area also disappeared. We had no clue to the possible cause(s) of nestling loss at the latter nests.

In 1969, 7 of the 29 tethered young (24 per cent) were definitely lost to predation; another simply disappeared. Three kills were intact, but with crushed skulls. The remaining four were largely consumed or badly chewed, and in two instances fresh coyote or dog scat was present.

With the probable exception of the latter four kills, we strongly suspect that Great Horned Owls were responsible for most Red-tail losses noted on the Rochester study area. The decapitation and skull damage described above are typical of Horned Owl predation (Errington, 1932; D. H. Rusch and E. C. Meslow, pers. comm.); and in one instance an owl feather was found at the kill. Many studies have reported interspecific predation between Great Horned Owls and Red-tails (Fitch, 1940; Hamerstrom and Hamerstrom, 1951; Craighead and Craighead, 1956; Orians and Kuhlman, 1956).

Daily activity periods of these two species show little overlap; adult Red-tails retire to their nocturnal perches at about the same time that

TABLE 6

COMPOSITE LIFE TABLE AND LIFE EQUATION FOR THE RED-TAILED HAWK

Approximate age interval	Age class	Number alive (1_x)	Interval mortality rate[1]	Proportion breeding in interval[2]	Eggs laid in interval[3]
0–6 weeks	Eggs, nestlings	1,000	0.29		
6–10	Nestlings	710	0.11		
10–12	Nestlings	632	0.18 } 0.62		
0.23–1.0 years	Juveniles	518	0.54 }		
1–2	Yearlings	238	0.20	0.03	7
2–3	Adults	191	"	0.80	153
3–4	"	153	"	"	122
4–5	"	122	"	"	98
5–6	"	98	"	"	78
6–7	"	78	"	"	62
7–8	"	62	"	"	50
8–9	"	50	"	"	40
9–10	"	40	"	"	32
10–11	"	32	"	"	26
11–12	"	26	"	"	20
12–13	"	20	"	"	16
13–14	"	16	"	"	13
14–15	"	13	"	"	10
15–16	"	10	"	"	8
16–17	"	8	"	"	7
17–18	"	7	"	"	5
18–19	"	5	"	"	4
19–20	"	4	"	"	3
20–21	"	3	"	"	3
21–22	"	3	"	"	2
22–23	"	2	"	"	2
23–24	"	2	"	"	1
24–25	"	1	"	"	1
25–26	"	1	"	"	1
26–27	"	1	"	"	1
27–28	"	1	"	"	
TOTAL					765

[1] Mortality rate sources as follows: 0–6 weeks, Table 3 and in text; 6–10 weeks, Table 4; 10–12 weeks, Table 5; 0.23–1.0 years, calculated from mortality rate given in Table 5 for nestlings age 3–4 weeks until fledging, and from first-year mortality rate for birds banded as nestlings age 3–4 weeks (Henny and Wight, 1970); 1–2 years and older, Henny and Wight (1970).

[2] Calculated rate of yearling breeding explained in text; adult breeding rate based on information in Table 1.

[3] Two eggs per breeding pair, see text.

Horned Owls begin their evening forays. During these crepuscular and nocturnal periods, unfledged Red-tails are probably vulnerable to attack from recently fledged or adult Horned Owls whose nesting cycle is completed about 1 month earlier. Over the 4 years 1966–69, rates of predation-disappearance among young Red-tails were 5, 12, 49 and 36 per cent respectively. The increase in losses was accompanied by a marked rise in nesting pairs of Horned Owls on the study area from 1 in 1966 to 3 in 1967, 8 in 1968 and 9 in 1969.

A life equation.—The foregoing adult reproductive parameters and nestling mortality rates may now be combined with estimates of juvenile and adult mortality to construct a tentative life equation. Such calculations should permit a preliminary assessment of the long-term numerical stability of our Red-tailed Hawk population at Rochester.

Henny and Wight (1970) estimated average first-year and adult mortality rates from a dynamic life-table analysis (Lack's method) of 117 Red-tail band returns. All members of this cohort were banded as nestlings before 1951 and between latitudes 42° N and 53° N; the mean date of marking was approximately 1 June, at about 3 to 4 weeks of age. As approximately 70 per cent of first-year recoveries were from shot birds and only about 20 per cent of total first-year mortality was from shooting, there may well be a differentially higher recovery rate of juveniles that tends to overestimate first-year mortality in a life table.

The Red-tail life equation (Table 6) summarizes chronologically the losses and gains of a theoretical cohort starting with 1,000 eggs. Reproductive rates and survival until fledging are from our Rochester study, while the average juvenile mortality rate of 54 per cent between fledging and 1 year and the mean annual adult mortality rate of 20 per cent are from Henny and Wight's (1970) analysis. Juvenile mortality of 54 per cent was calculated from the 38 per cent first-year survival (beginning at age 3 to 4 weeks) found by Henny and Wight, and the 82 per cent survival recorded by us between 3 to 4 weeks and fledging (Table 5). The estimate of 3 per cent yearlings breeding was derived by assuming a stationary population in which the per cent yearlings equalled the adult mortality rate (20 per cent), and then comparing this yearling/adult ratio of 20/80 for the total population with the 1/143 observed in the breeding season population at Rochester.

Integration of available population data in the life equation suggests that our Red-tailed Hawk population is not maintaining itself. Indeed, the indicated rate of decline under the given regime of reproduction and mortality is 23 per cent per generation. Generation length is here defined as the average length of time between the birth of a parent and the birth of its offspring; in our life equation (Table 6) this turns out to be about 6 years. Under these circumstances the population will decrease about 5 per cent annually or almost 75 per cent in 30 years. The former figure is in line with the observed short-term trend in resident pair numbers at Rochester, but this may of course be entirely fortuitous.

DISCUSSION

While we know of no really satisfactory indices of long-term trends in Red-tail populations, it seems clear that this species has not suffered the marked numerical and reproductive declines noted among certain other raptorial birds over the past 20 years (Spofford, 1969). Most conspicuous among the latter have been species that typically rely upon either fish or avian prey, such as the Osprey (*Pandion haliaetus*), Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*) and Cooper's Hawk (see Hickey, 1969; Henny and Wight, 1969, 1970). Implied here is that the offending pesticide residues, particularly chlorinated hydrocarbons, are lower in small mammals and hence also in the diet of the Red-tail Hawk, a predominantly mammal feeder.

If we are correct in assuming that, continentally, the Red-tail population has remained stationary, then obviously the life-equation (Table 6) allegedly depicting the Rochester situation needs revision. At several places in this life equation changes in individual mortality and/or reproductive parameters could theoretically produce numerical stability.

We believe that the required increase in hatching success from 74 per cent (Table 3) to 96 per cent would be unrealistic; as noted earlier, our 26 per cent recorded loss of clutches was close to the mean of other studies. A decrease in estimated nestling mortality from our recorded 27 per cent to only 5 per cent seems likewise untenable, and is not supported by previous investigations.

A significant additional input towards balancing the life equation would be made if all, or a high proportion of the yearling cohort bred. The main evidence that these birds do not breed is that brown-tailed individuals are rarely members of resident pairs. The reddish retrices of the adult plumage do not normally appear before the second summer of life, and thus at the start of the breeding season red-tailed birds are at least 2 years of age (F. Hamerstrom, in litt.; J. Grier, in litt.). We have contacted D. C. Hagar, G. H. Orians and J. J. Craighead, and each of these earlier workers indicated that without exception the resident pairs on their respective study areas were adults (i.e. red-tailed) birds.

If the proportion of adults that breed (produce a clutch) yearly were increased from 80 per cent to 100 per cent, the life equation (Table 6) would almost balance. This change cannot be justified because a sizable nonbreeding (nonlaying) adult cohort has been noted repeatedly (Orians and Kuhlman, 1956; Craighead and Craighead, 1956; Hagar, 1957; and present study).

The adult mortality rate of 20 per cent annually, as calculated by Henny and Wight (1970) from band returns, is probably free of serious error. It closely approximates that calculated for the Common Buzzard (*Buteo buteo*) of Europe by Olsson (1958). As already pointed out, good reason exists to suspect that the estimated first-year mortality rate for Red-tails is biased high. Unfortunately we have no satisfactory method of determining the magnitude of this bias, which stems from the differentially higher vulnerability of juvenile birds to mortality from shooting. Olsson's estimate of first-year mortality for *Buteo buteo* was lower than Henny and Wight's for the Red-tailed Hawk (57 per cent vs. 62 per cent), but may still be slightly high. Shot birds comprised about 42 per cent of Olsson's first-year band recoveries and 70 per cent of Henny and Wight's. A relatively modest reduction from 62 per cent to 51 per cent in the first-year mortality rate would balance our life equation for the Red-tail. We believe that the most probable source of error in the life equation does indeed involve this latter parameter.

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SUMMARY

A 4-year investigation of population dynamics of the Red-tailed Hawk was conducted near Rochester, Alberta, Canada.

Red-tails returned from their winter ranges during early April, and were present for 5 to 6 months. Incubation began about 1 May.

Breeding-season density averaged 1 resident pair per 2.7 square miles; 92 per cent of the population was paired; 86 per cent of the resident pairs were known to have produced a clutch. Hatching success was 74 per cent.

Mean clutch size from 98 nests was 2.0 eggs. Nests that failed during incubation contained significantly smaller clutches than nests that hatched. Four per cent of the eggs from successful nests failed to hatch. The minimum mean initial brood size was 1.9 nestlings per successful breeding pair. Nestling mortality from hatching to fledging averaged 27 per cent.

Increased losses of nestling Red-tails occurred as numbers of nesting Great Horned Owls increased.

Life equation calculations suggest a population decline of 23 per cent per generation (about 6 years). Although in agreement with observed short-term trends at Rochester, this conclusion was suspect because of likely overestimation of first-year mortality. First-year mortality (from 3 to 4 weeks after hatching until age 1 year) in stationary Red-tail populations is probably closer to 51 per cent than to the 62 per cent estimated from band recoveries.

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