The Effect of Brood Size on the Growth and Behaviour of Red-Shouldered Hawks in Southwestern Québec

In 1979 and 1980 a total of 8 Red-shouldered Hawk (Buteo lineatus) nests were observed to gather information on: productivity, diet composition (through observations and pellet examination), feeding frequency of the adults and aggression of young, prey biomass, and growth of nestlings.

Productivity data for our study area indicate a mean of 2 young fledging per successful nest. This value is intermediate with respect to productivity information on Red-shoulders in other locations (Bednarz, 1979; Janik, 1980).

Since prey availability was not able to be determined on a regular basis during this study, a basic assumption exists concerning the diet of Red-shoulders. Prey delivered to the young by adult hawks and that identified in the pellets, probably manifests part of a functional response by these raptors. In other words, what prey these hawks are utilizing may be reflecting what is available in the habitat, at least to a certain degree.

General diet composition of these birds in southwestern Québec, demonstrate as others have (Stewart, 1949; Portnoy, 1979; Bednarz, 1979) that they are not specialists and take a wide variety of prey. Herpetofauna and small mammals comprised the largest portion of the diet in both years. The former category consisted primarily of frogs, specifically green frogs (Rana clamitans), woodfrogs (Rana sylvatica) and leopard frogs (Rana pipiens). This was substantiated by our observations and our catching efforts near the nest sites in 1979. B. Lyon (pers. comm.) found these herpetofauna species were also a large part of the diet in nearby Mount St. Bruno, Québec and Craighead and Craighead (1956) reported a similar finding in Michigan.

Amphibians formed the larger portion of the diet in 1979 than in 1980 possibly due to the greater amount of precipitation during the nesting season of that year, although no significant difference was found in the amount of rainfall in the two years. In Iowa, Bednarz (1979) observed that Red-shoulders took more amphibian prey the year when water levels were high. Small mammals delivered to nests consisted of prey such as chipmunks (Tamias striatus), voles (Microtus pennsylvanicus), moles (commonly Condylura cristata), mice (Peromyscus sp.) and shrews (commonly Blarina brevicauda).

In 1979, the Red-shoulder diet contained a large number of chipmunks, a prey species common in other areas (Portnoy, 1979; Janik, 1980). Our first observation of Tamias striatus being brought

to a nest coincides with the approximate dates marking the emergence of young chipmunks from burrows in eastern Canada (Smith and Smith, 1972). Individual hunting abilities and preferences of Red-shoulders as well as differences in local prey densities likely account for differences in prey utilization between years.

Pellet analysis which was carried out according to the methods of Matniak (1938) is roughly comparable to observation data. However it should be considered as supplementary information because of the bias inherent in pellet analysis of this genus (Errington and Breckenridge, 1938). Though amphibians were known to be important in the Red-shoulder diet, bones of these herpetofauna and other osseous material are absent in pellets. The acidic nature of the gut in Buteos, causes the corrosion of osseous remains (Duke, 1975).

Larger broods were fed significantly more prey items ($\rho < 0.001$) than small ones. This has been described for Great Tits (Parus major) (Gibb, 1955) and Red-tailed Hawks (Buteo jamaicensis)(McInvaille and Keith, 1974). No difference was found in 1979, probably due to the limited range of brood sizes in that year.

In our analysis we defined broods of 1 and 2 as small broods and broods of 3 and 4 as large broods. The mean biomass of a prey item brought to a large brood was significantly greater than that brought to a small brood ($\rho < 0.05$).

On a per bird basis however, larger broods were not receiving as much food as small broods. This was derived from comparing the total biomass of prey brought to a brood of 1, with that brought to a brood of 4, during 7 observation blocks. The expected ratio is not 1 to 4, but more like 1:2.5 (275 to 650 grams respectively).

Sibling aggression, defined as any directed and potentially harmful attack of one young against another, was present in all broods observed. There was a greater frequency of this aggression in large as compared to small broods in 1979 and 1980 ($\rho < 0.001$ and $\rho < 0.01$, respectively). The theory that this behaviour is a response to low food supply (Lack, 1954; Newton, 1979) would support our previous findings.

Parent hawks were not able to increase the amount of food delivered in proportion to the number of young in the nest. This has also been documented in feeding studies on other birds (Lack and Silva, 1949; Gibb, 1955; Snyder and Snyder, 1973; McInvaille and Keith, 1974).

Growth data of Red-shouldered hawks in 1980 (Table 1) indicated that tarsus and bill length were the most accurate measurements, hence analysis was confined to these two parameters. Our initial hypothesis that stated that growth rate would be slower and mortality more common in large broods compared with small ones, was confounded by mortalities. However, there was no significant difference in the growth rates of different brood sizes based on the final brood size just before fledging.

Data of 1980 were pooled to derive asymptotes and growth constants for Red-shoulders. Small birds usually grow at faster rates than large birds (Newton, 1979). Since Red-tailed Hawks are larger congenerics for which K values and asymptotes of at least captive birds are known (Olendorff, 1971b) we proposed that growth rates should be faster and asymptotes lower for Red-shouldered Hawks. As hypothesized Red-shoulders did have faster growth rates and smaller asymptotes (Table 2).

When K constants for tarsus length were compared to other Buteo species (Table 3) including wild Swainson's Hawks (Parker, 1976) the Red-shoulder was still found to have a faster rate of growth.

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Table 1. Mean Measurements of Body Parameters of Nestling Red-shouldered Hawks in Southwestern Québec in 1980

Parameter*	Age in weeks 1	2	3	4	5
head width	27.61	32.0	34.12	36.94	38.6
bill length (with cere)	18.84	21.16	24.37	26.01	27.14
bill depth	23.81	28.06	32.43	35.0	36.33
bill width	9.55	11.09	11.94	12.39	12.78
tarsal length	27.88	46.34	63.51	71.12	74.73
toe length	10.31	16.27	20.51	23.01	23.62
wing feather length	—	33.43	61.22	97.94	122.36
tail feather length	—	—	51.01	80.92	110.95

* all measurements in millimeters

Table 2. Comparison of Growth Constants k and Asymptotes for Tarsus and Bill Length of Wild Red-shouldered Hawks (1980) and Captive Red-Tailed Hawks (Olendorff, 1971)

Red-Tail		Red-shoulder	
Mean k Value	Mean Asymptote mm	Mean k Value	Mean Asymptote mm
Tarsus			
0.160 (5)	88.0 (2)	0.1827 (16)	75.28 (16)
Bill length			
0.109 (3)	20.0 (2)	0.1183 (16)	18.43 (16)

Figures in parentheses represent sample size

Table 3. Values of growth constant (k) for tarsal length amongst various nestling buteos.

	Red-shouldered	Red-tailed	Swainson's		Ferruginous
	B. lineatus (wild)	*B. jamaicensis* (captive)	*B. swainsoni* (wild)	(captive)	*B. regalis* (captive)
species average (♂ & ♀)	0.183[a]	0.160[b]	0.1365[c]	0.164[b]	0.165[b]

a B. Penak, 1980

b R. Olendorff, 1969, 1970

c J. Parker, 1970