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INTER AND INTRASPECIFIC INTERACTIONS BETWEEN RED-TAILED HAWKS AND GREAT HORNED OWLS IN CENTRAL OHIO[1]

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Abstract. Interspecific relationships between Red-tailed hawks and Great horned owls reveal distinct chronological activities that facilitate their inter-related nesting patterns. The hawk to owl ratio in the study area in 1976 was approximately 1.3 : 1. This proximal nesting may have had some effect upon Red-tailed Hawk success, in that Great Horned Owl predation on Red-tailed Hawks was related to their interspecific nesting distances. Although Great Horned Owls partially depend upon Red-tailed Hawks for their nest sites (59%) and the diet of these two raptors do overlap in some prey selected, direct competition for these resources is minimized by the temporal segregation of their breeding chronologies and their daily activity patterns.

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Interspecific relationships between Great Horned Owls (*Bubo virginianus*) and Red-tailed Hawks (*Buteo jamaicensis*) have raised many questions concerning the status of their coexistence. Preceived as ecological counterparts, these two large, cosmopolitan raptors reveal distinct chronological activities that alternate their dominant-subordinate relationships, facilitate their inter-related nesting patterns, and stabilize their interspecific competition and predation (Craighead and Craighead 1965). Do Red-tailed Hawks and Great Horned Owls operate independently of one another, or have their survival strategies mutually coevolved? Although little quantitative information addresses the behavior of such mixed populations, studies which investigate both species simultaneously may help to shed some light on such questions.

STUDY AREA AND METHODS

Nesting populations of Red-tailed Hawks (RTH) and Great Horned Owls (GHO) were studied from 1974 to 1976 on a 197 square mile area located in Delaware County, Ohio. Topography in Delaware County is flat to gently rolling and land is devoted largely to agriculture, with small percentages of pasture and woodlots. Most of the continuous woodlots were located along the 3 major drainages traversing the study area from north to south.

To determine nesting populations of RTHs and GHOs, foot and aerial surveys were conducted. The reproductive chronology was developed by interpolating hatch dates from known body weights of each nestling. Age of the nestlings was determined by comparing body weights of each nestling to known growth rates of 5 nestling RTHs and 2 GHOs taken in the study area in 1975 and 1976. This information together with the natural growth rates reported by Hoffmeister and Setzer, (1947) enabled reliable approximations of nestlings' age for the first 3 weeks of growth. Beyond this time, age was determined by the linear measurement of the 7th primary and/or overall size and plumage development. Length of incubation, 34 days, was used for both GHOs (Baumgartner 1939) and RTHs (Hardy 1939 and present study). Length of nestlife for GHO's and RTHs was 45 days (Hoffmesister and Setzer 1947) and 42 days (this study), respectively. Inter and intraspecific internest distances of RTHs and GHOs were calculated by plotting the location on topographical maps and calculating the linear measurements between nest sites.

RESULTS AND DISCUSSION

The foot surveys and aerial surveys revealed that density and productivity of both raptors in 1976 were similar to

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the averages of those values reported elsewhere in North America, but our density figures for both species were considerably higher than those reported previously in Ohio. In 1976 we located 59 active GHO nests (1 pair/3.16 sq. mi.) and 78 RTH nests (1 pair/2.39 sq. mi.).

Each season, the GHO is notably the first raptor to begin its nesting, and this behavior, together with its noctural hunting abilities, has enabled it to dominate over other nesting raptors (Craighead and Craighead 1956). In the spring of 1976, we noted that nesting of GHOs preceeded that of the RTHs by approximately 40 days (fig. 1). Laying dates at 26 GHO nests in 1976 ranged from 12 January to 21 February with a mean at 5 February. Hatch dates ranged from 15 February to 26 March with the mean at 10 March. Fledging dates ranged from the last week in March to the first week in May. Laying dates at 55 RTH nests in 1976 ranged from 6 March to 6 April with the mean at 16 March. Hatching dates ranged from 9 April to 10 May with the mean at 19 April. Fledging dates ranged from the last week in May to the last week in June with the mean at 3 June.

A number of reasons for the staggering of nesting sequences have been proposed by Craighead (1956) and Orains and Kuhlman (1967). Perhaps the early nesting of the GHO reduces interspecific

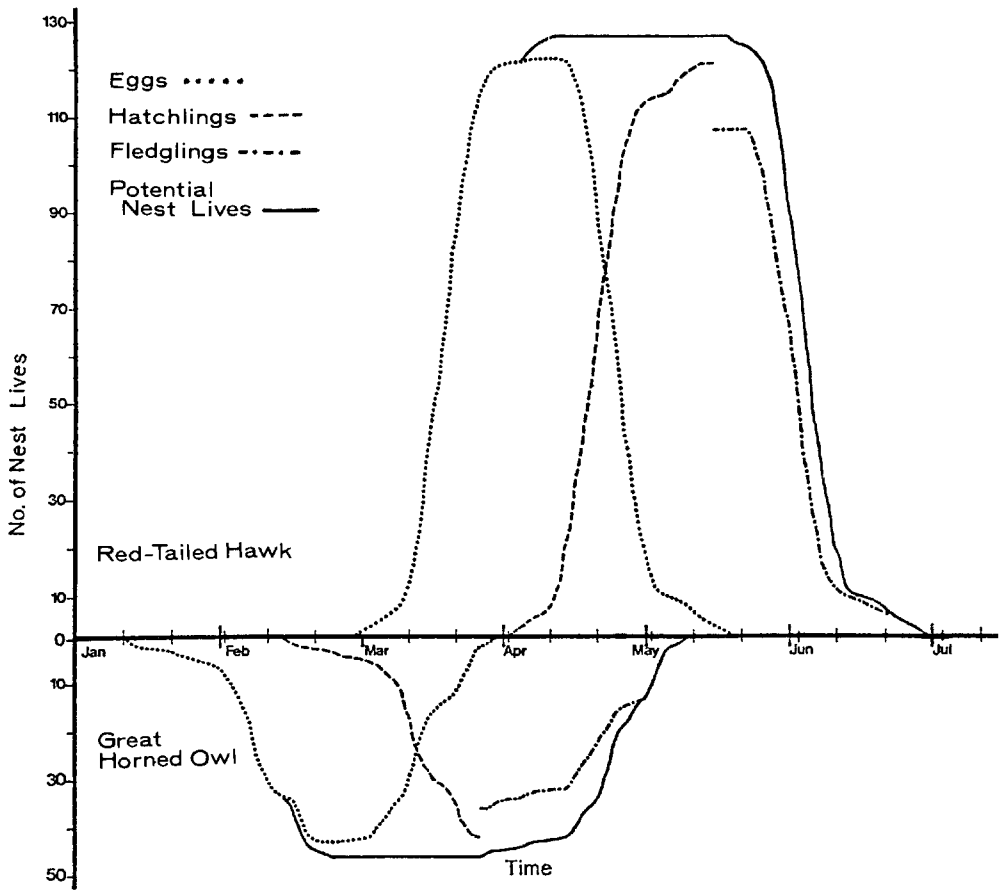

FIGURE 1. Reproductive chronology of 63 Red-Tailed Hawk nests and 39 Great Horned Owl nests in Central Ohio, 1976. Here fledglings are defined as young ready to leave the nest; thus, maximum number of fledglings decreases as they leave the nest. Potential nest lives represent the total number of nestlings produced before inherent egg loss (7.3% and 8.8%) and nestling mortality (19.7% and 13%) for Red-Tailed Hawks and Great Horned Owls, respectively.

competition for prey species which both it and the RTH utilize, or perhaps prey species are more vulnerable during the early spring months (before new vegetation provides sufficient cover). Others postulate that early nesting is a mechanism by which GHOs obtain their *limiting resource*, nest sites; therefore early nesting enables GHO to gain first access to old RTH nests before RTHs have a chance to reoccupy them (Craighead and Craighead 1956, Orains and Kuhlman 1956). Whatever the reasons for its existence, the staggering of the nest activities is a widely reported phenomenon which may have evolved in response to the interspecific relationships of the GHOs and other nesting raptors.

Intraspecific nesting distances of GHOs averaged 2.0 km, which was below the average internest distance of 2.9 km (Hagar 1975) and 3.1 km (McInvaille and Keith 1974). The shortest distance between active GHO nests observed in 1976 was approximately 0.9 km. Adjacent RTH nests were spaced an average an average distance of 1.5 km apart, with a minimum distance between active nests of 0.6 km. The average internest distance for RTH reported by other researchers averaged 2.07 km (table 1).

The relative densities of RTH and GHO populations can be expressed in terms of a simplified ratio of active hawk to owl nests. Those previous studies highest disparity of RTHs to GHOs occurred in sparsely wooded study areas, whereas those with the most equal number of RTHs to GHOs occurred in heavily wooded areas (table 2). In contrast, our

TABLE 1

Intra and Interspecific nesting distances (km) of Red-tailed Hawks (RTH) and Great Horned Owls (GHO).

Reference	Avg. RTH Internest Distance	Avg. GHO Internest Distance	Avg. Internest Distance RTH and GHO
Springer & Kirkley (1978)	1.5	2.0	1
Hagar (1957)	1.8	2.9	—
McInvaille & Keith (1974)	2.1	3.1	—
Seidensticker & Reynolds (1971)	2.1	—	—
Smith & Murphy (1973)	3.3	—	—
Wiley (1975)	0.84	—	—

TABLE 2

Nesting densities of Red-tailed Hawks and Great Horned Owls with respect to percent wooded study area.

Researcher and (Study Site)	% Wooded	Ratio Hawk to Owl Nesting	GH Owl Density (km^2) Per Nesting Pair	RT Hawk Density (km^2) Per Nesting Pair
Kirkley & Springer (1978) (OH)	9.0	1.3:1	8.2	6.2
McInvaille & Keith (1974) (Canada)	34.0	1.3:1	10.1	7.5
Hagar (1957) (NY)	50.0	1.5:1	12.2	8.0
Orians & Kuhlman (1956) (WI)	—	2.3:1	14.5	7.3
Cornman (1973) (OH)	3.0	5:1	82.9	24.9
Gates (1972) (WI)	0.3	10:1	108.8	10.6

study area was not extensively wooded (9%) but supported the highest nesting density of RTHs and GHOs, as well as having at 1.3:1 RTH to GHO ratio, equal to that of the heavily wood study areas. We believe this was due, in part, to our extensive coverage of the study area and not to any difference in habitat *per se.*

Internest distances between nearest RTH and GHO in 1976 averaged 1.0 km, which fell considerably below the averages of either hawk to hawk (1.5 km) or owl to owl (2.0 km) nest distances. In contrast, McInvaille and Keith (1974) reported no significant difference between adjacent RTH and GHO nests as compared with intraspecific nest distances. More striking was the fact that in 18 cases, our RTHs and GHOs attempted to nest within 0.5 km of one another, in one case as close as 50 meters. This high incidence of close nesting may be due, in part, to a combination of the RTHs' tendency to reoccupy the same territory each season (83%) and the GHOs' preference in using RTH nests for their nesting sites (59%).

Several researchers have reported the close nesting of GHO and hawks, often noting that attempts have resulted in the nest failure of either the hawk, the owl, or both raptors (Houston 1975, Freemeyer and Freemeyer 1970, Luttich *et al* 1971, Orains and Kuhlman 1956, Smith 1970, Wiley 1975). Minimum interspecific nesting distances between successful nests of the two species were approximately 200 meters.

As mentioned previously, the presence and/or predation of GHOs is sometimes suspected as being a major cause of RTH nest failure, especially in close nesting situations. Success is defined as the production of at least one fledgling per nesting attempt. In 3 studies (Hagar 1957, Luttich *et al* 1970, Smith 1976), 40 to 83% of RTHs failed when within 0.5 km of a GHO nest and only 3 nests were observed to be successful, two of which succeeded after the nearby owl had failed. In 7 cases where RTH nests were located within 0.5 km of a nonnesting GHO, only 2 nests were successful. Although in most instances concrete proof was lacking, circumstantial evidence indicates predation by GHOs. GHO feathers were found in 3 nests, and in 1 case, time lapse photography documented the predation by the GHO.

As a rough test to determine whether the success of RTH nests was related to their internest distance from GHOs, 69 RTH nests were categorized according to their distance from the nearest GHO activity center using the following four categories: less than 0.5 km, between 0.5 and 1.0 km, between 1.0 and 2.0 km, and greater than 2.0 km. Scattergram plots of RTH success between the distance of 1.0 to 1.5 km and 1.5 to 2.0 km showed no statistical difference between the two categories, while territorial behavior precludes such categorization. Red-tailed Hawk nests which were known to have failed from causes other than Great Horned Owl predation were not included in this sample. Grouping the Red-tailed Hawk nests according to the four categories listed above resulted in the distribution of 25, 25, 15, and 4 nests in each category, respectively and resulting success rates of 56%, 96%, 53%, and 100% within each of these groups, respectively (fig. 2). In close nesting situations (less than 0.5 km) owl to hawk tolerance is low, and this coupled with increase likelihood of being found by daily movements, may account for the low Red-tailed Hawk success. Between 0.5–1 km we found Red-tailed Hawk success

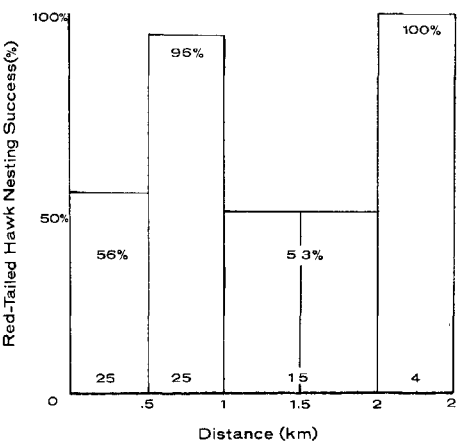

FIGURE 2. Red-Tailed Hawk nesting success vs. distance from Great Horned Owl activity centers in Delaware County, Ohio.

to be 96%. This leads one to believe that the further a hawk nest is from an owl activity center, the higher the chance for Red-tailed Hawk success. Between 1 and 2 km, however, Red-tailed Hawk success dropped to 53%. Upon inspection of Great Horned Owl territorial size, Miller (1930) reported that owls seldom venture over 1 km. Baumgartner (1939) substantiated Miller's findings. Craighead and Craighead (1956) reported owl territories ranging between 1 and 2 km. Because owls frequently peruse territorial boundaries and hunting areas, there is a greater chance for the Red-tailed Hawk nest to be found within 1 and 2 km than between 0.5 and 1. This may be the reason for the low success rate. Only through further controlled experimentation could such a hypothesis be substantiated.

Because GHO distance is only one of a number of variables which may affect RTH success, we are unable to draw any firm conclusions from such a simplified model, however, it is possible that GHO presence and/or predation may have had some effect upon the resulting RTH success rates.

Competition for food exists between RTHs and GHOs since the prey selected by these two raptors is similar (table 3).

TABLE 3

Prey of Great Horned Owls and Red-tailed Hawks in Central Ohio.

	Great Horned Owl Number in Diet	Red-tailed Hawk Number in Diet
MAMMALS		
Eastern Cottontail Rabbit (*Sylvilagus floridanus*)	18	20
Woodchuck (*Marmota monax*)	—	4
Red Squirrel (*Tamiasciurus hudsonicus*)	—	6
Eastern Fox Squirrel (*Sciurus niger*)	—	11
Eastern Gray Squirrel (*Sciurus carolinensis*)	1	—
unidentified squirrels	—	5
13-lined Ground Squirrel (*Citellus tridecemlineatus*)	—	1
Eastern Chipmunk (*Tamias striatus*)	—	22
Eastern Mole (*Scalopus aquaticus*)	—	2
Meadow Vole (*Microtus sp.*)	31	5
Meadow Mouse (*Peromyscus sp.*)	8	6
Norway Rat (*Rattus norvegicus*)	3	1
unidentified mouse or vole	—	16
Shortail Shrew (*Blarina brevicauda*)	22	16
unidentified mammals	9	1
Total and % occurrence	92 (66%)	116 (65%)
BIRDS		
Bobwhite Quail (*Colinus virginianus*)	12	1
Ring-necked Pheasant (*Phasianus colchicus*)	1	1
Common Grackle (*Quiscalus quiscula*)	3	10
Starling (*Sturnus vulgaria*)	1	4
Red-winged Blackbird (*Agelaius phoeniceus*)	—	1
Mourning Dove	10	4
Cardinal	1	1
Domestic Pigeon (*Columba livia*)	—	1
Song Sparrow (*Melospiza melodia*)	—	2
American Goldfinch (*Spinus tristis*)	—	1
Wood Thrush (*Hylocicha mustelina*)	1	—
Robin (*Turdus migratorius*)	3	—
Common Flicker (*Colaptes auratus*)	1	—
Eastern Meadowlark (*Sturnella magna*)	1	—
Blue Jay (*Cyanocitta cristata*)	1	—
Common Crow (*Corvus brachyrhynchos*)	1	—
unidentified birds	11	8
Total and % occurrence	47 (34%)	34 (16%)
REPTILES AND AMPHIBIANS		
Garter Snake (*Thamnophis sp.*)	—	28
Frog (*Rana sp.*)	—	1
Total and % occurrence	0	29 (16%)

Cottontail rabbits, mice, voles, and shrews are mammalian prey common to the diets of both raptors, while grackles and mourning doves are the avian prey common to both. Prey of considerable importance in the RTH diet but absent or rarely found in the GHO diet are chipmunks, arboreal squirrels, woodchucks, and snakes. Quail and numerous species of passerine birds comprise a larger proportion of the GHO diet than of the RTH diet. Many of the differences in prey selection are undoubtedly due to the temporally segregated activity patterns of the diurnal RTH and the nocturnal GHO.

In summary, Great Horned Owls were partially dependent upon Red-tailed Hawks for nest sites (59%) and the two often nested within 0.5 km of one another. This proximal nesting, as well as the nearly equal ratio of hawks to owls (1.3:1), may have had some effect upon Red-tailed Hawk nesting success, in that Great Horned Owl predation on Red-tailed Hawks may be related to their interspecific nesting distances. The diets of these two raptors do overlap in some of the prey species selected, but direct competion for food is minimized by the temporal segregation of their activity patterns.

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