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Nesting Ecology of Forest-dwelling Great Horned Owls, *Bubo virginianus*, in the Eastern Deciduous Forest Biome

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We investigated Great Horned Owl (*Bubo virginianus*) nest-site selection, productivity, prey items, and predation on sympatric raptors in extensive forest habitats of the Eastern Deciduous Forest Biome in New Jersey, New York and Connecticut. All nest sites were located in trees, mostly oaks (*Quercus* spp.), and were either old or recently usurped hawk, crow or squirrel nests. Eggs were laid in February or early March and young usually fledged by mid-May. Prey included at least 33 species of birds, mammals and fish but nongame birds were higher and lagomorphs lower compared to Great Horned Owl diets in open-country habitats. These dietary compensations may explain the lower productivity of young than typically reported in western North America. Adults or young of nine species of raptors nesting nearby were taken by Great Horned Owls.

Key Words: Great Horned Owl, *Bubo virginianus*, nest sites, forests, productivity, prey, sympatric raptor species, New Jersey, New York, Connecticut.

Most investigations of nesting Great Horned Owls (*Bubo virginianus*) in North America have been conducted in open-country habitats such as the mosaic of fields, farmland and woodlots of the eastern and central states (Baumgartner 1939; Boswell 1974; Craighead and Craighead 1956; Hagar 1957; Misztal 1974; Orians and Kuhlman 1956; Petersen 1979; Siminski 1976), grasslands and prairie of the Midwest (Gilmer et al. 1983; Luttich et al. 1971; Rusch et al. 1972), desert scrub of the Intermountain area and Southwest (Smith and Murphy 1973, 1982); forest edge of the West (Siedensticker and Reynolds 1971; Frounfelker 1977) and chaparral of the Far West (Fitch 1940, 1947).

Here we present information on nest sites, productivity, prey items and predation on sympatric raptors in extensive forest habitats of the Eastern Deciduous Forest Biome of the northeastern United States.

Methods

Nesting Great Horned Owls, uncommon in our study region, were found during the course of long-term breeding-bird and raptor studies (Bosakowski et al. 1987; Speiser 1981; Speiser and Bosakowski 1987) where most hawk nests were rechecked each year in addition to searches for new raptor nests and snags (for owls) in 1977-88. In this paper, we report only on those owls found nesting in heavily forested areas in and adjacent to the Reading Prong in New Jersey, New York, and northwestern Connecticut.

The Reading Prong is an extension of the New England Uplands, a belt of rolling, granitic hills

stretching from northwest Connecticut, crossing southeast New York and northern New Jersey, and terminating in eastern Pennsylvania. Despite its proximity to New York City, much of the region is sparsely populated and composed of many state, county and private forests. Forests are predominantly oak (*Quercus* spp.), maple (*Acer* spp.) and hickory (*Carya* spp.) with small, scattered stands of conifers in some areas. A detailed description of the study area and major tree associations can be found in Speiser and Bosakowski (1987).

TB and RS searched south and west of the Hudson River (parts of Orange and Rockland counties in New York and parts of Bergen, Hunterdon, Middlesex, Morris, Passaic, Sussex and Warren counties in New Jersey) in 1977-88. DGS and his associates recorded data on nests found in the extensively wooded and rugged hills of northwestern Connecticut (Litchfield County) and along the forested traprock ridges extending southward (New Haven County) as part of a general study of the raptors of Connecticut from 1972-88. Nest searches were confined to areas known to be occupied territories as determined by visual sightings of adults, history of territorial occupancy or response of Great Horned Owls to play back of tape-recorded song.

Results and Discussion

Of 33 nests located, sixteen were formerly used by Red-tailed Hawks (*Buteo jamaicensis*), seven were nests of the Common Crow (*Corvus brachyrhynchos*), one was in a Red-shouldered Hawk (*Buteo lineatus*) nest, one in a Northern Goshawk (*Accipiter gentilis*) nest, two in Gray

Squirrel (*Sciurus carolinensis*) nests, one in a Red Squirrel (*Tamiasciurus hudsonicus*) nest, and five were of undetermined origin.

Nests were usually situated in crotches of moderate or large-sized live trees: eleven in Red Oaks (*Quercus rubra*), four in White Oak (*Quercus alba*), four in White Pine (*Pinus strobus*), two each in Eastern Hemlock (*Tsuga canadensis*), Red Maple (*Acer rubrum*), and Black Birch (*Betula lenta*), and one each in Tulip Tree (*Liriodendron tulipifera*), American Elm (*Ulmus americana*), White Ash (*Fraxinus americana*), Black Oak (*Quercus velutina*), Sycamore (*Platanus occidentalis*) and Shagbark Hickory (*Carya ovata*). Two nest tree species were undetermined. One Great Horned Owl pair chose an old Red-tailed Hawk nest located in remaining branches of a large dead snag.

Regarding overall habitat in New Jersey and New York, six nests were associated with forested wetland, four were on dry, wooded hillsides, three were in level, forested terrain and one was on the bank of a major river in a floodplain forest. All fourteen nests were located in mature and submature second growth forest. Six of the nests were also near edge habitat composed of early seral stages of the deciduous forest biome (Shelford 1963). In Connecticut, thirteen nests were located on dry, heavily forested hillsides, four were in forests along traprock ridges and two were associated with forested wetland.

By backdating from the approximate ages of the nestlings, we estimated that in New Jersey and New York incubation usually began during the last week of February or the first week of March. Egg dates for 12 Connecticut nests ranged from 11 February to 20 April, although the latter date probably represented a renesting attempt. Dates that young were in nests ranged from 12 March to 11 May. Generally, eggs were laid from mid- to late February, and young fledged during the last week of April or the first two weeks of May.

While incubating, the female often postured low in the nest bowl, perhaps to decrease visibility or to improve thermal protection of the eggs. Hawes (cited in Bent 1938) reported a renesting attempt after two eggs were frozen, but Austing and Holt (1966) and Houston et al. (1987) have observed Great Horned Owl eggs to be relatively resistant to cold stress. Typically, the owls' eyes were closed, or nearly so, when on the nest. This may be a part of their normal concealment posture, or simply a feature of their diurnal sleeping behavior.

Productivity, figured from the late nestling stage, averaged 1.14 young reared per nesting attempt in New Jersey and New York. Six nests reared one young, five reared two young, two nests failed and one nest with eggs, located on the remains of an old Gray Squirrel nest, was blown out of the tree. Productivity of 10 Connecticut

nests with complete nest records averaged 1.33 young per nest (range 1-3 young). Both productivity rates are lower than typically reported for the open biotopes of western North America (Colorado: Boswell 1974; Olendorff 1975; Utah: Smith and Murphy 1979; North Dakota: Gilmer et al. 1983).

We observed significant variations in annual productivity; 1985 and 1988 were peak years whereas 1979 and 1987 appeared to be years when breeding activities of Great Horned Owls decreased significantly or "crashed", as was observed for Great Horned Owls in Colorado (Olendorff 1975) and central Utah (Smith and Murphy 1979). Our data are not extensive enough to infer any periodicity or mechanism for these "crashes".

Nest-site fidelity in successive years was not observed, as also reported by Craighead and Craighead (1956) and Orians and Kuhlman (1956). The habit of using a nest only once probably reflected poor durability of most stick nests to trampling by adult and nestling Great Horned Owls. As Great Horned Owls are not known to repair their nests (Bent 1938; Orians and Kuhlman 1956), a safer strategy would be to move to a newer nest or one in better repair the following nesting season, or alternately they may usurp another raptor's newly constructed nest (Bent 1938; many others). Nests containing eggs and young were sometimes blown out of trees (Worth 1978; G. Hanisek, personal communication; this study), thus illustrating the selective pressure for choosing a durable nest.

However, there might be other factors explaining the lack of nest fidelity. Austing and Holt (1966) believed that Great Horned Owls moved to different breeding areas in successive years within a large home range, perhaps to exploit areas of higher prey abundance. Craighead and Craighead (1956) noted that most Great Horned Owls were limited to certain woodlots, but some movement was observed from year to year. Our observations were of both types, some pairs appearing to be nomadic whereas others were sedentary, occupying the same general territory for several consecutive years. Smith and Murphy (1973) also noted home-range fidelity extending over several consecutive years by some Great Horned Owl pairs.

Diets of Great Horned Owls during the nesting season were determined from prey found in the nest or from prey and pellets collected below nests or nearby roost trees from late winter to late spring (Table 1). Prey included 14 mammal species, at least 17 bird species and 2 species of fish. Several prey items, the Common Goldeneye (*Bucephala clangula*), the Green-backed Heron (*Butorides striatus*), Red-winged Blackbirds (*Agelaius*

TABLE 1. Prey of Great Horned Owls found near nests or under nearby roost trees.

Prey Species	New Jersey- New York	Connecticut	Totals	% of totals
Mammals	32	130	162	57.6
Opossum, <i>Didelphis virginiana</i>	—	3	3	1.1
Hairy-tailed Mole, <i>Parascalops breweri</i>	1	—	1	0.4
Short-tailed Shrew, <i>Blarina brevicauda</i>	—	7	7	2.5
Unidentified shrews, <i>Sorex</i> spp.	—	2	2	0.7
Eastern Cottontail, <i>Sylvilagus floridanus</i>	2	4	6	2.1
Raccoon, <i>Procyon lotor</i>	—	3	3	1.1
Gray Squirrel, <i>Sciurus carolinensis</i>	15	11	26	9.3
Red Squirrel, <i>Tamiasciurus hudsonicus</i>	—	3	3	1.1
Southern Flying Squirrel, <i>Glaucomys volans</i>	—	1	1	0.4
Meadow Vole, <i>Microtus pennsylvanicus</i>	6	24	30	10.7
White-footed Mouse, <i>Peromyscus leucopus</i>	3	37	40	14.2
Muskrat, <i>Ondatra zibethicus</i>	1	6	7	2.5
Norway Rat, <i>Rattus norvegicus</i>	3	29	32	11.4
House Mouse, <i>Mus musculus</i>	1	—	1	0.4
Birds	42	68	110	39.1
Common Goldeneye, <i>Bucephala clangula</i>	—	1	1	0.4
Red-shouldered Hawk, <i>Buteo lineatus</i>	1	—	1	0.4
Eastern Screech Owl, <i>Otus asio</i>	1	2	3	1.1
Saw-whet Owl, <i>Aegolius acadicus</i>	—	1	1	0.4
Green-backed Heron, <i>Butorides striatus</i>	—	1	1	0.4
Ring-necked Pheasant, <i>Phasianus colchicus</i>	—	2	2	0.7
Common Grackle, <i>Quiscalus quiscula</i>	10	—	10	3.6
Common Flicker, <i>Colaptes auratus</i>	6	3	9	3.2
Mourning Dove, <i>Zenaida macroura</i>	1	—	1	0.4
Rock Dove, <i>Columba livia</i>	2	—	2	0.7
Unidentified flycatchers, <i>Tyrannidae</i> spp.	1	—	1	0.4
Common Crow, <i>Corvus brachyrhynchos</i>	4	8	12	4.3
Ruffed Grouse, <i>Bonasa umbellus</i>	2	5	7	2.5
American Robin, <i>Turdus migratorius</i>	3	2	5	1.8
Red-winged Blackbird, <i>Agelaius phoeniceus</i>	1	9	10	3.6
Blue Jay, <i>Cyanocitta cristata</i>	3	5	8	2.8
Unidentified passerines	7	29	36	12.8
Fish	0	9	9	3.2
White Sucker, <i>Catostomus commersoni</i>	—	6	6	2.1
Brown Bullhead, <i>Ictalurus nebulosus</i>	—	3	3	1.1
Totals	74	207	281	100.6

phoeniceus), Muskrats (*Ondatra zibethicus*) and fish, were found at nests associated with swamps or lake habitats. Generally, the diet of these forest-dwelling Great Horned Owls was high in nongame birds and tree squirrels and deficient in lagomorphs and game birds compared with studies in mostly open country (Craighead and Craighead 1956; Fitch 1947; Gilmer et al. 1983; Orians and Kuhlman 1956; Rusch et al. 1972).

We suggest that this compensatory shift in diet was the result of the generally poor habitat for cottontails (mature forest) and low populations of grouse in our study region. These dietary compensations may also explain the poor productivity we found for forest-dwelling Great Horned Owls compared to those nesting in open

habitats of western North America. Boswell (1974) found that nesting Great Horned Owls in Ohio preyed more heavily on birds and had a lower productivity than nesting pairs in Colorado.

We found evidence of Great Horned Owl predation at a number of raptor nests which were being monitored concurrently in the study region (Table 2). The carcasses of adult raptors were only partially eaten and were apparently seldom transported back to the owl's nest. Nearly all were decapitated. Nestlings of several raptor species were also found dismembered or had disappeared (not the result of fratricide). These observations suggested that predation on other raptors by Great Horned Owls might have been largely overlooked had we not been monitoring nearby raptor nests.

TABLE 2. Evidence of Great Horned Owl predation on sympatric raptors found by concurrently monitoring neighboring raptor nests.

Raptor Species	Observations
Red-shouldered Hawk, <i>Buteo lineatus</i>	5 adults, 3 nestlings; 15 feathers of 1 adult found beneath Great Horned Owl nest*, 1 adult and 1 nestling found atop snag and on log near their nest, plus 2 nestlings missing, 3 plucked adult carcasses; 1 on its nest, 2 on elevated perches near their nest site.
Red-tailed Hawk, <i>Buteo jamaicensis</i>	3 adults; 1 carried by owl, 2 found decapitated.
Cooper's Hawk, <i>Accipiter cooperi</i>	2 nestlings plucked, eaten at nest, (entire brood); 122 m from Red-shouldered Hawk nest listed above.
Northern Goshawk, <i>Accipiter gentilis</i>	1 adult decapitated near its nest, with sheared feathers, notched keel.
Broad-winged Hawk, <i>Buteo platypterus</i>	1 adult decapitated on snag with sheared feathers.
Great Horned Owl, <i>Bubo virginianus</i>	1 fledgling decapitated with sheared feathers, near 2 pairs of owls.
Eastern Screech Owl, <i>Otus asio</i>	3 adults*; feathers and skull of 1 in pellets beneath Great Horned Owl roost site near nest, decapitated body of another in Great Horned Owl nest, kill under plucking tree 50 m from Great Horned Owl nest.
Barred Owl, <i>Strix varia</i>	1 adult; skull and feathers in Great Horned Owl nest (M. Redmond, personal communication).**
Long-eared Owl, <i>Asio otus</i>	1 adult; feathers in Great Horned Owl nest (M. Redmond, personal communication).**
Saw-whet Owl, <i>Aegolius acadicus</i>	1 adult*; feathers, synsacrum, wing beneath Great Horned Owl nest.

*Also reported in Table 1, as these prey remains were found by traditional food habits study techniques.

**Not reported in Table 1 since these items were selectively collected without other prey items being recorded. Specimens were verified by DGS.

Thus, some traditional food studies may have underrepresented other raptors as prey items.

Other raptor studies have also documented or attributed loss of nesting adults and/or young to Great Horned Owl predation (Bent 1938; Craighead and Craighead 1956; Orians and Kuhlman 1956; Hagar 1957; Houston 1975; Luttich et al. 1971), but few food habits studies have reported large numbers of raptor remains at Great Horned Owl nests. Alternately, predation on raptors may have been higher than expected in our study region because of the low availability of large prey (rabbit and grouse).

Our findings indicate that forest-dwelling Great Horned Owls have a low productivity and may not nest every year. Although Great Horned Owls have a wider food niche (Knight and Jackman 1984) and greater habitat flexibility than other sympatric owls (Bosakowski et al. 1987), we conclude that this species is more successful in open habitat, especially outside the Eastern Deciduous Forest Biome.

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