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KEITH L. BILDSTEIN AND KEN MEYER

Accipiter striatus

FRENCH:
Epervier brun
SPANISH:
Gavilán pajarero

Sharp-shinned Hawk

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Once considered "the enemy of all small birds" (Sutton 1928), the Sharp-shinned Hawk is a small, slender, feisty accipiter, with short, rounded wings and a long, narrow tail. Although small mammals and even insects appear in its diet, this forest-dwelling predator feeds almost entirely on small birds.

Sharp-shinned Hawks are widely dispersed and seldom-seen nesters that breed mainly in large stands of deciduous, coniferous, and mixed pine-hardwood forests and pine plantations. In temperate areas, nesting coincides with the annual peak in songbird abundance. The species' secretive nature and the dense vegetation of its nesting habitat make it difficult to find and study during the breeding season. The early stages of nesting, in particular, are little studied. The bird is best seen, and most frequently studied, on migration, when large numbers of individuals concentrate along major migratory corridors and bottlenecks, particularly in the East.

As is true of many members of the genus, the Sharp-shinned Hawk has especially long middle toes and large eyes, useful attributes for catching highly mobile prey. The species is the most sexually dimorphic of all North American raptors, with males averaging only 57% of the body mass of females (Snyder and Wiley 1976).

The Birds of North America
Life Histories for the 21st Century

Figure 1.
Distribution of the Sharp-shinned Hawk in North and Middle America and the western Caribbean. This species also breeds in Puerto Rico and South America. In North America, breeding occurs very locally west to the dashed line. See text for details.

Order FALCONIFORMES Family ACCIPITRIDAE

Sharp-shinned hawks historically have been described as vicious bird killers—even by many ornithologists. In the first few decades of the twentieth century, gunners shot thousands of this species at Cape May Point, NJ; Hawk Mountain, eastern Pennsylvania; and other sites along important eastern migration corridors. Even so, the species is known for hunting songbirds in parks and near houses, and is often seen taking prey at bird feeders (Fisher 1893, Stone 1937, Klem 1981).

Important information on migration is available from studies in Wisconsin (Mueller and Berger 1967a, 1967b, Mueller et al. 1997), Pennsylvania (Bednarz et al. 1990, Allen et al. 1996, Viverette et al. 1996), and New Jersey (Murray 1964, Kerlinger 1984, 1985a, Holthuijzen et al. 1985, Niles et al. 1996). Detailed information on breeding biology is available from studies in Utah (Platt 1973), New Brunswick, Canada (Meyer 1987), and Puerto Rico (Delannoy and Cruz 1988). The possible relationship between the breeding biology of this species and its extreme sexual size dimorphism is poorly understood. Future studies of migration physiology and orientation, predation ecology, and reproductive biology (particularly fledgling behavior and development) should be especially rewarding.

Common names include "Sharp-shin," "Sharpie," "Blue Darter," "Little Blue Darter," and "Bird Hawk."

DISTINGUISHING CHARACTERISTICS

Smallest North American accipiter. Total length: males 24–27 cm, females 29–34 cm; wingspan: males 53–56 cm, females 58–65 cm; mass: males 87–114 g, females 150–218 g; measurements from temperate North America (Wheeler and Clark 1995).

Following generally applicable to widespread North American subspecies (*striatus* group; see Systematics, below). In adult (Definitive Basic) male upperparts, including wings and tail, bluish gray to slate, becoming slightly darker on the crown. Tail crossed by 3–5 visible slaty bands and narrowly tipped white. Tail usually appears square in shape when folded, but often appears slightly rounded when spread. Open wing appears dark above but whitish below with remiges boldly banded with black. Underparts primarily whitish and heavily barred with rufous or tawny on breast, belly, side, and flanks. Adult female similar in coloration, but upperparts more brownish olive and underparts less heavily barred than in males (Brown and Amadon 1968). Wings relatively short and rounded. Legs and toes yellow, long and sticklike with tarsometatarsus laterally compressed, hence the name "sharp-shin." Eyes red. Adult plumages similar throughout year.

In juveniles, head heavily streaked grayish brown and white or grayish brown and tawny on crown, nape, and sides of neck, with a pale superciliary stripe. Back, rump, and wings dark brown to dark brownish gray, with back and wing-coverts margined paler. Occasional white feather bases show on back and wing-coverts. Underwing white and boldly barred with dark brown. Tail as in adults but gray often replaced by brownish. Underparts white to cream with broad dark-brown streaking on breast, belly, side, and flanks. Eyes pale yellow.

Sharp-shinned Hawk unlikely to be confused with any other species within its range except the very similarly plumaged but larger Cooper's Hawk (*Accipiter cooperii*). Although female Sharp-shinned approaches size of male Cooper's, there is no overlap in overall length between the 2 species (Clark 1984). In addition to size, Sharp-shinned has a proportionally shorter tail that, when folded, is squarish, not rounded at the tip as in Cooper's Hawk, but Sharp-shinned's tail may appear slightly rounded when spread. Sharp-shinned is also less robust than Cooper's Hawk and, in the field, appears to have a proportionally smaller head—a feature that is useful when the bird is on the wing and when perched. Adult Sharp-shinned also lacks prominent dark cap of Cooper's Hawk (cap and back color do not contrast strongly in Sharp-shinned), while juvenile Sharp-shinned has more prominent superciliary stripe, more ventral streaking (some birds streaked, some with spotting), and less white on tip of tail than juvenile Cooper's Hawk. Much of the confusion that exists in separating these 2 accipiters stems from the fact that both are pursuit-hunters that do not remain in view for long. For a fuller discussion of differences between these species, see Clark 1984, Kaufman 1990, Howell and Webb 1995, and Wheeler and Clark 1995.

DISTRIBUTION

THE AMERICAS

Breeding range. Figure 1. ALASKA AND CANADA. Breeds throughout central, southcoastal, southeastern, and, rarely, western Alaska (Armstrong 1995). In Canada, breeds from n. Yukon, w. and s. Mackenzie, ne. Saskatchewan, n.-central Manitoba, n. Ontario, central Quebec, s. Labrador, and all but nw. Newfoundland, south to the U.S. border (including the Queen Charlotte Is., portions of Vancouver I., and probably Anticosti I.; Campbell et al. 1990, Ouellet and Bombardier 1996), but absent from se. Alberta, sw. and s. Saskatchewan (except

Cypress Hills), and sw. Manitoba (Godfrey 1986, Semenchuk 1992, Smith 1996).

Western United States. Breeds from Canadian border south locally through Washington, Idaho, and w. Montana to central California, s. Nevada (T. Floyd pers. comm.), nw. and se. Arizona (Arizona Breeding Bird Atlas [BBA] 1993–1998 unpubl.), and s. New Mexico (Hawks Aloft New Mexico pers. comm.), and east to se. Wyoming (Oakleaf et al. 1992), the Black Hills of sw. South Dakota (Peterson 1995), central Colorado (Levad 1998), and e.-central New Mexico (Hawks Aloft New Mexico pers. comm.). Also reported to breed in N. Dakota with most records from Turtle Mtns. and along Little Missouri River (Stewart 1975). Largely absent from areas of unsuitable habitat in Washington east and west of Cascade Mtns. and Puget Sound (Smith et al. 1997) and probably absent from similar areas in adjacent portions of Oregon. California range poorly known and described range tentative. Breeding or summering birds have occurred throughout the state, including the southern mountains, but most probably breed in northern half of state (Small 1994). In Arizona, recent breeding records concentrated along Mogollon Rim and in extreme se. Arizona (Arizona BBA 1993–1998 unpubl.). In New Mexico, breeds in mountainous regions throughout state, including the Chuska, Jemez, Mogollon (and adjacent ranges), Sacramento, Sandia / Manzano, San Juan, Sangre de Cristo, and Zuni ranges (Hawks Aloft New Mexico pers. comm.). May be a rare breeder in mountains of w. Texas.

Eastern United States. Breeds from Canadian border south to ne. Minnesota (Janssen 1987), n. Wisconsin (Robbins 1991), s. Michigan (Betz 1991), extreme n. Ohio (Peterjohn 1989), s. Pennsylvania, nw. New Jersey (and very locally in the south; Walsh et al. 1998), se. New York (possibly Long Island; Smith 1988), Connecticut (Smith and Devine 1994), and Rhode Island (Enser 1992). Range extends south through Appalachians to w. Virginia (Virginia BBA unpubl.), w. North Carolina, and w. South Carolina (few breeding records; McNair and Post 1993), west to southern half of Ohio (Peterjohn 1989), se. Indiana (Squires et al. 1998), central Kentucky (Palmer-Ball 1996), and w. Tennessee (Nicholson 1997), and south to "northern parts of Gulf states" (Am. Ornithol. Union 1998: 93). Also breeds in n. Indiana (Squires et al. 1998) and s. Arkansas (primarily the Ozarks; Robbins and Easterla 1992), and from main portions of eastern range west very locally to e. North Dakota (Stewart 1975), e. Kansas (Kansas BBA 1992–1997 unpubl.), and e. Texas (Texas BBA 1987–1992 unpubl.), and very rarely south of main range in se. U.S., north of Florida (Kale and Maehr 1990).

West Indies. Common but increasingly local resident on Cuba and Hispaniola (declining); rare and local on Puerto Rico (best seen in Toro Negro and Maricao forests). Vagrant on St. John, Virgin Is. (Delannoy and Cruz 1988, Raffaele et al. 1998).

Mexico and Central America. Resident in Mexico from e. Sonora, w. Chihuahua, and w. Durango, and from se. Coahuila, s. Nuevo Leon, and sw. Tamaulipas south to n. Oaxaca, with additional populations in w. Guerrero, n. Coahuila, and probably n. Baja California Norte. Also resident from extreme e. Oaxaca, and Chiapas, Mexico to w. and central Honduras and nw. Nicaragua (Howell and Webb 1995).

South America. Resident on forested slopes of w. Venezuela, in the Andes from Colombia to s. Bolivia, and from central Brazil and Paraguay south to n. Argentina (Brown and Amadon 1968, Howell and Webb 1995, Am. Ornithol. Union 1998).

Rarely seen during breeding season outside of unbroken forest canopies, making it, arguably, the most difficult North American accipiter to census (Reynolds and Wight 1978). The bulk of the population appears to breed in contiguous boreal coniferous forests, often close to open areas and deciduous woodlands. May prefer nesting near water (Reynolds et al. 1982). Generally absent from small woodlots and open areas.

Winter range. Figure 1. Migratory populations breeding in Canada and the U.S. generally winter from southcoastal and southeastern Alaska (Armstrong 1995), the coast and southernmost interior of British Columbia (Campbell et al. 1990), central Idaho, nw. and s. Montana, sw. and se. South Dakota, s. Minnesota, central Wisconsin, the n. Lower Peninsula of Michigan, southernmost Ontario, n. New York, central Vermont and New Hampshire, coastal Maine, coastal New Brunswick, Prince Edward I., and se. Newfoundland, south throughout the U.S. (Christmas Bird Count data), and Middle America to s. Baja California, and w. Panama, with occasionally records to central Panama (Ridgely and Gwynne 1989, Stiles and Skutch 1989, Howell and Webb 1995), and in the West Indies to the Bahamas (mainly Grand Bahama, Andros, and New Providence), with smaller numbers on Cuba, Jamaica, and perhaps the other Greater Antilles (Raffaele et al. 1998). Occasional winter resident on Bermuda (Amos 1991). In North America, main winter range extends north along lower St. Lawrence River to extreme s. Quebec, and individuals occasionally winter in other areas of the n. U.S. and s. Canada north of the main range. The se. U.S., particularly Florida, is the main wintering area for Sharp-shinned Hawks breeding in e. North America (Viverette et al. 1996). Populations breeding south of the U.S. (Middle America, West

Indies, South America) are probably resident or, at least, less migratory.

OUTSIDE THE AMERICAS

Not recorded.

HISTORICAL CHANGES

Few data. Difficult to assess because of the species' secretive nature, particularly in the breeding season. Dependence on relatively large tracts of contiguous forest for nesting, at least until recently, has almost certainly affected distribution historically, particularly in e. North America, where local and regional distributions shifted in responses to the widespread loss of the eastern deciduous forest at the end of the nineteenth and the beginning of the twentieth centuries. Currently appears to be expanding its breeding range southward, continent-wide.

FOSSIL HISTORY

Known from the Pleistocene of California, New Mexico, S. Dakota, Virginia, Florida, and the Bahamas, and from prehistoric sites in Arizona and Puerto Rico (Brodkorb 1964, Palmer 1988).

SYSTEMATICS

This account follows classification of American Ornithologists' Union (1998), which includes under Sharp-shinned Hawk the following taxa sometimes regarded as distinct species: *erythronemius* (Rufous-thighed Hawk) of se. South America, *chionogaster* (White-breasted Hawk) of Central America, and *ventralis* (Plain-breasted Hawk) of montane nw. and w. South America (cf. Hellmayr and Conover 1949, Friedmann 1950, Storer 1952, Monroe 1968, Blake 1977, and R. Ridgely in Sibley and Monroe 1990). Taxonomy of this complex unsettled and particularly in need of comparative analysis of morphology, ecology, behavior, vocalizations, and genetics.

GEOGRAPHIC VARIATION

Most geographic variation involves overall size, amount of pigmentation on upperparts, eye color of adults, and color and pattern of underparts; the following summary based largely on Storer 1952, Wattel 1973, and Palmer 1988. Size increases clinally southward in North America to the Isthmus of Tehuantepec, then decreases. Although size variation not thoroughly analyzed in North America, birds from the Pacific Northwest (*perobscurus*) average larger than *velox* elsewhere on the continent. Autumn migrants trapped in the Goshute Mtns. of Nevada weighed less and had longer tails and wings than those trapped at Cedar Grove, WI (Smith et al. 1990). West Indies populations small, about 10% smaller overall than continental North American birds (Delannoy and Cruz 1988). Color and pattern of underparts varies from dark and heavily marked on islands off the coast of British Columbia (*perobscurus*) to pale rufous with reduced and faint markings southward through Mexico, where tibial feathering (thighs, flags, or crural feathers) becomes unbarred light rufous. Amount and intensity of rufous on underparts in North American populations (*velox*) shows large amount of individual variation within a given population. West Indies forms tend to be rufous or rusty on side of head and on vent and vary in distinctness of barring on tail. Eye color of adults varies from red in northern populations to brown or brownish red in n. Mexico (*suttoni*), yellow in sw. Mexico (*madrensis*), and variable (amber to red) in extreme s. Mexico and n. Central America (*chionogaster*).

South American forms highly variable on underparts (entirely or extensively chestnut rufous, blackish, or tawny grayish more or less suffused with rufous) but always with deep rufous or reddish chestnut, immaculate tibial feathering; upperparts darker and more uniform and size averages smaller in se. South America (*erythronemius*; Blake 1977).

SUBSPECIES

Ten subspecies recognized (Brown and Amadon 1968, Stresemann and Amadon 1979), these divided into 3 subspecies groups by Am. Ornithol. Union (1998): Sharp-shinned Hawk (*striatus* group), White-breasted Hawk (*chionogaster* group), and Rufous-thighed Hawk (*erythronemius* group).

Sharp-shinned Hawk (*striatus* group). Four subspecies migratory or resident in continental North America to s. Mexico and 3 subspecies each resident on the 3 larger islands of the Greater Antilles. Storer (1952) noted that the southernmost race, *madrensis*, was an apparent bridge in characters toward White-breasted Hawk (*chionogaster*). For this reason, he listed all continental North American forms in sequence and moved the 3 West Indies races to follow *erythronemius*, which race he thought the West Indies forms resembled in barring of underparts, perhaps indicating a closer relationship with South American forms than with those of North America.

A. striatus velox (Wilson, 1812): See Distinguishing characteristics, above. Breeds North America from Alaska and Canada south to s. U.S.; some western populations only partially migratory or resident, others wintering over much of breeding range south through Middle America to central Panama, casually to the West Indies and Bermuda. Gray to grayish blue above, crown darker; tail with alternating narrower dark and broader pale tail bands (outer rectrices of all races have dark bars narrower than pale bars; some *velox* have width of dark bars equal to pale bars; Storer 1952); underparts white with conspicuous rufous or tawny bars, including tibial feathers; iris of adult orange to red.

A. s. perobscurus Snyder, 1938: Breeds on Queen Charlotte Is., British Columbia, and, possibly, adjacent mainland; partly migratory reaching Oregon and possibly farther south. Slightly darker than *velox* (especially in Juvenal plumage); underparts more heavily marked and white of belly reduced (Snyder 1938, Friedmann 1950). This race not recognized by Hellmayr and Conover (1949).

A. s. suttoni van Rossem, 1939: Resident in San Luis Mtns. of Chihuahua-Sonora boundary south locally in mountains of Mexico to Michoacán and from Coahuila to Veracruz; possibly intergrades with *velox* north to extreme s. Arizona and s. New Mexico (*suttoni* not definitely known from U.S. *contra* Am. Ornithol. Union 1957; see Storer 1952, Phillips et al. 1964). Similar to *velox* but tibial feathering unbarred and more reddish; paler below, especially on breast, with faint blackish shaft streaks. This race not recognized by Hellmayr and Conover (1949).

A. s. madrensis Storer, 1952: Resident in Sierra Madre del Sur, Guerrero and w. Oaxaca (west of Isthmus of Tehuantepec; Binford 1989). Similar to *suttoni* but much paler below, underparts whitish faintly washed and marked with pale rufous; tibial feathering pale, unmarked rufous.

A. s. striatus Vieillot, 1808: Resident on Hispaniola. Small, with russet or tawny tinge to sides of head and less-conspicuously barred tail; underparts with narrower and more regular barring than in *velox*; tibial feathers barred Sayal Brown (Friedmann 1950).

A. s. fringilloides Vigors, 1827: Resident on Cuba. Similar to nominate *striatus* except for cinnamon (no. 123a) sides of head; entire abdomen and under-tail-coverts white; tibial feathers barred grayish brown (Friedmann 1950).

A. s. venator Wetmore, 1914: Puerto Rico. Blackish tail bars more distinct than on other West Indian subspecies. Similar to *striatus*, but darker upper parts. Thigh feathers rufescent (Friedmann 1950).

White-breasted Hawk (*chionogaster* group). One subspecies. Storer (1952) interpreted a cline in pattern and color of underparts toward paler, relatively unmarked populations in s. Mexico (*madrensis*) as a bridge to the white underparts of *chionogaster* and therefore lumped this taxon with other Sharp-shinned Hawk forms to the north. Also, because *chionogaster* was in the past regarded as a race of *erythronemius* (along with *ventralis*) of South America (e.g., Hellmayr and Conover 1949), Storer (1952) believed all taxa should be merged under *striatus*. Monroe (1968) disagreed with this view and regarded all these taxa as separate species.

A. s. chionogaster Kaup, 1852: Chiapas, Mexico, south to Nicaragua. Smaller than other Mexican subspecies. Adults with upperparts sooty (head) to fuscous black; underparts white, with prominent blackish shaft streaks on chin, throat, and breast; tibial feathering unmarked, light ochraceous-buff.

Rufous-thighed Hawk (*erythronemius* group). Two subspecies, each sometimes regarded as distinct species (e.g., Sibley and Monroe 1990, Bierregaard 1994).

A. s. ventralis Sclater, 1866: Resident of Andean w. Venezuela, Colombia, and w. Bolivia. Highly variable, ranging from very pale below to heavily barred, with some melanism, the latter possibly restricted to males (Hellmayr and Conover 1949, but see Wattel 1973). Distinguished from both *velox* and *chionogaster* by deep rufous, reddish chestnut, or cinnamon brown (Smithe 1975–1981: color no. 33) tibial feathers; lighter on belly than on throat and breast; dark tail bands broader than paler bands.

A. s. erythronemius Kaup, 1850: Resident e. Bolivia, s. Brazil, Paraguay, Uruguay, and n. Argentina. Similar to *ventralis* but ventral barring, when present, more prominent and upperparts more uniform and darker (back almost entirely slaty black or fuscous brown); somewhat smaller than *ventralis*.

RELATED SPECIES

Similar to Eurasian Sparrowhawk (*A. nisus*), an ecological counterpart, in structure and plumage, and, to a lesser extent, the Rufous-breasted Sparrowhawk (*A. rufiventris*) of East and South Africa; these species often are considered Sharp-shinned Hawk's closest relatives on those bases (Stresemann 1924, Wattal 1973, Amadon et al. 1988, Sibley and Monroe 1990).

MIGRATION

NATURE OF MIGRATION IN THE SPECIES

The species is a partial, albeit sometimes long-distance (>1,500 km) migrant throughout much of its North American range (Appendix 1). Northernmost breeders largely abandon their breeding grounds each autumn. Individuals are absent from breeding grounds for 5–7 mo in s. Canada and n. U.S., and for shorter periods farther south. A high-altitude, broad-frontal migrant in autumn in the northernmost parts of its range, the species frequently concentrates along leading lines, including coastlines and mountain ranges, farther south (Murray 1964).

TIMING AND ROUTES OF MIGRATION

Fall. Timing of departure from breeding grounds not well quantified, but migrating individuals begin to appear at hawk-watches at Duluth, MN (Janssen 1987), and Cedar Grove, WI, (Robbins 1991) in the n. U.S. by early Aug. Observations at hawk watches in the Great Lakes Region and e. Pennsylvania indicate a relatively rapid movement in autumn. At Hawk Mountain Sanctuary, e. Pennsylvania, where on average 4,246 individuals seen annually (1934–1995; Bildstein 1998), and where migration peaks on 7 Oct, one-third of the flight passes by 3 Oct, two-thirds by 12 Oct, and 90% by 21 Oct; 98% of the flight passes between 9 Sep and 5 Nov. Passage rates peak at 7.2 birds/h in early Oct (Bednarz et al. 1990, Hawk Mountain Sanctuary unpubl. data). A similar passage phenology occurs at Cedar Grove, WI (Mueller et al. 1997). Migration occurs from late Aug–late Oct in British Columbia (Campbell et al. 1990), from mid-Sep–late Oct in s. California (Garrett and Dunn 1981), and from late Aug–late Nov in Cape May, NJ (Sibley 1997). Migrants recorded late Oct–late Mar in Panama (Ridgely and Gwynne 1989) and Feb–Apr in the Bahamas (Raffaele et al. 1998).

Highest one-day counts (which generally reflect when migration peaks) for raptor-migration watchsites in the U.S. include: 1,380, 21 Sep 1984, at Golden Gate Raptor Observatory, near San Francisco, CA; 51, 25 Sep 1996, at Lucky Peak, near Boise, ID; 780, 16 Sep 1989, in the Goshute Mtns., ne. Nevada; 114, 7 Sep 1988, in the Wellsville Mtns., UT; 1,623, 10 Sep 1991, at Hawk Ridge, Duluth, MN; 2,343, 15 Oct 1995, at Cedar Grove, WI; 712, 20 Sep 1987, at Lake Erie Metropark, south of Detroit, MI; 1,011, 25 Sep 1986, at Casco Bay north of Portland, ME; 777, 25 Sep 1988, at Quaker Ridge, near Greenwich, CT; 2,620, 8 Oct 1979, at Hawk Mountain Sanctuary, e. Pennsylvania; 11,096, 4 Oct 1977, at Cape May Point, NJ; 3,842, 29 Sep 1995, at Kiptopeke, VA, at the southern tip of the Delmarva Peninsula; and 166, 17 Oct 1995 on Grassy Key, FL (Mueller et al. 1997; Hawks Aloft Worldwide unpubl.). In coastal Veracruz, Mexico, annual counts averaged 2,400 in the early to mid-1990s, and peak passage occurred in early to mid-Oct (E. Ruelas pers. comm.).

Routes in fall. Band recoveries suggest that birds banded at Duluth, MN (Evans and Rosenfield 1985), Cedar Grove, WI (Mueller and Berger 1967a), along the Kittatinny Ridge in e. Pennsylvania and n. New Jersey (Viverette et al. 1996), at Cape May Point, NJ (Clark 1985), and Hawk Cliff, ON (Duncan 1982), winter largely in the s. U.S., with a few individuals recovered as far south as Guatemala (1 recovery; Mueller and Berger 1967a), Mexico (6 recoveries), Honduras, Nicaragua, and Costa Rica (1 recovery each; Evans and Rosenfield 1985), Cuba (2 recoveries), and Bermuda (2 recoveries each; Clark 1985). Males banded at Duluth wintered 900 km north of females banded there (i.e., 33°20'N vs. 24°50'N; Evans and Rosenfield 1985), whereas adult females banded at Cape May Point wintered farther north than juvenile females, and juvenile females wintered farther north than juvenile males (Clark 1985). None of the differences was significant, however (Mueller 1987, H. Mueller pers. comm.). In e. North America, juvenile movements are more coastal than adult movements (Viverette et al. 1996).

Autumn counts of 1,500 individuals at Grassy Key, FL, in Oct, suggest that at least some birds overwinter in the Caribbean, probably on the Greater Antilles and in the Bahamas (Raffaele et al. 1998).

Spring. Not as well studied as fall migration; a relatively ill-defined migration period. At Hawk Mountain Sanctuary, e. Pennsylvania, movements begin in late Mar and end in early May; passage peaks 11–30 Apr (Hawk Mountain Sanctuary unpubl.). At Derby Hill, NY, where movements begin in late Mar and end in early May, passage peaks 21–25 Apr, almost 4 wk later than that of Cooper's Hawks at the same site (Haugh 1975). Migration occurs late Mar–mid-May in British Columbia (Campbell et al. 1990), and mid-Mar–mid-May at Cape May, NJ (Sibley 1997). Banding recoveries from Duluth suggest that spring migrants "retrace the general route followed during fall migration" (Evans and Rosenfield 1985: 313).

Highest one-day counts for spring raptor-migration watchsites in the U.S. and Canada include: 406, 3 Apr 1990, at Cape Flattery, northwest of Seattle, WA; 97, 15 Apr 1987, in the Sandia Mtns., east of Albuquerque, NM; 44, 14 Apr 1981, at Dinosaur Ridge, east of Denver, CO; 110, 15 Apr 1989, at Windygates, southwest of Winnipeg, Manitoba; 158, 15 Apr 1992, at Indiana Dunes, southwest of South Bend, IN; 196, 30 Apr 1991, at Port Huron, northeast of Detroit, MI; 3,019, 28 Apr 1984, at Derby Hill, north of Syracuse, NY; 1,556, 18 Apr 1976, at Grimsby, se. Ontario; 116, 29 Apr 1990, at Eagle Crossing, southwest of Montreal, Quebec; 992, 3 May 1989, at Fort Smallwood Park, southeast of Baltimore, MD; 289, 2 May 1987, on Plum I., north of Boston, MA (Hawks Aloft Worldwide unpubl.).

Concentrations not as apparent as in autumn. In spring, Sharp-shinned Hawks make up 15% of the flight at Hawk Mountain Sanctuary, e. Pennsylvania (1969–1998, 1,085 of 7,433; McCarty et al. 1999), 12% of the flight at Derby Hill, NY (1963–1969, 16,068 of 137,452; Haugh 1972), and 32% of the flight at Delta, Manitoba (1968; 563 of 1,743; Haugh 1972).

MIGRATORY BEHAVIOR

Usually migrates alone (66% of 271 migrants in Central Park, New York City), or in small groups of several individuals that sometimes include Broad-winged Hawks (*Buteo platypterus*), Red-tailed Hawks (*B. jamaicensis*), and American Kestrels (*Falco sparverius*; Kerlinger 1989). Soars on migration, but also engages in active flap-sailing flight. In e. North America, autumn movement is associated with the passage of cold fronts, with flights at Hawk Mountain Sanctuary, e. Pennsylvania, peaking the day after frontal passage, and averaging 26% lower during the next 3 d than on the day of and the day after frontal passage (Allen et al. 1996, see also Mueller and Berger 1967a). Results from banding stations at Hawk Cliff, Ontario, Hawk Ridge, MN, and Cedar Grove, WI, indicate that juveniles precede adults by about 2 wk (Mueller and Berger 1967a, Rosenfield and Evans 1980, Duncan 1982), and that, within age groups, females precede males by about 1 wk (Rosenfield and Evans 1980, Duncan 1982).

Frequently hunts on migration—36% of 817 individuals migrating past Hawk Mountain Sanctuary, e. Pennsylvania, in autumn 1981 had visibly distended crops (Shelley and Benz 1985, see also Hofslund 1973). This fact, together with their tendency to move along traditional corridors and their relatively large numbers, makes them one of the most frequently trapped of all migrating North American raptors (e.g., Duncan 1982, Clark 1985). In autumn, species makes up 25% of all raptors seen at Hawk Mountain Sanctuary, e. Pennsylvania, (1934–1995; Bildstein 1998); 12% at Hawk Cliff, Ontario (1967; Haugh 1972), and 33% at Goshute Mountains, NV (1983–1990, S. Hoffman unpubl.).

Although the species makes water crossings of 18 km at Cape May Point, NJ, and 18–29 km at Whitefish Point, ON (Kerlinger 1985a), reverse and diverted migration in the face of a water barrier is not uncommon (Darrow 1963, Kerlinger 1984, 1985a, Holthuijzen and Oosterhuis 1985, Sutton and Kerlinger 1997). Recoveries in Bermuda of 2 juveniles banded in Cape May suggest that many Sharp-shinned Hawks using this corridor may be lost at sea (Clark 1985). At Cape May Point, individuals cross Delaware Bay to Cape Henlopen, DE, in light, but not strong, cross winds, and when the "flight at the shoreline [is] at high as opposed to low altitudes" (Kerlinger 1984: 1029). All but 1 of 48 females radio-tagged at the site during fall migration were lost upon release traveling north along Delaware Bay, presumably in reverse migration to reduce the length of over-water crossing. Birds captured before noon were more likely to move off quickly than were those captured after noon; the latter were more likely to perch and hunt in the area (Holthuijzen and Oosterhuis 1985). Avoids the 80–120 km water crossings made by Peregrine Falcons (*Falco peregrinus*) between Fire I., NY, and coastal New Jersey (Darrow 1963). Similar activity reported on Cape Cod, MA, peninsular Florida, and the Florida Keys (Palmer 1988). There is a small west-to-east reverse migration along the north shore of Lake Erie in the autumn (Duncan 1982).

At some sites, the flight increases in altitude toward the middle of the day, as individuals take advantage of midday thermals (Kerlinger and Gauthreaux 1984). At Cape May Point, for example, individuals flew lower in morning than at midday (approximately 200 m vs. 600 m), and lower on strong westerly winds than on other winds and calm periods (<300 m vs. 270–740 m), the former potentially explaining reported early-morning peaks in numbers at the site (Allen and Peterson 1936); the later, apparently, to avoid being blown out to sea (Kerlinger 1985b). At Hawk Mountain Sanctuary, e. Pennsylvania, passage rates increase rapidly through mid-morning, level off, and then begin to decrease slowly after noon before dropping off considerably after mid-afternoon (Hawk Mountain Sanctuary unpubl.). Observations there indicate Sharp-shinned Hawks fly lower than Broad-winged and Red-tailed hawks (37 m vs. 100 and 90 m, respectively), and flight altitude does not change over the course of the day (P. Porneluzi and N. Woffinden pers. comm.). Flight speeds of 37 Sharp-shinned Hawks migrating past Hawk Mountain Sanctuary, e. Pennsylvania, averaged 48 km / h, ranging from 26 to 96 km / h (Broun and Goodwin 1943).

CONTROL AND PHYSIOLOGY

Concentrations of migrating Sharp-shinned Hawks, particularly juveniles, along the mid-Atlantic coast of the U.S have been attributed to prey availability, wind drift, and leading lines (i.e., long and narrow topographical features, such as coastlines, that birds follow; Murray 1964, Mueller and Berger 1967a, 1967b, P. Kerlinger pers. comm.). The last, especially, appears to be particularly important (Kerlinger and Gauthreaux 1984, Clark 1985, Allen et al. 1996, but see Haugh 1972).

At least at Hawk Mountain Sanctuary, e. Pennsylvania, and Cedar Grove, but probably elsewhere as well, autumn movements increase following the passage of cold fronts, apparently because flight conditions are better then than at other times, and not because the birds are more likely to be visible to observers at such times (Mueller and Berger 1967a, Allen et al. 1996).

The species' tendency to feed on birds associated with human-modified landscapes, including those close to human habitation (Fisher 1893, Stone 1937, Dunn and Tessaglia 1994), may be responsible for considerable migratory short-stopping (i.e., geographic shortening of a traditional migration corridor), at least in New England and the mid-Atlantic region of eastern North America (Duncan 1996, Viverette et al. 1996). That juveniles make up the bulk of coastal migrants suggests that they are more prone to wind drift and following leading-lines than adults are (Mueller et al. 1981a).

HABITAT

BREEDING RANGE

Sea level to near alpine. Nests in most forest types in range, particularly those with at least some conifers. In Colorado, nests in quaking aspen (*Populus tremuloides*) and conifer (*Abies, Picea, Pseudotsuga*) forests (Joy et al. 1994), particularly in "dense stands with a well developed canopy" (Platt 1976: 103). In Missouri, found in oak-hickory (*Quercus-Carya*) and pine (*Pinus*) stands (Wiggers and Kritz 1994). In western coniferous forests, size of accipiter species and nest-tree size are often correlated (Siders and Kennedy 1996). In Wisconsin, species tends to nest in denser forests with younger, shorter trees and more conifers than does Cooper's Hawk (Rosenfield et al. 1991).

Hunts in mature aspen, conifer, and mixed aspen-conifer forests in Colorado (Joy et al. 1994).

Although habitat differences among the 3 sympatric species of North American accipiters typically are attributed to direct competition (Whaley and White 1994), larger accipiters (e.g., Northern Goshawk, *Accipiter gentilis*) are known to prey on smaller hawks (Bent 1937), and the extent to which indirect competition with and predation by larger accipiters shapes habitat use in Sharp-shinned Hawks remains an unexplored topic.

See also Breeding: nest site, below.

SPRING AND FALL MIGRATION

At a stopover site in s. New Jersey directly north of Cape May Point, Sharp-shinned Hawks flew lower over forests and fields than over marshes, and were 3–4 times more abundant over forests than over fields or marshes, possibly because of species' tendency to hunt in forests and along forest edge (Holthuijzen et al. 1985, Niles et al. 1996, but see Mueller and Berger 1967b).

WINTER RANGE

Few quantitative data. A frequent visitor to rural farmsites and areas around suburban homes, where individuals feed on birds at and around feedlots and bird feeders (Dunn and Tessaglia 1994, KLB). Based on banding recoveries, females may be found in open areas and in human dominated landscapes more often than males (Clark 1985). In piedmont N. Carolina, females used continuous deciduous forest and small dense pine stands within such forest; males used mixed forest and transitional habitat near open areas, where densities of potential prey species were higher (Meyer 1987).

FOOD HABITS

FEEDING

Main foods taken. Mostly small birds, some small mammals, occasionally large insects.

Microhabitat for foraging. Based on habitat preferences of species identified among prey remains, Reynolds and Meslow (1984) concluded that nesting Sharp-shinned Hawks in Oregon foraged in the upper canopy. Other information indicates a much broader range of breeding- and nonbreeding-season foraging habitats, including forest mid- and understory, fields, and shorelines (Kilham 1958, Peeters 1963, Storer 1966, Page and Whitacre 1975, Quinn 1991). Throughout range, sexes of wintering hawks differed significantly in use of habitats, with females in continuous deciduous forest and males in smaller patches of mixed forest and transitional habitats (Meyer 1987).

Food capture and consumption. Secretive, opportunistic; relies on surprise. Attacks flying or perched prey. Capture follows short chase or stealthy approach initiated from perch or low-level flight. Does not dive at high speed from above. When hunting from perch, remains motionless until darts rapidly toward quarry, often parting foliage and small branches in the process. Can maintain high speed for short distances; if prey is not captured fairly quickly, attempt usually abandoned. Uses natural features and man-made structures for cover when approaching prey, often remaining concealed—and obviously unable to see the target—until the last instant. Sometimes hunts speculatively, coursing low against a backdrop of vegetation or rising terrain, winding around shrubs, hedgerows, or tree trunks. Will slip quickly over some obscuring feature to surprise prey.

Long legs and toes enable individuals to reach into vegetation, and long, deeply curved, needle-sharp talons permit quick, sure grasping even while in motion. Sometimes reaches into wire-mesh traps and cages to impale birds within (KM).

Long history of using areas around houses and human structures as hunting habitat (Stone 1937). Particularly adept at preying on birds at bird feeders. Responsible for 35% of 1,138 predation incidents reported at feeders in continent-wide survey (Dunn and Tessaglia 1994). Feeder predation invoked as partial explanation for migratory short-stopping in e. North America, which may contribute to depressed counts at migration watchsites (Duncan 1996, Viverette et al. 1996).

While nesting, takes high proportion of nestlings from open-cup nests and fledglings. At 11 nests in Colorado, 60% of avian prey were nestlings or fledglings (Joy et al. 1994), as were 62% at 5 nests in New Brunswick (Meyer 1987). Twelve prey items at a nest in Alberta (Quinn 1991) included 6 fledgling Red-winged Blackbirds (*Agelaius phoeniceus*). Regurgitated pellets at the same nest contained 14 color bands from fledgling House Wrens (*Troglodytes aedon*) studied by author (number of individuals not given); no bands from adults were recovered, even though 74% of the known wren population was color-banded. Adults occasionally return to their nests in quick succession with 2–4 prey items of similar appearance, suggesting that hawks are capturing several young from a single nest (KM).

Data lacking for diurnal patterns of prey captures. In winter, traps baited with birds were most successful in early morning and late afternoon (KM). In Wisconsin, hawks that struck trapping lures were lighter than those that merely passed over; females were more likely than males to attack larger lure birds, and juveniles were more likely than adults to make passes at inappropriately large lures (Mueller and Berger 1970).

Plucks prey before eating, often on some raised object such as a tree stump or trunk, or upraised roots of a downed tree. Some plucking sites habitually used, especially near nests and on breeding-season foraging ranges. During winter, prey more often plucked on ground (KM). When delivering food to mate or young, adult males remove and eat heads of prey; in captivity, both sexes eat heads first (KM).

Detailed descriptions of woodpecker-like flight (bounding undulations) across open spaces (J. Schmitt pers. comm.) suggest that this behavior may serve to confuse quarry when hawk is approaching in full view.

Cooperative hunting and food-caching not reported.

DIET

Major food items. Data from stomach contents, direct observations, regurgitated pellets, and prey remains (mainly feathers) during the breeding season and winter show mainly avian prey with some small mammals. Insects frequently reported from stomach contents (Duncan 1980, Palmer 1988), but uncertain how many nonavian items eaten by hawks versus their avian prey (Duncan 1980). Quinn (1991) saw a male catch 2 large moths. Most avian prey <35–40 g, but American Robin (*Turdus migratorius*), with an average mass of 77.3 g (Dunning 1984), was second most common species among 833 items in 144 stomachs (North America, mainly autumn and winter; USFWS files, Storer 1966) and remains of 174 prey items at 10 nests (S. Woodley, K. Meyer, and D. Kirk unpubl.). The broad range of avian prey consists mainly of passerines but includes representatives of at least 6 other orders: Falconiformes, Galliformes, Charadriiformes, Columbiformes, Apodiformes, and Piciformes (Duncan 1980, Joy et al. 1994, Reynolds and Meslow 1984). Storer's (1966) analysis revealed that 5 genera with a total of 25 species made up 44% of prey items (in descending order of frequency): *Dendroica, Melospiza, Turdus, Hylocichla,* and *Spizella*. The 3 most common avian genera in 110 stomachs examined by Duncan (North America, mainly autumn, USFWS files, 1980) were *Junco, Passer, and Melospiza*. Mammals reported were mostly *Peromyscus, Microtus, Tamias, Tamiasciurus, Thomomys, and Clethrionomys* (Duncan 1980).

The smallest reported prey was an Anna's Hummingbird (*Calypte anna*, Peeters 1963), 4.4 g; the largest was Ruffed Grouse (*Bonasa umbellus*; S. Woodley, K. Meyer, and D. Kirk unpubl.), 577 g (body mass from Dunning 1984). Other large prey included a Marbled Murrelet (*Brachyramphus marmoratus*, 222 g; Marks and Naslund 1994) and a Dunlin (*Calidris alpina*, 244–407 g) that was struck but not captured (Page and Whitacre 1975; masses from Dunning 1984).

A female captured on spring migration at Whitefish Point, MI, had 3 porcupine (*Erethizon dorsatum*) quills through its foot (Kelley and Kelley 1969).

Quantitative analysis. Although the species captured vary considerably among locales, birds consistently represent >90% of prey items by number in all types of samples (Appendix 2). In Colorado, Joy et al. (1994) found that the numbers of mammalian prey increased relative to the numbers of birds over the course of the nesting cycle at 11 nests, and that, unlike birds, mammals were taken in greater-than-expected proportion to availability; thus, the authors concluded that the hawks foraged opportunistically for birds but selectively for mammals.

Mean mass of mammalian prey was greater than that of avian prey in a Colorado study where relative masses were presented (Joy et al. 1994; Appendix 2). Females generally took heavier prey than males. Differences were statistically significant based on stomach contents (Storer 1966), but not so for observations at traps baited with birds (Mueller and Berger 1970), or for observations at nests (Snyder and Wiley 1976, Mueller et al. 1981b, Meyer 1987; Appendix 2).

Of 132 prey items of 25 species collected at 10 nests in New Brunswick, 55% were classified as

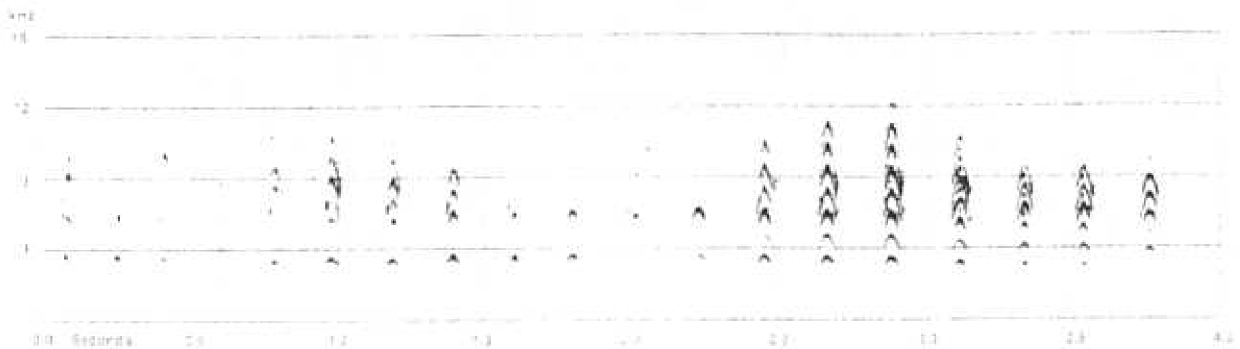

Figure 2. Alarm call of the Sharp-shinned Hawk. Prepared by the staff of the Borror Laboratory of Bioacoustics (BLB), The Ohio State University, using Kay Elemetrics DSP 5500 Sona-Graph (with an effective frequency resolution of 200 Hz and a 150 point FFT transform size) from BLB recording no. 5567, Sinton, San Patricio Co., TX.

Neotropical migrants, 40% as temperate migrants, and 5% as resident or irruptive species (S. Woodley, K. Meyer, and D. Kirk unpubl.).

FOOD SELECTION AND STORAGE

See Feeding, above.

NUTRITION AND ENERGETICS

No information.

METABOLISM AND TEMPERATURE REGULATION

Not well studied. Metabolic rate for 1 resting male (851 mW) lower than that of 2 resting females (1138 mW). Overall, metabolic rate 25% higher than predictions for resting falconiforms (Kennedy and Gessaman 1991). No information on temperature regulation.

DRINKING, PELLET-CASTING, AND DEFECATION

Drinking not reported in the wild; obtains water from prey. Pellets small and probably cast early on most days, but no data. Young defecate outward from edge of nest. As with other accipiters, excreta forcibly ejected, hitting the ground some distance from directly below the bird.

SOUNDS

VOCALIZATIONS

Not well studied. Much of what follows is from Palmer 1988. Silent most of the year, although less so during the breeding season in dense forest when vocalizations may be the primary means of communication between paired birds (see Rosenfield and Bielefeldt 1991). Male's voice seemingly higher than female's (KLB). The vehement *kek-kek-kek* or *kik-kik-kik* alarm call is higher, thinner, and possibly faster than that of the Cooper's Hawk (Fig. 2). Dawson (1923) reported a *ricky-ticky-ticky-ticky-ticky* alarm call from Sharp-shinned Hawk in pursuit of a Great Horned Owl (*Bubo virginianus*). Individuals also give a "plaintive" squealing call from favorite perch sites, presumably as part of courtship (Bent 1937). A morning duet is similar to the Cooper's Hawk (Palmer 1988).

Kip . . . kip given by male as it arrives at the nest; sometimes replied to by female with several *keps* or *keeeep*. Begging calls of nestlings and solicitation call of female a high-pitched *ee*. Sometimes utters "weak cackles" during copulation. An in-flight *chip* call is sometimes uttered by hunting juveniles in autumn, particularly in the evening (D. Evans in Palmer 1988: 308).

Calls of young similar to those of Cooper's Hawk. Weak adult-like alarm calls begin shortly before fledging.

NONVOCAL SOUNDS

None.

BEHAVIOR

LOCOMOTION

Walking, hopping, climbing, etc. Rarely walks on the ground. However, although most attacks on prey are made from the air, usually by surprise, pursues prey on the ground, even to the point of initiating chases from perches within 1 m of the ground. When chasing prey on the ground, individuals often take long jumps, aided by wing flapping (Bent 1937).

Flight. Buoyant in flight, particularly on migration. Typical accipitrine flight pattern of an alternating series of 3–6 shallow wing-beats, followed by short glides. Wing-beats crisper and more rapid than those of Cooper's Hawk. Commonly soars, especially in morning (Clark and Wheeler 1987). When hunting, swift and maneuverable; uses long tail as a rudder to change direction as its tracks prey and avoids vegetation. Will pursue prey in brush. In migration, engages in active flight, as well as slope and thermal soaring. (Soaring occurs when individuals extract energy needed for flight directly from the atmosphere. Slope soaring uses the upward deflection of air resulting from horizontal winds striking the sides of mountains and hills. Thermal soaring uses pockets of warm rising air resulting from the differential heating of the earth's surface [Bildstein 1999]). Lightest wing-loading (especially males) of all North American falconiforms thus greatly affected by wind; line of flight is often erratic (Poole 1938, Haugh 1972, Kerlinger 1989, Brett 1991). Compensate for wind drift while on migration by adjusting headings during periods of flapping flight (Kerlinger and Gauthreaux 1984). Sometimes travels in small groups on migration. Makes short-distance (<30km) water crossings at such times (Kerlinger 1984). See Migration: migratory behavior, above.

Swimming and diving. Unknown.

SELF-MAINTENANCE

Preening, head-scratching, stretching, bathing, anting, etc. Preening typical, using uropygial gland; frequently shakes body and wings during and after preening. A breeding female in S. Carolina preened frequently while incubating, as well as after being fed by the male (Mitchell and Pitts 1992). Head-scratching common. Unilateral stretching of wing and leg. Rarely raises its hackles (Clark and Wheeler 1987).

Sleeping, roosting, sunbathing. Roosts in trees with dense foliage, especially conifers. Communal roosting unknown. In Utah, a breeding male roosted in the "nest grove" 4 of 7 nights after eggs hatched, but not thereafter (Platt 1973).

Daily time budget. In Utah, a breeding male spent little time at the nest, and most of the day in ≥1 hunting territories. Hunting began in early morning, typically within 5 min of waking, with the first nest visit with food about 1 h later (Platt 1973). Eighty-five percent of the waking time of 1 male was spent in 2 disjunct hunting territories, the remaining 15% spent near the nest, traveling between the 2 hunting areas and the nest, or in other hunting areas (Platt 1973). In at least some locations, soars daily, especially in morning or late afternoon (Platt 1973, Clark and Wheeler 1987). In Utah, soaring more common over hunting areas than near the nest, but only after young had been fed. Migrants trapped and radio-tagged in Cape May, NJ, spent approximately 35% of the time perching, 30% in low hunting flight, 25% in flight above tree top level, and 7% circle-soaring with other raptors (Holthuijzen et al. 1985).

AGONISTIC BEHAVIOR

Adults and fledglings respond to intruders (inter- and intraspecific) at nests by vocalizing, chasing, and attacking (see Spacing, below). Dependent fledglings near their nests chased, struck, and grappled with intruding juveniles (Meyer 1987; see Breeding: fledgling stage, below).

Breeding males perched on plucking stumps with freshly plucked prey will crouch, lower head, part wings slightly, and utter very faint and slow version of *kek-kek-kek* call to draw female and exchange prey. If male does not leave nest area soon after delivering prey to female, female often dives at him or vigorously chases him away (KM). See Breeding: incubation, below.

SPACING

Territoriality. Highly territorial when breeding. In 19 territorial display flights observed at 5 nests by Delannoy and Cruz (1988), resident males flew straight at and chased approaching intruders; both hawks called repeatedly. Intruders usually thus evicted. When not, residents either dove at intruders from circling flight overhead or the 2 grappled, spiraling downward to within a few meters of the canopy before separating, after which intruders were evicted. No data concerning winter territoriality.

Individual distance. Mean distance between nests 4.1 km (range 1.8–6.0, $n = 4$) in Oregon (Reynolds and Wight 1978), 2.9 km (range 1.1–6.0, $n = 12$) in Alaska (Clarke 1984), and 1.2 km (range 0.7–2.4, $n = 4$) in New Brunswick (Meyer 1987).

SEXUAL BEHAVIOR

In general, poorly known due to secretive demeanor, poor visibility within nesting habitats, and lack of observations early in the nesting cycle or of marked individuals. See Delannoy and Cruz 1988, a study of resident Puerto Rican Sharp-shinned Hawks, for the most detailed descriptions of the period from courtship through hatching.

Mating system and sex ratio. Presumed monogamous, but no focused study.

Pairbond. The following summarized from Delannoy and Cruz 1988, based on 44 flights. Shortly after sunrise, the male began circling above the nest site, followed soon after by the female. Both mixed soaring and rapid flight accompanied by intermittent calling. Males flapped more frequently and circled higher than females. At irregular intervals, each performed undulating flight (a repeated series of shallow and deep dives, followed by recovery of height). Frequently, either male or female would plunge nearly vertically from a stationary position with closed wings, sometimes recovering just above the canopy (this behavior was not directed at the hawk's mate). Bouts lasted 3–20 min and were repeated several times, all ending with a steep dive into the forest.

Copulation preceded by courtship flights (Delannoy and Cruz 1988). At 1 nest the female flew directly to the male, perched beside him 40 m from the nest, and the male mounted her. Mount lasted about 10 s, accompanied by wing-flapping and vocalizations by both. Female flew off immediately, male remained perched. Similar description by L. Shelley (in Bent 1937), but in that case preceded immediately by subdued vocalizations and crouching by female. Male moved closer and uttered faint whine for 3 min, then mounted female. Remained perched afterward for 30 min.

No information on duration of pair bond. Nesting territories frequently reused, but identity of pair members not known (See Breeding: nest site, below).

Extra-pair copulations. None reported, but would be difficult to detect.

In Puerto Rico, nonresident males brought prey to nest sites in 2 of 20 intrusions observed by Delannoy and Cruz (1988) and in 1 case the female accepted the food in the absence of her mate. On 4 occasions, intruders brought nest material and deposited it in the nest. In none of these instances did females copulate with the intruder males.

SOCIAL AND INTERSPECIFIC BEHAVIOR

Degree of sociality. Usually solitary except during nesting season; even then, adults spend little time near mates or conspecifics.

Play. No information.

Nonpredatory interspecific interactions. No conflicts observed at 1 Sharp-shinned Hawk nest in Utah between pair and Cooper's Hawks or American Kestrels nesting nearby (Platt 1976). Adults near 12 nests in New Brunswick approached or chased Common Ravens (*Corvus corax*) and white-tailed deer (*Odocoileus virginianus*) but did not respond to Northern Harriers (*Circus cyaneus*), a mounted American Crow (*Corvus brachyrhynchos*), or a mounted Great Horned Owl (Meyer 1987). At the same nests, however, recently fledged young responded with vocalizations and approach to Broad-winged Hawks, Red-tailed Hawks, Northern Harriers, white-tailed deer, black bear (*Ursus americanus*), and a mounted Great Horned Owl.

Seen chasing, darting around trees from out of view, and attacking Pileated Woodpeckers (*Dryocopus pileatus*) foraging near active Sharp-shinned Hawk nests (age not given, Kilham 1958; adult, KM). Smith (1983) watched 2 juvenile hawks cooperatively harass a Pileated Woodpecker.

On migration occasionally mobs large raptors, including Bald Eagles (*Haliaeetus leucocephalus*) and Peregrine Falcons, both of which, in turn, have been observed killing this species (George 1989, C. Viverette pers. comm.). In experiments approached smaller models of owls without eyes more closely than larger models with eyes (Kerlinger and Lehrer 1982). Adults also approached the models more closely and made fewer vocalizations than did juveniles.

Nest defense. Mainly by the female, but limited; in New Brunswick, in 408 h of observations during incubation and nestling stages, females responded to only 7 individual intruders despite numerous intrusions by other species (Meyer 1987). In general, nesting adults remain inconspicuous unless the intruder approaches closely or lingers nearby (KM).

PREDATION

Due to small size, adults and young are vulnerable to other forest raptors at nests and roosts; concealed nests and secretive behavior are clearly adaptive in this regard. In New Brunswick and Nova Scotia, young taken from 2 nests by Northern Goshawks (KM). Reaction to human intruders at nests varies among individuals. May quietly leave nest, perch and call, fly about area while calling, or dive to within 1 m of intruder (Bent 1937, KM).

Based on reported predation on similar-sized or larger raptors, Kerlinger and Lehrer (1982) suggested that predation on Sharp-shinned Hawks by larger raptors is more frequent than reported. Migrating Bald Eagles (George 1989) and Peregrine Falcons (Klem 1985, C. Viverette pers. comm.) known to kill Sharp-shinned Hawks on migration, particularly individuals that are mobbing them.

Sharp-shinned-Hawks stoop at conspecifics caught in mist nets (Klem 1985).

BREEDING

PHENOLOGY

Pair formation. Figure 3. Last accipiter to arrive on breeding range in temperate North America, in Apr and early May. In Utah, arrives in late Apr–early May (Platt 1976). Resident in Puerto Rico, territorial only in the breeding season; reoccupies nest areas in Dec and Jan (Delannoy and Cruz 1988). Nesting season in Puerto Rico is 2 mo longer than elsewhere, as is typical for tropical versus temperate subspecies (Delannoy and Cruz 1988).

Nest-building. In Puerto Rico, began at a slow rate soon after reoccupying nest sites; did not become a steady process until 3–4 wk before egg-laying (Delannoy and Cruz 1988). No specific information for temperate locations, but relatively short period between arrival dates and laying dates for given areas suggests that nest building starts soon after arrival.

First/only brood per season. Probably timed to match peak demands for food for young with maximum availability of prey (Palmer 1988). In Puerto Rico, eggs laid mid-Mar–late Apr; young fledged mid-May–late Jun, attained independence late Jul–early Aug (Delannoy and Cruz 1988). In N. and S. Carolina, eggs laid early to mid-May; young fledged early Jul (Meyer and Mueller 1982, Mitchell and Pitts 1992). In Oregon, eggs laid early May–late Jun; young fledged early Jul–late Sep (Reynolds and Wight 1978, Henny et al. 1985). In New Brunswick, eggs laid mid-May; young fledged mid-Jul, attained independence in Aug (Meyer 1987). In Utah, eggs laid late May–early Jun (Platt 1976). In Missouri, eggs laid late May–late Jun; young fledged mid-Jul–late Aug (Wiggers and Kritz 1994).

Second brood per season. Reported only for Puerto Rico (Delannoy and Cruz 1988), where it was observed irregularly from 12 May to 5 Jul, peaking in late May–early Jun and occurring only after the first clutch or brood was lost.

NEST SITE

Selection process. Sites commonly reoccupied, but reuse of actual nest is rare (Platt 1976, Reynolds and Wight 1978, Meyer 1987, Delannoy and Cruz 1988, Joy et al. 1994). No information on selection behavior or interactions between sexes.

Microhabitat. Most reports describe nest locations against trunk on horizontal limbs in dense, well-developed portions of the crown well below the top of the canopy (Bent 1937, Platt 1976, Reynolds et al. 1982, Meyer 1987, Wiggers and Kritz 1991).

No selection for aspect of nest-tree slope or for side of tree relative to slope, but in Oregon 5 nests were in south quadrant, 2 east, 1 west, and 1 north (Reynolds et al. 1982, Moore and Henny 1983).

Site characteristics. Uses many species of trees (see Habitat: breeding range, above), typically within relatively dense stands. Conifers most frequently used, although deciduous are the norm in some locales (Platt 1976, Snyder and Wiley 1976, Quinn 1991); of 34 nests described in egg-collection records for Utah, 44% were in coniferous (mostly pine or spruce), 21% in cottonwood (*Populus* sp.), and 36% in maple (*Acer* sp.), oak, or other species. Of 27 nests directly observed, in Utah 85% were in conifers (Platt 1976). For nests in coniferous trees, associations of stands varied from purely coniferous or coniferous-dominated (Mueller et al. 1981b, Reynolds et al. 1982, Moore and Henny 1983, Meyer 1987, Wiggers and Kritz 1991) to small groves of conifers within deciduous stands (Platt 1976).

In Oregon, most of 10 nests studied were in 25–50-yr-old even-aged conifer stands with single-layer canopies (Reynolds et al. 1982). In New Mexico, nest-tree height and nest-tree diameter-at-breast-height (dbh) were positively correlated with body size among the 3 accipiter species; no correlations were found between body size and forest variables at the nest-site scale (e.g., basal area [summed dbh for all trees in an area], canopy closure) due to high intraspecific variation (Siders and Kennedy 1996).

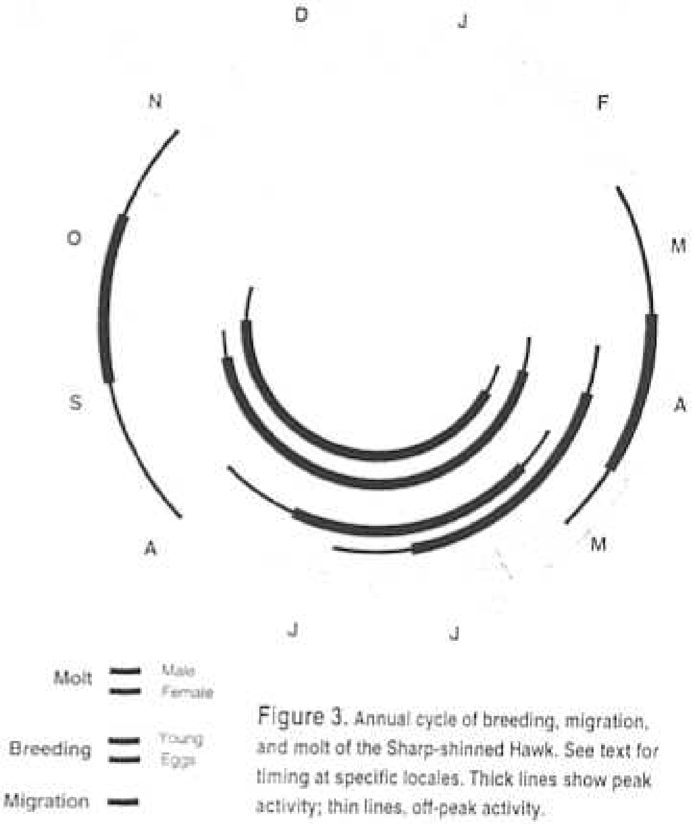

Figure 3. Annual cycle of breeding, migration, and molt of the Sharp-shinned Hawk. See text for timing at specific locales. Thick lines show peak activity; thin lines, off-peak activity.

Reported heights of nests range from 2.4 to 19 m. Mean height was 7.6 m for 15 nests in e. Oregon (Moore and Henny 1983), 17.7 m for 6 in nw. Oregon, and 12.8 m for 10 in e. Oregon (Reynolds et al. 1982). Dbh from 17.3 (New Mexico, Siders and Kennedy 1996) to 41.1 cm (Oregon, Reynolds et al. 1982); means reported elsewhere were intermediate.

Prey-plucking areas usually were upslope from the base of the nest tree (Reynolds et al. 1982, Meyer 1987).

NEST

Construction process. Material brought by both sexes, but female does most or all construction (H. Meng in Palmer 1988). At 1 nest, female gathered material in vicinity of male, who called frequently; female flew through understory in vicinity of the nest, dropped to the ground to snatch small branches (Mitchell and Pitts 1992).

Structure and composition matter. Broad, flat, constructed of dead conifer twigs with flakes of bark as a lining, if any (Bent 1937, H. Meng in Palmer 1988).

Dimensions. Often large relative to size of bird, but variable, about 35–60 cm for longest axis and 10–14 cm deep (Bent 1937, H. Meng in Palmer 1988, KM).

Microclimate. No information.

Maintenance or re-use of nests, alternate nests. See Nest-site, above. In Puerto Rico, some pairs built alternate nests and used them within season after first nest failed (Delannoy and Cruz 1988).

EGGS

Shape. Rounded, ovate, short ovate, oval (Bent 1937), short subelliptical or subelliptical (Palmer 1988).

Size. Forty-nine eggs from Puerto Rico averaged 37.6 mm ± 0.93 SD in length, 29.5 mm ± 0.57 SD in breadth (Delannoy and Cruz 1988). Length × breadth (means and extremes based on clutch averages): e. Canada: 37.55 (33.92–40.60) × 30.12 (28.60–31.89) mm; n = 21 clutches, (102 eggs); e. U.S.: 37.82 (36.11–40.9) × 30.43 (29.25–33.82) mm, n = 21 clutches (94 eggs); w. U.S.: 37.60 (33.48–41.47) × 30.37 (29.15–31.45) mm, n = 20 clutches (89 eggs). Data from L. Kiff, WFVZ. See also Bent 1937, Palmer 1988.

Mass. Eggs from temperate North America average 19 g, about 11% of body mass of female, or 43–54% of her mass for a typical clutch of 4-5 eggs (Newton 1979). Mass of 8 eggs in Puerto Rico averaged 18.5 g (± 0.41 SD), 10.8% of female's body mass, or 32% of her mass for the typical clutch of 3 eggs (Delannoy and Cruz 1988).

Color. Long prized by egg collectors for their handsomeness and variability in color and pattern. Ground color dull white or a fading pale bluish white. Some marked with splotches of light or dark shades of brown, vinaceous, violet, or hazel, sometimes grouped at the ends or middle (Bent 1937, Palmer 1988).

Surface texture. Smooth, sometimes with a sheen, but not glossy (Bent 1937, Palmer 1988).

Eggshell thickness. Anderson and Hickey (1972) reported the following for pre-DDT (prior to 1947) and DDT era (1947–1958) North American eggs: Pre-DDT era, shell mass, 1.48 g ± 0.02 SD (n = 568 eggs); thickness 0.268 mm ± 0.004 SD (n = 197 eggs); DDT era, shell mass, 1.35 g ± 0.08 SD (n = 9 eggs); thickness 0.245 mm ± 0.020 SD (n = 4 eggs). These data suggest a 9% decline in shell mass and an 8% decline in thickness during the DDT era. No data on post-DDT shell thickness. Three thin-shelled Sharp-shinned Hawk eggs, 2 partially crushed, collected in Oregon from 1969 to 1971, contained DDE levels approaching those of the highest ever recorded for arctic Peregrine Falcons, possibly reflecting the small passerine prey-base for the species (Snyder et al. 1973). In the late 1980s in ne. North America, DDE burdens continued to exist in Sharp-shinned Hawks in New York (3.3, 8.9 ppm [brain], n = 2) and e. Canada (3.5–18.6 ppm [eggs], n = 12; Stone and Okoniewski 1988, Noble and Elliott 1990). From 1991 to 1993, DDE burdens in individuals from e. North America ranged from 0.02–0.49 ppm (blood, n = 40; Wood et al. 1996). The recent burdens apparently develop in wintering areas in se. U.S., not in breeding areas (Elliott and Shutt 1993).

Clutch size. See Demography and populations: measures of breeding activity, below.

Egg-laying. Usually on alternate days (Palmer 1988).

INCUBATION

Onset of broodiness and incubation in relation to laying. Although eggs laid on alternate days, clutches generally hatch within 48 h (Reynolds and Wight 1978, Palmer 1988), suggesting that incubation is delayed until the clutch is partly complete or completed (Platt 1976, H. Meng in Palmer 1988). Nine eggs in 3 clutches observed by Delannoy and Cruz (1988) hatched as follows: the first and second eggs in all 3 clutches hatched < 24 h apart; the third eggs hatched 36–48 h after the second in 2 clutches and about 24 h later in the third clutch.

Incubation patches. No information.

Incubation period. Estimates based on concerted field efforts include 30 d (Platt 1976), 30–32 d (Reynolds and Wight 1978), and 32 d (Delannoy and Cruz 1988). Other estimates include 21–24 d (probably inaccurate; Bent 1937), and 34–35 d (Brown and Amadon 1968).

Parental behavior. Little or no male incubation (Snyder and Wiley 1976, Delannoy and Cruz 1988). Male generally roosts near nest during this stage and probably provides all of female's food (but no data; Snyder and Wiley 1976, Delannoy and Cruz 1988). No data on female incubation rhythm.

Hardiness of eggs against temperature stress. No information.

HATCHING

Slightly asynchronous. In Oregon, all eggs in each nest (n = 16) hatched within 24–48 h Reynolds and Wight 1978). Similar data for Utah (Platt 1976).

YOUNG BIRDS

Condition at hatching. Young emerge with eyes open; natal down dries within a few hours (Delannoy and Cruz 1988). Down is uniformly short white or whitish at hatching; longer white down appears 1 wk later (H. Meng in Palmer 1988). No data for mass or linear measurements at this stage.

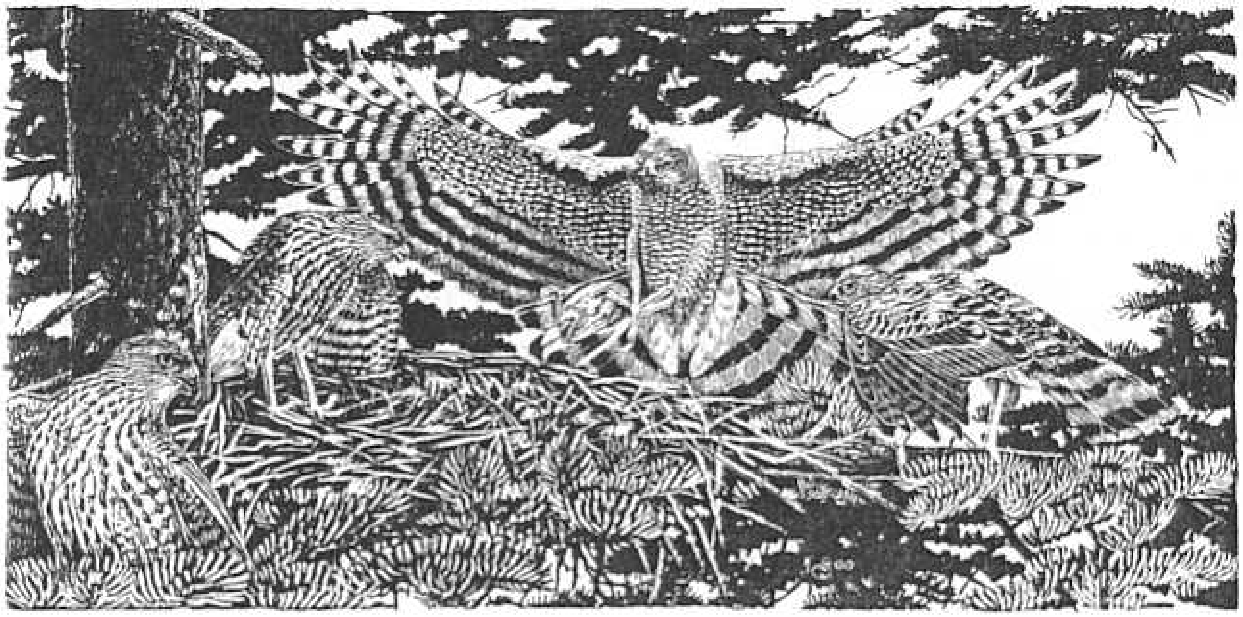

Figure 4. Adult female Sharp-shinned Hawk arriving at nest with prey to feed young. Drawing by N. John Schmitt.

Growth and development. Size difference of sexes apparent during first few days (Meyer 1987, Palmer 1988); plumage differences apparent at about 1 wk (Delannoy and Cruz 1988). See Moss 1979 for growth data in Eurasian Sparrowhawk (*Accipiter nisus*), in which sexes were significantly different in mass at 1 d. *Peep* calls uttered and heads raised to accept food from female on first day; by second and third days, able to peck at food held above them; by fourth day, capable of poorly coordinated preening (Delannoy and Cruz 1988).

No information on temperature regulation.

Males develop plumage and behavior, including flight skills, up to several days sooner than females (Meyer 1987, Delannoy and Cruz 1988, Palmer 1988). Sheathed contour and primary feathers of males appear after about 1 wk; rectrices at 9–11 d. First flap their wings and emit alarm calls at 12 d (Delannoy and Cruz 1988). In Utah (Platt 1976) and New Brunswick (Meyer 1987), males first left the nest at about 24 d, females at about 27 d. In Oregon, the nestling stage lasted 21–24 d, with males fledging sooner than females (Reynolds and Wight 1978). In Puerto Rico, males fledged at 28 d, females at 32 d. Full feather growth attained in Utah at about 38–40 d (L. Camp in Platt 1973).

No information on growth in mass and linear measurements.

PARENTAL CARE

Brooding. Young brooded until about 16–23 d of age, exclusively by the female (Delannoy and Cruz 1988).

Feeding. Male apparently provides all food for the female and young from egg production through brooding, delivering to the female at the nest (Snyder and Wiley 1976, Delannoy and Cruz 1988, Mitchell and Pitts 1992). Even so, nearly all feedings prior to fledging are by female (Meyer 1987, Delannoy and Cruz 1988). For at least the first half of the nestling stage at 9 nests in New Brunswick (Meyer 1987), females first dismembered the prey delivered by the male, then offered small pieces to their young; between days 10 and 14, females spent less time on the nest, tearing prey into fewer pieces; several days before fledging, females began dropping whole prey in the nest, lingering little if at all (Fig. 4). During the same period, males fed young directly only 3 times, at 2 different nests.

After young are fledged, both sexes deliver food to young, sometimes dropping it in the nest during the first few days, but gradually passing it to young in mid-air, either above or below canopy. The first young to detect delivery leaves the perch and flies directly to parent, vocalizing; some or all others follow. Parent passes food in air to first young to reach it, usually hovering briefly, if time permits, then kicking prey outward just before young arrives (Meyer 1987, Delannoy and Cruz 1988).

At temperate-zone nests, male increases delivery rate slightly and female begins delivering food around fledging, resulting in a gradual increase in feeding through the period until the end of the sixth week, when deliveries decline precipitously, mainly as a result of a slow-down of feeding by the male (Snyder and Wiley 1976, Mueller et al. 1981b, Meyer

1987). At subtropical nests in Puerto Rico, sharp drop in deliveries occurs 1–2 wk later (Delannoy and Cruz 1988). At 5 nests in New Brunswick, deliveries by male, which varied from 0.25 to 0.87 prey item/h, were significantly and positively correlated with brood mass (Meyer 1987). All authors except Snyder and Wiley (1976) noted that levels of potential prey were steady or increasing as feeding rates declined, suggesting a weaning process. Observed feeding rates and results of a limited food-provisioning and brood manipulation experiment indicated that adult males adjusted their feeding rates to the size and demands of their broods (Meyer 1987).

Sharp-shinned Hawks have been the subject of several studies that examined or provided relevant data on the relationship between diet and sexual dimorphism in size among raptors. Snyder and Wiley (1976), focusing on all 3 North American accipiter hawks, proposed that this dimorphism arose from selection for separate feeding niches of the sexes in order to reduce male-female competition and improve foraging effectiveness during nesting. They cited apparent food stress at nests they observed as support for this hypothesis. Subsequent studies of nesting ecology of Sharp-shinned Hawks (Mueller et al. 1981b, Meyer 1987, Delannoy and Cruz 1988, Joy et al. 1994) provided sex-specific data on diet, foraging behavior, and activity patterns that draw the niche-separation hypothesis into question (see Food habits: feeding, above).

Nest sanitation. Young back up to edge of nest, excrete over side. In latter part of nestling stage, some prey remains litter nest, but rarely found below (KM).

Carrying of young. Not known to occur.

COOPERATIVE BREEDING

None reported.

BROOD PARASITISM

None reported.

FLEDGLING STAGE

Departure from nest. See Young birds: growth and development, above. Young usually jump or fly between limbs of nest tree for 1–2 d after leaving the nest.

First flights from nest tree are below the canopy to nearby trees, usually to approach parents or siblings with food. Flight is awkward but fledglings can ascend to perches.

Growth. Full feather growth attained about 2 wk after fledging (L. Camp in Platt 1973).

Association with parents or other young. In most areas, fledglings remain dependent on parents for food and close to each other near their nest for about 3.5 wk after fledging (see Parental care: feeding). Perch and wait for their parents to arrive with food, initially below the canopy but later above (See Parental care: feeding).

Fledged broods of individually marked birds near their nests were joined by 1–3 young of similar ages on 20 occasions at 4 of 6 nests in New Brunswick (Meyer 1987). Intruders competed for food during parental feedings, occasionally succeeding. Parents apparently did not distinguish intruders from their own young, but resident young aggressively tried to displace intruders, including making physical contact.

Ability to get around, feed, and care for self. Numerous predatory efforts by fledged young beginning at about 40 d of age (about 2 wk after fledging; Mueller et al. 1981b, Meyer 1987, Delannoy and Cruz 1988). Only observed success was with *Anolis* lizards in Puerto Rico at 51–68 d (Delannoy and Cruz 1988), well after the age at which temperate-nest young leave nest area (see Parental care: feeding).

IMMATURE STAGE

No detailed study after independence. Platt (1973) radio-tagged 1 fledgling in Utah; it and 2 siblings remained in the nest grove until the fourth week, when it left the area and could not be relocated. All other reports of nesting studies that mention the transition to independence note sudden departure with no subsequent detection in the nest area (Mueller et al. 1981b, Meyer 1987, Delannoy and Cruz 1988, Mitchell and Pitts 1992).

DEMOGRAPHY AND POPULATIONS

MEASURES OF BREEDING ACTIVITY

Age at first breeding; intervals between breeding. Some, mostly females, breed at 1 yr, most at ≥2 yr. Four yearling females among 40 pairs in Puerto Rico (Delannoy and Cruz 1988); 5 yearling females and 1 yearling male among 14 pairs nesting in Alaska (Clarke 1984). All 10 females and all males at 10 nests in Oregon (Reynolds and Wight 1978) were in mature plumage, as were all breeders of both sexes at 12 nests in New Brunswick (Meyer 1987).

No information on intervals between breeding.

Clutch. Usually 4 or 5 eggs in temperate nests, range 3–8 (Bent 1937, Palmer 1988). Average 4.3 in Utah (n = 34 clutches, Platt 1976), 4.5 in Missouri (n = 8; Wiggers and Kritz 1994), and 4.6 in Oregon (n = 5; Reynolds and Wight 1978). In Puerto Rico, average 2.6 (n = 40; Delannoy and Cruz 1988).

Annual and lifetime reproductive success. Annual reproductive success, including hatching rates, nest success, fledgling success, and fledglings per nest, for birds breeding in Alaska, New Brunswick, Oregon, Puerto Rico, and Wyoming, are in Appendix 3.

Factors influencing nest success are not well understood. No mention of any relationship between laying date and reproductive success. No information on lifetime reproductive success.

Number of broods normally reared per season. No reports of >1 in U.S.

Proportion of total females that rear at least one brood to nest-leaving or independence. No information.

LIFE SPAN AND SURVIVORSHIP

No rigorous analysis of survival available. Based on 92 band recoveries plus 18 recaptured birds from North America, the following percentages reported/yr from 0 to 8 yr: 19%, 24%, 25%, 15%, 10%, 5%, 2%, and 2% (D. Evans in Palmer 1988). Only 19% of these 110 birds lived >3 yr. Longest lifespan reported: 13 yr (Keran 1981).

DISEASE AND BODY PARASITES

Diseases. No information.

Parasites. At 28 Puerto Rican nests that failed during incubation, and at which cause could be determined, warble fly (*Philornis* sp., Diptera, Muscidae) larvae fed subcutaneously on nestlings and damaged tissue, affected growth, and killed the host. In this study, parasitism by warble flies caused 69% of nest failures (total loss) during the nestling stage (Delannoy and Cruz 1988).

During autumn migration, juveniles more likely to have hemoparasites (*Hemoproteus* and *Leukocytozoon*) than adults; no gender differences reported (Powers et al. 1994).

CAUSES OF MORTALITY

Collisions with vehicles, predation, collisions with windows, and gunshot were the leading identifiable causes in 2 studies (Keran 1981, Evans and Rosenfield 1985). In the latter study, which involved birds banded on autumn migration in Minnesota, juvenile mortality was highest in fall and winter, while nearly half of adult deaths were in spring. See Conservation and management: effects of human activity, below.

At 28 Puerto Rican nests that failed during incubation, and for which cause could be determined, desertions were responsible for 73% of nest failures and human disturbance 20% (Delannoy and Cruz 1988). Nest predation was the third most frequent cause at 15%.

RANGE

Initial dispersal from natal site. See Breeding: immature stage, above.

Fidelity to breeding site and winter home range. No information.

Dispersal from breeding site. No information.

Home range. Both sexes of a pair nesting in Utah were fitted with transmitters and tracked for most of the nestling and fledgling stages (Platt 1973). Both used the same general area, which extended outward in 1 direction from the nest along and adjacent to a canyon. Area not given, but maximum excursion within the horseshoe-shaped area apparently was about 1.6 km.

In New Brunswick, ranges of 2 radio-tagged males extended in a linear fashion from their nests with major axes of 1.1 and 1.7 km; total areas were about 1.2 and 2.7 km^2 (Meyer 1987). Two females in the same study had more circular ranges roughly centered on their nests with total areas of about 0.9 and 1.4 km^2.

Three radio-tagged males wintering in N. Carolina had a mean range area of 2.5 km^2; for 3 females, 2.8 km^2 (Meyer 1987).

POPULATION STATUS

Numbers. Insufficient information for a range-wide census. Rarely seen during the breeding season; the most difficult accipiter and among the most difficult birds to census in North America (Reynolds and Wight 1978, Fuller and Titus 1990). In Puerto Rico 0.27 nest/km^2 (n = 11 nests; Delannoy and Cruz 1988); in New Brunswick, 0.88 nest/km^2 (n = 4; Meyer 1987), in Alaska 0.08–0.32 nest/km^2 (n = 4 nests each year in 3 yr; Clarke 1984).

Trends. Declines in counts at migration watchsites in e. North America from 1940s to early 1970s almost certainly due to widespread use of DDT and its effects on reproduction (Snyder et al. 1973, Henny 1977, Newton 1979, Cade et al. 1988); a rebound in numbers followed the U.S. ban of DDT (Bednarz et al. 1990). At Hawk Mountain in e. Pennsylvania, where Sharp-shinned Hawks rebounded from pesticide era lows more rapidly than any other raptor, counts averaged 9.80 ± 4.19 [SD] birds/h in 1934–1941 (pre-DDT era), 6.27 ± 2.07 birds/h in 1946–1972 (DDT era), and 14.20 ± 5.19 birds/h in 1973–1995 (post-DDT era; Bednarz et al. 1990, Hawk Mountain Sanctuary unpubl.).

Counts at e. U.S. raptor-migration watchsites suggested another population decline in the 1980s and early 1990s (Kellogg 1993, Kerlinger 1992, Viverette et al. 1996). The declines—which first appeared at coastal sites, where higher proportions of juveniles typically are observed relative to inland sites—initially were attributed to various factors acting singly or in concert: environmental contaminants (mainly organochlorines), migratory short-stopping, natural population cycles, depressed populations of

Neotropical migratory prey species, and the aging of eastern forests (Duncan 1996, Viverette et al. 1996, Wood et al. 1996). Recent analyses of concurrent Christmas Bird Count data from the region, however, have revealed significant increases in numbers of Sharp-shinned Hawks overwintering in areas north of the watchsites in question (i.e., e. Canada and the ne. U.S.), strongly suggesting that the declines are due to migratory short-stopping—perhaps the result of increased use of bird feeders as hunting habitat by sharp-shins—and not to an overall decline in eastern populations (Dunn and Tessaglia 1994, Duncan 1996, Viverette et al. 1996).

The species' dependence on contiguous forest for breeding almost certainly has resulted in historical changes in both abundance and distribution, at least locally. Breeding Bird Survey data from 1965 to 1979 indicate no significant changes in the U.S., except for a significant increase in spruce-hardwood forest in California. Record high densities were in the Canadian Rockies, Cascade Mtns., Allegheny Plateau, Montana, and British Columbia (Robbins et al. 1986).

POPULATION REGULATION

Few data. In northeastern forests, may be affected by cycling of spruce budworm (*Choristoneura fumiferana*), which influences abundances of songbird prey populations; and by the overall aging of these forests, which makes them more suitable for larger accipiters (J. Bednarz and I. Newton in Viverette et al. 1996). Taking of prey in vicinity of bird feeders may increase winter survival, particularly among juveniles (Duncan 1996, Viverette et al. 1996).

Wintering area probably smaller than breeding, potentially making winter the period of greatest competition between the sexes and with other species (Storer 1966).

CONSERVATION AND MANAGEMENT

EFFECTS OF HUMAN ACTIVITY

Sensitivity to disturbance. In Puerto Rico, Delannoy and Cruz (1988: 656) attributed 20% of nesting failures during the incubation stage to "human harassment" but did not elaborate. Some individuals respond aggressively to human intruders at nests, passing very close (but rarely making contact) in high-speed dives, but effects of such disturbance on nesting have not been quantified. None of 12 nests observed in New Brunswick failed due to checks by researchers (KM).

Shooting and trapping. Even though bounties on Sharp-shinned Hawks were largely abolished by the beginning of the twentieth century, large numbers of the species—thousands, annually, in Pennsylvania alone—were shot during the first third of the twentieth century, when armies of men gathered along traditional migration corridors and bottlenecks. At some sites, including Cape May Point, NJ, many of the shot birds were gathered as food (Stone 1937). At other sites, most were left to rot (Broun 1949). In part because of its songbird-eating habits, the species was unprotected in many U.S. states as recently as the mid-twentieth century, long after species of raptors perceived as beneficial were protected. In Pennsylvania, for example, the species received no protection until 1957, when it was first protected "during the fall-migration months of September and October, [but only] in the northeastern portion of the state." Statewide, year-round protection came in 1969. Federal protection occurred in 1972 when the Migratory Bird Treaty Act was amended to include all raptors (Senner 1984: 32). Although shooting undoubtedly still occurs to some degree, there is no evidence of present widespread occurrence or substantial impacts in the continental U.S. or Canada. Secretive nature on breeding and wintering grounds is an advantage in this regard; greatest vulnerability is during migration.

Pesticides and other contaminants. See Breeding: eggs, above, and Demography and populations: population status, above. Although concentrations vary widely among individuals, organochlorine levels in some hawks remain sufficiently high to affect reproductive success (Wood et al. 1996). The species may be vulnerable to pesticide use in Latin America, as many of its prey are Neotropical migrants that overwinter there. Reports from 1984 to 1995 of deaths at an oil refinery due to secondary fenthion poisoning and in grape vineyards due to secondary poisoning resulting from the use of granular organophosphorus and carbamate insecticides (Mineau et al. 1999).

Collisions with stationary/moving structures or objects. Frequently hit by cars and more frequently fly into windows near bird feeders (Keran 1981). See Demography and populations: causes of mortality, above.

Degradation of habitat. Lack of accurate estimates of Sharp-shinned Hawk abundance at any level (continental, regional, local) precludes assessment of population-level effects of forest management practices and habitat degradation due to agricultural and urban development in North America or the Neotropics. Loss of Neotropical forests important to prey species have been suggested as a partial cause of declines at migration watchsites (Viverette et al. 1996).

Falconry. Little used in falconry. Of an estimated 33 Sharp-shinned Hawks held for an average 1.3 yr by falconers in the U.S. in 1991, three-quarters were taken as nestlings, the remainder as passage (migrating) birds (Peyton et al. 1995).

Direct human/research impacts. Unknown, but likely to be small, as the species is little studied, except on migration, when thousands are trapped annually, with no apparent effect. But see Sensitivity to disturbance, above.

MANAGEMENT

Conservation status. The species—which is particularly difficult to survey and monitor—remained on several state special-concern (Arkansas, Connecticut, Massachusetts, Mississippi, New Hampshire), threatened (Tennessee), and even extirpated (Rhode Island) species lists as recently as the late 1980s (Adkisson 1988, Mosher 1989).

Measures proposed and taken. Comparative studies of nest-site characteristics and nesting habitat of accipiters in the w. U.S. (e.g., Reynolds et al. 1982, Moore and Henny 1983, Joy et al. 1994, Siders and Kennedy 1996) provide data that are potentially useful for managing forests for Sharp-shinned Hawks (see Reynolds 1983). Extent of implementation or effects have not been reported, however.

APPEARANCE

MOLTS AND PLUMAGES

Descriptions of *A. striatus velox* are based on Friedmann 1950, Blake 1977, Palmer 1988, Johnsgard 1990, unless otherwise stated, and upon examination of living birds and museum specimens by authors. For descriptions of other subspecies, see Systematics.

Hatchlings. At hatching, scantily covered with short white down, this soon replaced by a second, longer, thicker, white down beginning about 1 wk later; replacement occurs about 30% more rapidly than that of nestling Cooper's Hawk (Bent 1937, H. Meng in Palmer 1988).

Juvenal plumage. Primaries appear as pin feathers during third week, followed by scapulars, back and tail, then flanks, breast, and finally the head (Bent 1937). Plumage is fully developed 4 wk later.

Forehead, crown, nape, and sides of neck and throat variably streaked dark fuscous on white to buffy background. Ear coverts and sides of neck cinnamon-buff, streaked with fuscous. Pale or whitish supercilium with narrow dark streaks. The head is sometimes darker than other dorsal surfaces, and crown feathers may or may not have cinnamon margins. Back, scapulars, rump, uppertail-coverts, and wing-coverts muted grayish brown to brownish gray with most feathers having buffy, tan or true cinnamon (Smithe 1975–81: color 139) margins. Tail same color as back or grayer, crossed by 3–5 visible broad, blackish bands and tipped with white. Remiges same color as back with very dark, inconspicuous barring above, some scapular feathers and inner secondaries with large white patches, the outer edges of secondaries with narrow pale ground cinnamon (239) margins. Underparts white or whitish cream and streaked (except on chin, throat and undertail-coverts) with tan, brown, or dark cinnamon; streaks largest on breast, becoming narrower and appearing as teardrops and spots distally; flanks may be barred tan, brown or dark cinnamon, and thigh feathers barred with tan, brown, or dark cinnamon. Chin and throat white to buff, narrowly streaked with fuscous or black. Undertail-coverts whitish, sometimes margined with buff (124). Undersurface of wing whitish, primaries and all but distal portion of secondaries barred with dark fuscous, underwing-coverts and axillars with dark shaft streaks which widen to form dark-fuscous subterminal spots or dark-fuscous bars as feather size increases, but fuscous markings do not extend to edge of feather. Some males are slightly darker overall than females (Johnsgard 1990), but sexes otherwise similar.

Basic I plumage. Prebasic I molt complete; begins in late May–early Jun of second calendar year, and completed that fall. Primaries (10) molted from innermost outward; secondaries from outermost inward. Rectrices (6 pairs) start molting during remigial molt, beginning with central pairs, and ending with R2 or R5, not necessarily bilaterally symmetrical (Platt 1973, Palmer 1988).

Basic I plumage similar to Definitive Basic plumage except upperparts slightly browner with some feathers edged paler, and barring on underparts more brownish (Bent 1937). Detailed studies involving captive birds lacking, however.

Definitive Basic plumage. Acquired after complete molt at about age 1 yr and retained for a year. In Oregon, molt begins in late Jun–mid Jul and continues for at least 4 mo (Henny et al. 1985). Female molts while laying or incubating (Palmer 1988, Mitchell and Pitts 1992); molt slows or stops while nestlings are raised, and continues thereafter. Male begins several weeks later, after the female may be nearly half-way through her wing molt (Platt 1973). Molt (especially of secondaries, wing-coverts and rump feathers) continues into fall for some individuals, especially females (D. Evans in Palmer 1988). Primaries molt outward from P1, with associated greater-coverts. Typically, by the time one feather is growing in, the next is molted, so that more are being molted at the same time as the process proceeds (Henny et al. 1985). Secondaries molt in the following order (counting inward): S1, S5, and S9, and thence from S1 and S5 inward, and from S9 outward. Tail molt begins late in wing molt (after Jul in Oregon), with central pair (R1) first, followed, generally, by R3, R4, R6, R5, and R2, but variable (Henny et al. 1985). Pattern in wings more bilaterally symmetrical than in tail, especially in primaries. Head and body feather molt coincidental with that of remiges. Additional details in Henny et al. 1985.

Considerable plumage variation within *Accipiter striatus velox*. Colors below are generally less individually variable however. Crown is dark lead or sepia (119); forehead feathers are fringed in buffy cinnamon; occiput blackish plumbeous-black; nape lighter than occiput; lores gray; ear coverts and sides of head buffy or tawny to gray and brown; throat white, sometimes buffy, feathers often with blackish shafts. In males, remaining upperparts blackish plumbeous or blackish neutral gray (82), slaty bluish to bluish gray, fading to brownish; more fuscous, grayish brown, or vandyke brown (221) in females. Head only slightly darker than back. Tertials with partially hidden white and smaller rusty or ground cinnamon (239) spots. Underparts white to whitish with fine blackish shaft streaks, heavily barred with rufous to tawny on breast, belly, sides, and flanks; barring is heavy in some individuals, sometimes more so in males, but rarely does rufous color completely obscure white background. Thigh feathers frequently more heavily barred than other underparts, especially the abdomen. Chin and throat white or pinkish white. Undertail coverts white. Tail sometimes squarish, with 3–5 exposed dark blackish neutral gray bands in males (vandyke brown [221] in females), the distal one being noticeably wider; dark bands alternating with paler dark neutral gray (83) bands in males (olive brown [28] in females); tail with a white terminal tip that is more conspicuous in males, but which soon wears away. Paler tail bands wider than darker bands. Wings fuscous to deep plumbeous above, with flight feathers showing white near base on inner webs. Undersurface of wing pallid gray, with conspicuous dark fuscous to blackish barring (becoming paler at ends of secondaries and inner primaries), axillars and underwing-coverts white, otherwise marked as in juveniles except dark markings are rufous.

BARE PARTS

Bill and gape. Bill dark, black or blackish distally, becoming paler basally; gape yellow or greenish yellow; interior of mouth is a light cobalt blue (Palmer 1988, Johnsgard 1990).

Iris. Variable, apparently becoming redder with age (Snyder and Snyder 1974). Grayish at hatching, then yellow, through bright orange to ruby red; yellow to orange in juveniles. Birds with red irises are likely to be in at least their third calendar year. Transition to darker colors, which appears to occur earlier in males than in females, may serve as an aid to individual or age recognition during mate selection (Snyder and Snyder 1974).

Bare skin or wattles on head and neck. Cere whitish to yellow and greenish-yellow. Bare "eyebrow" oil green (Friedmann 1950).

Legs and feet. Tarsi and toes yellow (except for *ventralis*, where the tibiae are rufous or reddish chestnut); talons black.

Overall, soft parts of females slightly less bright than those of males (Johnsgard 1990).

MEASUREMENTS

A. striatus velox. Mean masses and body measurements of Sharp-shinned Hawks migrating past Cedar Grove, WI, are presented in Appendix 4. Juveniles weigh less (in fall), have lower wing-loading, and have proportionately longer tails and shorter wings than do adults (Mueller et al. 1979b, 1981a).

Wing-chord lengths of birds from Michigan averaged 170.8 mm ± 0.7 (SE), $n = 25$, for males and 201.5 ± 0.8, $n = 25$, for females (Storer 1966). Wing-chord lengths of breeding birds in Oregon averaged 172 mm ± 3.26 (SD), $n = 11$, for males and 199.7 ± 9.70, $n = 7$, for females. Culmen lengths (tip to cere) averaged 9.8 mm ± 0.45, $n = 9$; and 12.1 ± 0.57, $n = 6$, for females. Tails averaged 131.4 mm ± 2.55, $n = 10$, for males; and 161.6 ± 8.89, $n = 7$, for females. Masses averaged 96.5 g ± 3.3, $n = 6$, in May–Jun, and 95.2 ± 4.4, $n = 5$, for males and 147 g, $n = 1$, and 183.7 ± 24.3, $n = 6$, at the same times for females (Henny et al. 1985).

A. striatus chionogaster. Flattened wings averaged 169.8 mm, $n = 6$, for males; 204.2, $n = 5$, for females. Tails averaged 132.5 mm, $n = 6$, for males; 158.2, $n = 5$, for females. Culmen lengths (tip to cere) 10.8 mm, $n = 6$, for males; 14, $n = 5$, for females. Tarsus lengths averaged 50.2 mm, $n = 4$ for males, 57, $n = 1$, for females (Blake 1977).

A. striatus ventralis. Flattened wings averaged 170.8 mm, $n = 7$, for males; 196.8, $n = 8$, for females. Tails averaged 135.3 mm, $n = 7$, for males; 162.5, $n = 8$, for females. Culmen lengths (tip to cere) 11.4 mm, $n = 7$, for males; 13.9, $n = 8$, for females. Tarsus lengths averaged 50.2 mm, $n = 4$ for males, 57, $n = 1$, for females (Blake 1977).

A. striatus erythronemius. Flattened wings averaged 166.6 mm, $n = 9$, for males; 190.4, $n = 10$, for females. Tails averaged 130.4 mm, $n = 9$, for males; 148.2, $n = 10$, for females. Culmen lengths (tip to cere) 10.3 mm, $n = 9$, for males; 12.2, $n = 10$, for females. Tarsus lengths averaged 50.2 mm, $n = 4$ for males, 57, $n = 1$, for females (Blake 1977).

Additional linear measurements for *velox* (n = 27), *ventralis* (n = 1), and *erythronemius* (n = 19; wing tip, wing tip–primary 6, tarsus, middle toe, hallux claw, culmen, and tail) as a percentage of wing length are in Wattel 1973.

PRIORITIES FOR FUTURE RESEARCH

As the Sharp-shinned Hawk is perhaps the most secretive of North America's forest-breeding raptors, researchers still have much to learn about basic aspects of the breeding biology of this species, including its use of vocalizations, nestling and fledgling behavior, and postbreeding dispersal. Critical questions during the breeding season include effects of forest use on breeding ecology and success, including the impacts of forest-patch size, age structure, and species composition, as well as the impact of the control of forest insects; the latter in terms of both direct toxicological effects on hawks and indirect effects on the reduction of food for the species' songbird prey. The impact of aging forests in the eastern United States, particularly as it affects the likelihood of contact with Cooper's Hawks and Northern Goshawks—both of which are potential competitors *and* predators of Sharp-shinned Hawks—also needs to be addressed.

Although the species frequently feeds near human habitation, the extent to which this behavior influences winter distribution, abundance and survival remains an unexplored topic. Critical research topics in winter include sex differences in habitat use, the effect of bird feeders on overwinter distribution and survival, the limiting effects of winter weather, and the impact of habitat alterations and degradation.

The Sharp-shinned Hawk is perhaps as well studied on migration as any North American raptor. Even so, the extent to which habitat changes, particularly the percentage of cover and age structure of forests, affect migration behavior remains largely unknown, as are orientation mechanisms. A thorough, continent-wide, multi-site analysis of banding-return data, focusing on sex, age, regional differences, and both within- and across-year temporal differences in wintering areas is long overdue, particularly in light of the massive trapping effort (more than 39,000 individuals banded as of early 1998) that has been devoted to this species.

Continued periodic regional sampling of contaminant levels is warranted. This may best be achieved by trapping birds on both autumn migration, to gauge breeding-ground effects, and spring migration, to monitor wintering-ground effects.

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ABOUT THE AUTHORS

Keith L. Bildstein received his B.Sc. in biology from Muhlenberg College, Allentown, Pennsylvania, and his M.S. and Ph.D. in zoology from The Ohio State University, Columbus. He is Director of Research and Education at Hawk Mountain Sanctuary, Coordinator of the sanctuary's global conservation initiative Hawks Aloft Worldwide and Adjunct Professor of Wildlife Biology at the State University of New York (SUNY)-Syracuse. His current address is Hawk Mountain Sanctuary, 1700 Hawk Mountain Road, Kempton, PA 19529. E-mail: bildstein@hawkmountain.org.

Ken Meyer received his B.Sc. in zoology from the University of Maine and his Ph.D. from the University of North Carolina, Chapel Hill. He is a Research Ecologist for the Avian Research Conservation Institute, and Adjunct Professor of Wildlife Ecology and Conservation at the University of Florida, Gainesville. His current address is ARCI, 411 N. E. 7th Street, Gainesville, FL 32601. E-mail: meyer@arcinst.org.

Appendix 1. Mean hourly passage rates (individuals/h) during autum migration of Sharp-shinned Hawks at Cape May Point, NJ; Hawk Mountain Sanctuary, PA; Duluth, MN, and the Goshute Mtns., NV.

Year	Cape May[1]	Hawk Mtn.[2]	Duluth[3]	Goshute Mtns.[4]
1970		4.18 (456)		
1975		10.9 (490)	14.1 (762)	
1980	37.0 (917)[5]	9.47 (878)	12.5 (889)	
1985	32.7 (1,069)	7.19 (802)	11.1 (1,037)	4.85 (655)
1990	12.6 (992)	8.46 (961)	8.64 (1,152)	7.91 (667)
1991	15.9 (884)	5.72 (992)	16.4 (1,030)	5.23 (708)
1992	9.35 (878)	4.84 (957)	15.8 (1,034)	7.98 (743)
1993	15.9 (831)	5.53 (986)	18.5 (1,095)	4.30 (660)
1994	25.9 (1,024)	4.62 (1,068)	16.9 (1,134)	9.63 (710)
1995	33.7 (783)	6.02 (1,033)	17.6 (1,019)	6.84 (695)
1996	36.6 (834)	4.19 (1,068)		10.9 (620)
1997	60.6 (806)	5.79 (1,085)	19.4 (1,155)	5.71 (674)

[1] Cape May Bird Observatory unpubl.
[2] Hawk Mountain Sanctuary Association unpubl.
[3] D. L. Evans, Hawk Ridge Nature Reserve unpubl.
[4] S. Hoffman, HawkWatch International unpubl.
[5] Numbers in parentheses refer to total hours/season.

Appendix 2. Percentages and mean masses (g) of Sharp-shinned Hawk prey, including masses taken by male and female hawks, based on stomach contents (S), prey remains (R), and direct observations (O) at nests.

		Percentages		Mean mass				
Area	n[1]	Birds	Mammals	Birds	Mammals	Male prey	Female prey	Source
U.S.	3	97	3	–	–	17.6	28.4	Storer 1966 (S)
Arizona	150	–	–	–	–	16.0	34.8	Snyder and Wiley 1976 (O)
Ontario	32	–	–	–	–	26.0	35.0	Mueller et al. 1981b (O)
E. Oregon	116	98	2	25.4	201.4	–	–	Reynolds and Meslow 1984 (R)
Nw. Oregon	199	97	3	11.8	53.1	–	–	Reynolds and Meslow 1984 (R)
New Brunswick	39	100	0	32.5	–	31.5	38.1	Meyer 1987 (O)
Colorado	513	91	9	20.9	41.1	–	–	Joy et al. 1994 (R)

[1] Number of individual stomachs examed (S), prey remains examined (R), or observations with prey (O).

Appendix 3. Sharp-shinned Hawk reproductive success in different parts of its range. Hatching rate = % clutches with ≥1 eggs hatched; nest success = % clutches with ≥ 1 young fledged; fledgling success = % of hatched eggs that fledged; fledglings per nest = mean number of fledglings per successful nest. – = no data. Sample size (number of clutches or nests) given in parentheses.

Area	Hatching rate	Nest success	Fledging success	Fledglings per nest	Source
Alaska	83 (14)	–	79 (14)	3.5 (14)	Clarke 1984
New Brunswick	87 (8)	–	95 (7)	3.4 (6)	Meyer 1987
Oregon	70 (5)	92 (12)	81 (5)	2.7 (11)	Reynolds and Wight 1978
Puerto Rico	63 (40)	29 (40)	47 (40)	0.8 (40)	Delannoy and Cruz 1988
Wyoming	–	–	–	3.5 (2)	Craighead and Craighead 1956
North America	–	–	–	2.7 (31)	Apfelbaum and Seelbach 1983

Appendix 4. Measurements of Sharp-shinned Hawks migrating past Cedar Grove, WI, fall 1953–1964 and spring 1954–1957 and 1962–1965 (Mueller et al. 1979b). Data shown as mean ± SD (range, *n*).

	Males	Females
Fall migrants		
Mass (g)		
Juvenile[1]	98 ± 5.8 (80–116, 489)	166 ± 10.3 (125–197, 522)
Adult[2]	103 ± 6.4 (82–125, 435)	174 ± 10.4 (144–208, 487)
Wing chord (mm)		
Juvenile	169 ± 3.7 (158–182, 493)	200 ± 4.4 (183–213, 544)
Adult	171 ± 3.5 (161–182, 493)	203 ± 4.3 (192–217, 489)
Tail length (mm)		
Juvenile	134 ± 3.8 (121–144, 494)	158 ± 4.2 (146–174, 548)
Adult	132 ± 4.0 (115–143, 440)	156 ± 4.4 (144–175, 492)
Spring migrants		
Mass (g)		
Juvenile	101 ± 8.2 (89–117, 8)	173 ± 11.1 (158–189, 7)
Adult	99 ± 5.9 (87–107, 9)	183 ± 9.3 (172–199, 18)
Wing chord (mm)		
Juvenile	168 ± 5.0 (161–175, 8)	199 ± 5.0 (192–207, 7)
Adult	170 ± 3.3 (167–177, 9)	202 ± 2.9 (199–208, 18)
Tail length (mm)		
Juvenile	133 ± 4.2 (125–138, 8)	158 ± 5.7 (149–165, 7)
Adult	130 ± 2.8 (124–133, 9)	156 ± 4.0 (149–163, 18)

[1] First-year birds.
[2] Second-year and older birds.

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