Green Heron

Butorides virescens

Subspecies (4)

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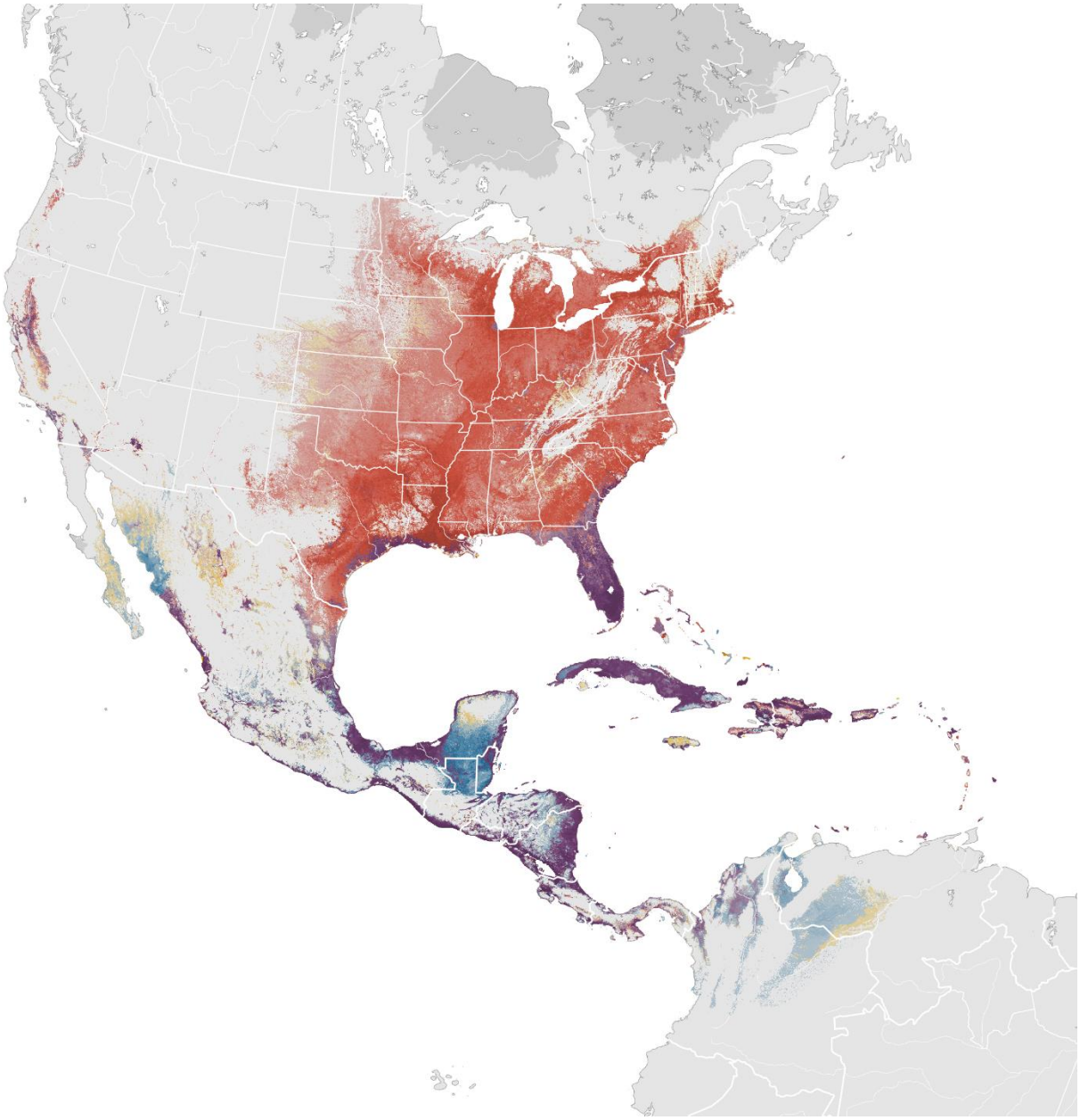
A relatively small, dark, compact, crested wading bird, the Green Heron is a common species of wetland thickets throughout much of North America. Although shy and retiring, it is a familiar sight to those spending time out of doors. Careful observers can see it stalking slowly through the water, perched quietly atop a branch, or as a dark form flying with slow wingbeats through the gathering dusk. Its flight call, an assertive *skeow*, is a sound typifying temperate and tropical wetlands of the Americas. Some of this bird's behaviors are especially well appreciated; flying away from human disturbance, for example, it often produces a scolding squawk and a stream of white defecation, giving it such vernacular monikers as "fly-up-the-creek," "shite-polk," and "chalk-line."

Although Green Herons generally nest solitarily, they sometimes nest socially in loose colonies. They feed day or night, standing patiently in shallow water waiting for fish, slowly stalking them through the shallows or diving on them from above. They are among the few tool-using birds, fabricating various baits that entice fish to where they can grab them.

Species limits within this small genus have been under intermittent review and revision, causing corresponding revisions in the "acceptable" English common name. The North American form of this species is part of a matrix of related populations, which differ somewhat in size and plumage coloration, allocated to numerous subspecies but in total found over much of the tropical and subtropical world (Hancock and Kushlan 1984). At times similarities and purported intergradation of features among populations have been emphasized, leading to the North American form being lumped with Old World and Neotropical forms into a single species, *Butorides striatus*, most recently called the Green-backed Heron, more traditionally called the Striated Heron, and locally called the Mangrove Heron. At other times, differences and purported lack of intergradation of features among populations have been emphasized, leading to the North American form being separated from the Neotropical and Old World forms as *Butorides virescens*, called the Green Heron or Little Green Heron. On the Galapagos Islands, a third, distinctive population is sometimes considered a separate species, *Butorides sundevalli*, called the Galapagos or Lava Heron, but more often this population is viewed as a well-marked subspecies of the Neotropical form.

As this monograph is about the North American population, we call our bird the Green Heron (*Butorides virescens*), which conforms to the most recent declaration of the American Ornithologists' Union's check-list (American Ornithologists' Union 1993). Because there is no evidence of fundamental differences in the biology (or indeed morphology) of any of the populations studied so far, however, we draw on information from *Butorides* herons worldwide.



Distribution of the Green Heron

Appearance

Identification

Small, stocky heron (41-46 cm long), neck and legs short relative to elongated structures of many other herons. Adult plumages similar, but females tend to be smaller, duller, and lighter. Sexual dimorphism appears geographically variable according to older studies (Oberholser 1912b). Adults with glossy greenish-black cap and back, wings black with greenish or bluish cast, underparts gray. Wing feathers edged in buff. Neck of adult is rufous-the character that distinguishes North American populations from those of *Butorides striatus* . Legs orange, bill dark. Shaggy greenish-black crest erectile. Young birds striped brownish on neck and below; back brownish with buff spots; shape and size distinguish them from young of any other species. Color pattern of both adults and young cryptic, clearly adaptive for undisturbed, solitary life in dense vegetation (Hancock and Kushlan 1984).

Molts

Molts poorly known, based on Bent 1926, Meyerriecks 1962b, McVaugh

Despite its widespread geographic distribution and abundance the molts and plumages of this species are poorly known. In addition, Cramp's (Cramp 1977) account of the sequence of molts in the closely related Striated Heron is confused and incorrect. No specific studies on Prebasic and Prealternate molts have been done in either species. Wheelock (Wheelock 1906), Hindwood (Hindwood 1933), Gavino T. and Dickerman (T and Dickerman 1972), and McVaugh (McVaugh 1975) documented the development of plumage and bare part colors of young birds in detail from hatching to fledging.

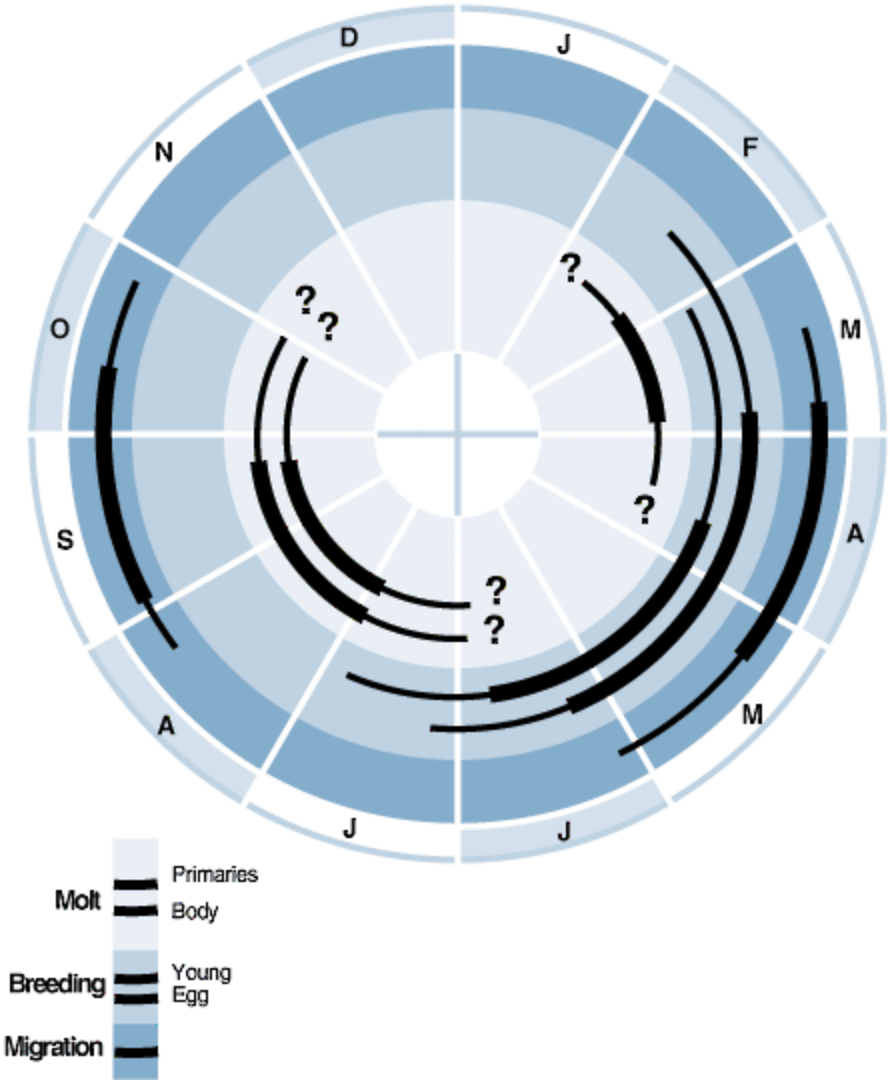


Figure 2. Annual cycle, USA.

Annual cycle of breeding, migration, and molt of the Green Heron in the United States. Thick lines show peak activity, thin lines off-peak. See Breeding: phenology, for a discussion of variation in the annual cycle of this species.

Hatchlings

Downy. At hatching, down on head, neck, and wings. Down longest (up to 19.1 mm) on forehead and crown, forming a crest (McVaugh 1975). Additional down appears on back, neck, and femoral tract by 3 d; down darkest on head, its color described as grayish brown (T and Dickerman 1972), hair brown (Bent 1926) to smoke gray (Meyerriecks 1962b); down shorter and

densest on back, paler (light gray to nearly white) on underside (Bent 1926, T and Dickerman 1972, McVaugh 1975).

Juvenile Plumage

Prejuvenile molt complete. Juvenile pin-feathers, including primaries and secondaries, first appear in the alar, humeral, and interscapular region of dorsal tract by 4 d; feathers emerge on spinal, ventral, and femoral tracts by 5–6 d; on the neck by 7 d; on head (forehead, crown, and nape) and tail (rectrices) by 10–11 d. By 25 d, entire body covered with Juvenile plumage, down remaining only on head. All traces of down lost by 37 d (T and Dickerman 1972, McVaugh 1975).

Contrary to some other authors (e.g., Meyerriecks 1962b), Bent (Bent 1926) and Oberholser (Oberholser 1974) state that sexes are distinguishable in Juvenile plumage. Ostensibly, in males, forehead and crown greenish black; sides of head and neck chestnut; malar stripe buffy white bordered above by blackish streak and below by blackish brown streaking which extends down side of neck; sides of neck yellowish white broadly streaked with diffuse dark chestnut streaks with ventral portion of throat and neck largely whitish with some narrow dark chestnut streaking medially; scapulars and back dark greenish gray with brownish cast; wing coverts are dark greenish gray except lesser coverts are edged chestnut, and median and greater coverts are rounded at tips, not pointed as in adults, with pale buff edgings and a triangular buffy white spot at the tip of each rachis; these spots rapidly fade to white and wear away. Lesser coverts dark gray edged chestnut; wing lining variegated. Remiges and rectrices dark gray with greenish cast; secondaries and primaries tipped with white in decreasing amounts from the inner secondaries to the outer primaries; underparts buffy white, streaked with buff, brown, or dusky; undertail coverts white tinged with buff.

Bent and Oberholser described females as differing from males in having chestnut streaks on crown, and having sides of head and neck streaked with chestnut, buff and dusky. Very few examples of sexual dimorphism in Juvenile plumage exist. Therefore, further studies should evaluate the validity of this purported early sexual dimorphism.

Basic I Plumage

Most birds replace all body plumage (i.e., not including flight feathers) during the Prebasic I molt, although some late-hatching birds undergo little or no molt (Townsend *in* Bent 1926). Occurs from few weeks (at most) after attaining flight until late winter (Figure 5). Oberholser (Oberholser 1974) erroneously states that Basic I plumage is attained by wear rather than by molt.

Plumage similar to Juvenile plumage but forehead and crown dark greenish gray, clear white on chin, throat, and underparts; upper breast and neck more broadly striped.

Alternate I Plumage

Prealternate I molt partial, limited to “taking on of some additional plumes on the back” as well as “a few new feathers...on the shoulders.” Most birds in this plumage have not acquired plumes as long as adults of the same sex in Definitive Alternate plumage (Townsend in Bent 1926). Molt occurs late winter or early spring (Meyerriecks 1962b). Extent probably more limited than in subsequent Prealternate molts (Meyerriecks 1962b).

Plumage similar to Definitive Alternate but upperparts duller; inner primaries, outer secondaries, primary coverts, and greater coverts with white or buffy tips; primaries duller; greater coverts more rounded; more white on lower throat and breast; and plumes in both sexes shorter (male plumes longer than female) (Meyerriecks 1962b, Oberholser 1974).

Basic II Plumage

Prebasic II molt usually complete, but some birds may retain at least some Juvenile secondaries (e.g., University Washington specimens [45754, 35962, 45348]; Meyerriecks 1962b). Molt begins early summer, earlier than subsequent Prebasic molts, and is completed by Nov (Meyerriecks 1962b: Figure 5).

Plumage generally similar to Definitive Basic. Crown glossy dark greenish gray or bottle green, with elongated erectile feathers; sides of head and most of neck chestnut or maroon; white stripe down throat; spots on lower throat and breast elongated and narrower than in earlier plumages; upperparts mostly glossy dark greenish gray; underparts brownish gray; wings dusky gray-green; buff edges to all coverts.

Definitive Alternate Plumage

Definitive Prealternate II molt more extensive than first Prealternate molt involving replacement of head and neck feathers, including ornamental plumes, and some body plumage (Meyerriecks 1962b).

Forehead, crown, and lower border of eye dark grayish bottle green with medium length erectile plumes extending from rear of crown forming a bushy crest when raised; remainder of head, neck, breast, and upper sides purplish maroon becoming mouse gray on remainder of underparts; thighs rufescent.

Malar stripe cream buff bordered above by blackish streak; chin and throat buffy white, medial portion of lower neck and breast white, spotted on upper neck and streaked on breast with grayish with variegated white and brownish streaks extending to the upper belly. Upper back and scapulars covered with medium length bluish gray plumes with a greenish cast; lower back greenish blue-gray; tail dark greenish gray with bluish cast. Outer scapulars, lesser and median coverts dark greenish gray margined with tawny buff, remainder of wing dark bluish gray with greenish cast, outer webs of tertials and innermost secondaries edged with white; leading edge of bend of wing buffy white; lining of wing slate gray margined with buff (Oberholser 1974). Male more brightly colored than female.

Definitive Basic Plumage

Definitive Prebasic Molt complete, from late summer or fall through winter. Plumage similar to Definitive Basic except plumes shorter.

Polymorphism

Unusual plumages include erythristic individuals from Cuba and Panama (Meyerriecks 1962b). Head and neck reddish chestnut with black cap, no white on throat and foreneck, wing coverts narrowly edged rusty, young nearly uniform brown.

Bare Parts

McVaugh (McVaugh 1975) provides the most detailed account of bare part colors in nestlings, and is summarized below unless stated otherwise. Other less detailed accounts that differ in some respects from McVaugh are Wheelock (Wheelock 1906), Hindwood (Hindwood 1933), and Gavino T. and Dickerman (T and Dickerman 1972).

Bill

At hatching, upper mandible pale greenish gray at base, culmen dark pinkish gray proximally and black distally, tip black; rounded sides of bill pinkish; black line runs just above commissural point to about one half length of bill; lower mandible black distally with ivory tip; by 3 d, upper mandible yellowish pink, black at tip, distal one half of tomia black; sides of lower mandible yellowish at base becoming pinkish and then blackish distally with small ivory tip. By 11 d, upper mandible greenish orange, more greenish basally, culmen pale orange with black tip, tomia black distally; lower mandible greenish orange basally becoming black distally with small ivory tip. By 24 d, upper mandible orange, distal end black with ivory tip; lower mandible orange, paler distally with small black tip. In adult, bill brownish black, lower mandible dusky green, yellowish at base; bill glossy black in breeding season. Mouth lining pale pinkish from hatching through fledging.

Iris

At hatching pale gray (off white in some birds) through 8 d becoming grayish white from 11 through 13 d, greenish to yellowish white from 17 d through fledging. In adults, orange and/or yellow, but may be deep orange during intense display.

Bare Skin On Head

At day 6, skin of forehead and crown pinkish, auricular area green, body pale yellow-green to gray-green; lores yellow to greenish yellow from 5 d through fledging (T and Dickerman 1972, McVaugh 1975). Eye-ring pale yellow-green at 3 d, pale green from 6 through 13 d, greenish yellow by 17 d, becoming greenish blue in some birds between 24 d and fledging. In adult, upper portion of lores and bare skin around upper eye and posterior lower portion of eye dull yellow-green, lower portion of lores blackish; lores bluish black at height of breeding season.

Legs And Feet

At hatching, tibiotarsus greenish flesh to flesh, heel and tarsometatarsus pale flesh; toes flesh above, pale flesh below, nails ivory. By 3 d, tarsi and toes pale yellow; nails pale bluish gray with paler tips. By 11 d, tibiotarsus pale green to yellow-green, heel and tarsometatarsus yellow; toes darker green than tibiotarsus with deep yellow undersides; nails medium gray with pale tips. From 17 d through fledging, tarsometatarsus yellow, pale yellow, or pale orange-yellow, toes darker greenish yellow above and orange beneath; web between second and third toes orange to orange-green; nails medium horn with paler tips. Tibiotarsus pale yellowish green (some grayish green) from 24 d through fledging. Adult, yellow or orange-yellow, glossy orange in breeding season.

Measurements

Linear Measurements

Bill lengths for 16 adults averaged 6.3 cm and 5.9 cm (Niethammer and Kaiser 1983). Females average larger in some parts of range, smaller in others (Oberholser 1912b). See Table 1 for measurements of males and females of *B. v. virescens* and *B. v. anthonyi* (and see Oberholser 1912b for measurements throughout geographic range).

Mass

Weights for 16 adults averaged 241 g, for 14 immatures 219 g (Niethammer and Kaiser 1983).

Systematics

Systematics History

Editor's Note: **This article requires further editing work to merge existing content into the appropriate Subspecies sections. Please bear with us while this update takes place.**

Geographic Variation

Considerable geographic variation in plumage and size. Oberholser (Oberholser 1912b) provided thorough documentation of the confusing level of plumage and size variation observed in museum specimens.

Subspecies

Oberholser (Oberholser 1912b) recognized 18 subspecies, mostly island forms. Most of these, including *patens* in area of *B. virescens-B. striatus* overlap in Panama, no longer recognized. Four subspecies currently accepted (Bent 1926, Payne 1974, Hancock and Kushlan 1984): *B. v. virescens*, central and e. North America to Panama; *B. v. anthonyi*, w. North America to n. Baja California, larger and paler; *B. v. frazari*, s. Baja California, with very dark neck; *B. v. bahamensis*, Bahama I., smaller and paler.

Relationships with related species a taxonomic yo-yo. Related to *Ardea*, *Egretta*, and *Nycticorax* herons (Sheldon 1987b). At genus level, *Butorides* usually considered distinctive, confirmed by recent biochemical analysis (Sheldon 1987b). Supposition that it is congeneric with *Ardeola* (e.g., Peters 1979) no longer supported.

Specific limits within genus are subject of considerable, ongoing debate, which we consider unresolved. *B. virescens* long considered a separate species (Wetmore 1965b: 83-88) and member of superspecies with *B. striatus* and *B. sundevalli* (Bock 1956, Meyerriecks 1962b). In 1970s combined with *B. striatus*, based on morphological and behavioral similarities and analyses of individuals in area of overlap (Bock 1956, Curry-Lindahl 1971, Payne 1974, Am. Ornithol. Union American Ornithologists' Union 1976, American Ornithologists' Union 1983, Debenedictis 1978). More recently argued, based on same specimens, to be separate species (Sibley and Monroe 1990, Monroe and Browning 1992, American Ornithologists' Union 1993, Debenedictis 1994). Debate probably not over. Additional studies of morphology and biochemistry still needed.

Green Heron (virescens/bahamensis) *Butorides virescens virescens/bahamensis*

Butorides virescens virescens

Distribution
C and E USA (E from North Dakota and C Texas) and SE Canada S to Panama and Caribbean.

Butorides virescens bahamensis

Distribution
Bahamas.

Butorides virescens anthonyi

Distribution
SW Canada, W USA and extreme NW Mexico (N Baja California).

Butorides virescens frazari

Distribution
S Baja California.

Fossil History

Closely related *Butorides validipes* from early Pleistocene of Florida (Campbell 1976c). But *B. virescens* also from Pleistocene of Florida (Wetmore 1931b) and California (Howard 1936b). Also from Native American kitchen middens about 500 yr old in California (Demay 1942). Not clear that *B. virescens* has been distinguished or is separable from *B. striatus* in paleontological material. Amadon (Amadon 1953a) speculated that *B. virescens* may have reached North America from Asia, whereas *B. striatus* may have reached South America from Africa. But given related Pleistocene fossils and dispersal ability of these herons, historic distribution and dispersion patterns remain unclear.

Distribution

Distribution

Breeding Range

Figure 1 . E. North America from se. Canada (New Brunswick, s. Ontario and Quebec) south to Florida and Bahama Is.; west to e. North Dakota through Great Plains, avoiding drier areas of West, through s. Texas, Arizona, and New Mexico; along Pacific Coast from British Columbia through Baja California, south through mainland Mexico to s. Panama, Greater Antilles, Tobago, and islands off n. Venezuelan coast (Meyerriecks 1962b, Peterson Peterson 2010a, Peterson 1990d, Hancock and Kushlan 1984). Range limited by high latitudes, aridity, and altitude. Local distribution constrained by suitable wetland marine or freshwater habitat for feeding.

Winter Range

Figure 1 . Postbreeding birds often disperse to areas where breeding does not occur. Most North American populations migratory; after postbreeding dispersal, most individuals from e. U.S. migrate south to winter along Gulf of Mexico, Florida, Caribbean islands, Mexico, through Central America to n. South America from ne. Colombia, Bonaire, and coastal Venezuela, infrequently as far as Guyana and Suriname. Small portion of northern populations winter north of Gulf Coast (e.g., Avakian 1984). Populations nesting in Florida and in southern states appear to be resident, but more data needed. Pacific Coast birds migrate southward to Mexico and Central America to El Salvador and Costa Rica, but many sedentary, some wintering as far north as Washington State.

Extralimital Records

Generally confined to AOU check-list area. Vagrants found in winter in Hawaii (Paton and MacIvor 1983). *Butorides striatus* populations widely distributed in tropical South America, sub-Saharan Africa, n. Madagascar, Indian Ocean islands, India, China, Japan, Southeast Asia

through New Guinea, Australia, Pacific Ocean islands (Cramp 1977, Hancock and Kushlan 1984, del Hoyo et al. 1992).

Historical Changes to the Distribution

Sparse census data from early twentieth century obscure any long-term changes in distribution, but land development, drainage of wetlands, and recreational use of coastal wetlands may have reduced populations locally. Range expanding in midcontinent of North America along rivers and especially along impoundments, where species may be more common than reported because of solitary nature and cryptic plumage (Ryder 1979). Both breeding and wintering range undergoing long-term expansion northward on Pacific Coast (Jewett 1939, Larrison Larrison 1940, Larrison 1947, Slipp 1942a, Miller 1945b, Eddy 1952, Peterson 1990d).

Habitat

Habitat in Breeding Range

Typically a bird of swampy thickets; has been said there is "scarcely a stream, swamp, or shoreline where it may not be found, whether fresh or salt" (Meyerriecks 1962b). Although much exaggerated, this assertion suggests species' flexibility.

Nests in forest and swamp patches; may nest in dry woods or orchards, but usually near water (see Breeding: nest site).

Feeds in swamps, riparian zones along creeks and streams, also marshes, human-made ditches, canals, ponds, lake edges, open floodplains (*B. striatus*, Brown et al. 1982), backwater oxbow ponds, sloughs and side channels (Kaiser and Fritzell 1984), salt marshes (Clarke et al. 1984), mangrove swamps, pastures (Bryant 1914b), mudflats, ponds in parks, and harbors. Although clearly prefers thick vegetation throughout range, will feed in open when food is available. In salt marshes, tends to hug creek banks; avoids open flats frequented by longer-legged herons.

Habitat in Nonbreeding Range

Habitat in Migration

Not specifically reported, but needs wetlands or coastal habitat for foraging on migration.

Habitat in Overwintering Range

Often coastal; uses all available marine and freshwater habitat. Mangrove swamp heavily used in tropical areas.

Movements and Migration

Migration Overview

Green Herons tend to wander after breeding, probably to seasonally more favorable foraging areas (Kushlan 1981). Dispersal not as extensive as in some heron species (Meyerriecks 1962b) but may be intermittently eruptive (Hancock and Kushlan 1984), with stragglers as far as England (Cramp 1977). Dispersal merges gradually into protracted fall migration for northern birds. Gradual and variable character of dispersal/migration can be seen in records of summer fledglings banded in Maryland and Virginia. During October, these birds found as far north as Wisconsin and as far south as Nicaragua and Puerto Rico. Southern U.S. and some Pacific Coast birds may be mostly sedentary.

Migrates north in late winter and early spring, usually but not always at night, often in flocks, sometimes in large numbers (Scott 1890c, Griscom 1923a, Bent 1926, Meyerriecks 1962b).

Timing and Routes of Migration

Fall migration begins late Aug-early Sep; most birds leave by mid-Oct (Bent 1926). Exact migration routes poorly known, but banded eastern birds have been recovered in Florida, Greater Antilles, Cayman I.; midcontinent birds in Texas, Florida, Mexico, Central America, Greater Antilles; western birds in Mexico. More banding data needed to establish precise migration routes.

Begins to arrive in ne. U.S. and California in Mar-Apr; e.g., in Ohio by mid- to late Mar (Peterjohn 1989b); in New York, "rare before mid-April" (Bull 1974); in Missouri, "not readily encountered" until late Apr (Robbins and Easterla 1992); in Vermont by mid-Apr (Laughlin and Kibbe 1985); in nw. U.S. by late May (Graf 1946). Arrives earlier than larger herons, perhaps because crepuscular feeding habits give birds longer feeding day (Seibert 1951).

Migratory Behavior

Not reported.

Control and Physiology of Migration

Not reported. Temperature controls food availability (i.e., ponds freeze) and thus ultimately influences timing of migration. Likely that day length initiates migratory activities, but no data available.

Diet and Foraging

Feeding

Main Foods Taken

Carnivorous, typically a fish-eating species, despite comments to contrary in literature. However, prey selection is broad, depending on availability, and includes all sorts of invertebrates.

Microhabitat For Foraging

Usually feeds by wading at water's edge or in very shallow water, reported as < 5 cm deep in Florida and New Jersey and 1-10 cm deep in New York (Recher and Recher 1980). In closely related Mangrove Heron (*B. striatus macrorhynchus*), percent of 67 min foraging was: 4% in water 0-0.1 cm deep, 8% in 0.11-4.9 cm, 55% in 5-9.9 cm, 33% in 15-19.9 cm (Recher et al. 1983).

Also perches on branches, herbaceous vegetation, or rocks, close to water, where it accesses deeper water. Also feeds in deeper water by plunging into water after prey.

Generally under cover of thick vegetation. Despite this predilection, will feed in open, e.g., on exposed mudflats, tidal channels, open marshes, and pond edges.

Food Capture And Consumption

Heavy bill for bird's size, so it can capture large prey such as frogs, but not large fish that struggle (Recher and Recher 1980). Cryptic in its feeding habitat; dark dorsal and cryptic ventral color patterns match predictions of evolutionary-decision tree model for predicting plumage color of a species based on its feeding behavior and habitat use (Kushlan 1978b).

Feeds at any time; during day, crepuscularly, also at night (Kushlan 1978b, Recher et al. 1983, Hancock and Kushlan 1984, McNeil et al. 1993). Most arrivals at New Jersey roost occurred after sunset, and birds left in morning about 30 min before sunrise, before there was enough light to register on photometer (Seibert 1951).

Prey captured with darting stroke of head and neck, often with body lunge. When striking from horizontal, bird darts head and neck forward and down (Meyerriecks 1960a). Prey generally grasped with bill but may be speared.

Green Heron (with Great Blue Heron [*Ardea herodias*]) has fewest recorded feeding behaviors of North American day herons (Kushlan 1976a). Of 36 heron feeding behaviors, Green Heron (including *B. striatus*) known to use 15: Standing, Baiting, Standing Flycatching, Head Swaying, Neck Swaying, Walking Slowly, Walking Quickly, Scanning, Feetfirst Diving, Foot Stirring, Foot Raking, Plunging, Diving, Jumping, and Swimming Feeding (Kushlan 1976a, Kushlan 1978b, Davis 1983c, Recher et al. 1983). Feeding activity index (measure of how actively bird moves while feeding) lower than that of any North American day herons and lower than that of nocturnal Black-crowned Night-Heron (*Nycticorax nycticorax*) (Kushlan 1978b).

Most common feeding technique is to stand in crouched posture, body horizontal, head and neck retracted, looking into water. Will stand still for long periods before changing feeding sites. Birds stay longer in a spot after successful attempt than after unsuccessful one (Betts and Betts 1977).

Standing is interspersed with Slow Walking, as bird moves slowly and methodically in crouched posture walking in water or along vegetation. When stalking prey, may move feet slowly, keeping 1 foot raised for up to 30 s. Foraging Mangrove Herons in 67 min of observation averaged 14 s/min walking, 13 steps/min, 0.9 steps/s for walking birds, 1 m/min distance moved, 0.2 prey attacks/min, and capture success rate of 57% (Recher et al. 1983).

Does feed more actively on occasion. In experiments with captive, bird sometimes Walked Quickly, perhaps to disturb hiding prey. Bird grabbed or speared fish, and had greatest capture success in shallowest water (76%, 0-10 cm) and poorest success in deepest water (20%, 20-30 cm) (Kramer et al. 1983a). When feeding actively, often flips tail and raises and lowers crest feathers (Meyerriecks 1962b). Foot Raking and Foot Stirring known but rarely used (Hoyt 1961b). Raking has been recorded for both immature and presumably adult birds (Meyerriecks Meyerriecks 1966, Meyerriecks 1971).

May dive from perches head first into deep water, becoming submerged (Barker 1901). Diving is usually from perch, e.g., branch, pier, or rock.

Green Herons bait for fish (Figure 2) with variety of baits and lures, e.g., crusts of bread (Lovell 1958), mayflies (Keenan III 1981), and feathers (by an immature bird; Norris 1975). For *B. striatus* in Japan, Higuchi (Higuchi 1986, Higuchi 1988) reported that they bait fish more frequently in open water with few suitable perches. Three of these Japanese birds used lure bait (twigs, leaves, berries) 80% of time, live bait (flies and other insects) 20%. One bird spent 84% of foraging time baiting for fish; other birds used feathers and plastic foam for bait. Success rate highest when live bait used; juvenile birds did poorly baiting. One bird dug earthworms from mud and used them as bait, and twice birds broke pieces of stick to make bait, an example of tool-making. Baiting behavior rare among other herons.

Diet

Major Food Items

Opportunistic forager with varied diet (Wheelock 1906, Meyerriecks 1962b, Kushlan 1978b, Niethammer and Kaiser 1983, Hancock and Kushlan 1984). Overall diet includes invertebrates such as leeches; earthworms; aquatic and terrestrial insects such as adult and larval dragonflies (Odonata), damselflies (Zygoptera), waterbugs (Belostomatidae), diving beetles (Dytiscidae), grasshoppers, crickets, katydids (Orthoptera); spiders; crayfish, crabs, prawns; snails; fresh- and saltwater fish; frogs, toads, tadpoles, and newts; snakes and lizards; and rodents. Fish constitute primary food; these include topminnows (*Fundulus*), minnows (*Notropis*), sunfish (*Lepomis*), catfish (Ictaluridae), pickerel (*Esox*), carp (*Cyprinus*), perch (*Aplodinotus*), gobies (Gobeidae), shad (*Dorosoma*), silverside (*Menidia*), eels (*Anguilla*), and in

urban areas and human-made ponds, goldfish (Brooks 1923); 1 goldfish reported to be 10 cm and weigh 16 g (Hawbecker 1949). Will exploit a superabundant resource, e.g., grasshoppers in California (Bryant 1914b) and frogs in New York (Recher and Recher 1980).

Quantitative Analysis

Diet variability and opportunistic foraging behavior illustrated by analyses that follow and Appendix 1 . Baynard (Baynard 1912) reported for 1 Florida Green Heron stomach: 6 small crayfish, 16 grasshoppers, 2 cut-worms, and small frogs. Meyerriecks (Meyerriecks 1962b) reported U.S. Biological Survey data on 255 stomachs: 39% noncommercial fish, 6% food fish, 21% crustaceans, 24% insects, 10% other. Recher and Recher (Recher and Recher 1980) reported mean weight (g) of prey and (g/min hunting) in: Florida 0.7, (0.2); New Jersey 0.9, (0.3); New York 6.9, (3.9) (included frogs up to 125 g). Niethammer and Kaiser (Niethammer and Kaiser 1983) reported on 27 Green Heron stomachs from Louisiana containing 193 prey items, 143 of which were weighed and measured (Appendix 1, Figure 3). Major insect types were dragonflies (Libellulidae), pygmy grasshoppers (Tetrigidae), and mole crickets (Gryllidae).

Food Selection and Storage

Not reported.

Nutrition and Energetics

Junor (Junor 1972) raised 2 *B. striatus* chicks on fish diet and reported that food requirements at flying stage were approximately 16% of body weight/d.

Metabolism and Temperature Regulation

Chicks (*B. striatus*) are apparently seldom left uncovered during first 9-10 d after hatching; thereafter adults visit nest in daytime only to feed chicks (Hindwood 1933). This suggests chicks achieve homeothermy by day 9 or 10. Cowles (Cowles 1930) reported that before sunrise chicks crouched low in nest and huddled together, presumably for warmth. Later in day they became less active and breathing became rapid, with bills open, presumably to facilitate evaporative cooling. On hot days adults may shade eggs with wings (Cooley 1942).

Drinking, Pellet-Casting, and Defecation

Adults often defecate while flying, particularly after being disturbed (Gordon 1961). Hindwood (Hindwood 1933) reported that scarcely any attempt is made by chicks to avoid defecation in nest, although others report that older chicks defecate over side of nest. Defecating bird lowers posterior, elevates tail, head, and neck, and droops wings slightly (Meyerriecks 1960a).

Sounds and Vocal Behavior

Vocalizations

Development

From hatching until fledging, chicks utter *tik-tik-tik-tik* (Meyerriecks 1962b) or *toc-toc-toc-toc* (Hindwood 1933). Because these calls are given most intensively when chicks have not been recently fed, and peak when adults arrive at nest, they are best considered food-begging calls.

Vocal Array

Call variously rendered as *skow* or *skeow* (Hancock and Kushlan 1984), *peu-ah* (Bent 1926), or *skyow* (Meyerriecks 1960a). *Skow* slurs down from $B_5$to F_5or $C_6$to G_5(Meyerriecks 1962b). Given as flight call and also as alarm call, the 2 being variously reported because of similarities. See Figure 4 . During attack by a hawk, a Green Heron gave repeated "squawks" (Becker and Byers 1976). When disturbed at nest, birds utter *ku-ku-ku-ku-ku-ku* (Meyerriecks 1962b), *skuk-skuk*, *kuk-kuk*, or strong, hostile *raaah-raaah* calls (Meyerriecks 1960a). When frogs jumped into a stream, a Green Heron emitted "squawks" before attacking frogs (Kalter 1932).

During breeding season, advertising calls or song by male are *show-ch* or *ow-ch* (Townsend 1928). Low-pitched *skow* call given from top of tree or other perch with bill up at 45° angle. Female advertising call is similar to alarm call, *skeow* or *skyow* . Attack calls a series of *raaahs* (Meyerriecks 1960a).

Phenology

Calls year-round. Low temperatures, wind, and rain reduce advertising and courtship displays, and hence reduce vocal component (Meyerriecks 1960a).

Daily Pattern Of Vocalizing

No data reported.

Places Of Vocalizing

Skow calls usually given in flight. Advertising call given from exposed perch or old nest.

Nonvocal Sounds

Bill-snapping (clicking mandibles together) by males before copulation. Interpreted as interaction of hostile and sexual elements (Meyerriecks 1960a).

Behavior

Locomotion

Walking, Hopping, Climbing

Slow and deliberate when foraging; head and neck retracted or extended, sometimes tarsus practically on ground. Walks slowly or quickly over branches and roots, hopping from 1 to another. When walking, often erects and depresses crest and flips tail up and down (Bent 1926). On ground, will often walk to shrub and jump to top before flying (Meyerriecks 1960a).

Flight

Slow, steady wingbeat at 2.8 beats/s, or 3.8/s after being flushed (Blake 1948a). Resembles a tail-less crow; crows, when climbing, have similar wingbeat (2.7 beats/s). Normally flies with head retracted and legs extended beyond body, but often makes short flights with head and neck extended. Flight speeds reported: 35 kph (Wood 1933), 54 kph (Mclean 1930b), 40 kph Meyerriecks (Meyerriecks 1960a).

When taking off, feathers sleeked, legs bent, posture horizontal with wings slightly extended, head and neck partially retracted, tail flipped or fanned laterally; then body thrust forward and upward by extending legs, wings extended upward, tail depressed, head and neck extended (crest erect or sleeked); then legs and feet brought together and extended rearward, and finally head and neck retracted. When landing, may make short glide, then head and neck extended to elevated position, crest erected, followed by dangling of legs which are then thrust forward and down, tail spread, wings beating as in hovering; perch grasped, head and neck retracted, crest lowered, body upright (Meyerriecks 1960a).

Swimming And Diving

Will swim after diving for prey (Hindwood 1933 for *B. striatus*). Web between middle and outer toes likely aids in swimming. One half-grown bird when placed in water swam gracefully 20 m, sitting erect "like a little swan" (Bent 1926).

Self-Maintenance

Preening, Head-Scratching, Stretching, Bathing, Anting

Meyerriecks (Meyerriecks 1960a) described maintenance behavior of Green Heron, which can reach entire body surface, except top of head and neck, with bill. Typical preening sequence begins with nibbling of breast powder-down patch; then grooms feathers, grasping each feather at base with bill tip, then moving smoothly upward or with rapid flicking movements. May shake with wings extended halfway, leaning forward, all feathers erect. Rubs head against body, may

groom some or all feather tracts, repeatedly nibbling power-down feathers. Grooms scapular plumes, raises and grooms neck feathers, nibbles and preens primaries with wing closed or partially open. Also preens under spread wing. Scratches head with pectinated claw of middle toe, crest raised. May peck toes. Ends bout with bill rubbing oil gland. Wipes bill on branch, alternating side of bill wiped. Stretches by extending head and neck, body forward, standing on 1 leg and extending opposite leg and wing. Yawns, especially after long incubation bout.

Powder down functions to dry and oil feathers in conjunction with oil gland (Hindwood 1933 for *B. striatus*). Of 3 pairs of powder-down feathers, pair on upper breast are largest, extending from near neck more than 6 cm. Second pair on rump, smallest pair on abdomen.

Able to tolerate high degree of attack by mosquitoes without employing defensive behavior (Edman et al. 1984). Corresponds with stealthy foraging behavior, where concealment is all important. When needed, will flick head and blink eyes to repel mosquitoes.

Sleeping And Roosting

Sleeps with neck retracted, wings drooped slightly, body feathers somewhat erect, eyes closed. May sleep while brooding or incubating, head resting on nest rim. On ground may sleep with 1 leg retracted (Meyerriecks 1960a).

May roost at night alone or in association with conspecifics or other colonial waterbirds. In mixed-species roosts, tends to segregate to a place adjacent to main roost. Up to 100 birds counted at one New Jersey roost (Seibert 1951).

Sunbathing

When sunbathing, droops half-open wings, raises head and neck slightly, usually faces sun, and may open bill, suggesting thermoregulation (Meyerriecks 1960a). Hauser (Hauser 1957) calls this "voluntary" or "normal" sunbathing, which often accompanies preening and other maintenance activities.

Daily Time Budget

No data reported.

Agonistic Behavior

Physical Interactions

On feeding grounds, will defend a food resource (Meyerriecks 1960a). A bird baiting fish with bread several times drove away American Coots (*Fulica americana*) with "threatening strokes of his long bill" (Lovell 1958).

On breeding grounds, if 1 bird gives Full Forward threat display (see below, Communicative interactions) and other bird displays in return, "a vicious fight ensues" (Meyerriecks 1960a: 29). During fights birds peck at each other's heads, flail with wings, stab from horizontal stance. Supplanting attacks, where attacking bird replaces other bird from perch, common during early nesting season (Meyerriecks 1960a). May attack and drive crows (*Corvus* spp.) away from eggs and nest, and usually intimidates grackles (*Quiscalus* spp.).

Communicative Interactions

When humans approach nest, birds call aggressively, with harsh croaks, elongating neck, fluffing feathers, and raising crest (Dickerman and T. 1969). In conflict situations, erect crest, often tail-flip. In Forward Display, heron faces opponent, body horizontal, head and neck retracted, crouched; crest, neck, breast, back, flank feathers, and scapular plumes moderately erect; bill horizontal and closed; slow tail-flipping. Full Forward Display like Forward, but head and neck fully forward, feathers fully erect, eyes bulging, bill open showing red lining of mouth, vigorous tail-flipping; then lunges at opponent with wings slightly extended, uttering *raaah* calls; may make short flight toward opponent. In rare stiff-necked Upright Display, bird stands up with neck and crest feathers erect; may combine attack, escape, and sexual tendencies. Pursuit Flights on breeding grounds are probably low-intensity attack behaviors (Meyerriecks 1960a).

Spacing

Territoriality

Defends feeding territories from conspecifics. In breeding season, song posts used to advertise territory, with most intense displays from old nest. These song posts mark courtship territories. In colonies and nesting aggregations, area defended around nest shrinks during nesting until, in some cases, only nest and immediately surrounding area are defended. Probably defends larger territories when nesting solitarily, but data needed.

Individual Distance

No information.

Sexual Behavior

Mating System

All evidence, including high dispersion of nest sites, indicates seasonal monogamy. Given high degree of extra-pair mating in other colonial wading birds, information from marked birds or from biochemical studies would be desirable.

Pair Bond, Courtship Displays, And Mate-Guarding

Meyerriecks (Meyerriecks 1960a, Meyerriecks 1962b) described typical courtship display sequence. Begins with Flying Around displays, which resemble normal flight but are oriented to breeding sites, and with *skow* advertising calls from song posts. Pursuit Flight and Circle Flight displays accompanied by *skowing*, Crooked Neck Flight displays with partially retraced kinked neck; these displays have hostile component. Flap Flight Display is highest intensity of flight displays, where male lurches through air with exaggerated flapping producing *whom-whoom-whoom* sound, neck crooked, legs dangling, *skow* ing, crest, neck, and scapular feathers erect, sometimes giving *roo-roo* calls before landing. Soft parts change color in breeding condition, with bills glossy black, lores blue-black, legs bright red-orange.

Display flights interspersed with nonaerial displays such as Snap Display where male on perch points body, head, and extended neck below horizontal until bill tip at or below level of feet, crest and neck feathers slightly erect, and snaps mandibles together producing *click* . Variant includes bowing and bobbing movements. In Stretch display, male points bill straight up, stretches neck, and bends neck backward until head almost touches back, during which interscapular plumes are erect and fanned; then sways neck and head from side to side; crest, breast, and flank feathers sleeked, eyes bulge, and iris may change from yellow to deep orange; emits *aaroo-aaroo* sound.

Male performs Stretch before female is permitted to enter nest. Female performs Stretch after male, but female Stretch less intense. Stretch is employed during nest construction and nest relief. After female first enters nest, male's *skow* ing and flight and Snap displays cease.

Copulation

Only on territory, usually on nest platform, and mostly during nest-building stage. First copulation usually on same day as pair formation. Before first copulation, birds engage in mutual bill-snapping and feather nibbling, but those behaviors reduced thereafter. Engage in Twig Passing and Stretch displays, some mutual, during copulation period. Typically, female in nest gives Stretch with back to male, who then mounts squatting female; both flap wings to maintain balance. Copulation lasts about 10 s (5-12); several hours between copulations. Copulations cease after last egg laid (Meyerriecks Meyerriecks 1960a, Meyerriecks 1962b).

Duration And Maintenance Of Pair Bond

Most authorities assume seasonal (serial) monogamy, but evidence from marked birds needed.

Extra-Pair Copulations

None reported.

Social and Interspecific Behavior

May nest in colonies with conspecifics or other colonial birds, generally somewhat apart from other species. In San Blas, Mexico, Burger (Burger 1978d) found in colony of 320 pairs: 16%

Tricolored Herons (*Egretta tricolor*), 13% Great Egrets (*Egretta alba*), 28% Boat-billed Herons (*Cochlearius cochlearius*), and 23% Green Herons, as well as 7% Olivaceous Cormorants (*Phalacrocorax olivaceus*) and 13% Anhingas (*Anhinga anhinga*). For an Alabama colony, Gaston and Johnson (Gaston and Johnson 1977) reported Green Herons nesting with Tricolored and Little Blue (*Egretta caerulea*) herons, Snowy (*Egretta thula*) and Great egrets, and Glossy Ibis (*Plegadis falcinellus*). Also nests near grackles, which may help warn herons of predators or intruders (Wheelock 1906). Reported as an uncommon secondary species associated with roosts of European Starlings (*Sturnus vulgaris*) and Common Grackles (*Quiscalus quiscula*) (Caccamise and Fischl 1985).

Green Herons, although typically solitary foragers, foraged in New Jersey salt-marsh habitat with wide variety of waders, waterfowl, shorebirds, gulls, terns, raptors, and passerines (Burger et al. 1982).

May respond to presence of predator by assuming "Bittern Stance" with bill held vertical. Can see with binocular vision across base of bill from this position. May be cryptic adaptation for reed-bed environment (Cowles 1930 for *B. striatus*). During Bittern Stance, neck stretched upward, feathers sleeked, legs straight, eyes bulged, body motionless, except head may turn to follow predator.

Reacts to warning calls of many birds, including at least 10 Ardeidae species, crows, blackbirds, and grackles, and assumes alert posture, Bittern Stance, or flies. After pair formation, aggressive toward all passerines, especially crows and grackles. Considered intermediate in sociality between solitary breeding *Botaurus* bitterns and highly colonial herons, e.g., *Nycticorax* (Meyerriecks 1960a).

Predation

Predation on eggs may be high, particularly by snakes (Dickerman and T. 1969, Kaiser and Reid 1987). Snake predation accounted for 25% of known nest failure in 1 study (Kaiser and Reid 1987). Meyerriecks (Meyerriecks 1960a, Meyerriecks 1962b) reported predation on eggs by Common Grackles and Fish Crows (*Corvus ossifragus*), and McVaugh (McVaugh 1975) reported probable predation by Boat-tailed Grackles (*Quiscalus major*).

Raccoons (*Procyon lotor*) probably take young birds (Dickerman and T. 1969). Becker and Byers (Becker and Byers 1976) reported unsuccessful attack on a flying Green Heron by a Broad-winged Hawk (*Buteo platypterus*). Innately recognizes some potentially dangerous animals. Six naive, hand-reared Panama birds fled from dead sea snake (*Pelamis platurus*), backing away with crests erect, then flew around aviary and tried to escape (Caldwell and Rubinoff 1983).

Breeding

Phenology

Pair Formation And Nest-Building

Figure 5 . Pair formation may begin during migration; in New York both sexes arrive at breeding grounds simultaneously and begin breeding activities at once (Meyerriecks Meyerriecks 1960a, Meyerriecks 1962b).

Because of wide latitudinal range of breeding, initiation dates differ geographically. In North America, generally later farther north. Egg dates for Florida as early as 29 Mar, Gulf Coast first wk Apr, Midwest second wk May, New England and New York 29 Apr to late June (Bent 1926, Meyerriecks 1960a), s. Ontario 4 May to mid-Jul (Peck and James 1983). In Oregon, birds nest Apr-Jun (Bent 1926, Graf 1946, Griffee 1954).

In tropics, nesting season related to temperature and rainfall. In Veracruz, Mexico, in permanent aquatic habitat, nesting begins with increase in temperature-in Feb or Mar-but in San Blas, Mexico, begins in Jul with rainy season and flooding of mangrove flats (Dickerman and T. 1969).

Second Brood Per Season

See Demography and Populations: measures of breeding activity: clutch size. Clutches for second nest begin soon after first is lost or completed; 5-9 d after loss of first clutch and as early as 9 d after successful nesting (Dickerman and T. 1969).

Nest Site

Selection Process

Nests in various habitats providing secluded nest sites and wetland feeding habitat: swamps, marshes, lakes, ponds, human-made or human-regulated habitat such as storm-water control impoundments and retention basins, even in dry woods and orchards in farmlands if feeding sites available (Bent 1926, Adams et al. 1985). Often nests on islands or tree islands in marshes. Nest is usually on or over water but may be up to 0.8 km from standing water (Kaiser and Reid 1987).

Nest may be placed alone, in loose aggregations, or in colonies. Kaiser and Reid (Kaiser and Reid 1987) suggested that birds nest alone if they can defend a feeding territory, e.g., along a stream, but nest in loose aggregations in wetlands where territorial defense is more difficult.

Single-species aggregations or colonies are small to moderate size. Examples include 70, 41, 17, and 8 pairs in Jamaica Bay, NY (Meyerriecks Meyerriecks 1960a, Meyerriecks 1962b). Nest densities variable. Of 137 nests in San Blas, Mexico, 45 ≤1 m apart, 75 1-2 m apart, and 21 > 2 m apart, with 5 nests only 15, 15, 20, 20, and 40 cm apart (Dickerman and T. 1969).

In mixed-species colonies, often nests somewhat apart from other species; usually well outnumbered by other species, e.g., 12 pairs in a mixed-species colony of 804 breeding pairs on Chimon I., CT (Marra and Bull 1986).

Nest site is chosen through process of territorial contraction. Male displays in and defends relatively large area that typically includes eventual nest site. As site is selected by pair and construction begins, pair concentrates its attentions on increasingly restricted area around nest.

Microhabitat

Nests in protected sites within trees or bushes. May nest in both aquatic and terrestrial sites in same area (Kaiser and Reid 1987).

Nest placed from ground level to 10 m above ground, occasionally to 20 m (Wheelock 1906, Huey 1915, Bent 1926, Howsley 1936, Cooley 1942, Mousley 1945, Meyerriecks 1962b, Steirly 1964, Douglass et al. 1965, Dickerman and T. 1969, McVaugh 1975, Sandilands 1977, Osborn and Custer 1978, Coffey 1981).

Nests in many species of plants, and nest height determined in part by height and thickness of plant. In San Blas, Mexico, for example, nests in 3 species of mangroves (red mangrove [*Rhizophora mangle*], black mangrove [*Avicennia nitida*], and particularly white mangrove [*Laguncularia racemosa*]); average height of 181 nests 0.68 m above water (Dickerman and T. 1969). On Ships Shoal I., VA, in shrubs 6-12 m high (Osborn and Custer 1978); also in Virginia, in loblolly pine (*Pinus taeda*; Steirly 1964). In Tennessee, in buttonbush (*Cephalanthus occidentalis*), 1-2 m above ground. In Arkansas, in post oak (*Quercus stellata*), 4 m above ground (Coffey 1981); also in Tennessee, in Virginia pine (*Pinus virginiana*), and cedars at heights of 4, 7, and 8 m, 5 m apart (Douglass et al. 1965). In Minnesota, in willow (*Salix* sp.) 1 m above water (Cooley 1942).

Meyerriecks (Meyerriecks 1962b) reported nests in New York from ground level to 5 m above ground, most commonly near water, with concealment variable. In Magnolia, MA, colony of 20-30 pairs in pitch pines (*Pinus rigida*), 7 m above ground; in Westport, MA, colony of 20 nests on salt-marsh island in cedars, sassafras, and hickories, 1-7 m above ground (Bent 1926). In N. Carolina, nests in black willows (*Salix nigra*) over water (McVaugh 1975). In California, a nest in willow 8 m high (Howsley 1936). In Ontario, once nested in Wood Duck (*Aix sponsa*) box (Sandilands 1977).

In Missouri, height of 77 nests averaged 10.5 m above ground (range 2.2-19.0), primarily in honey locust but also in buttonbush, black willow, box elder (*Acer negundo*), and short leaf pine (*Pinus echinata*) (Kaiser and Reid 1987).

Site Characteristics

Branches large enough to support nest, generally at a juncture. Birds appear to select trees with branching over those without. Overhanging branches to conceal nest nearly essential. Nest often suspended over water.

Nest

Construction Process

Male selects nest site. Old nests reused in some places, after considerable renovation (e.g., Dickerman and T. 1969). Also builds in old nests of Black-crowned Night-Herons and Snowy Egrets (Meyerriecks 1962b, Nickell 1966d). In other places, old nests not reused, but sticks from nearby old nests refashioned into new nests.

Male initially begins nest construction. After pairing, male gathers nest material for female who does most of construction. Twigs worked into nest structure by "tremble-shoving." Male typically breaks off twigs to pass to female. In early stages, twigs may be repeatedly dropped and retrieved. After eggs laid, incubating bird does most of building and repairing (Meyerriecks 1960a). Birds continue to add new sticks throughout nesting period and will pirate sticks from other active or old nests.

Building time for nest not reported in North America, but reported as 3 d and 7-14 d in *B. striatus* (Hindwood 1933, Brown et al. 1982).

Structure And Composition Matter

Nest round to elongate. Structure variable, from so thin that eggs are visible from beneath to substantial; total thickness of 72 nests averaged 11 cm, but recorded up to 24 cm thick, which may be reused nests (Dickerman and T. 1969).

Sticks used are relatively thin but may be quite long, up to 25 cm. Hindwood (Hindwood 1933) found about 220 sticks, as "thick as a lead pencil" and up to 46 cm long, in average nest of *B. striatus* . May also use reed, but doesn't use any lining material.

Dimensions

Diameter (outside) about 20-30 cm; Brown et al. (Brown et al. 1982) reported 30 cm; mean diameter of solid part of 119 nests was 23 cm (Dickerman and T. 1969). However, a nest in Quebec was boat-shaped and diameter measured 36 x 20 cm outside (Mousley 1945).

Nest cup shallow; depth of nest depression about 0-10 cm, averaging 4.5 cm for 145 nests (Dickerman and T. 1969).

Microclimate

No data available.

Maintenance Or Reuse Of Nests, Alternate Nests

Old nest is focus of territorial behavior, e.g., most intense threat displays usually made on nest platform (Meyerriecks Meyerriecks 1960a, Meyerriecks 1962b). May reuse old nest platforms from previous season and refurbish with sticks from other old nests. Fifty-three of 59, and 67 of 68 nests surviving over winter reused following season in Long I., NY, colonies. Also uses twigs from old nests for new nests. Nests partially destroyed can be fixed rapidly, even while young hang on to nearby branches. One pair built nest to 0.25 m thick as water level rose threatening it (Dickerman and T. 1969). For second clutch in same season, may reuse same nest or make another (Dickerman and T. 1969). More likely to relocate nest following failure and to reuse nest following successful nesting (Kaiser and Reid 1987).

Nonbreeding Nests

Not known.

Eggs

Shape

Elliptical to subelliptical.

Size

Length x breadth (mm): San Blas, Mexico (*n* = 232) 37.5 (range 34.0-40.8) x 29.2 (27.0-31.4) (Dickerman and T. 1969); New York (*n* = 74) 38.8 (35.7-43.3) x 29.6 (27.0-34.8) (Meyerriecks 1962b); California (*n* = 17) 39.0 (37.0-42.0) x 29.5 (28.2-30.0) (Huey 1926a).

Mass

No data.

Color

Initially clear, pale green to bluish, becoming duller and chalkier during incubation period. May become stained with mud from adults. Color range called Lichen Green to pale Niagra Green of Ridgway (Ridgway 1912) (Dickerman and T. 1969). Unusual clutches of Olive Buff reported (Dickerman and T. 1969).

Eggshell Thickness

Mean of 0.183 mm (*n* = 302) pre-pesticide era from 25 states; in regional comparisons with 1947-1973 data, changes from -1.2% to +1.6% (*n* = 124), none significant (Ohlendorf et al. 1979a). Mean of 0.169 mm (SD = 0.011, *n* = 8) from Tennessee Valley in 1980-1981 (Fleming et al. 1984a). Eleven percent thinning in eggs at Yazoo National Wildlife Refuge, MS, compared to pre-DDT era eggs (White et al. 1988a).

Clutch Size

Generally 3-5 eggs.

Egg-Laying

Mostly in morning and early afternoon (Meyerriecks 1962b, Dickerman and T. 1969). Clutches laid in 4-6 d, depending on clutch size. Second egg laid 2-5 d after first, in > 60% of cases laid on second day (Dickerman and T. 1969). Third egg laid 1-2 d after second, most commonly 2 d. Meyerriecks (Meyerriecks 1962b) found less variability in New York.

Incubation

Onset Of Broodiness And Incubation In Relation To Laying

Incubation typically begins with second egg, although first-egg start indicated in New York. Routine of "1 on, 1 off" incubation begins with second egg, but until third egg laid, incubation is intermittent.

Incubation Patches

No data reported.

Incubation Period

Somewhat variable, generally 19-21 d from last egg. Dickerman and Gavino T. (Dickerman and T. 1969) reported 19 d for 8 nests, 20 d for 12 nests, and 21 d for 11 nests. Meyerriecks (Meyerriecks 1962b) reported incubation period of 19 d for 1 nest, 20 d for 18, and 21 d for 1. Burns (Burns 1915a) reported 17 d, probably too short. Because of timing of start, however, eggs in same nest not incubated for same period, ranging from 19 to 23 d in single nest (Dickerman and T. 1969)

Parental Behavior

Both parents incubate and attend nest equally after full clutch. After third egg laid, male incubates mostly in midday and middle of night, with female mostly early morning and late evening, but schedule variable (Meyerriecks 1960a).

Billing and feather-nibbling at nest relief, sometimes silent Stretch display, sometimes by both birds, early in incubation; later little or no nest relief ceremony. Both birds usually use same approach to nest, but if different, each bird consistently uses its own route (Meyerriecks 1962b).

Hardiness Of Eggs

Eggs will die if exposed to sun and heat. Parents stand and shade eggs in direct sun (Dickerman and T. 1969). This behavior most important in exposed nests. Eggs and young can die from heat. Neglected eggs can be lost to predators.

Hatching

Preliminary Events And Vocalizations

Hindwood (Hindwood 1933) described hearing cheeping from chick and tap of egg tooth inside "slightly broken" egg, and "soft croaking" from another chick in perforated egg (in *B. striatus*).

Shell-Breaking And Emergence

Hatching reported at all daytime hours (Cooley 1942, Douglass et al. 1965). During hatching, membrane of egg pierced by egg tooth; crunching sound as bill is used as battering ram against shell; bird rotates in egg, cutting both membrane and shell until cap of shell is free.

Hatching asynchronous, but development period compressed such that chicks hatch in shorter interval than eggs laid; eggs laid over 5- to 6-d period generally hatch in 3-4 d (Dickerman and T. 1969). Generally hatch in order laid, but may hatch same day.

Parental Assistance And Disposal Of Eggshells

Adults usually toss eggshells over nest edge, but sometimes eggshells crushed in bottom of nest or pushed over edge by active chicks (Meyerriecks 1962b).

Young Birds

Condition At Hatching

Semialtricial, with limited movement but eyes open.

Average weight of 62 hatchlings before first meal 16.0 g.

At age 1 d, body length 95.3 mm, wing 15.9, bill 12.7, tarsus 15.9 (McVaugh 1975).

At hatching, natal down wet and clinging but dry and fluffy in several hours. Down grayish brown forming crest on head, whiter on belly, less developed on wings (T and Dickerman 1972). Down up to 19.1 mm long, darker gray on head.

Skin pink on forehead, crown, auricular area, and mouth lining, green around eyes; bill tipped black; tarsus and toes shades of greenish flesh (McVaugh 1975; see McVaugh's color illustrations and extensive descriptions of plumage and soft parts).

Can only raise head for short periods at hatching, but able to move about nest later on day of hatching (Meyerriecks 1962b).

Can only raise head for short periods, and eyes tend to close when head down (Douglass et al. 1965). In first day can make *tik-tik-tik-tik* food-begging calls (Meyerriecks 1962b).

Growth And Development

Weight of 1 chick: 11.5 g (hatching), 16.5 (day 2), 88.8 (day 7), 132.2 (day 14), 173.2 (day 21). Reach minimal adult mass of 160 g in about 2 wk (Dickerman and T. 1969).

Chick weights after first day highly variable, partly because of differences in amount of food in crop or stomach. Gavino T. and Dickerman (T and Dickerman 1972) reported that sibling competition was not major factor in weight gain; even small chicks experienced normal growth, and differences leveled off after first week; small chick could be first, second, or last to hatch.

Tarsus reaches 4.7 cm in 16-17 d; for daily increases in bill, tarsus, and eighth primary (see T and Dickerman 1972).

McVaugh (McVaugh 1975) reported that by day 3 upperparts mostly covered by gray down up to 19.1 mm long on forehead; by day 6, quills, with down tips, emerging from all tracts but crown and tail, and longest primary, secondary, and scapular pinfeathers 9.5 mm long; by day 8, crown and tail quills emerging; by day 11, most Juvenile feathers emerging; by day 13, quills and feathers covering most of chick; by day 31, body "well covered" with Juvenile feathers, but gray down still attached to some.

At 9-11 d, parents begin to leave chicks alone during day, and chicks adopt Bittern Stance (see above, Behavior: social and interspecific behavior) when approached. By 3 wk, chicks will regurgitate food if disturbed. In nest will stretch wing over leg, preen, and head-scratch.

Meyerriecks (Meyerriecks 1962b) reported first wing-flapping at 7-8 d, wing-preening by 6 d, fear response by 4-5 d (crouch, then Bittern Stance, then try to leave nest), climbing well by end of 1 wk, wing-stretching and forward stretching of head and neck by 8 d, snapping at flying insects by 9 d, jumping to nest from branch by 15 d, making short flights by 21 d.

On day 3, chicks peep but cannot leave nest; on day 5, extend wings and give *haa* call; soon climb using wings, neck, beak, and feet; by day 15 can escape capture by climbing (Douglass et al. 1965). Cooley (Cooley 1942) reported that by day 8-11, chicks left nest when approached, but quickly returned to nest when investigator entered blind. By 3 wk, chicks climb and move easily and will cling to branch with tenacity if handled. Will swim if they fall into water, with only top portion of back showing (Hindwood 1933).

Parental Care

Brooding

Both adults brood chicks. Meyerriecks (Meyerriecks 1962b) reported that adults brood almost constantly during week 1, after that spend progressively less time until brooding ceases by end of week 3. On hot days adult may shade young, standing with wings spread, especially at exposed nests (Dickerman and T. 1969). Adults utter *cuck cuck* calls as they approach to brood or feed chicks (Cooley 1942).

Feeding

Food delivered to chicks by both parents. Chicks give food-begging call, low-pitched *tik-tik-tik-tik*, from first day. First fed at age 1 d. Usually fed soon after nest relief. First few days, well-digested food regurgitated directly into chick's mouth or onto nest platform. At age 1 wk, chicks grasp parent's bill crosswise and take food directly. By 2-3 wk, both parents may feed chicks at same time. Number of feedings/d increases during first and second week, then reduced to 2-3/d. Chicks fed at any time of day in New York colonies (Meyerriecks 1962b). At age 6 d, chicks fed every 20 min, less frequently thereafter; after feeding, both adult and young preen, stretch, and rest (Cowles 1930 for *B. striatus*).

Food at first is nearly fluid; less-digested and larger items given to older chicks. Chicks fed in nest tree after they leave nest, and at other locations after they leave nest tree. Cooley (Cooley 1942) reported that adult may feed all, some, or 1 of chicks at a particular feeding.

Nest Sanitation

No attempt at nest sanitation by adults, but when strong enough to walk, chicks void over edge of nest (Cooley 1942). When a few days old, chicks shuffle backward to nest rim to void, later walk to rim; nest and surrounding area usually covered with excrement (Meyerriecks 1962b).

Parental Carrying Of Young

Not reported.

Cooperative Breeding

Not reported, and unlikely.

Brood Parasitism by Other Species

Not reported, but 9- and 10-egg clutches reported (Huey 1926a, Howsley 1936), suggesting egg dumping.

Fledgling Stage

Departure From Nest

At 16-17 d. Flying at 21-22 d. In a Michigan nest, young stayed in nest 15-16 d (Cooley 1942). Meyerriecks (Meyerriecks 1962b) reported nestling period of 16-17 d and flight at 21-23 d. Gavino T. and Dickerman (T and Dickerman 1972) reported young flying up to 10 m at age 21-25 d. Young fly around nest tree while parents forage and fly to nest tree when parents return to feed them 2-3 times/d. Young fly to feeding grounds with parents by 25 d.

Immature Stage

Time to independence unknown, but estimated at 30-35 d. Fledged young will enter water after prey and swim well. Most behavior at this stage little known. Hindwood (Hindwood 1933) reported for *B. striatus* that young, after leaving nest, stay in mangroves ≥1 mo where they are fed by adults and "taught" how to forage for fish. Observations of marked birds needed.

Demography and Populations

Measures of Breeding Activity

Age At First Breeding; Intervals Between Breeding

Usual age of first breeding probably 2 yr. At a New York colony, several breeding birds were in "immature" plumage, suggesting breeding at age 1 yr for some birds (Meyerriecks 1962b). Undoubtedly attempts to breed every year, but data lacking.

Clutch

Usually 3-5, but variable among nests and colonies. Latitudinal differences not apparent. No statistical difference from first to second broods. Data: 4 or 5 eggs in N. Carolina (McVaugh 1975); in New York for 76 first clutches, 3 eggs (n = 25), 4 (38), 5 (11), 6 (2) (Meyerriecks 1962b); in San Blas, Mexico, for 185 nests: 2 eggs (n = 53), 3 (125), 4 (7) (Dickerman and T. 1969). In Washington State, usually 4 or 5 eggs reported (Jewett et al. 1953). In Kentucky, mean of 4.3 eggs and young (Mengel 1965b). Large clutches of 7 (Coffey 1981), 8 and 9 (Huey 1926a), and 10 (Howsley 1936) reported, but not definitively laid by 1 individual.

Most individuals in northern latitudes (Meyerriecks 1962b) probably lay 1 clutch; farther south (Dickerman and T. 1969), generally double brooded. In all areas may renest after failure of initial nesting (Meyerriecks Meyerriecks 1960a, Meyerriecks 1962b, Dickerman and T. 1969). In Mexico, 32 pairs laid normal second clutches, 1 pair 9 d after first brood fledged, and 7 nests had new eggs laid in same nest after egg destruction or abandonment (usually after 5-8 d), likely but not certainly laid by same pair (Dickerman and T. 1969).

Annual And Lifetime Reproductive Success

Few data, none with marked birds. Widely dispersed and cryptic nature of solitary nesting pairs, together with small colony size of colonial nesters, makes collecting meaningful data on reproductive success difficult. Estimates that do not correct for unobserved losses may produce spuriously high results (Erwin and Custer 1982).

In Missouri, 78.8% of 62 nests successful (Kaiser and Reid 1987). In 104 nests in San Blas, Mexico, 191 chicks fledged from 211 of 290 eggs (Dickerman and T. 1969). In 76 nests in New York, 60 had at least 1 egg hatch; in 51 nests, all eggs hatched, with 1 egg failure in 8 nests, and 2 in 1 nest (Meyerriecks 1962b).

Life Span and Survivorship

Few data. Banded bird recovered in New Jersey age 4 yr (Cooke 1938) and in Mexico age 7 yr 11 mo (Clapp et al. 1982b).

Disease and Body Parasites

Disease

Green Herons are amazingly tolerant of mosquitoes, their only defensive movement being mild head-shaking (Edman et al. 1984); hence may be susceptible to mosquito-vectored diseases.

Body Parasites

Cercaria megalura (larva of a species of *Philophthalmus*) has been found in orbits of Green Herons in s. Indiana (Fisher and West 1958). Other parasites: 2 cestodes, *Hymenolepis ardea* and *Ophiovalipora minuta*, in Indiana (Coil 1950); nematodes, *Strongyloides ardeae* in Louisiana and *S. cubaensis* in Cuba (Little 1966); nematodes *Tetrameres ardamericanus*, *Contracaecum microcephalum*, and *Agamascaris* sp. in Massachusetts; also *T. ferminis* from Cuba (Boyd 1966a); a blood parasite, *Leucocytozoon iowense*, in Iowa (Coatney 1938); a nasal mite, *Tinaminyssus belopolskii*, in Louisiana (Pence 1972e).

Causes of Mortality

Little known. Predation may be severe on eggs and chicks. Of 290 eggs at San Blas (Nayarit), Mexico, 24 infertile, 40 broken or disappeared (Dickerman and T. 1969). Kaiser and Reid (Kaiser and Reid 1987) found nest losses were primarily from predation, wind, and weather, also heat stress and early embryo death.

Few reports of mortality in adults. Few instances of predation or attempted predation reported, although species' choice of dense habitats reduces risk but also opportunities for observation. No evidence of adverse affects of competition from other species.

Population Spatial Metrics

Initial Dispersal From Natal Site

Disperses from nesting site prior to fall migration. See Migration; also Distribution: winter range.

Fidelity To Breeding Site

Probable, but no data from marked birds. Some natal philopatry assumed, but birds banded as chicks in 1 area later seen far away. Evidence needed from marked birds.

Dispersal From Breeding Site Or Colony

Pronounced postbreeding dispersal, often into nonbreeding areas (see Migration) may be found wherever there is suitable foraging habitat within range.

Population Status

Numbers

Because most Green Herons are solitary nesters and are dispersed widely through marine and freshwater habitats, estimating numbers is difficult. Also, colonies tend to be small. Species is not included in many surveys of colonially nesting waders (e.g., Spendelow and Patton 1988) because of sparse data, which if reported, might be misleading (J. A. Spendelow pers. comm.). Hence, few data on populations or colony sites exist.

Reported as present in 33 colonies in 7 East Coast states, with estimate (an underestimate) of 526 breeding adults (Custer and Osborn 1977). Historically, colonies of 100 pairs reported for Tampa Bay, FL, in 1912, and 400 from Orange Lake, FL, in 1916 (Howell 1932), but more recent colony data report lower numbers, e.g., 38 pairs from Alligator Bay, NC, in 1969 (Custer and Osborn 1977). In San Blas, Mexico, about 300 pairs reported for a 1964 colony in mangroves (Dickerman and T. 1969).

Trends

With poor data on numbers (see above), trends difficult to determine accurately. No indication of overall population decreases; suggestion of increases from available data. From 1968-1979, North American Breeding Bird Survey data indicated slight but significant increases in central and eastern regions, also for continent. No state showed a decline. Florida and Louisiana had highest means; increases noted for Alabama, California, Mississippi, Wisconsin, and Texas. Increases also noted for western portion of Great Lakes Plain, central and southern part of Upper Coastal Plain, and southern portion of Lower Coastal Plain (Robbins et al. 1986a). Colony-based

census data needed, however, as reported increases in some areas may reflect increased coverage (Broadbooks 1946).

Positive trend of long-term population expansion at northern and central range limits noted elsewhere.

Population Regulation

Poorly studied; needs attention. Habitat alteration (especially drainage of wetlands) affects breeding and foraging habitat, and hence potentially numbers. Storms can cause substantial mortality during nesting season (Wheelock 1906); likewise predation, especially at accessible nests. Island nesting probably helps deter predators and thus boost reproduction, but data lacking. No data to suggest that interspecific competition is a major regulator of populations.

Conservation and Management

Effects of Human Activity

Shooting And Trapping

In past often shot for food (Bent 1926); P. A. Taverner (in McAtee 1919a) reported that Green Heron was "very good, a little more delicate than the Night Heron." Historically, Green Heron subject to predator-control programs at fish hatcheries (Slipp 1944); probably continues today at some hatcheries.

Pesticides And Other Contaminants

Found to accumulate persistent pesticides, but no evidence of general reproductive failure, despite some localized effects.

Except for DDE, mirex, and *cis* -nonachlor, frequency of organochlorines in Green Heron eggs "considerably" lower than average for 17 species of herons, bitterns, ibises, and storks from eastern U.S. (Ohlendorf et al. Ohlendorf et al. 1978b, Ohlendorf et al. 1979a). Mirex particularly common in eggs from Savannah National Wildlife Refuge (NWR), SC, where highest concentration of DDE was also found (1.4 parts per million [ppm] wet weight). PCBs usually less than half the average for all species, but highest in birds from Potomac River, MD (1.6 ppm). From Southern Atlantic, inland, and Gulf Coast regions combined, Green Heron egg (n = 89) percentages with detectable residues were: DDE (97%), DDD (1%), DDT (7%), dieldrin (10%), mirex (8%), Oxychlordane (1%), *cis* -chlordane (1%), *cis* -nonachlor (1%), PCBs (28%).

Eggshell thinning evident in comparisons with pre-1947 egg samples, but not considered deleterious (see Breeding: eggs). In Tennessee Valley, DDE concentrations fairly high (detected in 100% of eggs sampled; mean = 3.9 ppm wet weight; range = 1.3-12.0 ppm; n = 8).

White et al. (White et al. 1988a) reported that DDE contamination of Green Heron eggs at Yazoo NWR, MS, in 1984-1985 ranged from 0.63 to 43.0 ppm wet weight (n = 59, mean = 7.4). DDE concentrations correlated negatively and significantly with hatching success; threshold concentrations = 5.1-10.0 ppm. Sources of contamination, although probably local, remain unknown.

Disturbance

Increased recreational use of river channels leads to decreased use by Green Herons and reduced foraging time, but does not affect heron use of backwater habitat such as oxbow ponds, side channels, and marginal pools (Kaiser and Fritzell 1984).

Human/Research Impacts

In Mexico, investigator disturbance, particularly during early egg-laying period, caused nest abandonment; also mortality through egg breakage and exposure to sun (Dickerman and T. 1969).

Management

Conservation Status

No population considered to be threatened.

Measures Proposed And Taken

Because threat of pesticides to reproductive efforts of Green Herons appears to be minor, and because most populations are stable or increasing, management has not been major focus.

Primary concern is conservation and management of wetlands of all sizes, including small ones, as these are habitats on which Green Herons depend. Various parks, refuges, lakes, and recreation areas managed by various government agencies support Green Heron populations across North America. Management of this species should include (1) identifying wetlands and especially protected areas used by Green Herons and (2) including species' needs in habitat management plans for areas.

Some developments have enhanced habitat for this species: e.g., reservoirs that create permanent water in otherwise dry environments, permanent water marshes created along coast for mosquito control, and wetland management for waterfowl. Dredged material islands, created for channels, are widely used by colonially nesting wading birds; Green Herons have been reported nesting on dredge material islands in Texas, Florida, N. Carolina, New Jersey, and Great Lakes region (Landin and Soots 1977).

Priorities for Future Research

Priorities for Future Research

1. Get better information on wintering areas of specific North America populations and their migration pathways. This may require additional attention or banding studies.

2. Develop better understanding of habitat use and choice, especially on migration and in wintering areas.

3. Factors influencing reproductive success and population regulation in this species remain poorly known and demand attention.

4. Molts and plumages are clearly in need of study. Correct aging of individuals depends on such knowledge.

5. Systematics of species remains unresolved. A better understanding of population structure of *B. virescens*, and also of Neotropical *B. striatus*, is needed. Future research should focus on anatomical and biochemical studies of the several populations. This research is of interest from both a systematic and conservation perspective.

6. Flexibility of species in nesting colonially or solitarily in the same areas deserves additional attention.

7. Biology of populations on islands, where species can be quite common, remains little known. If Galapagos Heron is any indication, such studies should prove interesting and affect thinking about breadth of adaptability of species.

8. Suggestions that recreational disturbance adversely affects habitat use should be pursued in additional areas. Extent that disturbance adversely affects this rather retiring species is critical for proper management of populations on refuges and reserves where human recreation is encouraged.

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Tables and Appendices

Table 1

Average mean measurements (mm) of Green Herons B. v. virescens and B. v. anthonyi (after Oberholser 1912). Sample size (n) shown as male/female.

- Oberholser 1912b
-

	B. v. virescens *n* = 14/13	*B. v. anthonyi* *n* = 11/9
Wing		
Male	181.1	196.3
Female	175.1	189.9
Tail		
Male	66.5	72.9
Female	65.5	70.3
Exposed culmen		
Male	60.9	60.8
Female	59.8	60.3
Tarsus		
Male	53.0	53.3
Female	51.2	52.6

Appendix 1

Stomach contents of 27 Green Herons from nw. Louisiana in late summer. A = percent frequency of stomachs with prey type; B = percent of total diet by weight. After Niethammer and Kaiser (1983).

- Niethammer and Kaiser 1983

	A	B
Fish	**93**	**93**
Mosquitofish (*Gambusia affinis*)	11	1
Shiners (*Notropis* spp.)	7	2
Sunfish (*Lepomis* spp.)	26	35
Pirate perch (*Aphredoderus sayanus*)	4	2
Threadfin shad (*Dorosoma petenense*)	48	53
Crustacea	**22**	**1**
Crayfish (*Cambarinae*)	11	1
Prawns (*Palaemonetes kadiakensis*)	11	< 1
Insecta	**63**	**6**
Coleoptera	4	< 1
Hemiptera	19	1
Odonata	48	2
Orthoptera	26	3
Arachnida	**22**	**1**
Water spiders (*Dolomedes* sp.)	22	1