

Chapter 12

CLAPPER RAIL

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Abstract: The 8 North American subspecies of clapper rail (*Rallus longirostris*) occur in coastal habitats from southern New England to south Texas, and in the Florida Keys, lower Colorado River ecosystem, and West Coast salt marshes from San Francisco Bay to Mexico. All but the northernmost races are non-migratory. Clapper rails have high nesting success in good quality habitat, and often repeatedly re-nest and produce second broods. The size of hunted populations is controlled mainly by severe climatic events; hunting mortality is probably low. Call-count or tape-playback surveys conducted in a standardized format are probably the most efficient techniques for estimating population trends. Harvest trends of clapper rails are unknown because reliable methodology for assessing harvest is lacking. State and provincial migratory bird biologists believe hunting pressure is low and not likely to increase because hunter interest in clapper rails is static or decreasing. Population management needs include development and application of breeding population surveys, continuation and expansion of banding programs, and implementation of a harvest survey. Habitat management of clapper rails in the East should involve continued protection of coastal marshes, restoration of degraded marshes, inventory of habitats, and evaluation of existing management practices that affect coastal marshes. Research needs for clapper rails include refining breeding population survey techniques, conducting basic life history studies of the (particularly southern) subspecies, identifying migration pathways and behavior, assessing effects of habitat management on both breeding and wintering birds, and improving techniques for external sex and age classification.

The following account includes information from all subspecies of clapper rail. Endangered taxa are relatively well-studied because of recent emphasis on identifying aspects of their life history; this information is discussed under the appropriate sections. Insofar as information is available, we emphasize hunted populations. Plant names follow Scott and Wasser (1980).

DESCRIPTION

Clapper rails are crow-sized birds with a laterally flattened body. The bill is thin, decurved, longer than the head, and is orange to orange-red in breeding adults and pinkish to pale orange in juveniles and non-breeding adults (Meanley 1985:103). The tail is short and inconspicuous unless the bird is agitated. One row of undertail coverts is white, the remainder are barred black and white. Legs and toes are long relative to body length and are flesh-colored to dark gray-brown.

Adult clapper rails are uniformly gray or brown ventrally from the neck to the abdomen, white on the abdomen, and have black and white barring on the flanks. The back is darker, with black centers on feathers of the neck, back, and

scapulars. A faint superciliary line is present on adults. The cheeks and auricular area are paler than the top of the head and neck. The throat is white or off-white. The remiges are uniformly dark brown or gray, and a richer shade often characterizes the upper wing coverts. The sexes are identical in coloration.

Eight subspecies of clapper rail have been recognized in North America north of Mexico (Am. Ornithol. Union 1957, Ripley 1977, Meanley 1985), including northern (*R. l. crepitans*), Wayne's (*R. l. waynei*), Florida (*R. l. scotti*), mangrove (*R. l. insularum*), Louisiana (*R. l. saturatus*), California (*R. l. obsoletus*), light-footed (*R. l. levipes*), and Yuma (*R. l. yumanensis*) (Fig. 1). All except the Yuma clapper rail occur in tidal wetlands, mainly salt marshes and mangroves, but also brackish marshes (Meanley 1985).

The northernmost and westernmost subspecies generally have longer wing chord, tail, and tarsus; but the western subspecies have a shorter culmen (Ridgway and Friedmann 1941, Ripley 1977). The smallest race overall is the mangrove clapper rail of the Florida Keys and the largest is the California clapper rail of San Francisco

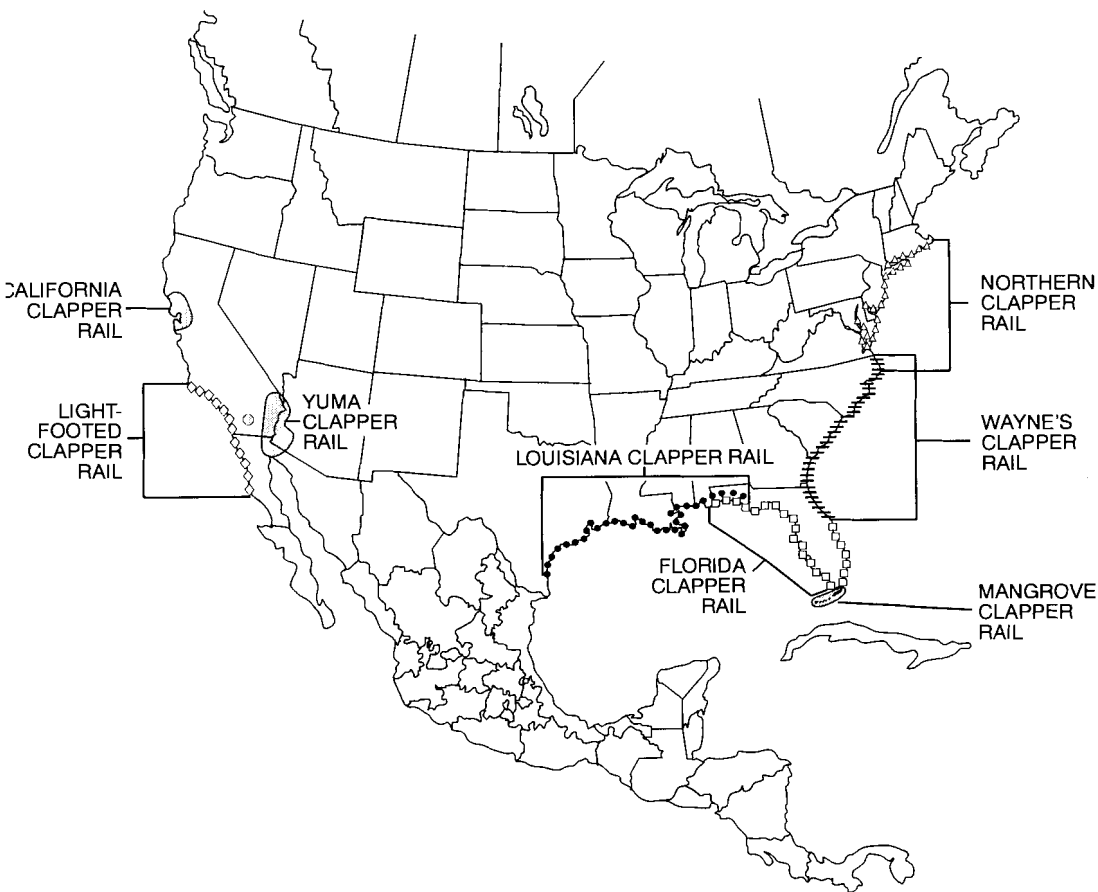


Fig. 1. Breeding distribution of clapper rail subspecies in North America.

Bay. Weights of adult clapper rails of the Yuma, northern, Wayne's, and Louisiana races range from 160 g for a small female *yumanensis* (W. R. Eddleman, unpubl. data) to 401 g for a large male *saturatus* (Bateman 1965). Males average 20% larger than females (Meanley 1985).

LIFE HISTORY

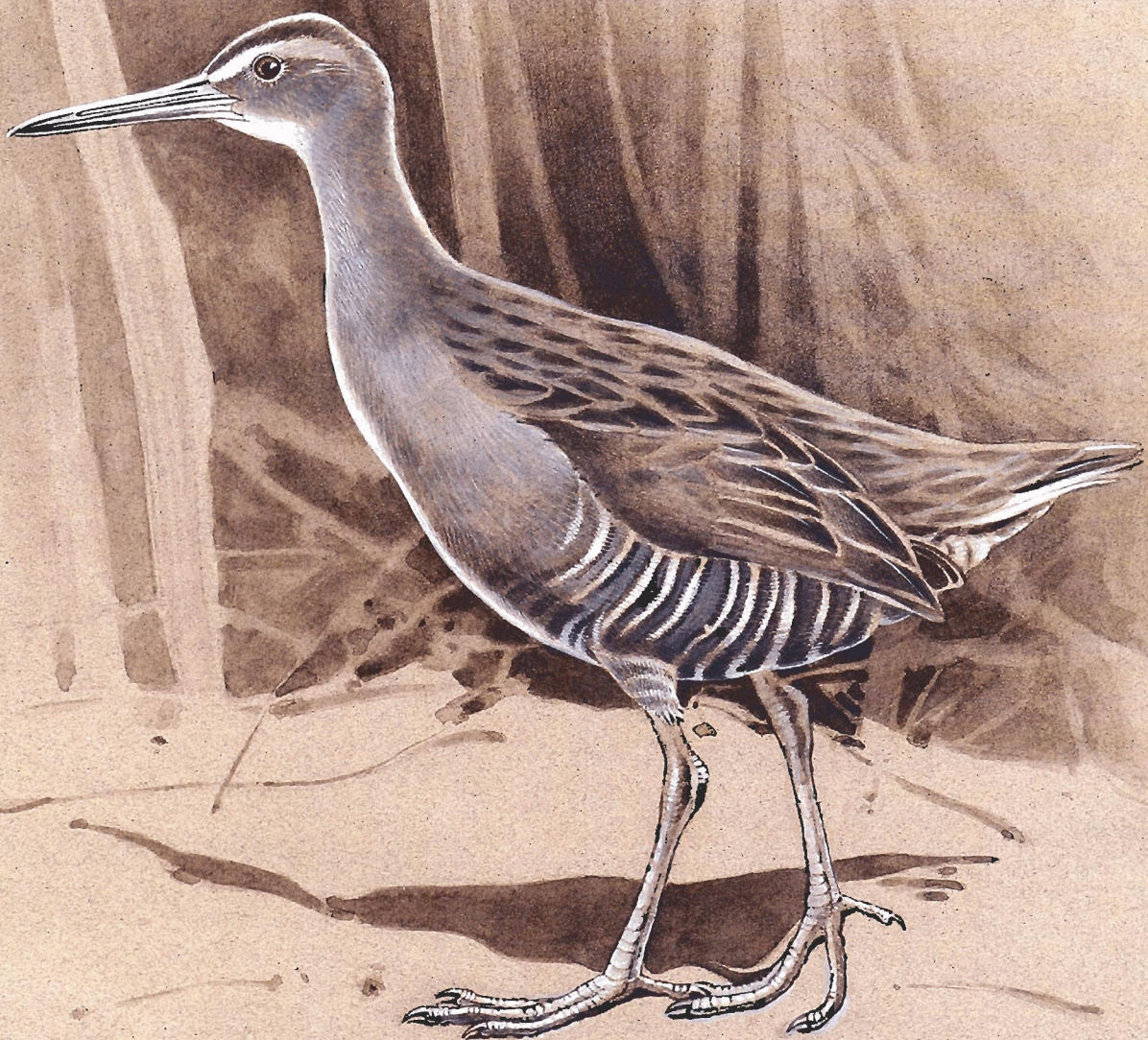
Ripley (1977) and Meanley (1985) summarized much of what is known about the life history of eastern clapper rail subspecies. We review information on reproduction, survival, and diet relative to their importance to habitat and population management of clapper rails.

Social Organization

Clapper rail pair bonds are formed on breeding areas (Meanley 1985:43). Males begin giving their mate attraction call (kik or *kek* repeated in a monotonous series) in late January or early February in western and southern areas and

March in northern areas (Sharpe 1976, Meanley 1985:42, Massey and Zembal 1987, Eddleman 1989). Paired birds give a duet *clapper* or *clatter* call, which may be heard within 2 days of the initiation of male advertising calls. The age of first breeding is unknown, but presumably yearlings are capable of nesting. Sex ratios are poorly documented; studies suggest either even or male-dominated ratios (Adams and Quay 1958, Sharpe 1976:63). Surplus males are suspected in Yuma clapper rails because solitary males occur during the breeding season, and trapped samples consist of 2.2 males/female (Bennett and Ohmart 1978, Eddleman 1989). The latter documentation is suspect, however, because trapping techniques may have been biased toward males.

Clapper rails are probably annually monogamous, and both sexes share in incubation duties (Meanley 1985:43). Individuals may or may not pair with the same mate in subsequent years, although mated pairs in non-migratory subspe-



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cies will continue to maintain adjacent home ranges after the breeding season (Eddleman 1989, Zembal et al. 1989).

Juveniles stay in loosely-organized family groups until about 5–6 weeks of age, when they become independent (Adams and Quay 1958). Individual clapper rails are solitary after the breeding season, although there may be considerable overlap among home ranges (Eddleman 1989). After pairs and family groups break up in June–September, individuals begin local wandering and migration. No differential migration by birds of different age and sex has been noted.

Reproduction and Recruitment

The southernmost races (Yuma and Louisiana clapper rails) begin nesting in mid to late March (Sharpe 1976:20, Eddleman 1989). Nest initiation at mid-latitudes in North America is about 1 month later, ranging from early to mid-April in northern clapper rails (Stewart 1951a, MacNamara and Udell 1970, Mangold 1974, Meanley 1985:47), 1 April for Wayne's clapper rails (Adams and Quay 1958), and 10–25 April for California clapper rails (DeGroot 1927, Harvey 1988). The peak of nesting shows little geographic pattern, and may sometimes occur later in Yuma clapper rails (mid-May) (Eddleman 1989) than in Wayne's clapper rails (late Apr) (Adams and Quay 1958). Peak nesting of northern clapper rails varies from the second week of May in New York to late May–mid-June in Virginia (Stewart 1951a, MacNamara and Udell 1970, Meanley 1985: 47). Late nesting dates that probably represent renesting attempts or second nests show no evident geographic variation, and range from 2 June (Adams and Quay 1958) to mid-August (Stewart 1951b, Sharpe 1976:18).

Clutch size in first nests ranges from 4 to 12, although dump nests with up to 20 eggs have been found (Meanley 1985:55). Mean clutch size varies from 8.2 to 10.0 in the range of northern clapper rails (Schmidt and McLain 1951, Mangold 1974), from 8.2 to 10.5 for Wayne's clapper rails (Oney 1954, Adams and Quay 1958), and average 8.2 for Louisiana clapper rails (Sharpe 1976:23), 7.3 for California clapper rails (Harvey 1988), 6.4 for light-footed clapper rails (Massey et al. 1984), and 7.8 for Yuma clapper rails (Bennett and Ohmart 1978). Similar data are lacking for Florida and mangrove clapper rails. Second nests have smaller clutches, averaging 1 fewer egg in Georgia (Oney 1954), 2.2

fewer in Louisiana (Sharpe 1976:28), and 3.4 fewer in Virginia (Stewart and Meanley 1960).

Incubation commences before the last egg is laid (Meanley 1985:58). Both sexes incubate, the male typically during the night and sporadically during the day, and the female during most of the day (Eddleman 1989). The incubation period is 21–29 days; the range is explained by the variation in hatching sequence because incubation starts before the last egg is laid (Johnston 1956, Harvey 1988, Eddleman 1989).

Nesting success varies widely, but is generally high in good habitat and given good tidal and weather conditions. Nest success of 10–100% has been observed, but most observations exceed 80% (Stewart 1951a, Blandin 1965, Mangold 1974, Sharpe 1976:29, Bennett and Ohmart 1978, Ferrigno 1990). Most nest failures result from flooding by extreme high tides (Adams and Quay 1958, Mangold 1974), but predation may be the primary source of nest loss on the Gulf Coast (Sharpe 1976:29). The only consistently low nesting success observed in clapper rails was in the California subspecies that experience only 38% nesting success because of Norway rat (*Rattus norvegicus*) predation (Harvey 1988). Egg success is also high, often exceeding 90% (Mangold 1974). Renesting has been observed in nearly all subspecies of clapper rail, and most subspecies will average successful completion of >1 nests (Blandin 1963, Mangold 1974, Massey et al. 1984, Meanley 1985).

One parent will usually take the first chicks while the second incubates the remainder of the clutch (Adams and Quay 1958). Chicks are semi-precocial and are brooded on a number of brood nests during the first few days of life (Meanley 1985:63). Brood nests are platforms constructed by muskrats (*Ondatra zibethicus*), old nest sites of water birds, or platforms constructed by adult rails. The family forages in a loosely-organized group over an area that may exceed 50 m in diameter (Adams and Quay 1958). Survival of young between hatching and fledging is generally <80%, and may be <50% (Blandin 1965, Bennett and Ohmart 1978). Broods of 2–7 chicks ($\bar{x} = 3.2$) are observed after hatching (Meanley 1985:62).

Fall populations are mainly hatch-year birds, depending on productivity. Age ratios as high as 13.6 young/adult have been observed in New Jersey (Mangold 1977). During fall, age ratios in the harvest range from 2.0 to 5.8 young/adult (Adams and Quay 1958, Sharpe 1976:64, Meanley 1985:62).



Fig. 2. Clapper rail habitat in low salt marsh at high tide, dominated by smooth cordgrass and needle rush, Big Bend Wildlife Management Area, Dixie County, Florida (Photo by W. R. Eddleman).

Survival and Non-hunting Mortality

Banding programs for clapper rails have been limited in size and geographic extent, and recovery rates have been low (0.63–2.3%) (Stewart 1954, Mangold 1974, Ferrigno 1990). Consequently, no estimates of survival using band recovery data are available. Annual adult survival of Yuma clapper rails ranged from 49 to 67% using patterns of mortality of radio-marked birds (Eddleman 1989). These estimates may be biased by the effects of transmitter harnesses on bird survival. Most natural mortality of *R. l. yumanensis* has been attributed to predation during postbreeding and winter.

A variety of predators prey on nests, eggs, and adults of eastern clapper rails (Meanley 1985: 92–95). Introduced predators, especially red fox (*Vulpes vulpes*) and Norway rats, are the principal factors implicated in the recent decline of California clapper rails (Harvey 1988, Anon. 1991b).

Natural catastrophes may cause local or regional mortality of clapper rails, but populations usually recover (Meanley 1985:87). For exam-

ple, New Jersey had record low breeding populations of clapper rails in 1990 (Ferrigno 1990). An examination of banding data showed 80% of birds banded in New Jersey during 1948–88 and recovered in the southern U.S. were wintering in the South Carolina–Georgia coastal area where Hurricane Hugo struck in October 1989. The decline in New Jersey breeding populations was therefore attributed to mortality of wintering birds during the hurricane.

Coastal estuaries often act as settling basins for environmental contaminants that may enter clapper rails through the detrital food chain. For example, mercury levels in the Brunswick and Savannah estuaries in Georgia exceeded the Food and Drug Administration limit of 0.5 ppm in clapper rails, prompting a warning to hunters (Odom 1975). DDE levels in light-footed clapper rail eggs were also elevated (Eddleman et al. 1988), but clapper rails appeared to be less susceptible to eggshell thinning caused by chlorinated hydrocarbons than other birds (Klaas et al. 1980). Selenium levels in Yuma clapper rail tissues were within the range that causes hatching defects in many other birds, but the impli-

cations for population biology were unknown (Rusk 1991).

Diet and Nutrition

Clapper rails feed on a variety of invertebrates in tidal marshes (Heard 1983). They feed opportunistically on the most common and available foods in a given marsh type or geographic location. Clapper rails forage visually, using mainly surface gleaning and shallow probing into the substrate (Meanley 1985:37-38, Zembal and Fancher 1988). The highest intensity of foraging occurs in late evening.

Subspecies on the Atlantic and Gulf coasts most often eat fiddler crabs (*Uca* spp., *Sesarma* spp.), grasshoppers, crayfish (especially *Procambarus* spp.), periwinkle snails (*Littorina inornata*), and clam worms (*Nereis* spp.) in summer and fall (Oney 1954, Bateman 1965, Roth et al. 1972, Meanley 1985:33-36). Fiddler crabs are dormant in winter when temperatures drop below 13.5 C, but clapper rails nonetheless are capable of locating them (Meanley 1985:36). Diets of eastern clapper rails change slightly in winter, when some individuals eat more seeds (Roth et al. 1972).

West Coast clapper rails have diets similar to those of eastern subspecies, consisting of crabs (*Pachygrapsus crassipes*, *Hemigrapsus oregonensis*), snails, clams, insects, and a variety of other invertebrates (Moffitt 1941, Zembal and Fancher 1988). Yuma clapper rails eat mostly crayfish (*Procambarus clarki*, *Orconectes virilis*), isopods, freshwater shrimp (*Palaeomonetes paludosis*), freshwater clams (*Corbicula* spp.), water beetles, and fish (Ohmart and Tomlinson 1977, Eddleman 1989). Prey items become less abundant in winter, resulting in increased foraging movements and larger home range size of rails in autumn and winter (Conway et al. 1993).

Nothing is known about seasonal changes in body lipid levels in clapper rails, or whether there is variation between migratory and sedentary subspecies. Yuma clapper rails that are mostly sedentary [although possibly a partial migrant (Tomlinson and Todd 1973, Bennett and Ohmart 1978)], show wide variation in body weights (Eddleman 1989). Adult males weigh the least in late summer ($\bar{x} = 241$ g), and reach peak weight in November–February ($\bar{x} = 314$ g). Females show similar annual patterns. The significance of this weight change is unknown, although the combined stresses of nesting, brood-

rearing, and prebasic molt coincide with low summer weights.

HABITAT

Optimal habitat of clapper rails is low tidal salt marsh (low being defined as sites flooded at least once daily during high tide) dominated by cordgrass of moderate height and salinity levels exceeding 7,100 ppm at low tide and 5,600 ppm at high tide (Meanley 1985:31) (Fig. 2). This requirement is met by low salt marsh dominated by smooth cordgrass (*Spartina alterniflora*) in eastern areas and Pacific cordgrass (*S. foliosa*)-pickleweed (*Salicornia virginica*) on the West Coast (Hon et al. 1977, Holliman 1981, Massey et al. 1984, Foin and Benchley-Jackson 1991). Sharpe (1976:33) found Louisiana clapper rails were most abundant in dense smooth cordgrass, but comparisons with other studies were not made because of small sample sizes.

Nesting habitat of California clapper rails has 4 important characteristics: low marsh vegetation, tidal sloughs, tall high marsh (high being defined as sites flooded irregularly by the highest high tides), and abundant prey (Harvey 1988). High marsh is not often mentioned in nesting habitat needs on the East Coast, but uninterrupted tidal flow is essential to maintain vegetational communities preferred by clapper rails (Ferrigno et al. 1987). Nests of clapper rails are typically in smooth cordgrass of medium height, and grass height is the major cue used in selecting nest sites on the East Coast (Adams and Quay 1958, Storey et al. 1988). Early nests may be placed in needle rush (*Juncus roemerianus*), perhaps because of the greater cover provided by this plant in early spring (Adams and Quay 1958). Most nests are also within 15 m of tidal creeks or pool edges (Lewis and Garrison 1983); nests averaged 1.7 m from open water in Virginia (Meanley 1985:51) and 7.8 m in California (Harvey 1988). Nest placement shows no apparent pattern relative to creeks for Louisiana clapper rails (Sharpe 1976). Yuma clapper rails nest in riverine wetlands that were historically exposed to periodic flooding (Todd 1986). Consequently, nest sites selected by this subspecies are near uplands in shallow sites dominated by mature marsh vegetation, often in the base of a shrub (Conway et al. 1993).

Foraging habitat of clapper rails is mostly along tidal creeks and mud flats adjacent to dense emergent or mangrove (*Rhizophora* spp.) cover (Clark and Lewis 1983, Lewis and Garrison 1983,

Conway et al. 1993). Sites with at least 50% of the shoreline adjacent to emergent marsh are optimal (Lewis and Garrison 1983). These sites are selected because of prey abundance, ease of movement by foraging rails, and presence of nearby escape cover that is especially important for chicks that are unable to fly (Harvey 1988, Conway et al. 1993).

Habitat needs of clapper rails after nesting are poorly known, and rail density may vary during post-breeding as a result of tides, winds, ice coverage, and cold rather than vegetation structure or prey abundance (Meanley 1985:82). Habitat use by migrating birds is unknown. Clapper rails in North Carolina move from low marsh into mixed cordgrass and needle rush or high marsh during November to early April (Adams and Quay 1958). Yuma clapper rails also move into different cover types in winter, showing preference for denser cover than in summer (Anderson and Ohmart 1985, Eddleman 1989).

DISTRIBUTION AND ABUNDANCE

Clapper rails are distributed throughout North America (Fig. 1) in tidal salt and brackish marshes that are dominated by cordgrass. Three subspecies (Yuma clapper rail, light-footed clapper rail, and California clapper rail) are listed as federally endangered (U.S. Fish and Wildl. Serv. 1989a). Yuma clapper rails nest in freshwater wetlands along the lower Colorado River from Needles, California, to the mouth of the river, on the lower Gila River, in marshes associated with the Salton Sea, and at isolated sites in Arizona (Todd 1986). Light-footed and California clapper rails are restricted to tidal marshes in coastal southern California and San Francisco Bay, respectively.

The 5 eastern subspecies of clapper rail occur from coastal southern New England to southeastern Texas (Am. Ornithol. Union 1957, 1983; Ripley 1977; Meanley 1985) (Fig. 1). Northern clapper rails breed from Rhode Island to coastal North Carolina, where they intergrade with Wayne's clapper rail. Wayne's clapper rail ranges southward to the central east coast of Florida (Crawford et al. 1983), where it is replaced by the Florida clapper rail. Florida clapper rails nest in southern and western Florida and the Florida panhandle. Mangrove clapper rails are resident in the Florida Keys, while Louisiana clapper rails range from extreme western Florida to southern Texas.

All subspecies except the northern clapper rail are thought to be non-migratory (Am. Ornithol. Union 1957). Northern clapper rails winter as far north as the southern part of their breeding range (Stewart 1954) (Fig. 1), but principally winter in South Carolina, Georgia, and north-eastern Florida; a few go as far south as the central east coast of Florida (Crawford et al. 1983). Stragglers may also remain in the northern portions of the breeding range (Meanley 1985:81).

Movements observed for other subspecies of clapper rail might not be true migration (Hon et al. 1977, Crawford et al. 1983, Eddleman 1989). Five types of dispersal movements are recognized in Yuma clapper rails: juvenile dispersal, breeding season movements by unmated males, postbreeding dispersal by adults, movements in late winter associated with acquisition of breeding territories, and home range shifts associated with high water or drying of habitat (Smith 1975, Bennett and Ohmart 1978, Eddleman 1989). Similar movements have been documented or suggested for other subspecies (Orr 1939, Crawford et al. 1983, Am. Ornithol. Union 1983, Zembal et al. 1985), but the scale of these movements does not suggest long-distance migration.

Home range size of clapper rails varies widely in different marsh habitat types, among years at a given site, and among seasons. Radio-telemetry is the most accurate technique for identifying spatial use by clapper rails and other railids, because mapping locations of vocalizing birds usually underestimates home range size (Eddleman 1989). Yuma clapper rails have the largest home ranges, averaging 7.6 ha for males and 10.0 ha for females (Conway et al. 1993). The relatively low production of preferred foods in their habitat and their need for different marsh types for foraging and nesting explain their large spatial needs. In coastal salt marshes, home ranges of clapper rails are substantially smaller, ranging from 0.04 ha (Roth et al. 1972) to 1.66 ha (Zembal et al. 1989) during the nesting season, and 0.10 to 2.00 ha in winter (Roth et al. 1972). Home range size and movements increase after the nesting season and in winter, ranging up to 43 ha for Yuma clapper rails (Eddleman 1989). Winter home range size in coastal marshes is 52.00 ha (Roth et al. 1972).

Density of breeding clapper rails also varies among marsh types, ranging from a low of 0.15/ha for yumanensis (Smith 1975) to 10.0/ha for

crepitans in Virginia (Meanley 1985:49). In coastal cordgrass marshes, densities usually exceed 1 bird/ha (Oney 1954:32; Mangold 1974, 1977; Sharpe 1976:32; Harvey 1988; Zembal et al. 1989). Densities of calling clapper rails are recorded annually in 8 different marsh habitats in New Jersey (Mangold 1974, Ferrigno 1990). Salt hay (diked and farmed) and common reed (*Phragmites communis*) typically supported no clapper rails. Low numbers (<0.5 calls/station) occurred in marshhay cordgrass (*Spartina patens*) and mixed vegetation types. Smooth cordgrass had the highest number of calling rails (0.5 to 8 birds/station), and birds preferred sites dominated by the short growth-form of smooth cordgrass (Mangold 1974).

Densities of wintering clapper rails have not been estimated because their secretive nature and low rate of calling in winter makes detection difficult (Adams and Quay 1958). Winter abundance is highest from Camp Lejeune, North Carolina, to Titusville, Florida, based on Audubon Christmas Bird Count data (Root 1989: 73).

Current Survey Techniques

Few surveys are currently conducted to monitor population trends of clapper rails except for endangered subspecies (W. R. Eddleman, unpubl. data). An annual tape-playback survey is conducted to census Yuma clapper rails throughout the U.S. portions of their range (Tomlinson and Todd 1973, Powell 1990). An inter-agency team of cooperating federal and state biologists from Arizona and California conduct this survey by playing tapes of the primary advertising and territorial vocalizations of clapper rails throughout suitable habitat. However, results should be interpreted with caution. Problems include observers changing between years, variation in time of survey relative to breeding stage, and many areas of suitable habitat that are surveyed sporadically between years (Eddleman 1989). Additional problems include inconsistent response rates of clapper rails known to be present (Conway et al. 1993), unfamiliarity of many biologists with all vocalizations of clapper rails (Eddleman 1989), the dynamic nature of some habitat areas, and failure to survey suitable habitat where rails occur in Mexico.

Light-footed clapper rails and California clapper rails are also surveyed regularly using a combination of evening vocalization counts, tape-playback, nest searches, flushing counts, and

counts of birds seen at high tide (Gill 1979, Zembal and Massey 1985, Harvey 1988).

A variety of techniques has been suggested for surveying clapper rails in the eastern United States including counting calling birds, tape-playback, nest counts, track counts, and sighting (Stewart 1951a, Mangold 1974, Meanley 1985:108). Call-counts are used in New Jersey to census clapper rails along standardized routes (Mangold 1974). These routes are patterned after those used for mourning doves (*Zenaidura macroura*), with periodic stops to listen for calling rails during 2-minute periods. A tape recorder is used to record responses for later analysis to avoid differences in observers' ability to detect calls. Call-counts are conducted in the evening to avoid confusion with singing passerines (Mangold 1974). These data are stratified into 8 habitat types and the area of each habitat type is estimated by aerial surveys. The number of calls heard/minute is averaged for each cover type and multiplied by the percentage of mapped wetlands in each cover type to obtain an index. The indices are totaled for all 8 cover types to derive an annual statewide index of clapper rail abundance, and allows rough comparison of relative abundance among years. This method has documented a recent upward trend in clapper rail numbers in New Jersey, but populations fluctuate in relation to weather, territorial behavior, and tidal destruction of nests (Ferrigno 1990).

Surveys of clapper rails using tape-playback may increase the probability of locating clapper rails (Tomlinson and Todd 1973, Mangold 1974), but an inconsistent proportion of birds respond depending on population size, stage of the nesting cycle, time of day, and weather (Meanley 1985:109, Eddleman 1989, Conway et al. 1993). Nest counts have been used on a local basis to estimate breeding density (Stewart 1951a), but are labor-intensive, not applicable on a regional scale (Stewart 1951a), and impractical in dense habitats (Eddleman 1989). Track counts and sightings have been used to provide an index to relative abundance on a local scale, but are useful only where rails occur in relatively low density, such as in winter (Meanley 1985:108).

Population Status and Trends

No estimate of the total size of clapper rail populations in the eastern U.S. is available because of sporadic and inconsistent application of population estimation techniques. A total of

46 Breeding Bird Survey (BBS) routes include coastal marsh habitats, so this technique may also be used to monitor numbers of clapper rails in the East (U.S. Fish and Wildl. Serv., unpubl. data). Analyses of BBS data for clapper rails during 1966–91 indicate a mean annual increase ($P < 0.01$) of 4.3% in populations in the north-eastern United States, and no change for south-eastern and the entire United States. Similar analyses for the last 10 years show a mean annual increase ($P < 0.05$) of 6.8% in the south-eastern United States and no change for the entire United States.

Information on population trends of clapper rails in eastern states in the last 15 years was obtained in response to a questionnaire sent in 1992 to state migratory bird biologists (W. R. Eddleman, unpubl. data). Biologists in Connecticut, Georgia, New Jersey, New York, Rhode Island, and Virginia were confident enough to estimate trends in clapper rail populations in their states. Clapper rail populations are believed to be increasing in New Jersey, decreasing in New York (especially on Long Island), and stable in the other states. No eastern state lists clapper rails as warranting special management status, although Florida indicates the species may be deserving of closer monitoring (Millsap et al. 1990).

The gross trend for Yuma clapper rails based on the annual tape-playback survey was stable to slightly increasing between the late 1970's and 1983 (Powell 1990). Extensive flooding on the lower Colorado River in 1983 degraded much of the available habitat (Powell 1990). At least 700 birds have responded during counts in the late 1980's to 1991.

Call-count surveys in the United States indicate a decline from 500–700 light-footed clapper rails in the early 1970's (Wilbur 1974) to 470 birds in 1991 (Anon. 1991a). An additional 500–700 birds occur in salt marshes in Baja California. California clapper rails have declined rapidly from an estimated 4,200–6,000 birds in the early 1970's to 1,500 birds in the early 1980's (Harvey 1988), to only 400 birds in 1991 (Anon. 1991a).

HARVEST

Clapper rail hunting is most effective when exceptionally high tides force clapper rails into the open and allow hunters to pole boats through the marsh and flush birds (Meanley 1985:77). The unpredictable nature and annual occur-

rence of these "marsh hen tides" results in extreme fluctuations in annual harvest. Additionally, a long-term, steady decline in interest in hunting rails may contribute to variation in the harvest (W. R. Eddleman, unpubl. data). The combination of unpredictability of conditions for good hunts, poor harvest monitoring, and declining hunter interest make assessment of trends in clapper rail harvest difficult.

Thirteen states on the East and Gulf coasts from Rhode Island to Texas allow harvest of clapper rails, and New York is the only coastal state in this region with no clapper rail season (W. R. Eddleman, unpubl. data). However, few reliable estimates of clapper rail annual harvest are available (Mangold 1977; W. R. Eddleman, unpubl. data). Current and past U.S. Fish and Wildlife Service estimates are based on samples of waterfowl hunters who also hunt rails, and may represent only 60% of the total harvest (Banks 1979, Martin 1979, U.S. Fish and Wildl. Serv. 1989b). Estimates also group clapper rail harvest with king rails (*Rallus elegans*) and Virginia rails (*R. limicola*), although clapper rails comprise most of the harvest in coastal states (U.S. Fish and Wildl. Serv. 1988, Conway and Eddleman 1994). Estimated mean annual harvest for 1964–86 using these data was 100,983 (95% C.I. = 74,100–127,400) in the coastal states that allow hunting of clapper rails, ranging from a low of 24,100 in the 1965–66 season to a high of 175,200 in 1970–71 (Conway and Eddleman 1994). An average of 1.6% of waterfowl hunters hunted rails other than soras (*Porzana carolina*) in the Atlantic Flyway during 1964–76, with an average annual bag of 9.7/hunter. Similar data for the Mississippi Flyway were 0.9% of waterfowl hunters that bagged an average of 3.58 clapper rails/hunter/year. The percentage of waterfowl hunters who hunted rails showed significant annual increases of 0.06 and 0.08% in the Atlantic and Mississippi flyways, respectively, during the same period. Recent estimates of clapper rail, king rail, and Virginia rail harvest in the coastal states of the Atlantic Flyway were 18,500 during the 1987–88 hunting season and 33,900 during 1988–89 (U.S. Fish and Wildl. Serv. 1989b).

A few states within the range of clapper rails (Louisiana, Maryland, New Jersey, Texas, and Virginia) have conducted harvest surveys for rails (W. R. Eddleman, unpubl. data). Louisiana averages a higher total rail harvest than the other 4 states, but discontinued its survey of rail

harvest in 1988 because of the imprecision of the estimates. These state surveys have the advantage of including all rail hunters in the sampling scheme and not just waterfowl hunters. The most recent (1987–88 for Louisiana, 1991–92 for other states) estimates of rail harvest for these states are 20,000 for Louisiana; 9,549 in Virginia; 1,200 in Texas; 800 in New Jersey; and 200 in Maryland. New Jersey's harvest estimate in the late 1970's was 15,000–25,000 annually, suggesting a substantial decrease in that state's clapper rail harvest over a period of only 10–15 years (Mangold 1977). Reasons for this decline are unknown, but could be due to unfavorable weather during the hunting season or decline in hunter interest.

Most state regulations for harvest of clapper rails have not changed in the last 15 years (W. R. Eddleman, unpubl. data). Bag limits range from 10 to 15 daily (in aggregate with king rails in Texas, Delaware, and Georgia), and possession limits are double the daily bag limit. Season opening dates range from 19 August in Virginia to 19 September in Louisiana. The season continues for about 2.0 to 2.5 months in most states. Louisiana had a split season in 1992, with a short rail season during the September teal season (19–27 Sep) and a longer second season (21 Nov–20 Jan).

MANAGEMENT NEEDS

Habitat Management

Habitat management for clapper rails consists mostly of maintaining the structure and function of tidal salt marshes (Meanley 1985). Despite losses of salt marshes to coastal development, and degradation of these habitats by adjacent development and pollution, large areas of suitable habitat still remain on the East Coast (Meanley 1985:17). The stable to increasing trends noted for eastern clapper rails on BBS routes (U.S. Fish and Wildl. Serv., unpubl. data) imply that clapper rails have benefitted from coastal wetland protection laws (Eddleman et al. 1988).

Most habitat management of clapper rails involves either prevention of tidal flow alteration or restoration of altered tidal flows (Shisler and Schulze 1976, Ferrigno et al. 1987). Interference with tidal flow has a number of effects on salt marshes, including drying of habitats so that high marsh plants become dominant in former low salt marshes (Ferrigno et al. 1987); lowering

of salt content, allowing invasion by common reed; or permanent flooding of impoundments for waterfowl management, which can result in change to brackish or freshwater wetlands dominated by submerged or floating-leaved plants (Chabreck 1988:82). One method for restoration of diked areas used for salt hay production is the tidal restoration of salt hay impoundments (TRSHI) that has been initiated on several altered salt marshes in New Jersey. In New Jersey, clapper rails were absent on salt hay impoundments that were dominated by high marsh vegetation, but occurred on restored salt marshes (Ferrigno et al. 1987).

Open marsh water management (OMWM) is another practice that might affect clapper rail habitat (Shisler and Schulze 1976). This technique is used to control salt marsh mosquitos, and includes connecting existing pools in salt marshes and allowing fish to move between pools to eat mosquito larvae. The effects of OMWM on clapper rails are poorly known, but spoil from ditches may provide nest sites for clapper rails. Additional evaluation of the effects of TRSHI, OMWM, restorations of degraded marshes, and impoundments on clapper rails are needed for proper habitat management.

Western clapper rails have many of the same habitat management problems as the eastern races, although degradation of tidal marshes is much more severe in coastal California (Massey et al. 1984, Eddleman et al. 1988, Anon. 1991b). Yuma clapper rails are affected by water flow management on the lower Colorado River, but respond positively to water level manipulations on diked freshwater management units. Marshes of all ages should be maintained in managed wetland complexes to increase suitability for clapper rails (Eddleman et al. 1988, Conway et al. 1993).

Population Management

Subspecies. — Management of eastern subspecies should be as an Atlantic Coast Unit consisting of northern and Wayne's clapper rails, and a Gulf Coast Unit consisting of Florida and Louisiana clapper rails. Separate management of mangrove clapper rails is justified because they are little-known and probably insignificant as a game bird. The rationale for these management units is that the biology of the eastern races is relatively well-known, they seem to have similar habitat needs and occur together over a wide area in winter (Stewart 1954, Crawford et

al. 1983, Ferrigno 1990), probably have higher harvest pressure, and share similar reproductive biology. Florida and Louisiana clapper rails are less well-known in almost all aspects of their biology, do not seem to have significant distributional overlap with the 2 Atlantic coast races, have relatively low harvest pressure, and may have somewhat different habitat and reproductive needs. Additional research on the Gulf Coast subspecies should clarify the validity of this management scheme. Season opening dates might also be different between these 2 regions, because existing frameworks sometimes result in rail seasons opening after many local birds have migrated south on the Atlantic Coast (W. R. Eddleman, unpubl. data). Seasons could be opened earlier on the Atlantic Coast to allow hunting opportunity prior to autumn migration, and split or opened later on the Gulf Coast where clapper rails are resident and birds may still be breeding in early autumn. The specific needs of the 3 endangered western subspecies are being addressed (Powell 1990, Anon. 1991a).

Surveys.—Surveys for clapper rails need refinement to obtain results that are comparable among years over the species' range. Call-count surveys using broadcasts of taped vocalizations show the most promise of standardization and require the least effort. However, calling behavior of clapper rails needs to be assessed to determine optimal timing and methodology for conducting surveys.

Current surveys for clapper rails are conducted regularly only in New Jersey, but general trends can be obtained from the BBS. The BBS is not designed to provide good trend data for birds of specialized habitats such as marshes, and surveys specifically designed for marsh birds may be needed (Gibbs and Melvin 1993). Such surveys could be designed to include all marsh birds, and would be more justifiable given the level of interest in clapper rails as game birds and the relative difficulty of access to their habitats.

Harvest Management

Implementation of the National Migratory Bird Harvest Information Program should provide accurate information on harvest of clapper rails. Analysis of data obtained under this program should help clarify if separate management of Atlantic and Gulf Coast subspecies is appropriate.

Obtaining estimates of population parameters

should be a priority to insure effective harvest management of clapper rails. Additional banding studies are needed to identify migration routes, survival, and hunting mortality for northern, Wayne's, Florida, and Louisiana clapper rails. Techniques to assign age and sex of clapper rails must be developed before age and sex composition of the harvest can be estimated (Mangold 1974, Eddleman 1989).

RESEARCH NEEDS

Research needs for clapper rails have changed little in the last 15 years (Mangold 1977), and are listed in priority order.

1. Identify relative abundance, distribution, and population trends. This will involve assessment of the relative efficacy of call-count, tape playback, or other techniques for large-scale monitoring of clapper rail relative abundance and population trends, perhaps in concert with similar studies of other rails or marsh birds.
2. Develop additional banding programs at several sites throughout the eastern range to estimate survival rates of local breeding populations using mark-recapture techniques (Pollock et al. 1990). These programs might also result in additional clarification of dispersal patterns in sedentary subspecies, and wintering patterns in migratory races.
3. Identify habitat use and effects of existing habitat management techniques. Existing information on habitat requirements of eastern subspecies is largely qualitative and has been examined only on a local scale during the nesting season. Additionally, well-designed manipulative studies on effects of tidal marsh management techniques will clarify their effects on clapper rails. Application of radio-telemetry to study of western subspecies has revealed considerable detail on the range and characteristics of habitats used by clapper rails during all seasons of the year. Similar studies should be conducted on eastern and southern subspecies.
4. Develop and refine harvest surveys in conjunction with the National Migratory Bird Harvest Information Program. The U.S. Fish and Wildlife Service should cooperate with states that currently conduct such surveys to develop standardized methodologies.
5. Investigate aspects of basic biology that are currently unknown or poorly known. Such

studies should emphasize basic life history (especially annual variation in productivity and survival of the different subspecies, calling behavior, and habitat preferences), external age and sex criteria, post-breeding biology (including movements, migration, and habitat preferences), and wintering biology (including movements, survival, and habitat preferences).

RECOMMENDATIONS

The following is a summary of specific recommendations presented in descending order of priority.

1. The U.S. Fish and Wildlife Service (USFWS) and the Atlantic and Mississippi Flyway councils should implement programs to monitor population and harvest trends for clapper rails based on Atlantic Coast and Gulf Coast management units.
2. The USFWS and Atlantic and Mississippi flyway councils should conduct, assist, fund, and/or promote funding of identified applied research needs

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LITERATURE CITED

- ADAMS, D. A., AND T. L. QUAY. 1958. Ecology of the clapper rail in southeastern North Carolina. *J. Wildl. Manage.* 22:149-156.
- AMERICAN ORNITHOLOGISTS' UNION. 1957. Check-list of North American birds. 5th ed. Port City Press, Baltimore, Md. 691pp.
- . 1983. Check-list of North American birds. 6th ed. Allen Press, Lawrence, Kans. 877pp.
- ANDERSON, B. W., AND R. D. OHMART. 1985. Habitat use by clapper rails in the lower Colorado River Valley. *Condor* 87:116-126.
- ANONYMOUS. 1991a. Regional News. *Endangered Spp. Techn. Bull.* 6(9-12):3.
- . 1991b. The California clapper rail: a beleaguered bird faces new threats. *Endangered Spp. Techn. Bull.* 6(2):2,5-6.
- BANKS, R. C. 1979. Human related mortality of birds in the United States. *U.S. Fish and Wildl. Serv., Spec. Sci. Rep. Wildl.* 215. 16pp.
- BATEMAN, H. A., JR. 1965. Clapper rail (*Rallus longirostris*) studies on Grand Terre Island, Jefferson Parish, Louisiana. M.S. Thesis, Louisiana State Univ., Baton Rouge. 144pp.
- BENNETT, W. W., AND R. D. OHMART. 1978. Habitat requirements and population characteristics of the clapper rail (*Rallus longirostris yumanensis*) in the Imperial Valley of California. Unpubl. Rep., Univ. California, Lawrence Livermore Lab., Livermore. 55pp.
- BLANDIN, W. W. 1963. Renesting and multiple brooding studies of marked clapper rails. *Proc. Southeast. Assoc. Game and Fish Comm.* 17:60-68.
- . 1965. Clapper rail studies in South Carolina: a preliminary report with particular emphasis on productivity. *Progr. Rep., Proj. W-31-R. South Carolina Wildl. Resour. Dep., Charleston.* 19pp.
- CHABRECK, R. H. 1988. Coastal marshes—ecology and wildlife management. Univ. Minnesota Press, Minneapolis. 138pp.
- CLARK, J. D., AND J. C. LEWIS. 1983. A validity test of a habitat suitability index model for clapper rail. *Proc. Southeast. Assoc. Fish and Wildl. Agencies* 37:95-102.
- CONWAY, C. J., AND W. R. EDDLEMAN. 1994. Virginia rail. Pages 192–206 in T. C. Tacha and C. E. Braun, eds. *Migratory shore and upland game bird management in North America.* Int. Assoc. Fish and Wildl. Agencies, Washington, D.C.
- , S. H. ANDERSON, AND L. R. HANEUBURY. 1993. Seasonal changes in Yuma clapper rail vocalization rate and habitat use. *J. Wildl. Manage.* 56:282-290.
- CRAWFORD, R. L., S. L. OLSON, AND W. K. TAYLOR. 1983. Winter distribution of subspecies of clapper rails (*Rallus longirostris*) in Florida with evidence for long-distance and overland movements. *Auk* 100:198-200.
- DEGROOT, D. S. 1927. The California clapper rail: its nesting habits, enemies, and habitat. *Condor* 29:259-270.
- EDDLEMAN, W. R. 1989. Biology of the Yuma clapper rail in the southwestern United States and northwestern Mexico. Final Rep., Intra-agency Agreement 4-AA-30-02060. U.S. Bur. Reclam., Yuma Proj. Off. Yuma, Ariz. 127pp.
- , F. L. KNOPF, B. MEANLEY, F. A. REID, AND R. ZEMBAL. 1988. Conservation of North American rallids. *Wilson Bull.* 100:458-475.
- FERRIGNO, F. 1990. Wetlands ecology—Clapper rail nesting survey. Performance Rep., Proj. W-58-R-14. New Jersey Div. Fish, Game, and Shellfisheries, Trenton. 21pp.
- , J. K. SHISLER, J. HANSEN, AND P. SLAVIN. 1987. Tidal restoration of salt hay impoundments. Pages 284–296 in W. R. Whitman and W. H. Meredith, eds. *Waterfowl and wetlands symposium.* Delaware Dep. Nat. Resour. and Environ. Control, Dover.
- FOIN, T. C., AND J. L. BENCHLEY-JACKSON. 1991. Simulation model evaluation of potential recovery of endangered light-footed clapper rail populations. *Biol. Conserv.* 58:123-148.
- GIBBS, J. P., AND S. M. MELVIN. 1993. Call-response

- surveys for monitoring breeding waterbirds. *J. Wildl. Manage.* 57:27-34.
- GILL, R., JR. 1979. Status and distribution of the California clapper rail (*Rallus longirostris obsoletus*). *Calif. Fish and Game* 65:36-49.
- HARVEY, T. E. 1988. Breeding biology of the California clapper rail in south San Francisco Bay. *Trans. West. Sect., The Wildl. Soc.* 24:98-104.
- HEARD, R. W. 1983. Observations on the food and food habits of clapper rails (*Rallus longirostris* Boddaert) from tidal marshes along the East and Gulf Coast of the United States. *Gulf Res. Rep.* 7:125-135.
- HOLLIMAN, D. C. 1981. A survey of the September 1979 hurricane damage to Alabama clapper rail habitat. *Northwest Gulf Sci.* 5:95-98.
- HON, T., R. R. ODOM, AND D. P. BELCHER. 1977. Results of Georgia's clapper rail banding program. *Proc. Southeast. Assoc. Fish and Wildl. Agencies* 31:72-76.
- JOHNSTON, R. F. 1956. The incubation period of the clapper rail. *Condor* 58:166.
- KLAAS, E. E., H. M. OHLENDORF, AND E. CROMARTIE. 1980. Organochlorine residues and shell thicknesses in eggs of the clapper rail, common gallinule, purple gallinule, and limpkin (Class Aves), eastern and southern United States, 1972-74. *Pestic. Monitor. J.* 14:90-94.
- LEWIS, J. C., AND R. L. GARRISON. 1983. Habitat suitability index models: clapper rail. *U.S. Fish and Wildl. Serv. FWS/OBS-83/10.* 15pp.
- MACNAMARA, E. E., AND H. F. UDELL. 1970. Clapper rail investigations on the south shore of Long Island. *Proc. Linnean Soc. N.Y.* 71:120-131.
- MANGOLD, R. E. 1974. Research on shore and upland game migratory birds in New Jersey: clapper rail studies. Final Rep., New Jersey Div. Fish, Game, and Shellfisheries, Trenton. 17pp.
- . 1977. Clapper rail (*Rallus longirostris*). Pages 84-92 in G. C. Sanderson, ed. *Management of migratory shore and upland game birds in North America.* Int. Assoc. Fish and Wildl. Agencies, Washington, D.C.
- MARTIN, E. M. 1979. Hunting and harvest trends for migratory game birds other than waterfowl: 1964-76. *U.S. Fish and Wildl. Serv., Spec. Sci. Rep. Wildl.* 218. 37pp.
- MASSEY, B. W., AND R. ZEMBAL. 1987. Vocalizations of the light-footed clapper rail. *J. Field Ornithol.* 58:32-40.
- , ———, AND P. D. JORGENSEN. 1984. Nesting habitat of the light-footed clapper rail in southern California. *J. Field Ornithol.* 55:67-80.
- MEANLEY, B. 1985. The marsh hen: a natural history of the clapper rail of the Atlantic coast salt marsh. *Tidewater Publ., Centreville, Md.* 123pp.
- MILLSAP, B. A., J. A. GORE, D. E. RUNDE, AND S. I. CERULEAN. 1990. Setting priorities for the conservation of fish and wildlife species in Florida. *Wildl. Monogr.* 111. 57pp.
- MOFFITT, J. 1941. Notes on the food of the California clapper rail. *Condor* 43:270-273.
- ODOM, R. R. 1975. Mercury contamination in Georgia rails. *Proc. Southeast. Assoc. Game and Fish Comm.* 28:649-658.
- OHMART, R. D., AND R. E. TOMLINSON. 1977. Foods of western clapper rails. *Wilson Bull.* 89:332-336.
- ONEY, J. 1954. Clapper rail survey and investigation study. Final Rep., Proj. W-9-R. Georgia Game and Fish Comm., Atlanta. 50pp.
- ORR, R. T. 1939. Fall wanderings of clapper rails. *Condor* 41:151-152.
- POLLOCK, K. H., J. D. NICHOLS, C. BROWNE, AND J. E. HINES. 1990. Statistical inference for capture-recapture experiments. *Wildl. Monogr.* 107. 87pp.
- POWELL, R. 1990. 1990 Yuma clapper rail census. Yuma Clapper Rail Recov. Team, Blythe, Calif. 4pp.
- RIDGWAY, R., AND H. FRIEDMANN. 1941. The birds of North and Middle America. *U.S. Natl. Mus. Bull.* 50. 254pp.
- RIPLEY, S. D. 1977. Rails of the world: a monograph of the family Rallidae. David R. Godine, Boston, Mass. 406pp.
- ROOT, T. 1989. Atlas of wintering North American birds. Univ. Chicago Press, Chicago, Ill. 336pp.
- ROTH, R. R., J. D. NEWSOM, T. JOANEN, AND L. L. MCNEASE. 1972. The daily and seasonal behavior patterns of the clapper rail (*Rallus longirostris*) in the Louisiana coastal marshes. *Proc. Southeast. Assoc. Game and Fish Comm.* 26:136-159.
- RUSK, M. K. 1991. Selenium risk to Yuma clapper rails and other marsh birds of the lower Colorado River. M.S. Thesis, Univ. Arizona, Tucson. 75pp.
- SCHMIDT, F. V., AND P. A. MCLAIN. 1951. The clapper rail in New Jersey. *Proc. Northeast. Fish and Wildl. Conf.* 7:164-172.
- SCOTT, T. G., AND C. H. WASSER. 1980. Checklist of North America plants for wildlife biologists. *The Wildl. Soc., Washington, D.C.* 58pp.
- SHARPE, T. L. 1976. Productivity and distribution of the clapper rail in a Louisiana salt marsh. M.S. Thesis, Louisiana State Univ., Baton Rouge. 91pp.
- SHISLER, J. K., AND T. L. SCHULZE. 1976. Some aspects of open marsh water management procedures on clapper rail production. *Trans. Northeast. Sect., The Wildl. Soc.* 32:101-104.
- SMITH, P. M. 1975. Habitat requirements and observations on the clapper rail, *Rallus longirostris yumanensis*. M.S. Thesis, Arizona State Univ., Tempe. 35pp.
- STEWART, R. E. 1951a. Clapper rail populations of the Middle Atlantic states. *Trans. North Am. Wildl. Conf.* 16:421-430.
- . 1951b. Clapper rail studies. Pages 56-58 in *Investigations of woodcock, snipe, and rails in 1951.* U.S. Fish and Wildl. Serv., Spec. Sci. Rep. Wildl. 14.
- . 1954. Migratory movements of the northern clapper rail. *Bird-Banding* 25:1-5.
- , AND B. MEANLEY. 1960. Clutch size of the clapper rail. *Auk* 77: 221-222.
- STOREY, A. E., W. A. MONTEVECCHI, H. F. ANDREWS, AND N. SIMS. 1988. Constraints on nest site selection: a comparison of predator and flood avoidance in four species of marsh-nesting birds (Genera: *Catoptrophorus*, *Larus*, *Rallus*, and *Sterna*). *J. Comp. Psychol.* 102:14-20.

- TODD, R. L. 1986. A saltwater marsh hen in Arizona: a history of the Yuma clapper rail (*Rallus longirostris yumanensis*). Final Rep., Fed. Aid Proj. W-95-R, Arizona Game and Fish Dep., Phoenix. 290pp.
- TOMLINSON, R. E., AND R. L. TODD. 1973. Distribution of two western clapper rail races as determined by responses to taped calls. *Condor* 75: 177-183.
- U.S. FISH AND WILDLIFE SERVICE. 1988. Final supplemental environmental impact statement: issuance of annual regulations permitting the sport hunting of migratory birds. SEIS 88. U.S. Gov. Print. Off., Washington, D.C. 340pp.
- . 1989a. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12. U.S. Gov. Print. Off., Washington, D.C. 34pp.
- . 1989b. Trends in harvest and hunting activity for migratory game birds other than waterfowl. U.S. Fish and Wildl. Serv. Admin. Rep., Laurel, Md. 11pp.
- WILBUR, S. R. 1974. The status of the light-footed clapper rail. *Am. Birds* 28:868-870.
- ZEMBAL, R., AND J. M. FANCHER. 1988. Foraging behavior and foods of the light-footed clapper rail. *Condor* 90:959-962.
- , AND B. W. MASSEY. 1985. Distribution of the light-footed clapper rail in California, 1980-1984. *Am. Birds* 39:135-137.
- , ———, AND J. M. FANCHER. 1989. Movements and activity patterns of the light-footed clapper rail. *J. Wildl. Manage.* 53:39-42.
- , ———, C. S. NORDBY, AND R. J. BRANSFIELD. 1985. Intermarsh movements by light-footed clapper rails indicated in part through regular censusing. *Calif. Fish and Game* 71:164-171.