

Appendix 2.2

LITERATURE REVIEW MATERIALS

Features associated with King Rail detections

Physical Environment – Microhabitat

Andrews 1973

- “Available habitat may be the greatest single factor influencing the size of the rail population at Wnous Point. This habitat consists of plant species and their life form, interspersed of plant species, water of suitable depth, and preferred foods.”
- Table 15, page 94: King Rail sightings by vegetation type and month – Cattail and marsh mallow were habitat types which offered the most abundant cover in spring. Water was always present (1-24 inches) in stands of cattail and marsh mallow holding rails. Fine vegetation and flattened marsh mallow and cattail provided travel lanes over deeper water. Rails listed as occurring in pure marsh mallow stands were encountered at the edges of those stands near other marsh vegetation (e.g. blue joint grass, cattail). King rails used partially drained canals as travel lanes and to forage for snails and crayfish, and tracks were abundant though few birds were sighted. King rails were observed using the dense vegetation and overhanging banks as travel lanes, as well as the dikes.

Baird 1974; Kansas

- Three nests observed: Nest One "in alkali bullrush...contained 12 eggs... [all] hatched"; Nest Two "containing 12 eggs was located in alkali bullrush in 3 inches water... hatched June 9"; and Nest Three "dense alkali bulrush in 1 inch water near trap... two cold eggs... trapping activities over three days probably forced abandonment"

Bent 1926; Florida

- A King rail nest with 9 fresh eggs was found hidden in a clump of pickerel weed, but about 8 inches above water a foot deep - in “an extensive swamp overgrown mainly with pickerel weed, a scattered growth of tyty bushes, and a few flags

Bent & Copeland 1927; Florida

- A king rail nest with 9 fresh eggs was found in the midst of a boat-tail grackle breeding colony in a marsh overgrown with pickerel-weed and "ty-ty" bushes

Bowditch & Philipp 1910; North Carolina

- A King Rail nest was found at Ellis Lake (possibly Ellis Simon Lake?) “in a thick patch of rushes in a wet part of the marsh”.

Busby and Zimmerman 2001; Kansas

- This Breeding Atlas concluded that marsh habitat is rare and locally distributed, but king rail can use even very small marshes. “In a 3-acre cattail marsh in Brennam block (Kiowa County), four KIRA responded to taped calls on 11 June 1997.”

Cairo 1985; Colorado

- “I saw a King Rail at lower Latham Reservoir... disappeared into the cattail marsh... a "bup-bup-bup" coming from a hard stem bulrush (*Scirpus acutus*) marsh on the south side of the road.”

Erichsen 1919; Georgia

- A King Rail nest was found “fourteen inches above water, in rushes growing in an abandoned rice plantation, and was composed of the stalks and leaves of cattail flags”

Hamilton 1925; New York

- A King Rail nest was “composed of cat-tails and was situated on the ground, but well built up from it, the depth being five inches.”

Hankinson 1916; Illinois

- King Rail nest with 12 eggs built as “a pile of dead grass on the ground about 10 inches in diameter and 5 inches high” and “poorly concealed by grass and a few small buttonbushes.”

Henniger 1911; Ohio

- “11 May 25: a nest of the Ring Rail, with eleven eggs, was found in the tall grass of a small pool of water not deeper than twelve inches, perhaps sixty feet square, not more than seventy five feet away from the public highway.”

Hiemenz 1984; Minnesota

- King rail nest in a clump of sedge in 10 inches of water near cattails in a very boggy area. The nest was eventually destroyed by cattle trampling the sedge.

Kushlan 1973; Florida

- King rail nested sawgrass strands in Everglades sawgrass/cattail marshes.

Manci & Rusch 1988; Wisconsin

- Spring densities of the seven marsh bird species were determined in five distinct habitats of Horicon National Wildlife Refuge: deepwater cattail, shallow water cattail, dry cattail, river bulrush, and sedge. King Rails and Least Bitterns were only heard calling in deepwater and shallow water cattail (at 15% of 96 plots containing these habitat types, with density of 0.2 calling individuals per ha), and American Bitterns were heard only in shallow water and dry cattail. Cattail comprised 94% of the emergent plant habitats on Horicon NWR. Approximately 58% of the cattail habitats were classified as dry. Dry cattail contained no standing water by the end of June. Shallow water cattail comprised 26% of cattail habitat and contained standing water through mid-August. Mean water depth was approximately 5 cm in early June. Deepwater cattail was the least abundant cattail type, comprising approximately 16% of the cattail habitats. Mean water depth was 29 cm in early June. River bulrush and sedge occupied approximately 4% and 2%, respectively, of the emergent plant habitats. River bulrush habitat contained standing water through mid-August; sedge habitat was dry by the end of June.

Meanley 1956; Arkansas

- “Generally, King Rails forage in water so shallow that only the bill, or part of it, disappears beneath the surface while food is sought. However, on March 25, 1954, I observed a pair of rails feeding in a roadside ditch where the water varied from 6 to 12 inches in depth.”

Meanley & Wetherbee 1962; Delaware

- Vegetation composition samples were collected from three sites: (1) the upper reaches of the brackish marsh at Fleming's Landing, where only King Rails were collected or observed, had 15% *Spartina alterniflora* and 50% *S. patens*; (2) the outer brackish marsh at Woodland Beach on the Delaware Bay, where only Clapper Rails were observed, had 70% *S. alterniflora* and 0% *S. patens*; and (3) the intermediate area between these two stations at Taylor's Gut, where both species occur, had 50% *S. alterniflora* and 1% *S. patens*.

Meanley 1969; North America

- In a 1-mile strip of 50 feet wide “silted in canal where shallow ponds were interspersed with dense patches of vegetation dominated by clump grass (*Spartina spartina*)”, 19 King Rail were counted. Page 18 and Table 3.
- In an area dominated by fall panicum (*Panicum dichotomiflorum*), twenty birds were counted in 20 minutes along a 1-mile strip approximately 200 yards wide, at 6pm in January. Page 20 and Table 3.

- In January, between 5:30 pm and 6pm 24 birds were counted along a 1-mile strip approximately 200 yards wide where the dominant vegetation types in the areas were southern bullrush and fall panicum. Page 20 and Table 3.
- Florida Spring King Rail observation is an area where marsh vegetation was mostly maidencane (*Panicum hemitomon*), pickerelweed (*Pontederia cordata*), and sawgrass (*Cladium jamaicense*). White waterlily (*Nymphaea odorata*) was in the open water pond and the bordering forest community was pond cypress (*Taxodium ascendens*). Here the density of KIRA in this area was estimated at 30 birds per 100 acres Page 26 and Table 3.
- In the Savannah NWR giant cutgrass is the dominant vegetation. Feeding territories were in the canals where there were floating mats of alligatorweed. Nesting territories were built “on the other side of the dike in a deep-water impounded marsh containing a mixture of giant cutgrass, sawgrass, royal fern, button bush, and myrtle.” Meanley estimated a density of one pair per acre in the cutgrass marsh bordering the river where alligatorweed forms extensive mats. In the nesting territory, he counted 46 males during a roadside count of calling males in April. Page 31-32 and Table 3)
- A breeding population of 14 males “in a nearly pure softstem bulrush (*Scirpus validus*) marsh where the bulrush averaged 5 feet in height, and the marsh had a firm bottom covered in 1-2 inches of water.” Page 32 and Table 3.
- Four KIRA nests, located at the base of the rosemallow plants, were found in a 20 acre section of a Nanticoke River marsh dominated by Olney's threesquare with rosemallow scattered throughout.
- Figure 19 - Nest with 9 eggs constructed of saltmeadow cordgrass and Olney's three-square. In the area, “small patches of saltmeadow cordgrass were scattered throughout the dense growth of hightide-bush (*Iva frutescens*)”. On a nearby island, a KIRA nest was found in a pure stand of saltmarsh cordgrass.
- Four pairs of KIRA nested in 10 acres of shrub swamp-marsh mixture where softrush, tussock sedge (*Carex stricta*), and arrowhead (*Sagittaria sp.*) were the common emergent herbaceous plants. Woody marsh plants included swamp viburnum (*Viburnum nudum*), arrow-wood (*V. dentatum*), button bush, alder (*Alnus serrulata*), winterberry (*Ilex verticillata*), red maple, and willow.

Miller 1908; Pennsylvania

- King Rail nest “placed half a foot up in a clump of reeds, two feet high in a shallow marsh” with two eggs and another deserted nest (23 days later) “not a square away from the site of the other, placed on muddy water in a shallow marsh amid tussocks and thin and scattered stalks of cat-tails, along the edge of a cat-tail marsh.”

Miller 1911; Pennsylvania

- One nest found in “a small bulrush marsh” and another in “a thick cattail marsh”

Morris 1896; Massachusetts

- A young King Rail was taken in the *Zizania aquatica* which grows so profusely along the banks of the Connecticut River.

Perkins 2007; Gulf Coast

- KIRA: N=180, Water depth average = 10.2cm, SD = 8.6cm, Range = 0-45.7cm.
- The average for all rails was 8.0 cm, with a maximum depth of 45.7cm. All rail species were also captured in areas where there was no standing water at the location of capture.

- King and Clapper rails were first distinguished by location (KIRA if caught in freshwater, CLRA if caught in saltwater), and then later by size measurements also.

Reid 1989

- Chap 1: In spring, Sora, Virginia, and King rails were flushed from sites with significantly different ($P < 0.05$) water depths, with King rail using intermediate water depths. A similar pattern was observed in Fall, but all species moved into shallower water in fall. KIRA spring: $N = 49$, Mean = 97 mm \pm 6 mm SE, Range = 25-200 mm, CV = 42 mm. KIRA fall: $N = 31$, Mean = 79 mm \pm 9 mm SE, Range = 10-245 mm, CV = 65 mm.
- Chap 1: In spring, King rail sites had greater stem density than sora (N.S.) or Virginia rail ($P = 0.043$) sites, but in Fall the densest vegetation sites were occupied by Virginia rail. KIRA spring: $N = 49$, Mean = 293 stems/m² \pm 29 SE, Range = 50-1000 stems/m², CV = 70 stems/m² (measured in 20 x 20 cm quadrats). KIRA fall: $N = 25$, Mean = 308 stems/m² \pm 36 SE, Range = 50-750 stems/m², CV = 59 stems/m². ** 6/31 observations on bare mudflat excluded from fall measures **
- Chap 1: In spring, all three rails were associated with perennial, moist-soil vegetation. King rail were flushed from sites dominated by ricecut grass or burreed. In fall, Virginia and King Rail continued to occupy perennial moist-soil vegetation, but Soras and Yellow rail were more commonly associated with annual moist-soil vegetation. The fall King Rail were observed on open mudflats and in vegetated sites dominated by barnyard grass, cattail, or burreed.
- Chap 1: In fall, King rail occupied taller vegetation than did Sora or Virginia rail. KIRA spring: $N = 49$, Mean = 50.6 cm \pm 1.8 cm SE, Range = 31-84 cm, CV = 24 cm. KIRA fall: $N = 25$, Mean = 78.0 cm \pm 6.7 cm SE, Range = 65-195 cm, CV = 40 cm. ** 6/31 observations on bare mudflat excluded from fall measures **
- Chap 2: All King rail nests sites ($N=67$ over 5 years) were located in perennial vegetation dominated by Hart Wright's sedge, ricecut grass, or water smartweed and species selectivity varied by year. Nests were typically over shallow water (66% over water, mean < 8 cm, range 0-22 cm), with open water very near the nest site (1-15 m). Nests were typically in dense clumps of vegetation, with later nests occurring in taller vegetation as the plants grew to mature size.
- "Height of vegetation is undoubtedly important only as long as a threshold level (greater than or equal to 45 cm), which hides adults, is reached."
- Chap 3: Brood foraged in unvegetated swales and mudflats within a mosaic of vegetated habitat; habitat usage was distinct from migration and nesting periods. Brood often appeared to habitually use a drying swale until it was almost completely dry, developing specific foraging routes among several small pools. Table 17 Water depths (mm) at King Rail foraging sites by life stage: Early brood ($N=85$) Mean 26.6 \pm SE 2.1; Range 0-75; CV 72; Late brood ($N=68$) Mean = 21.7 \pm SE 2.1; Range 0-56; CV 80; Separate young ($N=28$) Mean = 31.1 \pm SE 3.6; Range 0-68; CV 61. Table 18 Vegetation height (cm) at King Rail foraging sites by life stage: Early brood ($N=85$) Mean 2.7 \pm SE 1.9; Range 0-152; CV 656; Late brood ($N=68$) Mean = 0; Range 0; Separate young ($N=28$) Mean = 10.6 \pm SE 5.2; Range 0-112; CV 262.

Shipman 1927; Ohio

- A king rail nest built in bur-reed above 14 inch deep water held nine eggs, of which all but one were observed to have hatched on a repeat visit.

Springer & Stewart 1948; Maryland

- Surveyed several types of tidal marsh: switchgrass (KIRA), saltmeadow cordgrass, saltmarsh bulrush-saltgrass, big cordgrass, cattail (KIRA), needleruch, olney's threesquare, saltmarsh cordgrass, wildrice, spatterdock and pickerelweed.
- Switchgrass marsh-meadow (brackish marsh-meadow type). Switchgrass was the dominant plant and occurred in scattered hummocks or patches throughout... 2.5-3 ft high.
- Cattail marsh (brakish and freshwater type). A dense stand of narrow-leaf cattail and scattered clumps of southern cattail. Numerous shrubs of rosemallow were scattered throughout as an understory. The cattails ranged from 5.5 to 6 ft high while shrubs were mostly 2.5 ft.

Stewart & Robbins 1958: Maryland

- King rail most commonly found in marshes with vegetation including "narrow-leaved cattail, Olney three-square and switch grasses; occurring most commonly in the higher areas of marsh that contain scattered shrubs."

Tacha 1975; Kansas

- Found a nest in alkali bullrush and shaded by a canopy of bullrush. It contained 12 eggs which hatched on 31 May.
- Two other nests of KIRA were found in alkali bullrush, one above 3 and the other above 8 cm of water. One contained 12 eggs which hatched 19 June...the other contained 2 cold eggs; disturbances due to trapping in the immediate area may have caused desertion.
- Table 5: Total responses of KIRA at various water depths in combined study areas for 1975: 0 cm = 0 KIRA; 0-3 cm = 15 KIRA; 0-5 cm = 19 KIRA; 0-8 cm = 1 KIRA; 0-10 cm = 1 KIRA; 0-25 cm = 0 KIRA; 0-30 cm = 0 KIRA

Trautman 1940; Ohio

- Preferred King Rail habitats were described as: "Cattail marshes, buttonbush swamps, wet prairies containing coarse grasses, sedges, and bulrushes, edges of marshy pools in swamp forests, and wild rose and blackberry tangles in swampy meadows." "Nests were made of cattails, rushes, sedges, or coarse grasses, and usually of the most readily available material." Also, "many were built directly upon the ground, but some of those in the cattail marshes floated upon the water that was as much as 2 feet deep."

Wayne 1910; South Carolina

- A King Rail nest was found in a button-wood bush, which was in a pond of water

Tanner 1953; Iowa

- Table 20, page 64. Data based on 6 KIRA nests in 1951. Water depth range = 4.0 to 18.0, mean = 10.6, SE = 2.2, SD = 5.5 in inches.
- On May 16, one KIRA was flushed from the Kentucky bluegrass on the upland 60 feet from the nearest marsh.
- On May 21, one KIRA was flushed from a thicket of western buckbrush 100 feet from the nearest marsh.

Physical Environment – Landscape

Andrews 1973; Ohio

- Studied 236.2 acres in an impounded marsh area of 1300 acres. Percent cover for 4 sites defined, but bird capture data are pooled with no indication of which site offered more birds. Several comments on KIRA movement and dispersal, but not in format suitable for data entry. Good microhabitat data regarding plant species associated with king rail sightings and trapping.

Baird 1974; Kansas

- Author estimated KIRA density at 20 to 40 pairs for the entire Chgeyenne Bottoms marsh area (470 acres); observed density of individ/ha from trapping (pool 2 = 0.34; pool 4 = 0.05; pool 5 = 0.30)

Bent 1926; Florida

- A King rail nest with 9 fresh eggs was found in “an extensive swamp overgrown mainly with pickerel weed, a scattered growth of tyty bushes, and a few flags.”

Bent & Copeland 1927; Florida

- A king rail nest with 9 fresh eggs was found in the midst of a boat-tail grackle breeding colony in a marsh overgrown with pickerel-weed and "ty-ty" bushes

Blom 1996; Maryland

- This Breeding Atlas concludes that “inland nesting is apparently very rare and irregular”, but King Rail is a regular breeder in extensive coastal marshes and impoundments.

Bolduc 1992; Minnesota

- Observed a king rail standing on the north edge of the gravel road adjacent to a cattail marsh.

Bowdish & Philip 1910; North Carolina

- The King Rail is described as common at Ellis Lake (possibly Ellis Simon Lake?) where uses the “wet, reedy marshes around the lake” as breeding habitat.

Brewer 1972; Michigan

- A King Rail occurred in a small park in November where it was wading in a small stream which flows through an extensive marsh and bog into Kalamzoo River. It occasionally moved into an area of bog shrubs bordering the streams. The bird was missing one foot, the amputation having occurred high on the tarsus.

Brock 1896; Maine

- A king Rail was shot in a brackish marsh near the mouth of a large river (Presupscot).

Broun 1931; Massachusetts

- A King Rail was observed at a narrow inlet at the head of Pontoosuc Lake moving among the grasses at the edge of the water. It was observed in the early morning and again, later the same day, at the same location.

Burdick et al. 1989; Louisiana

- Appendix 1B: King Rail observed in bottomland hardwood forest of Tensas River NWR during bird counts, but “do not frequently use bottomland hardwood forest, or were sighted too infrequently to be included in regression analyses.”

Burtch 1946; New York

- One adult with one juvenile foraging along muddy shoreline of freshwater lake/wetland edge. The juvenile was banded and observed until mid-September to frequent the cattails and mudflats. The adult was last observed at the end of September about a 300 m from the site of the original observation.

Busby and Zimmerman 2001; Kansas

- This Breeding Atlas concluded that marsh habitat is rare and locally distributed, but king rail can use even very small marshes. “In a 3-acre cattail marsh in Brennam block (Kiowa County), four KIRA responded to taped calls on 11 June 1997.”

Cahn 1930; Illinois

- King rail observed in “cypress swamp” and “aquatic” habitats

Cairo 1985; Colorado

- “I saw a King Rail at lower Latham Reservoir... disappeared into the cattail marsh... a "bup-bup-bup" coming from a hard stem bulrush (*Scirpus acutus*) marsh on the south side of the road.”

Craig 1990; Connecticut

- King Rail found in fresh and brackish marshes with salinity ranging from 0-17 ppt where detected.

Craig & Beal 1992;

- Table 2 page 300; with Presence (Marsh Area = 145.6, 121.6, 155.4, 215.2 ha) and Undetected (Marsh Area = 56.4, 39.5, 23.1, 21.6, 119.7, 26.9, 30.7 ha)
- Table 2 page 300: with Presence (Mudflat Area = 3.6, 24.1, 6.7, 6.6 ha) and Absence (Mudflat Area = 13.6, 1.1, 3.1, 0.6, 7.4, 0, 0 ha)
- Manuscript has more details for heterogeneity and isolation?

Deaderick 1936; Arkansas

- Shot a King Rail in a low field near a fence row.

Delap 1979; Oklahoma

- “Along a narrow drainage ditch that parallels a country road... the King Rail has been seen repeatedly in summer during recent years. The ditch is sometimes full of water, sometimes dry, but by mid-summer it is lined with sedge and grass up to 4 feet high no matter how dry the season.”
- “Two young birds...about half a mile southwest of ditch”
- “saw the species along the ditch... one parent preening its plumage while the other, accompanied by at least 6 chicks, fed on a mudflat. The chicks, about third-grown, were still covered in black down. They moved in and out among the sedge...”
- ...King Rails along the ditch again on the morning of 1 July, observing first an adult as it walked out onto the road several yards from where I stood, then one of the fully feathered young ones, no longer black but dusky with whitish front, as it crossed the road.

Dempsey 1991; Minnesota

- A king rail was visually and auditorily detected just inside the reed edge of a pond

Duvall 1937; Virginia & North Carolina

- A family group (2 adults and at least 5 young) was shot while crossing a road between brackish marsh habitats on Knott's Island, June 1.

Eckert 1984; Minnesota

- A King Rail was detected calling several times – 75 feet from railway tracks, later 20 feet into marsh edge from open water. The marsh was on the west side of Mud Lake, which is a shallow backwater area of the St. Louis River.

Eifrig 1913; Illinois

- "Beside the above mentioned wet spots between fields, there are some sloughs, large and small, but usually not large enough to entice ducks or Black Terns to breed, while on the other hand the King Rail, Least Bittern, Long- and Short-billed Marsh Wrens and the inevitable Redwing find even the smallest of them to their liking."

Eifrig 1930; Texas

- In prairie with intensive grazing: “Every pool here harbored young and old King Rails, Bitterns, Redwings, Grackles, and Dickcissels.”

Fay 1911; Massachusetts

- Records King Rail shot or captured in fresh, brackish, and saltwater marshes

Gabrielson 1914; Iowa

- Bird observations made over several years (1907-1911) in farmland in typical prairie countryside speckled with “kettle holes”, cat-tail swamps, ponds, and small lakes” with much of the land still containing native vegetation. “There were, during the years of study, two ponds of thirty and forty acres respectively, and fifteen small swamps, ranging from one or two square rods to three acres in size, scattered over the region.” King Rail nests were usually built in the thick grass around the small swamps, though they were occasionally placed in the hay fields some distance from the water.

Gochfield 1975; New York

- A King Rail was flushed from low ground cover on the open beach, in an area where common terns were nesting after early season failures. After the second flushing, it flew across the beach, over a small dunes stabilized by beach grass, and landed in a marshy site.
- A King Rail was observed where Annesvillle Creek enters Hudson River, one mile north of Peekskill, in January.

Goelitz 1915; Illinois

- King Rail were flushed and nests observed along the marshy edge of Butler’s Lake. “This lake covers from thirty to forty acres and is surrounded by a few wood-lots, pastures, house yards, and a public road. The margin is shallow and swampy, with cat-tails and reeds extending in from twenty to two hundred feet from the hilly ground surrounding the lake.”

Graves 2001; Virginia

- King rail family foraged for prey in the water, but consumed prey (crayfish) on neighboring banks and vegetation mounds.

Hallman 1934; Florida

- A King Rail nest with 11 eggs near hatching found in an area of “freshwater cypress ponds”

Hamilton 1925; New York

- Winter capture of a King Rail in “an open run which emptied into a larger stream, where the tide water entered... within thirty paces of the location in which a nest of the same species was found the previous summer.”

Hamilton 1925b; New York

- The King Rail nest was found “in a small cat-tail marsh of brackish water which bordered the salt meadows, and was about four hundred yards from a large creek which emptied into Douglaston Bay.”

Hankinson 1916; Illinois

- King Rail nest in the “grass-buttonbush zone” NOT the “rush-flag zone” of a “primitive prairie” remnant, such as are commonly found in the poorly drained portions of agricultural landscapes. The ponds surveyed were up to 10 acres in size and held shallow standing water during the wet season.

Henniger 1911; Ohio

- “11 May 25: a nest of the Ring Rail, with eleven eggs, was found in the tall grass of a small pool of water not deeper than twelve inches, perhaps sixty feet square, not more than seventy five feet away from the public highway.”

Hiemenz 1984; Minnesota

- King rail nest in a “boggy area of heavy new cattails at outer edge of east sedge marsh at Fielder’s farm.”

Howell 1910; Missouri

- Two king rails observed “in a wet ditch along a railroad.”

Howell 1910; Illinois

- An adult King Rail with two young in a small marshy pond in the river bottoms.

Illicky 1969; Michigan

- A King Rail resided several days in a rural backyard: “The bird would run along at a fast pace through the tall grass that only permitted its head to be exposed. In addition to the high grass, the habitat was composed of a marshy meadow, with a 3-acre area containing a white birch, black cherry, white pine sapling complex. A fast moving 3 feet wide stream flows through the area.”

Johnson 1950; Indiana

- A king rail family group observed “near a drainage ditch in a lowland meadow”

Jones 1912; Ontario

- King rail were commonly observed feeding along the margin of the marsh at any time of day, and many nests were found in the swamp. The birds were so wary that the least disturbance sent them scurrying into the dense vegetation bordering the water of the swamp.

Latham 1954; New York

- The most unusual King Rail record: “The nest was on the base ground in a potato field 150 yds from the margin of a salt marsh.”, and was later destroyed by farm machinery.

Meanley 1953; Arkansas

- Much higher frequency of bird detections in ditches than in rice fields. Calculating from his notes on area surveyed in each habitat, density in ditches (17.06 nests/ha) than in rice fields (0.18 nests/ha), but effort was not equally applied.
- More nests were located near major highways than near minor roads, because highway ditches were wider and had greater abundance and diversity of aquatic vegetation.
- Suggested that King Rail may switch from nesting in ditches to foraging in rice fields

Meanley 1956; Arkansas

- “Rails do most of their feeding in places concealed by plant cover or in relatively open areas where they blend well with their surroundings. Occasionally, however, the birds are very conspicuous as when feeding on mud flats or in recently flooded fields where rice sprouts are 3 or 4 inches in height.”

Meanley 1957; Arkansas

- 2nd paragraph: "I made observations mostly during the months of February, March, and April, 1954 and 1955. At this season of the year King Rails in the rice belt are found chiefly in roadside ditches and in rice field canals, but in the course of feeding and courtship activity they sometimes wander into partially inundated rice stubbles, pastures, and fallow fields bordering such ditches and canals. "
- During the last week in February and the first week in March, one male King Rail gave the mating call at various points along 975 feet of roadside ditch. By the second week in March its mating calls were heard from about 500 feet of roadside ditch; its territory was then about half its original size. The diminishing territory was caused by (a) pressure from another courting male, (b) burning of cover along part of a ditch bank within the original calling territory, and (c) relatively modest territorial requirements for nesting, particularly if there is plenty of water in the area about the nest where the rail can find ample aquatic animal life for food.

- An idea of the size of nesting territories was determined by measuring the distances between 3 nests in the same ditch: from the nest in the center there was a distance of 298 feet to the nest on one side and 166 feet to that on the other. The ditch was about 30 feet wide at all three points. There were 22 occupied nesting territories along 6 miles of continuous roadside ditch.

Meanley & Wetherbee 1962; Delaware

- 1st paragraph: "The closely related King Rail (*Rallus elegans*) and Clapper Rail (*Rallus longirostris*) are characteristic of distinct types of habitat in the coastal plain along the Atlantic and Gulf coasts. Ordinarily, King Rails are found in both fresh and brackish tidal marshes, and Clapper Rails in tidal salt marshes. In a few areas, however, intermediate brackish-salt marshes occur where King and Clapper rails may be found together." This conclusion was based on a study that examined three neighboring marshes (fresh, brackish, and saline). King rail were present and nesting at sites within the 3700 ppm to 7190 ppm salinity range. King rail were absent where salinities measured 7480 ppm (low tide) and 7600 ppm (high tide) but it was not mentioned whether this was due to higher salinity, presence of Clapper Rails, or associated differences in vegetation.

Meanley 1969; North America

- General quote supported by following observations: "The KIRA probably occurs in a wider variety of habitats than any other rail. The species ranges from coastal salt and brackish marshes to shrub swamps and occasionally is found even in the fields near marshes where it forages for grasshoppers and grain, and where it sometimes nests."
- During the breeding seasons of 1960-1964, King Rail were collected in the Broadway Meadows marsh from three neighboring stations: (a) the upper reaches of a brackish marsh, where KIRA only were observed, (b) an outer brackish marsh, where CLRA only were observed, and (3) an intermediate area between these two stations, where both KIRA and CLRA occurred". - pg 9
- Observed King Rail while surveying two marshy impoundments during summers of 1965 and 1966. Knowles Unit 2 = 20 acres with 10 acres as "shrub swamp or marsh or a mixture of the two" = 4 pairs in 1965 and 0 pairs (due to high water) in 1966, and Knowles Unit 1 = "larger, but contained only about 6 acres of marsh and shrub swamp at the time" = 1 pair in 65 and in 66. (page 14)
- In January, King Rail were heard "calling from what appeared to be an abandoned silted in canal where shallow ponds were interspersed with dense patches of vegetation dominated by clump grass (*Spartina spartina*)" In a 1-mile strip, 50 feet wide, 19 King Rail were counted. Page 18 and Table 3.
- A census of wintering KIRA, based on calls, was made in a marsh bordering a road, 2 miles south of the old Intracoastal Canal, Vermillion Parish. Twenty birds were counted in 20 minutes along a 1-mile strip approximately 200 yards wide, at 6pm. The dominant vegetation in the census area was fall panicum (*Panicum dichotomiflorum*). Page 20 and Table 3.
- A census of wintering KIRA, based on calls, was made 5 miles south of the Intracoastal Canal on the east side of a road. Between 5:30 pm and 6pm 24 birds were counted along a 1-mile strip approximately 200 yards wide where the dominant vegetation types in the areas were southern bullrush and fall panicum. Page 20 and Table 3.

- The density of KIRA in April was estimated at 30 birds per 100 acres in a tract on the east side of Highway 512 in Florida. King rail were most common in the drier marshes. Page 26 and Table 3.
- Georgetown, about 8 miles from the coast, has a narrow strip of marshland bordering the PeeDee and Black Rivers (survey area totaling about 3000 acres). The water is slightly brackish with a tidal range of 3.5 feet and the dominant vegetation is big cordgrass (*Spartina cynosuroides*), especially along old ricefield canals. Ten, 10-acre plots were surveyed for at least 1 hour each, from which he concluded that “the average number of breeding rails per 100 acres could be inferred to be 25 pairs”. Density ranged from 0-6 rails per 10-acre plot. Higher density on PeeDee was attributed to higher prey density.
- The Savannah NWR is a freshwater tidal marsh with a tidal range of 1 foot. The former rice plantation, which is about 25 miles upriver from the ocean, is divided by the Savannah River. Giant cutgrass is the dominant vegetation and red-jointed fiddler crab are abundant along the tidal creeks and edges of the marsh. Feeding territories were in the canals, while nests were built on the other side of the dike in a deep-water impounded marsh. Meanley estimated a density of one pair per acre in the cutgrass marsh bordering the river where alligatorweed forms extensive mats. In the nesting territory, he counted 46 males during a roadside count of calling males in April. Page 31-32 and Table 3)
- Spot-mapping of April mating calls resulted in an estimate of a breeding population of 14 males in the 13 acre tract. The breeding King Rail were found in “in a nearly pure softstem bulrush (*Scirpus validus*) marsh along US highway 17A, about 2 miles from Savannah, GA. The bulrush averaged 5 feet in height, and the marsh had a firm bottom covered in 1-2 inches of water.” Page 32 and Table 3.
- In a brackish bay marsh community King Rail called at night in May from a narrow band of big cordgrass bordering Pokata Creek. Page 36.
- Four KIRA nests, located at the base of the rosemallow plants, were found in a 20 acre section of a Nanticoke River marsh in June. This typical muskrat marsh was dominated by Olney's threesquare with rosemallow scattered throughout.
- Figure 19 - Nest and nine eggs of KIRA in a brackish marsh where small patches of saltmeadow cordgrass were scattered throughout the dense growth of hightide-bush (*Iva frutescens*). On another Chesapeake Bay island (Miller's Island) a KIRA nest was found in a pure stand of saltmarsh cordgrass.
- Four pairs of KIRA nested in 10 acres of shrub swamp-marsh mixture.

Meanley 1986; Maryland

- “During the period 1965-1970. I banded 55 King Rails (*Rallus elegans*) in the marshy-shrub swamp sections of several impoundments at the Patuxent Wildlife Research Center.”

Miller 1908; Pennsylvania

- King Rail nests found in “meadows” of the Delaware River

Montagna & Wimsatt 1942; Virginia

- One King Rail was observed in the “drier marsh grasses” during a June collection trip to 40-acre Rogue Island - a low untenanted marsh, about eleven miles off the main coast, situated among other islands. “Not over twenty per cent of it is above tide level. Along the middle of the island is an elevated ridge, which at its highest point is possibly five feet above the high-water level. The ridge forms a long crescent-shaped strip, about one hundred feet wide and runs east and west along the northern side of the island. This portion is characterized by a heavy growth of eel grass and more or less continuous clumps of tide-water bushes. The

latter are low shrubby plants rarely growing over four or five feet in height. Along the middle of the ridge are three isolated groups of stunted cedars. These probably cover less than an acre altogether. The area was at one time completely forested, but after many fires these few cedars are the only surviving trees.

Morris 1912; Massachusetts

- King Rail was captured in abundant wild rice along the shores of the Connecticut river

Morss 1918; Massachusetts

- King Rail shot at “edge of a fresh water pond”

Nauman 1927; Iowa

- A king rail waited out a late snowfall on a farmhouse covered porch about 300 m from a river.

Neubeck 1992; Minnesota

- While walking a gravel path under a highway bridge near the Isaak Walton League Bass Ponds, the author and several friends observed a King Rail feeding. The bird was at the margin between open water and “three to five foot tall grasses” where a drainage culvert emptied into the marsh, about 200 yards past the bridge.

Oberholser 1925; Texas

- King Rail identified as resident of “Coast Prairie Aquatic Association” vegetation which “is made up chiefly of the coast prairie fresh water ponds and their margins, but includes also the actual water and the muddy grassy margins of the various streams and ditches that intersect the prairie land, together with the extensive rice fields.”

Olson 1997; Florida

- Author notes that KIRA are in decline and many seemingly suitable freshwater wetlands appear uninhabited.
- A male King Rail was captured “along the paved road bordering the eastern side of the freshwater marsh.” The other side of the road was a saltwater marsh.

Pangburn 1919; Florida

- A King Rail “spent several weeks in a brackish bog not a hundred feet in diameter, and very near one of the city streets. It could be seen frequently and heard oftener.”

Potter 1926; New Jersey

- A calling King rail emerged from the “short grasses” of a cattail and grass marsh

Potter 1928; New Jersey

- Observed a King Rail foraging down the middle of a stream running through a muddy tidal pool in a marsh. Small prey were consumed while in water, but larger prey were dragged to dry shore.

Provost 1947; Iowa

- Pp. 493: “The king rail is far less common [than the Virginia Rail] and haunts the fens and creek borders of inlets and outlets to marshes rather than the marshes themselves.” The marshes mentioned were alkaline and rich in submerged aquatic vegetation, varied 6 inches to 3 feet deep, and had active muskrat communities. Too few King Rail were observed to conduct quantitative analysis.

Rabatsky 1997; Florida

- King and clapper rails detected in saltwater marshes during spring breeding season

Rabe 2001; Michigan

- “The king rail prefers permanent freshwater marshes in the Midwest, although it uses brackish wetlands elsewhere..... Although expansive stands of marshy herbaceous vegetation are typically considered preferred habitats, Rabe (1986, unpub) found king rails occupying

marsh habitats interspersed with willow and dogwood when Great Lakes water levels are high.”

- Based on his review and personal observations: "Mowed areas next to good nesting habitat are often used for feeding, so birds have been observed on dikes, edges of parking lots, and lawns."

Reagh 1903; Massachusetts

- A female king rail was shot while “skulking among some low bushes and dry grass near a salt marsh” in January.

Reid 1989; Missouri

- “Water depth and distance to open water were important factors in predicting nest success among the continuous variables, but location of a nest within a management unit alone fit the log-linear model for categorical variables and the logistic regression model for all factors. This relationship suggests that small wetland units or units with large shoreline development that yield greater “edge” area may be more susceptible to king rail nest failures.”

Risen 1992; Minnesota

- King Rail foraged mostly in water “as deep as its belly”, but immediately returned to a dry area of shore to consume the prey item

Sandborn & Goelitz 1915; Illinois

- A King Rail nest with set of twelve eggs located in Skokie Marsh, five feet from a ditch of running water, and a hundred feet from a public road.

Sikes 1984; Texas

- King rail observed in freshwater sites (n=6): 23 at edge canals, 3 at edge roads, 9 at edge ponds, 6 interior marsh (>5 m) = 41 KIRA where salinity <0.5 ppt;. King rail observed at brackish sites (n=5): 0 at edge canals, 0 at edge roads, 1 at edge ponds, 0 interior marsh (>5 m) = 1 KIRA where salinity 5-15 ppt. Most data were pooled for king and clapper.

Smith 1903; Georgia

- A King Rail was shot in “an old field” and was considered an accidental species for that region (near Atlanta).

Springer & Stewart 1948; Maryland

- Surveyed several types of tidal marsh and also noted marsh size, seasonal weather, edge habitat characteristics, and salt/brackish/fresh quality.
- Switchgrass marsh-meadow (brackish marsh-meadow type). These areas were interspersed with wetter marsh types....A few scattered shrubs were also in the area.... Size = 30 acres. Edge: surrounded by marsh-meadow of the same type.
- Cattail marsh (brackish and freshwater type). Numerous shrubs of rosemallow were scattered throughout as an understory. Size = 16.5 acres. Edge = three sides bordered by marsh of similar type and one side by sandy beach on shore of Chesapeake Bay.
- Effective trapping area about 12 ha in a 100 ha patch of marsh. Table 14 gives estimated population from 1975 trapping results (11 Adults, 30 immature). So estimated adult density: $11/12 = 0.9166$ individuals; immature density: $30/12 = 2.5$; total density: 3.4166

Sprunt & Chamberlain 1949; South Carolina

- The King Rail makes it “home of cattails, rushes, and aquatic growth in freshwater situations.... Now and then, however, one may be seen picking here and there on a muddy spot, unobstructed by growth.”

- “During spring and fall, the King Rail now and then appears in salt marshes, or even in the streets of towns and cities where it has doubtless become confused by lights in its migratory journey.”

Spurrell 1917; Iowa

- Commonly observed breeding in local ponds and near the inlet to a lake.

Stewart & Robbins 1958: Maryland

- Generally found in marshes of the tidewater region, using “various brackish and freshwater marsh types, including narrow-leaved cattail, Olney three-square and switch grasses; occurring most commonly in the higher areas of marsh that contain scattered shrubs.”

Sutton 1938; Oklahoma

- A female king rail was taken from her nest at the edge of a shallow lake near the Cimarron River.

Tanner 1953; Iowa

- A study conducted in a 402 acre tract of prairie in Clay County, northeast Iowa, included a group a small, shallow marshes which were deemed rather typical of rail habitat existing in the prairie region of the Upper Midwest.
- Table 24, page 75. Data based on 6 nests distributed among 4 study sites. Nest density = 3.3, 13.0, 4.7, and 1.3 acres/nest. Acres per nest converted to nests/ha: 0.7, 0.2, 0.5, 1.9 with mean 0.8 and SD 0.7
- Table 24 page 75: Patch size where nests observed: 1.3 acres (1 nest), 4.7 (1), 10.0 (3), 13.0 (1).
- From April 30 until May 23.. Only 11 KIRA, or one per 7.5 hours observation (83 hours total)... Nearly all these birds were flushed either from the edges of pond inlets and outlets or from the upland, rather than from the emergent vegetation of the marshes... On May 4 four KIRA were flushed singly along the inlet of Drainage System A.. On May 16 one KIRA was flushed from the Kentucky bluegrass on the upland 60 feet from the nearest marsh. On May 21, one KIRA was flushed from a thicket of western buckbrush 100 feet from the nearest marsh.
- Page 95: During the present study the minimum distance between occupied nests of KIRA was 352 feet, between an occupied KIRA nest and occupied VIRA nest 264 feet, and between an occupied KIRA nest and an occupied SORA nest 102 feet.
- Each field was systematically searched for nests by a crew of 2-4 people walking 10-20 m apart. Crews walked parallel until the entire field was covered. Table 2.4: 2004 had 37 nests, 3.4 +/- 0.87 per km²; 2005 had 40 nests, 4.8 +/- 0.93 per km².

Tanner & Hendrickson 1956; Iowa

- On 96.4 acres of marsh searched (in a 402 acre area with 28 small marshes) six occupied nests were found. The four successful nests produced a total of 39 young, an average of 9.8 per successful nest, or one young to about 2 acres.

Trautman 1940; Ohio

- Identifies the King Rail as the locally "most numerous nesting rail species" with "more than 50 pairs nesting annually between 1922 and 1930... thereafter 45 pairs or less. Preferred habitats were described as: “Cattail marshes, buttonbush swamps, wet prairies containing coarse grasses, sedges, and bulrushes, edges of marshy pools in swamp forests, and wild rose and blackberry tangles in swampy meadows.”

Twomey 1945; Illinois

- King Rail identified as an incidental visitor in an elm-maple forest where the silt-loamy soil remains saturated year-round in many areas and a stream tributary runs about 400 yards south of the forest.

Viosca 1928; Louisiana

- "Going from fresh to salt water marsh the animal associations change gradually, as do those of the plants. Many of the species named above tolerate brackish water but are absent from the tidal marshes. The fresh water terrapin is replaced by the diamond back, the king rail by the clapper, the strictly fresh water fish disappear and are replaced by salt water minnows and other types, and more or less generally by the young of larger marine species which inhabit shallow water. "

Wayne 1910; South Carolina

- In the month of April 1900 I was observing a nest of this species in a button-wood bush, which was in a pond of water, and, about every other day, I waded into the pond to see how many eggs were there. About the 8th of May, ... a huge Moccasin (*Ancistrodon piscivorus*)... had eaten all the eggs and perhaps caught the bird as the feathers were scattered around the nest.
- I made observations on a nest in the Spring of 1900, and noted that the female laid an egg each day after 11 o'clock in the morning, and upon laying the last egg, which was the twelfth, she began to incubate.

Wilson 1929; Kentucky

- King Rail bred on a large (approximately 300 acres) transient lake that formed following an unusually extended spring rainy season. The King Rail and many other unusual species remained until the lake full dried in mid-July.

Worthington & Todd 1914; Florida

- A King Rail was observed "in the high marsh grass along the shore of the bayou". Horseshoe Bayou is a desolate region surrounded by sand-dunes, covered with bushes and scrub.

Wright 1988; Minnesota

- A King Rail was found in a bank parking lot with two broken legs.

Physical Environment – Climate/Weather

Bales 1911; Ohio

- An abandoned nest found with two muddy eggs was assumed to have been damaged by recent floods from excessive rains.

Gault 1989; Illinois

- A King Rail settled in the backyard of "a house well within the resident section of Chicago" and remained there for the month of May until injured. It's behavior was unusual, "in the manner of a domestic hen".

Henniger 1902; Ohio

- A King Rail observed "on the banks of Crooked Creek".

Hicks 1938; Ohio

- King rail appear to be one species that utilized wetlands created by severe flooding. "By July 15, the twenty-five square miles estimated to have been covered by flood waters [in late June] in the Bellevue area at one time had dwindled to about 1,500 acres of land-locked ponds which slowly decreased in size."

Isely 1912; Kansas

- A dead King Rail, found by a pond where these birds commonly nest, was assumed to have been killed by a recent hail storm.

Meanley 1953; Arkansas

- Several nests were destroyed during periods of heavy rain and consequent flooding of ditches and canals.

Seiple 1931; Pennsylvania

- “The excessive dryness of the country drove the water birds to seek haven in the swamp (Pymatuning) in large numbers.” The checklist included one adult and two juvenile king rail.

Sherman 1909; Upper Mississippi Valley

- Following a heavy rain that turned the yards very muddy, a king rail was observed on a residential road and in a residential yard. It “spent four hours, covering about three acres of a hillside, in its search for food. A portion of the time it spent among the raspberry bushes, the rest of the time it was moving about through the orchard and pasture with all the fearlessness and unconcern of a chicken that was in its own home.”

Biological Environment – Prey

Graves 2001; Virginia

- Describes the feeding behavior of two adult and two juveniles processing a crayfish.

Kennedy 1950; national

- Review of historical USFWS stomach content data concludes King Rail likely do NOT eat dragonflies.

Martof 1956; Michigan

- The study of frog mortality states that “king rail stalk the shallows in search of frogs and tadpoles” but does not provide a citation or data to support this claim.

Meanley 1956; Arkansas

- Animal prey constituted 79% of King Rail diet annually (90% in spring and summer, 58% in winter). Crayfish made up 23% by volume of annual animal diet. Fish were consumed, especially when trapped in shallow waters during drawdown. Aquatic and land insects, frogs were also eaten. Unusual items included remains of a snake and a shrew.

Meanley 1962; National

- Prey items found in King Rail pellets included fragments from: crayfish, aquatic insects, red-jointed fiddler crab, and clams.

Meanley 1969; North America

- “Crayfish are a prime food of the rails and are usually carried to the tops of muskrat houses for eating.”
- The higher King Rail density at Georgetown (4-6 calling KIRA/10 acres plot) than at its upriver tributary Black River (0-2 calling KIRA/10 acre plot) could be attributed to the higher proportion of red-jointed fiddler crabs (*Uca minax*) at Georgetown.
- Savannah River NWR king rail feeding in canals on floating mats of alligatorweed where there were many aquatic insects, fish, crustaceans, and amphibians.

Potter 1928; New Jersey

- Describes foraging behavior of adult King Rail capturing and consuming a small blue crab.

Reid 1989; Missouri

- Food resources had a patchy distribution in space and time. Total prey densities in core samples differed significantly among brood periods (greatest for late brood, then early

brood, then separate young stage) and among locations (greater at water sites than mud or mud/water interface sites). Data were examined by species and period. Brood sites had greater predictability of prey and greater density of prey. Prey availability by taxa also varied through brood stages suggesting potential diet shifts.

Risen 1992; Minnesota

- Describes foraging behavior in water “as deep as its belly” with subsequent capture, dismemberment, and consumption of a painted turtle the size of a silver dollar.

Biological Environment – Predators

Baird 1974; Kansas

- Many problems with mink killing trapped King Rail

Errington 1912; Wisconsin

- King Rail remains found in Great Horned Owl pellets

Errington & Breckenridge 1936; Iowa, Minnesota, and Wisconsin

- King rail remains found in gullet of a Marsh Hawk.

Meanley 1986

- King Rail predated by a Red Fox.

Reid 1989; Missouri

- Raccoon tracks found by 2 of 13 predated nests. Reid suggests that borrow areas along the edges of units might serve as travel lanes for mammalian predators given higher nest failure in edge habitat.

Stevenson & Meitzen 1946; Texas

- Food brought to a Sennett's White-tailed Hawk nest consisted principally of rabbits, rats, and pocket gophers. The birds brought in were King Rail (*Rallus elegans*), Meadowlark, and Dickcissel (*Spiza americana*).

Wayne 1910; South Carolina

- A king Rail nest in a buttonwood bush over water was predated by a huge Moccasin (*Ancistrodon piscivorus*) which ate all the eggs and “perhaps caught the bird as the feathers were scattered around the nest.”

Biological Environment – Other co-occurring Species

Bailey 1928; Louisiana

- The King Rail “is usually a common bird but the only specimen I saw was one caught by a boy in a muskrat trap.”
- Meanley 1956; “Winter specimens [of King Rail] were furnished by a local mink trapper who caught about one a day along his trap line.

Bent 1926; Florida

- A King rail nest with 9 fresh eggs was found in the midst of a colony of grackles and not far from a least bittern's nest.

Bent & Copeland 1927; Florida

- A king rail nest with 9 fresh eggs was found in the midst of a boat-tail grackle breeding colony

Birkenholz 1963; Florida

- Muskrat active in King Rail habitat

Campbell & Campbell 1934; Ohio

- Two adult rails, a male and female, were captured in mink traps

Gower 1939; Michigan

- King rail captured in a muskrat trap in December

Hamilton 1925a; New York

- King rail captured in a muskrat trap in December

Hamilton 1925b; New York

- A King Rail nest which had 50% hatching success (7 of 14 eggs hatched, 7 predated) was found about 60 yards from a Virginia Rail nest.

Kellogg 1929; Southeast US

- King Rail remains found in alligator stomachs

Low 1945; Iowa

- King rail nest and produce young within the nesting and rearing habitat of redhead, but "exerted no harmful effect upon that duck."

Meanley & Meanley 1959; Louisiana

- "Nesting associates of the Fulvous Tree Duck in Louisiana rice fields, in order of relative abundance, are: Redwinged Blackbird (*Agelaius phoeniceus*) , Purple Gallinule (*Porphyrio martinica*) , King Rail (*Rallus elegans*) , Least Bittern (*Ixobrychus exilis*), and Long-billed Marsh Wren (*Telmatodytes palustris*). These nesting associates usually nest in May, June and July, but there are also August records for each."

Meanley 1962; National

- "Pellets usually are deposited in some concealed location where rails prefer to hide while consuming their prey. Characteristic deposition sites are along grassy runways, in a clump of bushes, or behind a clump of grass. However, in Delaware tidal marshes, a favorite deposition site is on a muskrat house or some other high spot in the marsh. As many as 14 pellets were found on a single muskrat house."
- King and Clapper rail occur together in Delaware brackish marshes.

Meanley 1969; North America

- "The distribution of the KIRA's habitat coincides rather closely with that of the muskrat. Muskrats create optimum habitat for rails by opening up marshes and producing networks of pathways leading to plunge holes, and rails use them as drinking places. Muskrat trails are also favorite places for crayfish burrows. The crayfish are a prime food of the rails and are usually carried to the tops of muskrat houses for eating."
- Four KIRA nests in a typical muskrat marsh.
- Figure 19 - KIRA nest with 9 eggs was only 15 ft from a Black Duck (*Anas rubripes*) nest.
- Four pairs of KIRA nested in 10 acres of shrub swamp-marsh mixture in an area where Woodcock were common in late summer.

Meanley 1989; Virginia

- Hybrid King-Clapper rail caught in muskrat trap in Rappahannock River marsh

Miller 1892; Massachusetts

- A King Rail that was caught in a muskrat trap early in February of a very mild winter

Potter 1926; New Jersey

- Documented an aggressive interaction between King and Virginia Rails, with both calling identical calls and rushing at one another. A search of the marsh found one active Virginia nest with 8 eggs and two false nests of the King Rail.

Smyth 1912; Virginia

- "One male brought to me alive, caught by the foot in a musk-rat trap on November 12."

Swales 1896; Michigan

- “On June 9 I was exploring a little inland swamp in St. Clair county Michigan, and ran across a Rail's nest that puzzled me greatly. I flushed a King Rail off the nest, but imagine my surprise when I found it to contain 17 eggs - 9 of the King Rail and 7 of the Virginia Rail, and to cap the climax, one of the Sora Rail. The nest was unusually large, and flattened down. Could all three Rails use the nest as their own or had some of them deserted it while the other rails hatched out the batch of eggs? I would like to have some explanation on the subject.”

Williams 1938; Texas

- A King and Clapper Rail were observed feeding together in a coastal salt marsh.

Factors affecting King Rail detections

Weather conditions

Nauman 1927; Iowa

- Following a late (April) season snowstorm which dumped about 8 inches, a king rail appeared on a farmhouse covered porch, eating food laid out, and remained until the snow melted. The house was about 300 m from a river.

Habitat

Andrews 1973

- “King rails were often sighted on dikes (38 of 106 observations), which they used as travel lanes, but since they were more easily seen here, Table 15 may be somewhat misleading.”

Audubon 1835

- “...they generally confine themselves to places so swampy and covered with briars, smilaxes, and rough weeds, that they are scarcely accessible.”

Trapping methods

Andrews 1973

- Drive trapping (May & June) versus set trapping (year round): 1 to 10.7 for king rail.
- Day trapping versus night trapping: 17 to 1 for immature king rail, 7.5 to 1 for adult king rail
- Capture by trap type: 9 poultry netting traps in 1971 = 2 adult and 10 immature king rail; 51 ramp traps in 1971-72 = 15 adult and 8 immature king rail; bobwire, funnel, drop-door and mist-net methods found to be unsuccessful

Fehon 1952

- “The method used to collect King Rail was relatively simple, being merely a case of sitting quietly in a suitable spot and waiting for the birds to show themselves” and then shooting them with 20 gauge shot-gun.

Meanley 1986: Maryland

- 55 King Rail were captured over a 5 year period in two-cell All-Purpose or Cloverleaf Traps, with two offset entrances and drift fences leading to the entrances or funnels. Twelve Virginia Rails and 17 Soras were also caught in the traps, as were an occasional Common Snipe, Black Duck, Wood Duck. Least Bittern, and Red-winged Blackbird.

Tacha 1975; Kansas

- Table 11: Numbers and ages of rails trapped at three study areas 1975. Attributes excellent trap results in 1975 relative to 1974 to: 1) flat substrate allowed for level effective drift

fences, 2) relatively stable conditions of water and vegetation compared to 1974, 3) little predation by mink, and 4) improved placement of traps and drift fences.

- Traps were moved every 8-10 days to follow changes in water level

Hybridization

Fehon 1952

- Table 8, pp 37: A King-Florida Clapper hybrid's skeletal measurements differed from either parent: 11 were measurements were larger than either parent species, 13 were closer to King rail, and 6 were closer to Florida rail.

Meanley 1969; Delaware

- "During the breeding seasons of 1960-1964, a series of specimens was collected in the Broadway Meadows marsh... Specimens were obtained at three stations: (a) the upper reaches of the brackish marsh at Flemings Landing, where KIRA only were observed, (b) the outer brackish marsh at Woodland Beach on Delaware Bay, where CLRA only were observed, and (3) the intermediate area between these two stations at Taylor's Gut, where both KIRA and CLRA occurred." - pg 9
- "In fact, almost any Coastal Plain river that has extensive brackish marshes and a sizable fiddler crab population is a potential KIRA-CLRA mixing ground."

Olson 1997; Florida

- "18 May 1967... Fred Shanholtzer collected 2 adults and 1 downy young from a pool on the fresh side" of a paved road separating fresh and salt marshes. One adult was a King Rail and the other appeared to be a hybrid KIRA-CLRA.

Rabatsky 1997; Florida

- King and clapper rails detected in saltwater marshes during spring breeding season and responded with equal frequency to each other's calls

Playback Methods

Manic & Rusch 1988; Wisconsin

- "We used descending, advertising calls to elicit responses from both sexes of rails and male calls to elicit responses from bitterns and wrens. Following 2 min of blank tape, three sequences of calls from each of the seven species were recorded consecutively on a cassette tape with a 5- to 10-s pause separating calls of different species. Two min of blank tape and an "end" signal followed." King rails heard during callback survey: Before playback (2 min) = 1; During playback (3 min) = 9; After playback (2 min) = 2

Tacha 1975; Kansas

- Only one nest of a KIRA was found by using taped calls to locate birds, whereas 4 nests were located accidentally during routine activities.

Spatial scales of King Rail observations

Movement

Andrews 1973

- Retraps for 1971 and 1972 included 6 adult and 2 immature king rail. Three of the king rail were recaptured in the same trap as the original capture. Average time elapsed between

captures and average distance between the points of capture were: (1) immature – 4.3 days, 240 feet; (2) adults – 19.9 days, 1411 feet.

- Radio-tracking: One king rail traveled 3600 feet during the 7.5 hour daylight period, before the signal was lost.

Johnson 1950; Indiana

- A King Rail juvenile was captured one morning from its family group. When returned the next morning, the family had “not moved far since the previous afternoon” and as I approached the adult responded to the cries of the captive.

Meanley 1986

- Recaptures of interest for interannual movement: (1) an adult retrapped the following year approximately 50 feet from where banded; (2) an adult banded August one year was caught in the same trap in June the following year; (3) an immature banded at one of the impoundments was found dead at a Red Fox den, three years later, approximately one mile from where the rail was banded.
- Recaptures of interest for seasonal movement: (1) a six-week old chick banded July 12, 1968, was recovered in the same impoundment as late as December 12, 1968.

Tacha 1975; Kansas

- One KIRA banded as an adult by Baird on 14 June 1974 was retrapped in the same area at Cheyenne Bottoms on 2 August 1975. It was captured with 5 downy young and a second adult was moving around the trapsite giving the "tuk-tuk-tuk" call along with guttural grunts.

Comments on King Rail productivity and survival

Eggs & Nest Success

Andrews 1973; Ohio

- At least four different broods were observed in 1971, with two to seven chicks. Only 1 juvenile king rail was observed in 1972 and it was fully capable of flight.

Baird 1974; Kansas

- Three nests observed: Nest One "in alkali bullrush...contained 12 eggs... [all] hatched"; Nest Two "containing 12 eggs was located in alkali bullrush in 3 inches water... hatched June 9"; and Nest Three "dense alkali bulrush in 1 inch water near trap... two cold eggs... trapping activities over three days probably forced abandonment"

Bales 1911; Ohio

- Nine nests observed. The eight active nests had 10-12 eggs/nest, with mean of 10.875 eggs. The inactive nest had been damaged by flooding (two mud covered eggs).

Bowdish & Philipp 1910; North Carolina

- A King Rail nest was found at Ellis Lake (possibly Ellis Simon Lake?) with “ten eggs advanced in incubation”.

Hamilton 1925; New York

- A King Rail nest in a marsh but over dry ground “was found on May 24, when it contained thirteen eggs. On the next visit, one week later, fourteen eggs were observed.”
- Seven eggs hatched between June 16 and 20. My next trip to the nest was on the 21st, when I found seven eggs remaining, all punctured and the contents drained by some animal.

Harlow 1918; Pennsylvania & New Jersey

- “Data on five nests give, average set 9 or 10 (6-13); average date, June 5 (earliest, May 30)”

Hiemenz 1984; Minnesota

- A King Rail nest is destroyed by cattle trampling the sedge at edge of bog.

Meanley 1953; Arkansas

- Of 16 nests observed, 3 were abandoned. The successful nests had clutch sizes of 8 to 14 eggs/nest, with a mean of 10.8. Most of these nests were in canal/ditch habitat.
- Twelve of 13 active nests hatched at least one egg, with five of the thirteen hatching full clutches. Of 147 eggs laid (in 16 nests by including three abandoned nests) 80.9 percent hatched.

Reid 1989; Missouri

- Over 5 year study period most nests were started between 3rd week May and 1st week June and the mean hatch date of all successful nests was 30 June. Incubation averaged 21 days.
- For 55 nests observed, mean clutch size was 10.5 eggs (range 8-13 eggs). 54 (81%) of the nests were successful with 39 (58%) hatching complete clutches. Mammalian predation (raccoon) appeared the likely cause of the 13 nest failures.
- Logistic regression of nest success in response to water depth, distance to open water, vegetation height, and vegetation stem density, found significant ($p < 0.10$) correlation between water depth (positive) and distance to open water (negative) – but there was strong correlation between these two explanatory variables
- Second log-linear model comparing nest success by location (marsh units with and without drawdown during the nesting period) and habitat (marsh, seasonally flooded, or borrow ditch) found that nests located at edges of drawdown units or in borrow ditches were 300 times more likely to fail than those located at interior of non-drawdown units.

Tacha 1975; Kansas

- A nest which contained 12 eggs hatched on 31 May.
- Two other nests of KIRA were found on 12 June 1974. Each was situated in alkali bullrush, one above 3 and the other above 8 cm of water. One contained 12 eggs which hatched 19 June...the other contained 2 cold eggs; disturbances due to trapping in the immediate area may have caused desertion.

Tanner 1953; Iowa

- Table 29, page 96 and 101: Size of Complete Clutch (13, 13, 8, 14) plus one unknown as "complete" but 12 eggs present when nest first found and 12 eggs hatched when revisited.
- Table 29, page 96: 4 of 6 nests failed due to nest destruction by mammal and/or bird
- Table 29, page 96: Number of egg hatches per nest: 11 of 13, 5 of 8, 11 of 14, 12 of 12.
- Each field was systematically searched for nests by a crew of 2-4 people walking 10-20 m apart. Crews walked parallel until the entire field was covered. Table 2.4: 2004 had 37 nests, 3.4 +/- 0.87 per km²; 2005 had 40 nests, 4.8 +/- 0.93 per km². Table 2.5: Mean Clutch Size 2004 was 9.32 +/- 0.35 and 2005 was 9.06 +/- 0.35. Table 2.5: Daily Nest Survival Rate 2004 was 0.979 +/- 0.0058 and 2005 was 0.977 +/- 0.0074. Table 2.5: Mayfield Nest Survival 2004 was 52.1 and 2005 was 50.03

Tanner & Hendrickson 1956; Iowa

- On 96.4 acres of marsh searched (in a 402 acre area with 28 small marshes) six occupied nests were found with total of 60 eggs, of which 39 hatched from 4 successful nests. This was translated to an average of 9.8 per successful nest, or one young to about 2 acres.

Wayne 1910; South Carolina

- A water moccasin ate all the eggs and perhaps the parent of a King Rail brood.

- A female “laid an egg each day after 11 o'clock in the morning, and upon laying the last egg, which was the twelfth, she began to incubate.”

Chicks & Fledgling Mortality

Andrews 1973

- At least four different broods were observed in 1971, with two to seven chicks. Only 1 juvenile king rail was observed in 1972 and it was fully capable of flight.

Baillie 1940; Ontario

- Five dark immature birds of this species were observed together in one of the marshes bordering the lower Humber River
- Three dark immatures were seen together at a small cat-tail marsh on golf course, then four days later, at the same site, one immature bird was observed with one adult.

Burtch 1946; New York

- One adult and one juvenile repeatedly observed foraging at the cattail/mud edge.

Delap 1979; Oklahoma

- An adult king rail observed foraging on a mudflat with at least 6 chicks, still with black down, “about a third-grown.”
- An adult with one juvenile, “no longer black but dusky with a whitish front”, crossed the road near the ditch.

Duvall 1937; Virginia & North Carolina

- A family group (2 adults and at least 5 young approximately 2 weeks old) was shot while crossing a road between brackish marsh habitats on Knott's Island, June 1.

Graves 2001; Virginia

- Family group with two adult and two juveniles observed foraging together.

Hicks 1933; Ohio

- An adult with at least four young observed at Pymatuning Bog, “a crescent-shaped area of about twenty-five square miles of mostly wooded swamp and bog”

Howell 1910; Illinois

- An adult King Rail with two young in a small marshy pond in the river bottoms.

Meanley 1953; Arkansas

- “The number of young in 10 broods ranged from 2 to 9 with an average of 5. If average hatching success is 9.9 (based on the 12 study nests), then survival rate, after two weeks, is about 50 per cent.”

Meanley 1986; Maryland

- “An adult King Rail and eight chicks approximately two weeks of age, caught in a trap on July 8, 1966”

Spiker 1927; Iowa

- Documented “featured victims of the automobile” while touring by bicycle. Noted one juvenile carcass by a paved road, but no adult carcasses and no carcasses by dirt or gravel roads.

Tacha 1975; Kansas

- Young were seen repeatedly at Cheyenne Bottoms in 1975, despite finding no nests. The first, caught by hand in alkali bullrush on 19 June, was estimated to be about 1 week old. A brood of 5 (about 2-3 weeks old) was seen on a mudflat on 11 August.

- Table 11: Numbers and ages of rails trapped at three study areas 1975. KIRA only caught at Cheyenne Bottoms - 21 locally hatched, 8 hatched this year but maybe not within study area, and 11 adult "after hatching year" birds. 29 juveniles to 11 adults in one study area = 2.63 juveniles/adult in traps
 - One trap event: 5 young, two adults (one adult in trap and one outside)
- Williams 1919; Florida
- Observed one adult with one "half-grown" juvenile in late May.

Adult Mortality

Farley 1905; Massachusetts

- An emaciated King Rail was caught on the ice of a small pond in the Fresh Pond marshes and soon died.

Kuerzi 1926; New York

- A freshly dead adult male King Rail was found in a tidal saltwater marsh during a severe February hail storm, with a wind injury.

Johnston & Haines 1957; national

- King Rail mortality noted from airport ceilometer laser beams.

Meanley 1956

- "Most stomachs representing the nesting season were taken from dead rails found along local highways."

Meanley 1986

- A three year old King Rail was found dead at a Red Fox den approximately one mile from the impoundment where the rail was banded when immature.

Pettington 1946; Texas

- An adult King Rail found impaled on a barbed-wire fence that ran along a minor road through a marsh.

Wolfe 1994; Kansas

- A dead King rail found impaled on barbed wire fence running east-west along US Highway 75

Wright 1988; Minnesota

- A King Rail was found in a bank parking lot with two broken legs.

Sexual ID

Fehon 1952

- Pp 68-69: Clear evidence of sexual dimorphism in skeletal structure, with male rails larger than female counterparts.

Management practices and king rail

Water level management

Andrews 1973; Ohio

- Pp. 84-103: Summer drawdown, aimed at providing food for fall migrating ducks, led to the establishment of smartweed-millet-cyperus community by about mid-August in 1971 and 1972. Rails returned to these areas when they were reflooded, with most activity in the areas where the flooded vegetation was bordered by cattails and marsh mallow.

Mounts 1930; Georgia

- Many new or rare water and marsh bird observations, including King Rail, were attributed to (1) an unusually wet Spring following two dry years, and (2) the establishment of a duck and game preserve in an old clay pit area south of town and near the river. King Rail observations were made in a meadow where wet seasons produce a “reedy, marshy” area between two streams.

Reid 1989, Missouri

- “On intensively managed refuges, a complex of wetland units should include marsh habitat that naturally dries during summer and may include extensive perennial vegetation.”

Burning

Vogl 1973, Florida

- Counted birds over a 4 month period immediately post-burn (vs unburned control) along a wet prairie 30 ha impoundment pond shore in north Florida. In absence of fire, the wetland had a heavy grass mat that covered water and soil and impaired new plant growth. More birds were observed in burned than unburned habitat (754 vs. 236), but only one King Rail was observed. It occurred in the burned habitat.

Ditching & Draining or Water Drawdown for Irrigation

Gabrielson 1914; Iowa

- A natural prairie pothole farmland that had been observed for several years (1907-1911) surrounding land has been drained in 1911, eliminating the swamps and ponds. A visit during August, 1913 resulted in only five species of birds (Tree Swallow, Barn Swallow, Bartramian Sandpiper, Killdeer, and Meadowlark) in a region where in 1910 or 1911 from forty to fifty species (including King Rail) could be noted any August day.

Hicks 1935; Ohio

- Based on study from 1924 to 1933, the author concluded: “[Human activity was] indirectly responsible for the disappearance of three [bird species formerly abundant in Ohio stream valleys] due to the lowering of water levels: the King Rail, the Virginia Rail and the Marsh Hawk.”

Trautman 1940; Ohio

- Provides strong anecdotal support for negative effects of agricultural ditching and stream straightening on KIRA populations. Prior to wetland conversion to agriculture in 1930s, “more than 50 pairs nesting annually... thereafter 45 pairs or less. This change resulted chiefly from the effectual draining of the swamplands north and east of the lake.”

Recreational & Development Activities

Graves 2001; Virginia

- “Several breeding pairs of rails... were habituated to human foot traffic on the elevated boardwalk that winds through emergent stands of rushes, cattails, and lizard's tail in the central wetlands of [Huntley Meadows Park].”

Neubeck 1992; Minnesota

- Foraging behavior within 200 yards of US highway.

Wolfe 1994; Kansas

- Mortality on barbed wire fence near US highway.

Jones 1906; Ohio

- King Rail observed to have declined from common to rare because “this bird is being rapidly crowded from its former haunts into the great marshes which still remain unexploited by steel works and ship yards.”

King Rail (*Rallus elegans*) Literature Review

30 April 2007

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This literature review was conducted for the purpose of developing GIS based species-distribution models to aid in the USFWS in stepping down national population objectives to regional and refuge levels. Data from each article is being summarized in LitReview Central, a new bird literature review database developed by Dr. Ed Laurent at NCSU. This review is still in progress. The data characteristic, “mappable”, indicates that the species data can be linked to one or more mapped landcover classes or mapped landscape features. Please contact Ashton for further information, or if you identify missing citations.

Publication Category	Category Description	Number of Articles
Quantitative mappable data	Publications provide a date, measured landscape or landcover variable, and response in terms of abundance, density or productivity	13
Qualitative mappable data	Publications provide an observation in terms of abundance, density or productivity, with description of associated habitat	88
Comments without mappable data	Literature reviews, most atlas or breeding birds summary reports, and publications where either the date or habitat was not mentioned in association with bird observations	48
Not relevant	King Rail were not mentioned in the text (often true where a king rail publication was cited in references), study was outside the geographic region of interest (North America), or study had no relevance to species-habitat associations (e.g. English study on origin of species' common names, paleontological studies, geographic location rather than habitat type noted)	126
Library still seeking	A few publications remain in the NCSU Interlibrary Loan pipeline	8
		Total = 283

Publications with quantitative mappable data

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