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Cover Page Footnote

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Distribution and Reproduction by the Purple Gallinule (*Porphyrio martinica*) in Arkansas

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Running Title: Purple Gallinule in Arkansas

Abstract

The Purple Gallinule (*Porphyrio martinica*) is a rare bird in Arkansas, and its populations likely have declined due to loss of marshy areas with emergent vegetation. By use of online sources for citizen science combined with a field study, we elucidate the current distribution of this bird in Arkansas, and document characteristics of reproduction and development. Purple Gallinules arrive in Arkansas as early as April and remain to late October. Nesting occurs from early May into July, and nests may represent second broods. Ontogenetic changes in in plumage and bill coloration hatchlings are described.

Introduction

Baerg (1931) observed that the Purple Gallinule (*Porphyrio martinica*) had not been reported from Arkansas, but believed it likely was a rare summer transient in Arkansas because it was apparently common in Louisiana. However, James (1974) wrote that this bird was formerly common in low wetlands from Pulaski and Lonoke counties and southward, but the species was informally listed as an endangered breeding bird in Arkansas due to limited habitat.

Larger breeding colonies of Purple Gallinules had existed in abandoned fish farms in the Grand Prairie region near Stuttgart until about 1954, when colonies declined after reclamation by agriculture (James and Neal 1986). Similarly, regular breeding by Purple Gallinules in southern Oklahoma was observed when neglected fish hatchery ponds had become chocked with vegetation, but breeding birds disappeared when the ponds were cleaned (Baumgartner and Baumgartner 1992). Because 90% of historic wetlands in Arkansas have been drained for agriculture, wetland vegetation declined, followed by declines in Arkansas populations of this bird (Budd 2007).

The most recent summary of information regarding the Purple Gallinule in Arkansas was compiled by James and Neal (1986). At that time, this marsh bird was known as a local migrant or summer resident in Chicot, Columbia, Crittenden, Hempstead, Jefferson, Lafayette, Lonoke, Pike, and Pulaski counties. Evidence of reproduction was seen in the presence of flightless young at some of these locations. The birds had been observed in cattail-lined lily-pad ponds or in flooded fields and ditches that had suitable vegetation. Because gallinules have especially long toes for walking on marsh vegetation, their habitat options are limited in Arkansas. Data gaps now exist in terms of current distribution, habitat, and reproduction.

Currently, Arkansas has a hunting season for these birds. As has been for many years, the 2019-2020 Early Migratory Bird Season for Common (*Gallinula galeata*) and Purple Gallinules was 1 September – 9 November, with daily limits of 15.

Materials and Methods

To determine distribution and dates of migration, we compiled records verified by the Arkansas Audubon Society and published on their website (http://www.arbirds.org/aas_dbase.html), the citizen science website hosted by the Cornell Lab of Ornithology (https://ebird.org/explore), and reports on the discussion list ARBIRD-L (ARBIRD-L@listserv.uark.edu) hosted at the University of Arkansas. These sources included not only records of sightings, but comments describing presence and appearance of young, indicating reproduction.

Study Site. – We discovered a population of Purple Gallinules at the oxidation ponds (part of the Arkadelphia water treatment facility) 4 km S of Arkadelphia in Clark Co., and followed their behavior and reproductive cycle through the summer of 2019. There, a rectangular pond of about 300 x 140 m (= 4.2 ha), develops a thick growth primarily of 2 plants. A tall plant reaching heights of about 1.2-1.5 m (4-5 ft.),

Smooth Bur Marigold (*Bidens laevis*, family Asteraceae) dominated the pond and provided feeding and hiding cover, and elevated perches. A shorter (< 0.3 m, or 1 ft.), trailing plant, Floating Marsh Pennywort (*Hydrocotyle ranunculoides*, family Apiaceae) grew along the banks and was scattered in a mosaic pattern among the *B. laevis* across the pond. Gallinules foraged and nested among both plants.

Adults and their young were philopatric to small territories on the pond. Over a period of several weeks, we photographed hatchlings (Nikon D7000 camera with DX 300 mm lens, distances between 10-35 m) from 2 nests at our study site, and used these images of known-aged birds to estimate ages of other young found at our study site, as well as images provided by citizens on e-bird. These data were used to estimate timing of reproduction for nests of otherwise unknown hatching dates. Detailed observation of nests and chicks was limited to those found within about 35 m of the bank.

Having estimated hatching dates of chicks based on patterns of development in size and plumage, we further back-dated to estimate the dates of nest completion. Incubation period has been measured at 18-22 d (Gross and Van Tyne 1929; Grimes 1944; Trautman and Glines 1964; Matthews 1983). We used an estimate of 20 d to determine the likely timing of nest completion and onset of incubation.

Results and Discussion

Distribution: The first Purple Gallinule recorded from Arkansas was in Hempstead Co. on 28 May 1939, followed by one in Prairie County on 25 August 1940. The earliest reported date in Arkansas was in northern Arkansas (Benton Co.) on 9 April 2010. Records of the birds across appropriate habitats in Arkansas continue almost uniformly through the spring and summer, with the last bird sighting reported on 21 October. The birds tend to become summer residents in marshland habitats near river systems (Arkansas, Ouachita, Red, and White) and their tributaries. Reported locations, including rare observations, are included in Fig. 1. As these records are composited from "citizen science", it must be remembered that the data do not represent a systematic survey, and that less accessible habitats also may support summer residents and nesting pairs.

Most sightings record only a few birds, but good habitats have produced higher counts on a given day, e.g.: Arkansas County at Arkansas Post (26); Hempstead County at Lester Sitzes III Bois d'Arc WMA (36); Howard County at Millwood Lake (10); and Pulaski County at Faulkner Lake (25). For this reason, these sites are visited often by birders wishing to see this rare species in Arkansas.

Examination of historical distribution shows the longest term of continued occurrence in the lowlands of the eastern Arkansas River area, and in southwestern Arkansas near the Red River system (Fig. 2). From 1939-1969, the species was recorded from Arkansas, Chicot, Columbia, Hempstead, Jefferson, Lincoln, Logan, Lonoke, Perry, Prairie, Pulaski, and Woodruff Cos. During the decade of 1970-1979, the bird was reported from only 4 cos. including the addition of Crittenden and Union Cos. From 1980-1989, these gallinules were reported from 5 cos. including 4 new cos. (Howard, Lafayette, Pike, and Pulaski). From 1990-1999, occurrence was reported in 4 cos. including the addition of Cleburne and Scott.

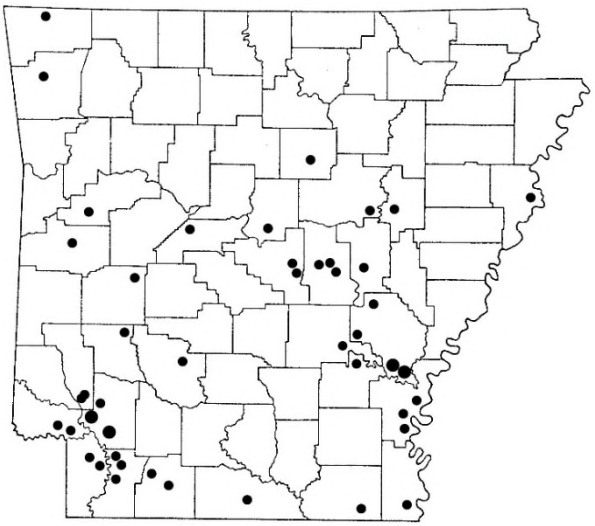

Figure 1. Distribution of Purple Gallinules (*Porphyrio martinica*) in Arkansas based on literature and records compiled in ebird.com. Dots indicate locations of observation, and larger dots (Arkansas and Hempstead Cos.) indicate "hot spots" frequented by birders due to public accessibility and expectation of seeing marsh birds.

Interest in birds and reporting of records increased after 2000. From 2000-2009, observations were reported from 10 cos., with new records for Clark, Desha, Faulkner, Little River, Miller, and White Cos. Ashley, Benton, and Montgomery Cos. were added from 2010-2019, and birds were reported from 13 cos. during the decade. To date, Purple Gallinules have been recorded in 29 counties.

Nesting, Eggs, and Hatching: Apparently, the first record of Purple Gallinules breeding in Arkansas was an observation from 1947 reported by Baerg (1951) in

Lonoke Co. James (1974) reported a second nest observed in Woodruff Co. in 1967. Although few other details of nesting have been reported in Arkansas, successful reproduction is evidenced wherever flightless young birds are seen. Birds described by citizens as chicks, poults, juveniles, immatures, young, or fledglings have been reported in Arkansas, Chicot, Clark, Hempstead, Howard, Lafayette, Lonoke, Miller, Pulaski, and Woodruff Cos. (Fig. 2). These observations reflect more recent nesting in those counties.

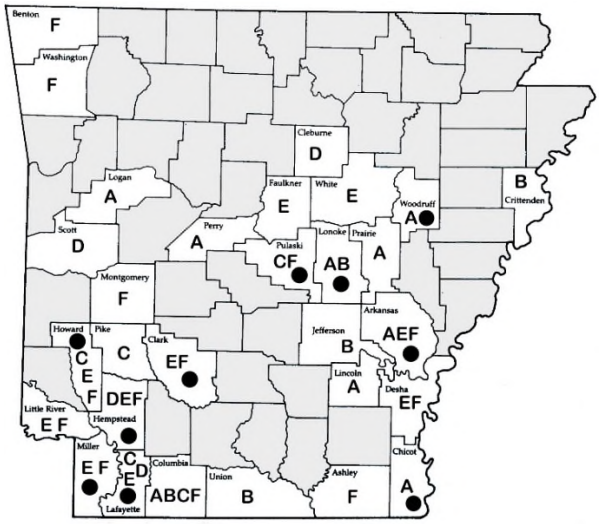

Figure 2. Historical distribution of Purple Gallinules in Arkansas. Unshaded counties have records, and lettering represents time frames for the records: A = 1939-1969, B = 1970-1979, C = 1980-1989, D = 1990-1999, E = 2000-2009, and F = 2010-2019. Dots indicate counties in which breeding has been reported.

James (1974) commented that nests often were made of cattails in shallow marshes having open water, tall weeds, and floating vegetation. Abandoned rice fields, similar to natural habitat, were thought to be suitable for nesting. Rice fields, especially those lined by ditches, support breeding Purple Gallinules in the Gulf Coastal Plain of southwestern Louisiana, where the species is common (Pierluissi *et al*. 2010). However, no breeding Purple Gallinules were detected closer to Arkansas in rice fields of the Mississippi Alluvial Valley in northeastern Louisiana (Valente *et al*. 2012). Similarly, Budd and Krementz (2011) found Purple Gallinules at only 2 sites in the Mississippi Alluvial Plain of eastern Arkansas, and no evidence of breeding except the observation of a bird at Arkansas Post National Memorial carrying nest material.

Records from eBird and ARbird web sites document nests at Joe Hogan State Fish Hatchery in Lonoke Co. from 1955-1957, on dates ranging from 4 June – 5 July. Also, in Lonoke Co., nests were observed at Anderson Minnow Farms on 7 July 1971.

We found 3 nests at the Clark Co. site. On 15 June, we located a nest with 3 newly-hatched black chicks. This nest was positioned in an open area, about 10 cm above the water and consisted of leaves of *B. laevis*, *B. laevis* pulled over the top of the nest. The female incubating the eggs sat with her wings slightly spread, presumably providing shelter against the heat. On 10 August, a third nest was found elevated about 0.5 m above the water, in *B. laevis*, and the nest composed of its leaves. These nests are consistent with the descriptions of the 3 nest types found in southern Louisiana rice fields (Helm 1982), and plant materials there included *Hydrocotyle* (Helm *et al*. 1987). Based on images of young in Arkansas, available on e-Bird, other plants used as habitat and associated with nesting populations include American Water Lotus, (*Nelumbo lutea*), Water Hyacinth, (*Eicchornia crassipes*), Alligator Weed, (*Alternanthera philoxeroides*), cattail, (*Typha* sp.), and Smartweed (*Polygonum* sp.).

In Arkansas, eggs in nests have been reported on dates ranging from 28 May – 12 June (James and Neal 1986). Consistently, more recent online reports also note nests with eggs in Lonoke and Hempstead Cos. from late May to mid-June. At our Clark Co. site, we found eggs in nests on 15 and 27 June. By use of age estimates of 14 clutches of chicks (10 at our site and 4 images posted online), we calculated (assuming a 20-day incubation period) that eggs would have started incubation on dates ranging from 3 May – 9 July. Egg dates in Texas ranged from 9 April – 12 August (Oberholser 1974).

From earlier records, James and Neal (1986) reported clutch size as 4 – 6 eggs. Our field records plus online comments show a clutch size of 3 – 6 ($\bar{X}$ = 4.6, mode = 5) based on 9 clutches of eggs. Estimated and known hatching dates together ranged from 23 May – 29 July.

Ontogeny of Young: We examined our series of images to determine changes detectable in birds of known age. Ontogenetic changes in appearance of young are illustrated in Fig. 3, and are consistent with Helm (1982). Hatchlings were black and fuzzy, and their beaks were reddish at the base, transitioning to black then whitish (which could form a band around the beak). Blackish coloration continued to near the tip of the beak, which had a white dot on top (the egg tooth, which disappears within 3 weeks). At 14 days, young were overall larger, but the neck and legs had elongated compared to the body. Otherwise, coloration

of the beak was less discrete, but the body still was uniformly black.

By 23 days, young became buffy (light brown) along the underside of the body from the face to the tail. The back was becoming lighter as well, but the back of the head and neck were black, and 2 black streaks were present from the thoracic region to the rump.

By 31 days, legs and toes were well-developed, feathers on the wings were becoming distinguishable, and only short dorsolateral streaks of black feathers were visible above and anterior to the wings. After this period, young birds became overall buffy with no black coloration, and elongation of remiges were the best indication of age. Full adult coloration did not appear in any of the immature birds we observed, though tinges of adult bluish coloration were becoming apparent on the wings as the birds were able to begin flight.

As the beaks age, the differences in color become less apparent and a dark region expands up the forehead behind the reddish base of the beak. This structure continues to expand forming a forehead shield that will become a turquoise color at maturity.

***Second Clutches and Maturation*:** Our estimated dates of hatching were bimodal, with somewhat continuous dates from 3 May to about 7 June followed by a gap of over 3 weeks, after which 5 clutches were produced in late June and the first 1.5 weeks of July. Further, we observed 2 instances in which juveniles from a territory that produced a successful nest were helping younger birds on the same territory. Those juveniles moved to cover and guide the chicks into protective vegetation upon our approach. Thus, we interpreted the chicks to be from a second clutch by the same pair of adults. A similar presumed second clutch with fledged juveniles caring for younger birds, and both responding to vocalizations of the adult, was witnessed on 15 September 2019 in Arkansas Co. Helpers in Purple Gallinules can increase reproductive success of the breeding group (Hunter 1985). Multiple clutches with juveniles as helpers are known in tropical populations (Krekorian 1978) and presumed in coastal North America (Grimes 1944, Helm 1982, West and Hess 2020).

Most adults had migrated from the Clark Co. site by 13 September, but we found a lone adult on 19 October. Several fledged, buffy juveniles remained on this date and were assumed to have migrated later. However, the smaller birds from later clutches, which had not fledged at our last observation, may have succumbed to cold weather.

***Foods and Care of Offspring*:** Adults tend to consume invertebrates (West and Hess 2020). Photos from Arkansas show dragonflies (Amberwing, *Perithemis tenera*, and a pennant *Celithemis* sp.) and an unidentified crayfish being eaten. Young forage in the territory of the parents, and respond quickly to parental vocalizations by seeking cover within vegetation (West and Hess 2020). In the oxidation ponds, dipterans are abundant and are expected to be the primary food base. We witnessed young feeding among the *H. ranunculoides*, and running for shelter when adults vocalized.

Acknowledgments

We thank the many bird enthusiasts who systematically collect and report observations of birds. We thank Dan Scheiman for his efforts in updating the eBird data base for Arkansas birds, which made this project much easier to conduct. Brett Serviss identified the plants.

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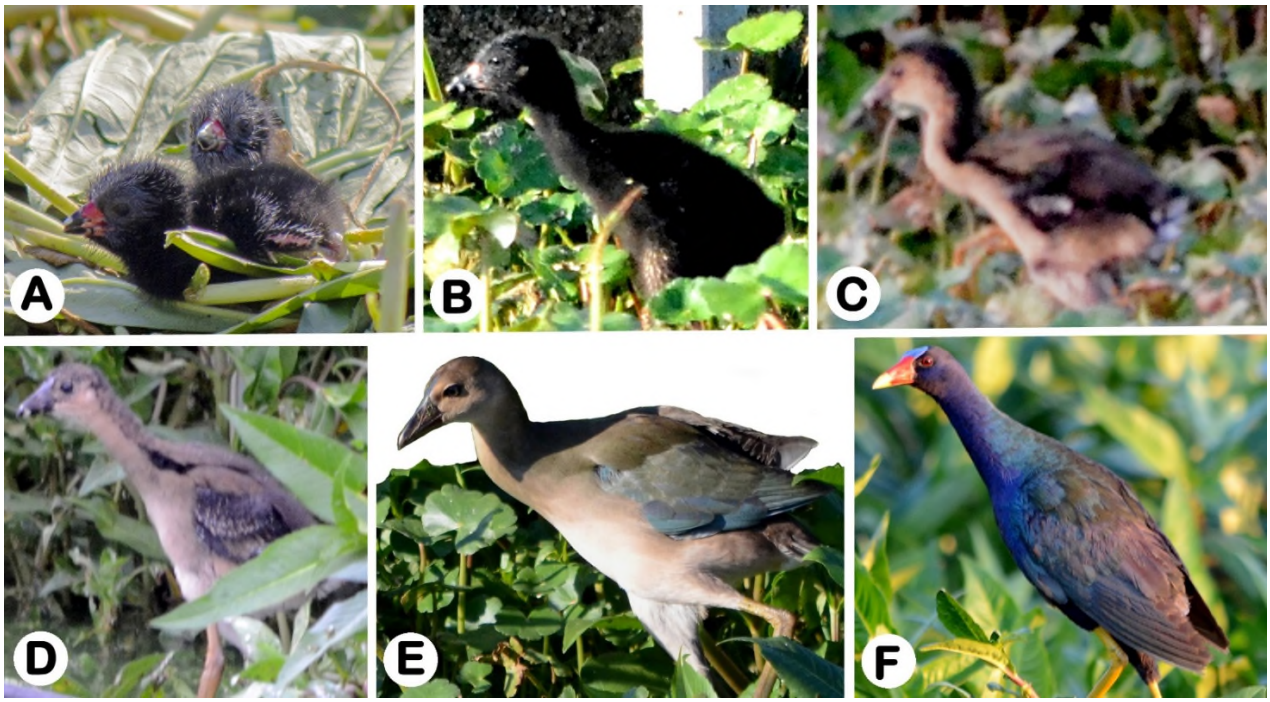

Figure 3. Ontogeny of development of chicks of Purple Gallinules in Clark Co. A: newly hatched chicks are covered in black fuzzy down. The beak is reddish at the base, transitioning to black then whitish (sometimes forming a band around the beak), then blackish continues to near the tip of the beak, which has a dorsal white dot. B: at 14 days, young were overall larger and still black but less fuzzy, the neck and legs had elongated. Reddish coloration of the beak was less discrete. C: by 23 days, young became buffy along the underside of the body from the face to the tail. The back was becoming lighter, but the crown and neck were black, and 2 dorsolateral black streaks were present from the thoracic region to the rump. Color distinction on the beak was increasingly blurred. D: by 31 days, legs and toes were well-developed, feathers on the wings were becoming distinguishable, and only short dorsolateral streaks of black feathers were visible above and anterior to the wings. Some distinction of coloration on the beak remained, but the formerly reddish region appeared reduced as the forehead shield developed up the face. E: after this period, young birds became overall buffy (darker dorsally and lighter ventrally) with no black coloration, and elongation of remiges was the best indication of relative age. The beak became more uniformly grayish, and the facial shield extends to the level of the eyes though it does not obtain adult coloration. Full adult coloration did not appear in the plumage or facial shield of any of the immature birds we observed, though tinges of adult bluish coloration were becoming apparent on the wings as the birds were able to begin flight. Images are not to the same scale.