Limpkin (Aramus guarauna) establishment following recent increase in nonnative prey availability in Lake Seminole, Georgia

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Limpkin (*Aramus guarauna*) establishment following recent increase in nonnative prey availability in Lake Seminole, Georgia

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ABSTRACT—The Limpkin (*Aramus guarauna*) is a medium-sized wading bird found in peninsular Florida and Central and South America, whose distribution is strongly tied to the presence of apple snails (genus *Pomacea*). Historically, Limpkins have been infrequently observed in the lower Apalachicola-Chattahoochee-Flint (ACF) watershed, including Lake Seminole, the most downstream reservoir in the system. In the past decade in Lake Seminole, a rapid increase in the nonnative *P. maculata* has been documented. In 2016, a Limpkin was observed in the lake, and we made efforts to document all subsequent Limpkin observations there. In the following year, we observed Limpkins (including several mating pairs) each month from February to July 2017. Limpkins were only observed in the Flint River section of the reservoir, the same area where the greatest abundance of *P. maculata* has been documented. We hypothesize the rapid increase of *P. maculata* is responsible for the recent regular Limpkin observations at the lake because observations of Limpkins prior to the recent expansion of *P. maculata* were rare and infrequent. Apple snails are likely to expand within the southeastern United States in the future, thereby creating additional suitable habitat for Limpkins and other specialist avian predators of apple snails. *Received 28 July 2017. Accepted 8 August 2018.*

Key words: apple snail, invasive species, Limpkin, predator-prey interaction, range expansion.

Establecimiento del carao (*Aramus guarauna*) en respuesta al incremento reciente de disponibilidad de presas no-nativas en Lake Seminole, Georgia

RESUMEN (Spanish)—El carao o carrao (*Aramus guarauna*) es un ave vadeadora mediana que se encuentra en la Florida peninsular, Centro y Sudamérica cuya distribución está ligada a la presencia de caracoles del género *Pomacea*. Historicamente, *A. guarauna* fue observada con poca frecuencia en la cuenca baja de Apalichola-Chattahoochee-Flint (ACF), incluyendo Lake Seminole, el embalse más aguas abajo del sistema. En la década pasada se documentó un rápido incremento de *Pomacea* no-nativos en Lake Seminole. En 2016, se observó un *A. guarauna* en el lago e hicimos esfuerzos para documentar todas las observaciones subsecuentes de esta especie. Al siguiente año, observamos a *A. guarauna* (incluidos varios individuos emparejados) cada mes de febrero a julio de 2017. Solo observamos a *A. guarauna* en la sección de Flint River de este embalse, misma donde se ha documentado la mayor abundancia de *P. maculata*. Hipotetizamos que el rápido incremento de *P. maculata* es responsable de las observaciones regulares recientes de *A. guarauna* debido a que los registros de esta ave antes de la expansión reciente de *P. maculata* eran raras y poco frecuentes. Es muy probable que los caracoles colonicen otros sitios del sureste de los Estados Unidos en el futuro, creando con ello hábitat disponible adicional para *A. guarauna* y para otras aves depredadoras especialistas de este caracol.

Palabras clave: especies invasoras, expansión de rango, interacciones depredador-presa, *Pomacea maculata*.

Limpkins (*Aramus guarauna*) are largely solitary, medium-sized, marsh birds common throughout wetlands and marshes of peninsular Florida, the Caribbean, and Central and South America. The Limpkin call is easily distinguished across marsh habitats and is useful in surveying these social birds, particularly given their camouflaged coloration (Conway 2011). Limpkin distribution is driven by the availability of their principal prey, apple snails (genus *Pomacea*), which may constitute >70% of their diet (Cottam 1936). Accordingly, presence of apple snails, specifically the Florida apple snail (*Pomacea paludosa*), has been a strong predictor of Limpkin presence in peninsular Florida (Snyder and Snyder 1969). Recently, nonnative *P. maculata* have been introduced across the *P. paludosa* range and are expanding throughout freshwaters of the southeastern United States (Benson 2017). When *P. maculata* and *P. paludosa* co-occur, the larger *P. maculata* appear to displace *P. paludosa* (Posch et al. 2013), which has consequences for predator foraging and prey handling of the larger *P. maculata* (Darby et al. 2007).

Methods

Study area

Lake Seminole is a 15,261 ha impoundment in the Apalachicola-Chattahoochee-Flint (ACF) watershed, located in southwestern Georgia (Fig. 1). The impoundment of the Chattahoochee and Flint

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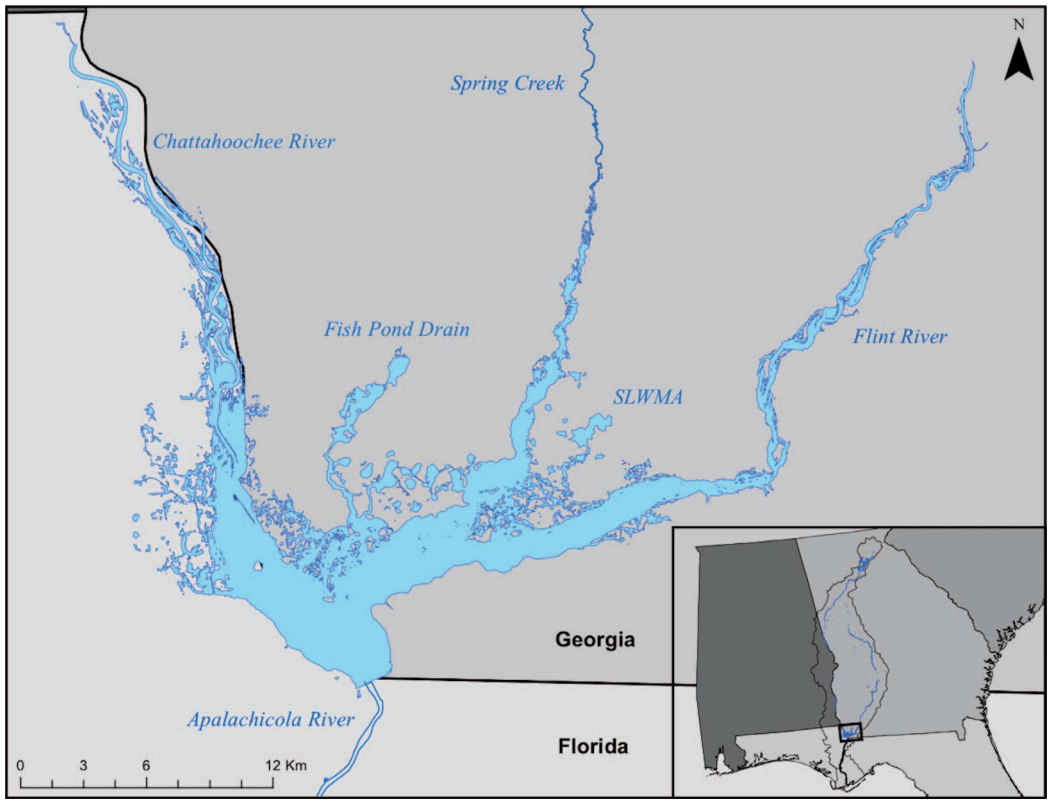

Figure 1. Location of Lake Seminole in the Apalachicola-Chattahoochee-Flint (ACF) watershed (inset). Major surface water inflows are included, as well as smaller drainages.

Rivers in 1953 created Lake Seminole and altered hydrological and biological processes in the basin and in the Apalachicola River, which is formed below the dam outflow. Lake Seminole is a run-of-the-river reservoir with a low water storage capacity, noted for its ability to significantly transform biogeochemical processes through hydrologic variability and the seasonality of submerged aquatic vegetation (SAV) across the lake (Shivers et al. 2018).

Limpkin observations

We began concentrated surveys to look and listen for Limpkins during our routine monthly sampling on Lake Seminole starting in July 2016. Observations and calls were recorded into a spatial database along with date, bird counts, and notes on behavior. Limpkins, among other marsh birds, are noted as social birds and responsive to calls (Conway 2011). We initiated call and response surveys using Limpkin calls obtained from the Cornell Lab of Ornithology and broadcasted over the lake using a JBL Flip 3 Bluetooth speaker, following the call and response methodology described in Conway (2011).

Following our surveys, we consulted historical observations obtained from online birding databases (e.g., eBird, AviBase, NatureServe, and BirdLife). We reviewed these databases for Limpkin observations to help determine if its historical range included the ACF basin and to find the most recent observations in the ACF (Sullivan et al. 2009). We consulted with the Georgia Department of Natural Resources (GADNR) and the Georgia Museum of Natural History for their records of Limpkins in the lower Flint River basin, including Lake Seminole.

Results

The first Limpkin observed was a fortuitous encounter on 11 July 2016. The bird was seen in a

Table 1. Limpkin observations on Lake Seminole starting in July 2016. Each observation corresponds with the number of birds observed at each date, a behavioral classification, and whether the bird responded to call and response cues.

Date	Bird count	Behavior	Call/response
11 Jul 2016	1	Wading	Yes
2 Feb 2017	1	Foraging	No
8 Feb 2017	1	—	No
1 Mar 2017	2	Depredating apple snail	Yes
4 Apr 2017	2	Wading	Yes
10 Apr 2017	2	Standing in tree and on boat dock	No
2 May 2017	1	—	No
30 May 2017	1	Wading	No
1 Jun 2017	1	—	No
13 Jul 2017	3 (2 separate sightings)	—	Yes
24 Jul 2017	1	Wading	No
25 Jul 2017	2 (separate sightings)	Wading/standing in a tree	No

wetted channel connecting the Flint River and Spring Creek during regularly scheduled sampling on Lake Seminole. Following this first observation, we observed Limpkins on 7 separate occasions on Lake Seminole (Table 1). Following the initial sighting, no birds were observed until 2 February 2017, but subsequent observations occurred monthly through July 2017. We were unable to determine if we observed the same bird more than once, but our observations suggested that several individuals were present along the Flint River arm of the reservoir (Fig. 2). Also, pairs were observed on several occasions, including a pair on 1 March 2017 that actively depredated an adult *P. maculata*. We observed this pair removing the snail from the water and removing the snail tissue from the shell (Fig. 3). Limpkins were observed in the upstream reaches of the Flint River arm of Lake Seminole (Fig. 2). Farther downstream, multiple observations occurred along a stretch of developed shoreline on the southern shoreline of the Flint River arm, an area corresponding to the greatest number of *P. maculata* egg masses observed during shoreline surveys from 2013 to 2016 (Marzolf et al. 2018). Limpkins were also observed on several occasions along the northern shoreline of the Flint River arm and in the connecting channels to Spring Creek. Depredated *P. maculata* shells were observed in aggregations on the shoreline with increasing frequency across the areas where Limpkins were observed.

The eBird database showed no records of Limpkins in the Lake Seminole area, but recent observations in the ACF basin were noted in Albany, Georgia, ~129 km north. Starting in July 2016, Limpkins were frequently documented in northern Albany and other locations closer to the Flint River, which runs through the city. The AviBase database reports Limpkins as rare in Georgia (Lepage 2017). The BirdLife database reports Limpkins as native throughout Florida and a small area in southeastern Georgia, no records exist in the ACF basin or in southwestern Georgia (BirdLife 2017). NatureServe reports Limpkins as "Critically Imperiled" in Georgia, although this designation is based solely on records from southeastern Georgia (NatureServe 2017). GADNR reported Limpkin calls from Lake Seminole and observed one bird consuming an adult gastropod (*Campeloma* spp. or *Viviparus* spp., not *Pomacea* spp.; J. Wisniewski, GADNR, pers. comm.). The Georgia Museum of Natural History reported no Limpkin observations from the Flint River basin in their records (N. Castleberry, Georgia Museum of Natural History, pers. comm.).

Discussion

Limpkin occurrences in Lake Seminole further highlight the potential implications of continued expansion of nonnative apple snails. The rapid increase of *P. maculata* in the lake has been thoroughly documented (Marzolf et al. 2018), primarily in the Flint River arm of Lake Seminole, with rapid expansion into the other arms of the lake. We documented Limpkins in the area of the lake with highest density of *P. maculata* egg

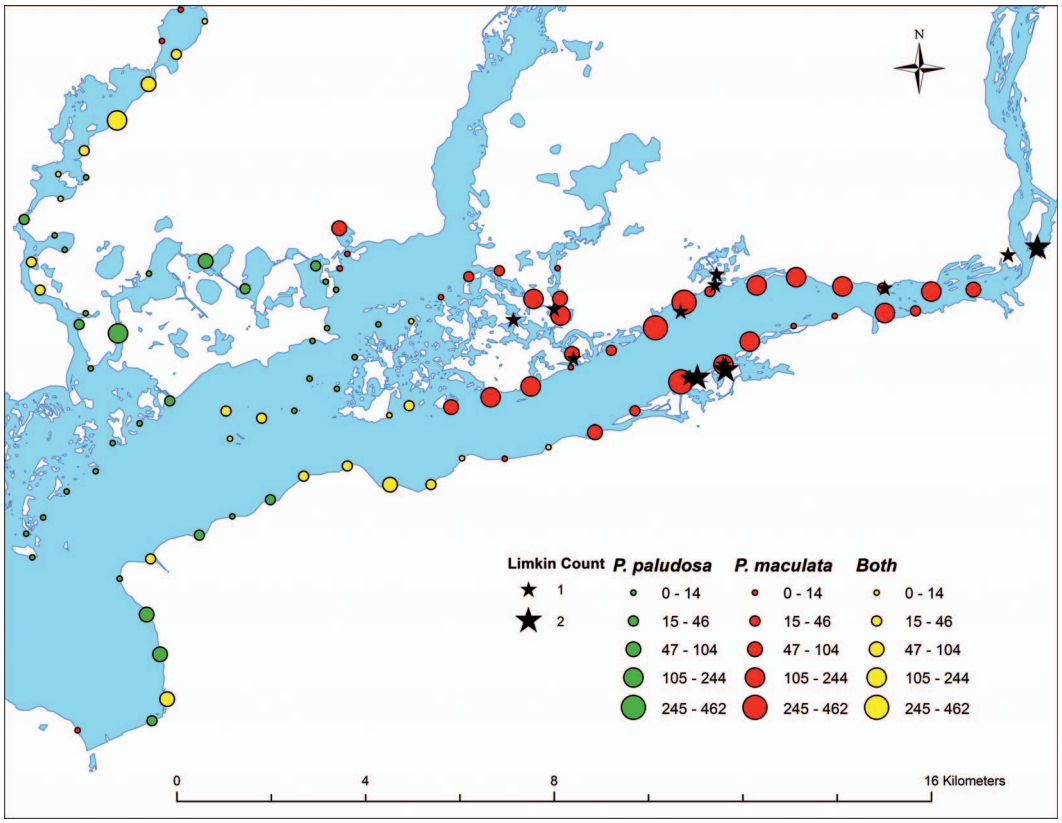

Figure 2. Limpkin observations in Lake Seminole indicated by black stars, starting in July 2016. Larger stars are proportional to number of Limpkins observed at each date. Colored circles represent apple snail egg masses: red (*P. maculata*), green (*P. paludosa*), and yellow (both species). Circles are proportional to the number of egg masses observed in July 2016.

masses. Further, we observed and photo-documented predation by Limpkins on *P. maculata* in this area (Fig. 3).

The documented increase in *P. maculata* has led to questions on the changing food web and predator–prey interactions following their introduction. Our observation of Limpkin predation (Fig. 3) was the first observed predation event in Lake Seminole by our research group. Difficulties in answering aquatic predator–prey questions relate in part to the diversity and abundance of both prey and predators in the lake, but the Limpkin–apple snail interaction might be easy to document because the birds are terrestrial and aggregate snail shells. Ample prey availability in Lake Seminole, including other snails and mussels, suggest that Limpkin establishment in the area is sustainable. In addition, projections toward regional warming will likely increase *P. maculata* range, and similarly expand the Limpkin range (Byers et al. 2013).

The current *P. maculata* distribution extends from North Carolina to Texas across the southeastern United States (Benson 2017), greatly expanding possible foraging habitat for Limpkins if the birds disperse into new areas containing invasive apple snails. The recent increases in *P. maculata* in Lake Seminole have resulted in more frequent observations of Limpkins and likely represent a range expansion of Limpkin within the southeastern United States. We conclude that the establishment of Limpkins in Lake Seminole is in response to increases in prey availability and raises further questions on the suitability of Lake Seminole for other avian predators of apple snails, notably the Snail Kite (*Rostrhamus sociabilis*). Like the Limpkin, the range of the Snail Kite may be expected to expand in the future as a result of

Figure 3. Sequence showing Limpkin foraging an adult *P. maculata* from Lake Seminole (top left), moving to solid ground (top right), extricating snail tissue from shell (bottom left), and walking away with snail tissue in its beak (bottom right). Photos taken at ~50 m on 1 March 2017.

regional *P. maculata* increases, combined with projected increases in regional temperatures to a more tropical climate favoring *P. maculata* (Byers et al. 2013, Hopkinson et al. 2013).

Limpkin call records dating back ~10 yr from the Georgia DNR suggest a historical Limpkin presence in the lake (J. Wisniewski, pers. comm.). Online databases suggest Limpkins are infrequent to absent in the lower Flint River basin. Our observations suggest that the recent expansion of *P. maculata* in the lake may allow a sustained population of Limpkins, at least throughout the Flint River arm of the lake. We have observed *P. maculata* activity throughout the year, ensuring a reliable source of food for Limpkins (Marzolf et al. 2018). Continued *P. maculata* expansion will likely increase the range of the Limpkin foraging habitat across the entirety of Lake Seminole and allow interaction with native *P. paludosa*, which rarely co-occur with *P. maculata* for extended periods in the lake (Marzolf et al. 2018). Additionally, GADNR provide evidence for Limpkin predation on non-*Pomacea* snails, which suggests that historical native snail populations, including *P. paludosa*, may have been sufficient to sustain at least a low level of Limpkin foraging.

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