

# Highlight: The Past, Present, and Future of American Alligators (*Alligator mississippiensis*) in the Lower St. Johns River

## H1. Background

Alligators are one of the most iconic species in the United States and part of the cultural identity of Florida (Alderson 2020). They can play important ecological roles in aquatic ecosystems through predation and ecosystem engineering (Somaweera et al. 2020) and they contribute significantly to Florida's tourism, hunting, and farming economies (Rosenblatt et al. 2021). Yet despite their cultural, ecological, and economic status, alligators in the Lower St. Johns River (LSJR), and across their entire range, are frequently maligned and marginalized by human society, typically seen as nuisance animals at best and vicious eating machines at worst. Human activities have pushed alligators out of some of their historical habitats and limited their population growth in the LSJR, and we are increasingly making life difficult for them in a variety of ways. In this section of the report, I will provide an overview of the history of alligators in the LSJR, how modern research is shedding new light on their behaviors in urban environments, and what the future holds for these important Florida animals.

## H2. The Past: “Incredible Numbers” to “Nearly Exterminated” and Back Again

A French artist, Jacques Le Moyne de Morgues, accompanied the 1564 colonization expedition of Rene Goulaine de Laudonniere as he established Fort Caroline at the mouth of the St. Johns River in the area now known as Jacksonville, FL (de Bry and Le Moyne 1591). The artist's depictions of the indigenous Timucua people included scenes where they hunted, killed, and cooked alligators, and these are the earliest known images of alligators in North America. Though Le Moyne did not make any attempt to quantify the number of alligators in the region, it is clear from his account that alligators were common and abundant (de Bry and Le Moyne 1591).

It took 200 years for another alligator account from the LSJR to surface, and it came from the explorer and natural historian William Bartram. He traveled widely in north Florida and the LSJR in the 1770s and wrote extensively about the alligators he saw (Bartram 1791). In one of his most well-known passages, Bartram wrote:

“...the river (in this place) from shore to shore, and perhaps near half a mile above and below me, appeared to be one solid bank of fish, of various kinds, pushing through this narrow pass of St. Juans [St. Johns River] into the little lake, on their return down the river, and that the alligators were in such incredible numbers, and so close together from shore to shore, that it would have been easy to have walked across on their heads, had the animals been harmless.”

Though this vision of alligators packed so densely that one could walk across their heads is almost certainly an exaggeration, it suggests that even as recently as the late 18<sup>th</sup> century the LSJR supported a remarkably large alligator population.

The alligator story started to shift in the late 19<sup>th</sup> century as their hides became popular in the leather industry (Barrow Jr and Woodward 2022). Alligator hunting was widespread in Florida during this time, and the U.S. Fish Commission issued a report in which they estimated that at least 2.5 million alligators were killed in Florida just between 1880 and 1890, with most of the hide trade occurring in Jacksonville (Smith 1893). The report went on to say, “in the St. Johns River . . . the alligators are very nearly exterminated in that part of the river below Palatka, and above that point the number is becoming less year by year. . . a skillful hunter could easily secure 600 alligators in two or three weeks.” Even though it was obvious that alligator populations were declining rapidly in the LSJR and the rest of Florida, alligator hunting remained unregulated by the state for another 50 years (Barrow Jr and Woodward 2022). To add insult to injury, alligator populations in Florida were also increasingly threatened by habitat destruction resulting from the post-WWII development boom in the state (Barrow Jr and Woodward 2022).

Though it is debatable how close alligators actually came to extinction, concern amongst federal government wildlife officials was high enough that alligators were listed as “endangered” in the 1966, 1969, and 1973 versions of federal endangered species legislation (Barrow Jr and Woodward 2022). With strong federal protections in place alligator numbers rapidly rose in many parts of their range, and especially in Florida (Barrow Jr 2009), because wetlands were still abundant in many areas and female alligators can lay large numbers of eggs per year. Today, the Florida Fish and Wildlife Conservation Commission (FWC) estimates that Florida supports around 1.3 million alligators. We do not have the ability

to accurately estimate alligator population sizes in centuries past so we cannot directly compare modern populations to those from long ago, but Florida's current alligator population is considered stable and thriving.

### H3. The Present: Do Urban Lifestyles Suit Alligators?

Alligator populations have certainly grown across Florida over the past 50 years, but how are alligators in the LSJR specifically doing? The FWC estimates alligator population sizes in the southernmost part of the LSJR (Lake George and the portion of the LSJR near Welaka) from annual population surveys. According to these estimates, between 1989 and 2016 the adult alligator population (> 1.8 m total length) increased in Lake George and Welaka by 91% and 191%, respectively. This is clearly a strong growth, but the FWC does not survey the portion of the LSJR that flows through Jacksonville. Accordingly, our knowledge of how alligator populations are affected by living in the heavily urbanized part of the LSJR is lacking.

Starting in 2018, my students and I began surveying nine tributaries of the LSJR to estimate the relative density of alligators in the Jacksonville area (Fig. H1). We chose these tributaries because they span a gradient of urban development, from the mostly undeveloped Black Creek to the heavily developed Arlington River (Fig. H2). During July of each year, we drive a boat 8 km upstream in each tributary and use spotlights to locate alligators via their "eyeshine." Whenever we spot an alligator, we get as close as possible to visually estimate its body size, then assess the habitat it occupies relative to the available habitat upstream and downstream from its location. Before beginning the research, we hypothesized that alligators would be more abundant in the tributaries that are less developed. We also hypothesized that alligators would mostly avoid human structures (docks, houses, bridges, hardened shorelines) and instead prefer to occupy more naturally vegetated shorelines (Fig. H3). Our hypotheses were informed by two previous studies of alligator populations in "urban-influenced" areas in Texas, which found that alligators generally avoid habitats with the highest levels of human activity (Lewis et al. 2014; Eversole et al. 2018).

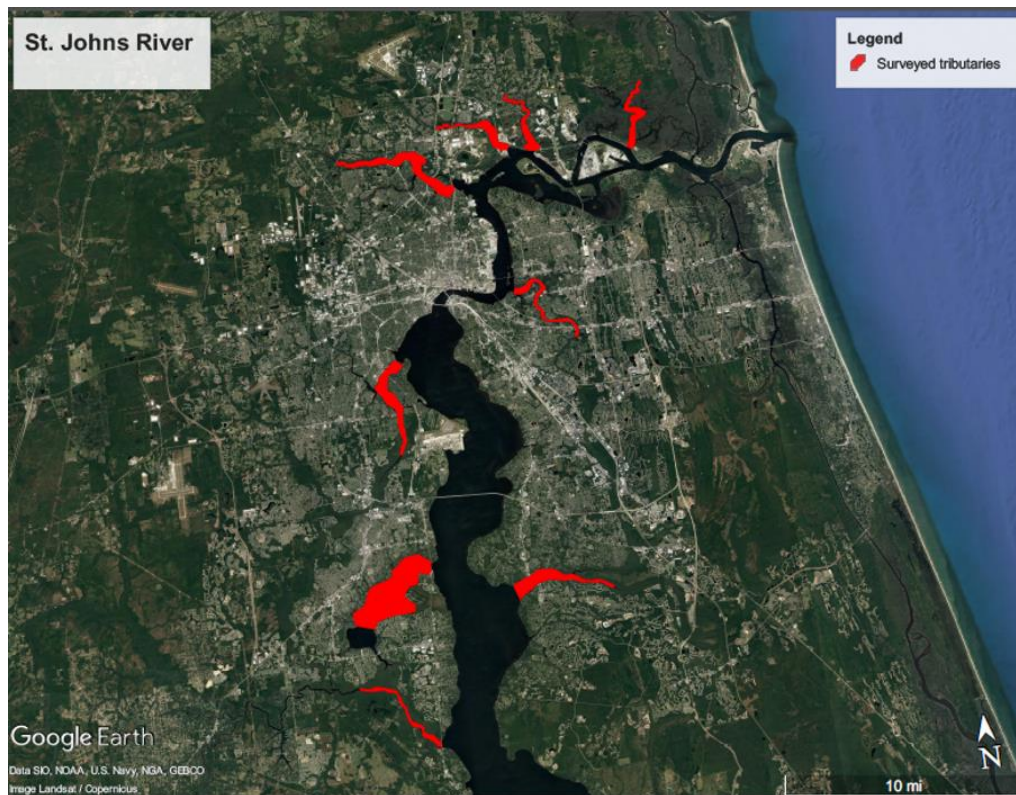


Figure H1. Map of the Lower St. Johns River as it flows through Jacksonville, FL. The tributaries surveyed as part of the urban alligator research study are highlighted in red. The tributaries, from south to north are: Black Creek, Doctors Lake, Julington Creek, Ortega River, Arlington River, Trout River, Broward River, Dunn Creek, and Clapboard Creek.

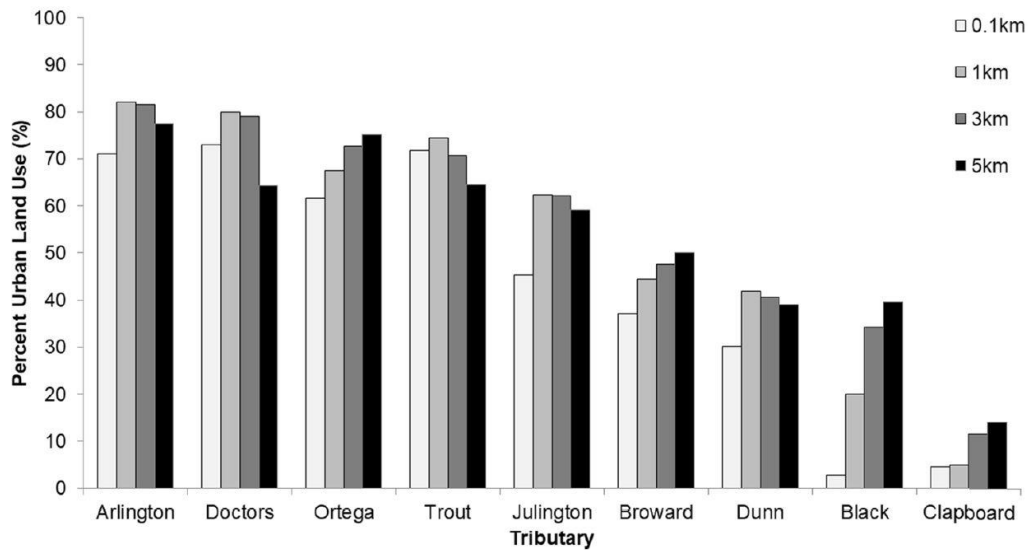


Figure H2. Percentage of land classified as “urban” around nine tributaries of the LSJR. The different shades represent urban percentages within different distances from each tributary, from 0.1 km to 5 km away (Beal and Rosenblatt 2020).



Figure H3. An alligator exhibiting its preference for natural vegetation in Jacksonville, FL. Small alligators like this one (approximately 1.2 m total length) generally seek out vegetation because it provides cover to hide from larger, cannibalistic alligators.

A statistical analysis of our initial surveys revealed that our first hypothesis was not supported (Beal and Rosenblatt 2020). Alligator relative density across all tributaries was not significantly affected by the amount of urban development. Rather, alligator spatial distribution within the LSJR in the Jacksonville area was primarily determined by water salinity. We found that alligators strongly avoided the saltiest tributaries closest to the Atlantic Ocean and instead chose to inhabit freshwater tributaries further upstream. This result is not particularly surprising given that alligators are known to be sensitive to salinity and abandon habitats when salinity rises (Lauren 1985; Rosenblatt and Heithaus 2011). Another analysis, though, showed that our second hypothesis was supported: we found that within each tributary alligators avoided human structures and preferred habitats with naturally vegetated shorelines. Surprisingly, during our surveys, we spotted only one adult alligator; all the rest were either hatchlings, juveniles, or subadults. This pattern has held through all the years of our surveys. Between 2018 and 2022, we were able to estimate the body size of alligators 182 times, and only three were large enough to qualify as adults.

The most likely explanation for the lack of adults is that adult alligators in the LSJR near and within Jacksonville have been removed by hunters or nuisance alligator trappers over time. According to hunter harvest data from the FWC, between 2011 and 2022, there were 281 alligators harvested in Duval County (where Jacksonville is located), all exhibiting an average length of only 228.3 cm. This puts Duval County alligators in the bottom 25% of all Florida counties in terms of body size



and suggests there are not many large adults in this part of the LSJR. The adults who remain in the county have likely learned to avoid areas with human activity and adopted more cryptic lifestyles. The nuisance alligator data from the FWC tell a similar story. Between 2006 and 2018, the average total length of nuisance alligators captured in Duval County declined from 185 cm to 145 cm.

The picture that has emerged through our research is that small alligators can still be found in the Jacksonville portion of the LSJR, but the adult population is small and isolated. Recruitment into the adult population is probably very low because once individuals attain adult sizes, they have a higher chance of being hunted or trapped. The young alligators in the Jacksonville portion of the LSJR generally distribute themselves to avoid tributaries with high salinity water and areas with lots of human structures and activity within each tributary. My lab has documented similar patterns within Jacksonville's retention ponds. We rarely find adults in these ponds, and the small alligators that do inhabit the ponds are restricted to those near Guana Lake, a protected reserve just south of Jacksonville that contains approximately 1300 alligators (unpublished data). This suggests that alligators do not disperse easily across urbanized environments.

## **H4. The Future: Climate Change and Urbanization Could Reshape Alligator Populations**

Alligators, as a species, are in no danger of extinction any time soon. Across their range, alligator populations are considered healthy and stable after enduring steep declines during the 20<sup>th</sup> century. In fact, alligators are held up as one of the best conservation success stories in the history of the United States (**Barrow Jr 2009**). Despite their remarkable recovery, there are threats on the horizon. These threats are unlikely to cause species-wide collapse, but alligator populations in certain areas could suffer, including in the LSJR.

The first threat is climate change-induced drought. Climate research has shown that drought frequency and severity are increasing across large sections of the U.S., including areas with sizable alligator populations like east Texas, most of Louisiana, and north Florida (**Ficklin et al. 2015**). The reason drought is a potential problem for alligators is because alligator egg mortality increases dramatically as humidity declines (**Reigh and Williams 2020**). The water content of an alligator nest is primarily determined by the amount of rain that hits the nest (**Chabreck 1975**), so if droughts were to occur in the middle of alligator nesting season across multiple years, it could lead to extremely low hatching success rates and population declines.

The second threat is climate change-induced warming. As climate change continues and air temperatures keep rising, the balance of males and females in alligator populations could be thrown off. The sex of hatchling alligators is determined by the incubation temperature within the nest, with low and high temperatures producing females and temperatures in between producing males (**Lang and Andrews 1994**). Rising air temperatures can influence the temperature within the egg chamber and could skew sex ratios toward females over the coming decades (**Bock et al. 2020**). Alligators may be able to compensate for rising temperatures by building their nests in cooler microclimates (**Bock et al. 2020**), but there may not be adequate nesting habitat for most females to make this switch. If alligator populations become strongly female-biased, then reproduction rates would drop and cause a population decline over time as well.

The third threat is salinization of coastal habitats that have historically supported alligators. This is a problem for alligators because they are sensitive to salinity, and multiple studies have shown that alligators in coastal habitats generally avoid areas strongly affected by seawater (**Rosenblatt and Heithaus 2011, Fujisaki et al. 2016**). One cause of salinization is climate change-induced sea level rise, whereby coastal habitats like those in and around Jacksonville will become flooded with seawater more frequently (**Weiss et al. 2011**). Another cause of salinization is river dredging, a process that has occurred repeatedly in the LSJR to accommodate larger ships. River dredging is known to impact salinity regimes, but the extent of salinization depends on a range of factors that vary across river systems (**Miller 2023a**). When the U.S. Army Corps of Engineers modeled the potential environmental impacts of deepening Jacksonville Harbor, which occupies the 20 miles of the LSJR closest to the Atlantic Ocean, from 40 to 47 ft, they concluded that the project would only cause "minor" changes in the salinity regime and that any ecological impacts of increased salinity caused by dredging would be "minimal" (**USACE 2014a**). However, they also stated that "Uncertainty exists about the magnitude of both the effect of deepening on salinity and the ecological response to changes in salinity." If salinity in the downstream portion of the LSJR does increase appreciably because of dredging, I would expect alligators in the area to relocate further upstream. My lab is continuing to survey the tributaries of the LSJR so we can monitor how alligators respond to dredging over the coming years.

The last threat is continued urban development. Urban land area in the southeast U.S. is expected to grow between 101% and 192% by 2060, including in some parts of the LSJR (**Terando et al. 2014**). My lab's research has demonstrated that alligators become marginalized and isolated in urban environments because they prefer habitats with natural vegetation and avoid areas with a lot of human structure and activity when possible. Large alligators in urban areas are also targeted for removal by hunters and nuisance alligator trappers, thereby limiting population size.

## **H5. Conclusions**

Alligators have a rich history in the LSJR, first as part of Timucua culture and now as part of Florida culture. Alligators also play important roles in the ecology and economy of Florida and have shown remarkable resilience in the face of overexploitation, habitat destruction, and degradation. However, the future for alligators in the LSJR is not secure due to four interacting threats: droughts, rising temperatures, salinization, and urbanization. Any one of these threats by themselves could significantly impact the LSJR alligator population in terms of abundance and distribution. All four occurring simultaneously make it all but certain that the LSJR alligator population, especially in and around Jacksonville, will undergo dramatic changes over the coming years and decades. If we do not take steps to protect the LSJR alligator population in and around Jacksonville, there is no guarantee that alligators will continue to exist here.

The most impactful conservation actions for alligators would involve more tightly regulating land development in and near wetlands, limiting further river dredging, and reducing greenhouse gas emissions that are driving climate change. Limiting land development would have the most immediate positive impacts on the LSJR alligator population, while reducing greenhouse gas emissions is more important over the long term. Along with these efforts, it is imperative to continue to educate the public about alligator history and behavior as well as the contributions alligators make to the ecology and economy of the LSJR and the entire state. Only through increased knowledge and appreciation will people come to realize that it is better to live in a world with alligators than a world without them.