Final Performance Report

Office of Conservation Investment

U.S. Fish and Wildlife Service

OK T-126-R-1 An assessment of American alligators in southeastern Oklahoma: Evaluating presence-absence, dispersal, movements and habitat requirements.

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Federal Award Recipient Contact(s):

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Public Description:

This grant is intended to study populations of American alligators in southeastern Oklahoma with the overall aim of determining key elements of population dynamics and informing future management plans. The objectives and approaches outlined in the following proposal aim to determine presence-absence of alligators in various aquatic habitats of southeastern Oklahoma, quantify movement patterns of dispersing juvenile alligators at Red Slough Wildlife Management Area (RSWMA), and to examine habitat requirements of different size classes of alligators at RSWMA.

Federal Award Accomplishments				
Strategy	**Proposed Objective**	**Activity**	**Unit of Measure - Proposed**	**Unit of Measure - Reported**
Research, Survey, Data Collection and Analysis	Conduct investigations (legacy)	Fish and wildlife species data acquisition and analysis (legacy)	1 Investigations	1 Investigations

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Project Statement: OK T-126-R-1 An assessment of American alligators in southeastern Oklahoma: Evaluating presence-absence, dispersal, movements and habitat requirements.
Project Statement Approval Status: Final Approved

Objective Name: Objective 1: Complete 1 investigation by December 31, 2024

Strategy: Research, Survey, Data Collection and Analysis
Proposed Objective: Conduct investigations (legacy)
Pertains to R3: No

Activity Performed: Fish and wildlife species data acquisition and analysis (legacy)
# of Investigations: 1
Principal Investigator: Jake Pruett
Geographic Location:

- General Location: Oklahoma
- Includes Marine Federal Waters: No
- Detailed Location:
    - Bryan County
    - Choctaw County
    - Johnston County
    - Marshall County
    - McCurtain County
- Location Description:

  Our primary study site will be RSWMA (McCurtain County) where we will use telemetry and GPS tracking to document movements, habitat use, and dispersal. We will conduct spotlight surveys at RSWMA, Grassy Slough WMA (McCurtain County), along the Red River to and in Lake Texoma (McCurtain, Choctaw and Bryan Counties), within Tishomingo National Wildlife Refuge (Johnston and Marshal Counties), and along the Little River and lentic bodies of water within the Little River National Wildlife Refuge (McCurtain County). Any administrative/office activity will take place at Southeastern Oklahoma State University, 425 W. University Blvd., Durant, OK 74701.

Activity Report Comments

Objective 1.

Overall, we had very few alligator detections outside of RSWMA. We surveyed sites in Love (n=2), Marshall (n=6), Johnston (n=3), Bryan (n=10), Choctaw (n=8), and McCurtain Counties (n=12). Of the 39 water bodies we surveyed, we detected alligators at 7 locations. One of those detections occurred on the Marshall and Bryan County line, so the alligator was recorded as one detection for both counties. We recorded a total of 19 alligator detections with 3 occurring during daytime surveys and 16 occurring at night. The total shoreline distance surveyed was 200.7 km for an average of 0.09 alligators per km. For comparison, we conducted nighttime surveys at RSWMA with the same method in May 2023 and recorded 78 total alligator detections over 32.9 km of shoreline for an average of 2.37 alligators per km.

Most alligator detections occurred in McCurtain County (Figure 3). We recorded 14 total alligator detections at 12 sites, but 13 of those occurred at one location, Ward Lake. Ward Lake is just outside the boundary of RSWMA, and alligators can move between the WMA and Ward (see results for objective 2 below). We recorded 2 alligator detections in Choctaw County in 2 different water bodies, but it is worth noting those water bodies were in close proximity on the same parcel of private land close to the Lower Kiamichi River. We recorded 3 detections in Bryan County in bodies of water in and near the north end of Lake Texoma. As mentioned above, one of the alligators observed was an adult located on the Marshall and Bryan County line. No alligators were observed in Love and Johnston Counties.

We surveyed reservoirs, wetlands, ponds/borrow pits, and creeks/old river channels. The majority of our detections occurred in reservoirs, but primarily those within RSWMA (Fig. 4). The only wetland habitat surveyed was within RSWMA, and alligators were commonly observed within that habitat type. No alligators were detected in Oxbows despite surveying 9 oxbow lakes close to RSWMA, Ward Lake, and the Red River.

We proposed surveying river systems in southeastern Oklahoma but have yet to conduct those surveys due to time and logistical constraints. Furthermore, some of the river systems have limited access. We have identified access points and acquired drones to conduct surveys when alligators are most likely to be basking (sunny days in late March to early May based on observations at RSWMA). We plan to conduct those surveys in spring 2025 at no cost to ODWC or this grant.

Objective 2.

We collected data on movements and dispersal of 17 juveniles (9 males and 8 females) captured at RSWMA. One juvenile, a female, was tracked during both years. The dataset includes 4 juveniles captured just prior to and tracked through the winter of 2022/2023, and 3 individuals from a cohort dispersing from their natal den in 2024. Body size of telemetered juveniles ranged from 400-800 mm SVL, but even the largest individual tracked was just under the body size cutoff for what is considered a juvenile alligator.

Movement frequency and transmitter retention varied among individuals. Thus, the number of locations and tracking days was also highly variable (Table 1). The number of locations recorded ranged from 6-24, and tracking durations ranged from 33-186 days. We recorded at total of 200 unique locations that were used in analyses of movement patterns as well as habitat use and home range size (objective 3 results given below). For juveniles tracked in the winter months, very little activity was observed from December-early March. By mid-March, most animals began making short distance movements away from overwintering sites, but one individual remained within and in close proximity to a den until April. For the individuals tracked from the same natal den in project year 2, dispersal from the natal area did not begin until July. Those individuals made independent movements of varying sizes but came back together at a new location after leaving the natal area. After a short second period of association, the siblings began making apparently independent movements again until all three eventually entered Push Creek. At that point, one transmitter detached. The other two juveniles continued to make what appeared to be independent movements, based on travel routes and timing of movements, until they eventually reached Ward Lake.

Movement patterns varied with some individuals moving further from their initial locations than others. Some observed distances between subsequent locations were as small as 7 meters while the greatest distance moved between subsequent locations was 2.7 km. However, we did not find any statistical differences in movement distances between juvenile male and female alligators (Fig. 5). All tracked individuals utilized multiple units within RSWMA, and movement among units may be facilitated by deeper areas alongside levees and Push Creek. It is evident that some overland movements occurred including a few individuals crossing Mudline, Blackland, and Crystal Hollow Roads. Through both years of tracking, we confirmed that four juveniles dispersed to private lands, including WRP land, adjacent to RSWMA.

Objective 3.

Home range size and habitat use of juveniles

Juvenile home range sizes were variable and ranged from 1.06-159.9 ha (Table 1; Figs. 6 and 7). Small home range sizes were observed in 3 juveniles and excluded from analysis. Qualitatively, one of these home ranges centered around a den in Push Creek that was used during an extended hot and dry period of the summer of 2024. We suspect that juvenile utilized the den as a refugia during this period. The other two juveniles with small home ranges had already dispersed from their natal areas. One of those was captured and tracked in year 1 then again in year 2. The home range for year 2 (2 ha) was considerably smaller than the home range from year 1 (79 ha). The other juvenile was originally captured 2 years prior with presumed siblings at an overwintering den near Bittern Lake. This juvenile was among the largest captured for the study and would potentially reach sexual maturity in the next 1-2 years. Larger home ranges appeared to be in part attributed to long dispersal movements as indicated by the elongated polygons (see Figs. 6 and 7). We found no statistically significant differences between average home range sizes of juvenile male and female alligators in either year 1 or 2 of the study (Fig. 8).

We used satellite imagery to measure the percent area of reservoir, wetland, and creek habitat available at RSWMA. Comparing the relative abundance of these habitat types to our juvenile location data show that reservoirs are more commonly used relative to their abundance (Table 2). While wetlands are used relatively less than their abundance, they remain a critical habitat type for juveniles. Creek locations were often associated with den use. Patterns of den use are similar in the spring, but we presume increased den use was associated with refuge use during a drought in year 2 (Fig. 9). We compared microhabitat data collected at alligator and random locations. A year effect was observed for percent algae and woody vegetation cover (Fig. 10). Drier conditions in year 2 were associated with reduced algae cover in wetlands whereas several juvenile occupied wetland areas with 100% algae cover in year 1. More woody vegetation was available along shorelines of some management units due to tree cutting as part of ODWC management in year 2. Some juvenile occupied areas around downed trees which may have been attracting prey. Juvenile alligators occupied sites with a higher percentage of floating vegetation but a lower percentage of emergent vegetation than was observed at random locations (Fig. 10). However, juveniles used floating and emergent vegetation for cover in both reservoir and wetland habitats. We found strong year effects for other habitat variables that were likely driven by large differences in precipitation. The dry period in year 2 restricted alligator activity to reservoirs and edges of wetlands that were able to retain water while many areas of RSWMA dried out. Thus, distance to open water increased while distance to vegetation cover decreased between years 1 and 2 (Fig. 11). Water depth increased in year 2 despite drier conditions as juveniles utilized reservoirs and the deep areas along the margins of wetlands during the dry periods.

Home range size and habitat use of adults

Capture rates for adult alligators were low over the entire study period, which is often a difficult circumstance of studying crocodilians. We captured and attached transmitters to 9 adult alligators over the total project period. Processing of adult tracking and habitat data is ongoing.

In year 1, we tracked 2 adult males and 4 adult females. We recorded over 30 locations via radio-telemetry and over 50 via GPS tracking. We have provided an example of a simple spatial analysis from a large male (total length = 3.4 meters; mass = 167.8 kg) fitted with a GPS transmitter (Fig. 12). All of the male's activity was restricted to the 2 largest reservoirs at RSWMA (Pintail and Lotus), but some areas within the animal's home range appear to be key "hot spots" of activity. Adult females were observed moving among Pintail, Lotus, and Stork reservoirs. A smaller male and one female also were located in Push Creek and used den sites along the creekbank. One interesting observation from our telemetry work is that dens are used year-round by alligators of various size classes.

In year 2 we tracked 2 adult females and 1 adult male. One smaller female was fitted with a radio transmitter. The other female and the male were fitted with GPS transmitters. The smaller female was capture in Stork but quickly moved to a small pond on private land adjacent to the WMA. She remained there until her transmitter detached in late summer. With landowner permission, we searched the area for signs of alligator nesting but found none. The other female was tracked the previous year. Similar to year 1, she spent a large portion of her time in a den. The female also moved into a private pond between Stork and Pintail, which we did not observe in year 1. The large male exhibited similar movement patterns as shown for the male from the previous year, however, it occupied Otter Lake for most of the tracking period and had a considerable overlap in Pintail Lake with the male tracked in the previous year.

In contrast to juveniles, the vast majority of adult locations were within reservoirs. Four locations were in Push Creek and only one individual moved into a wetland. We recorded microhabitat variables at adult alligator locations that were paired with random sites as we did for juveniles. A preliminary analysis indicated that the major differences between adult alligators and random locations was in water depth. In general, adult alligators were located in deeper water than random paired sites. Only the smallest adults tracked made substantial overland movements onto private land. In these cases, ponds and isolated pools in bottomland forest provided the only available habitat.

Objective 4.

Most alligator mortality at RSWMA appears to occur in early life stages. In particular, nests are vulnerable to predation, inundation by water, and invasion by fire ants. Despite maternal guarding, hatchlings are also vulnerable to predation, but freezing temperatures also present a high risk of mortality for young alligators.

We located 6 nests in 2023 and 7 in 2024. For 2023, 49.9% of nests were not successful (Fig. 13). Three of these nests were inundated by water following large rainfall events. Hatchlings from a nest that hatched in 2023 failed to absorb their egg yolk prior to emerging from the nest and multiple dead hatchlings were found in the area around the nest. One hatchling that appeared uninjured but very lethargic was observed for a few hours before it died. These observations suggest that some problem in development may have led to mortality of many of these offspring. We counted a total of 37 hatchlings born in 2023 which was down from 77 the previous year (Fig. 14). All 7 nests located in 2024 were predated by racoons prior to hatching (Fig. 13), and no hatchlings were located in 2024 (Fig. 14).

A notable challenge for young alligators is freezing events. Alligators at RSWMA were observed across multiple years engaging in their typical icing response (Fig. 15). Data collected from monitoring multiple age classes in 2021 (via research not funded by this grant) suggest that hatchlings are more susceptible to freezing events (Table 3). In December 2022, we observed 100% mortality for a brood of hatchlings during a freezing event. Mortality of the young appears to be attributed to their small body size as even hatchlings engage in the freezing response. However, their entire body is subjected to cold temperatures near the surface whereas the lower portion of larger alligator bodies can reach warmer waters near the bottom. Additional refreezing may close the breathing holes of hatchlings which are substantially smaller than those of adults. Two adults (1 male, 1 female) were found dead at RSWMA in year 2. Cause of death could not be determined but appeared to be of some natural cause and occurred in late winter.

Predation may be higher on nests than on hatchlings, but we did observe predation on hatchlings by otters and great blue herons. Game camera footage indicates that predator encounters are fairly common, and maternal attendance is critical for protection of the hatchlings. While hatchlings are highly vulnerable to predation, risk is thought to decrease with age. Upon reaching dispersal size, larger alligators and poaching become the major threats. We did observe one unsuccessful attempt of predation on a dispersing juvenile by a large male alligator. Longer term mark-recapture work could provide more insight into survival rates.

* Totals to date represents a cumulative total of all periods of performance and may exceed the objective.

Objective Report	
Period of Performance	**# of Investigations**
Jul 1, 2022 to Jun 30, 2023	
Jul 1, 2023 to Jun 30, 2024	
Jul 1, 2024 to Dec 31, 2024	1
Totals to Date*	1

Species Tags

Species Tags
American Alligator; alligator; gator; Florida alligator; Mississippi alligator; Louisiana alligator *Alligator mississippiensis*

Activity Performed Attachments

Note: Some attachments listed here may not appear in the Appendix due to file incompatibility. All attachments can be accessed using the links below.

Descriptive Name	Field Tags	Attachment Type
No Files Attached		

Performance Reporting Questionnaire

1. What progress has been made towards completing the objective(s) of the project?

Executive Summary:

In this report, we provide the results of our study of American alligators (Alligator mississippiensis) over the entire project period. We made progress toward meeting all 4 objectives outlined in our proposal. Overall, we conducted surveys at 39 water bodies across 6 counties in southeastern Oklahoma. Alligators were detected in 4 of those counties, but detection rates outside of McCurtain County, and particularly Red Slough Wildlife Management Area (RSWMA), were very low. We used radio telemetry to track the movements and document habitat use of 17 juvenile alligators captured at RSWMA. While individual home range sizes and movement patterns were highly variable, no significant differences were observed between juvenile males and females or between years. We radio tracked 9 adult alligators over the grant period. Individual movement patterns were also variable for adults, but the larger males occupied larger home ranges than females and smaller males. Some individuals of both age classes exhibited site fidelity and very small home ranges. We noted any alligator mortality observed at RSWMA and marked/tagged 79 juveniles and adults and 155 hatchlings for long term population monitoring. Natural sources of mortality were observed for hatchling and adult alligators. Predation and extreme cold weather events are significant sources of mortality for alligators at RSWMA. Below, we provide cursory management recommendations until a final management plan is submitted. All methods were approved by the Southeastern Oklahoma State University Institutional Animal Care and Use Committee.

Overmatch:

Southeastern Oklahoma State University (SEOSU) has provided overmatch for this grant. SEOSU did not request reimbursement for eligible grant expenditures which were in excess of the amount needed for non-federal match, resulting in overmatch.

See final report attached.

2. Please describe and justify any changes in the implementation of your objective(s) or approach(es).

No changes in the project Objectives or Approaches were required. The project was completed per the original Objectives and Approaches.

3. If applicable, please share if the project resulted in any unexpected benefits, promising practices, new understandings, cost efficiencies, management recommendations, or lessons learned.

Preliminary Management Recommendations

As previously stated, the original research proposal and resulting grant awards were divided into two companion projects, including those by Jake Pruett and Tim Patton at Southeastern Oklahoma State University, and Jared Wood at Southwestern Adventist University, now at Fort Worth Nature Center (T-125-R-1). As part of the overall project, the inclusion of comprehensive management recommendations will be addressed by a subcontractor (Dr. Dennis Scarnecchia, University of Idaho) as part of the grant reporting by Jared Wood. Those management recommendations will be based on data analysis from both projects and an extensive literature search. The comprehensive management plan is scheduled for completion near the end of 2025. The following management recommendations are relevant only to the objectives stated in this grant by Pruett and Patton. These recommendations should be considered cursory and will likely be elucidated in the final recommendations submitted by Dr. Scarnecchia and Dr. Wood in the final performance report for grant T-125-R-1, as we intend to contribute to the final management plan.

Objective 1. Determine presence-absence of American alligators in southeastern Oklahoma by surveying multiple sites.

We detected American alligators in only 7 of 39 water bodies surveyed outside of RSWMA. With the exception of Ward Lake, which is adjacent to RSWMA, numbers of alligators detected were very low. We don't know if these low rates of detection are due to actual sparse distributions and low densities of alligators outside of RSWMA, or if they are a function of the survey protocol. If alligator densities are low, detection rates based on two visits (one each, diurnal and nocturnal) are likely to be proportionally low. However, because our rates of detection at RSWMA and Ward Lake were relatively high, we suspect low rates of detection outside of these two areas were due to low densities and high rates of absence. And while we knew going into the project that there was no standardized protocol for surveying for alligators in areas that likely have low densities and high incidences of absence, the intention of this objective was to conduct surveys extensively. That is, to survey a large number of sites but with only two attempts per site, thereby providing a coarse and preliminary view of distribution. We recommend the following:

1. In the short term:

a. Continue survey efforts across the likely area of alligator distribution in southeastern Oklahoma using an extensive approach.

b. Consider visiting a subset of sites more than twice to see if detection rates at those sites increase.

2. In the longer term:

a. Develop a research component to determine the amount of effort needed to detect the presence of alligators at a given site (e.g., the probability of detection based on a single survey, or the number of surveys necessary to meet a 90% probability of detection when alligators are present).

b. Develop a standardized sampling protocol for alligator surveys. Such an SSP should include three categories of variables, including technical variables (sight selection, mode of transportation specific to the situation, noise control, types of lighting, incorporation of sight distance, etc.), environmental variables (seasonality, time of day/night, air temperature, water temperature, atmospheric conditions, vegetation density, etc.), and personnel variables (number and experience/training levels of surveyors, etc.).

c. Utilize citizen-based observations and reports of the presence of alligators to assist with determination of distributions. This may include providing opportunities and avenues for citizens to report sightings, as well as some sort of verbal surveys of landowners in areas of likely alligator presence. In our efforts to address objective 1, we anecdotally found such sources to be very useful and reasonably accurate.

d. Utilize ODWC district personnel, or provide contracts to entities outside of ODWC, to conduct periodic surveys for alligators. These surveys may include, for example, surveying X sites per year per district following a standardized sampling protocol, as well as following up on the citizen-based reports.

Objective 2: Describe patterns of dispersal of juvenile alligators at RSWMA

Based on radio tracking of juvenile alligators, patterns were variable. But regardless of the pattern, travel corridors are necessary to facilitate movement, and with respect to juvenile alligators, that centers on water availability. Water level management is likely the single most important management option available at RSWMA. We are not able to control the amount or timing of rainfall, but there is at least some control of water level management within the WMA. Numerous water control structures are in place that allow the capture of water in the reservoirs and the movement of water from the reservoirs to the wetland units. We observed that adult alligators used primarily the reservoirs, whereas the juveniles utilized reservoirs during early development but then often utilized the wetland units for movement and dispersal from natal sites. The wetland units are relatively shallow compared to the reservoirs and are thus much more subject to drying. Water levels in the wetland units are currently managed to optimize spatiotemporal habitat components for various species of waterfowl and shorebirds. Because RSWMA was established primarily for the management of avifauna, we recognize that water levels will continue to be managed primarily for that purpose. However, there is likely a lot of overlap in optimization of habitat for avifauna and alligators. It is beyond the scope of this report to provide highly specific spatiotemporal recommendations for water level management, but we will work with Dr. Scarnecchia to provide information for the final management plan that will include more specific recommendations. Cursorily, we recommend the following:

1. Based on results from this study, use the temporal patterns of movement to identify the optimal times for increasing water levels in the wetland units to facilitate dispersal of juvenile alligators. In general, this is in late summer and early fall.

2. Determine if there is a current, specific water level management plan that is in use for the management of avifauna.

3. Based on optimal times for the two taxa of interest (avifauna and alligators), identify if existing water level management can be modified to optimize movement opportunities without compromising management of avifauna. In other words, consider the effect of water level management for avifauna in the context of optimizing or enhancing juvenile alligator movement and dispersal.

Objective 3: Describe the patterns of space and habitat use for adult and juvenile alligators at RSWMA

Radio-tracking indicated, in general, that reservoirs and areas with deeper water around edges of wetlands are occupied by both adults and juvenile alligators. As a product of the construction of RSWMA for holding water for avifauna, both of the primary habitat types (reservoirs and wetland units) have relatively deep channels adjacent to the constructed levees and decreasing water depths with increasing distance from those levees. Thus, these channel habitats provide much of the preferred habitat among all three classes of alligators addressed in this objective (males, females, and juveniles, though there is some overlap among these classes). Accordingly, management objectives that focus on the utility of the channels are clearly important.

There are five reservoirs; three of the reservoirs (Pintail, Lotus, and Bittern) have levees and corresponding channels on all four sides; the other two reservoirs (Otter and Stork) have levees and corresponding channels on three sides. There are approximately 20 wetland units that hold water for a significant portion of the year. Among these, the number of levees and corresponding channels varies, but most have one or two. Thus, there is less relative area of the preferred habitat in the wetland units compared to the reservoirs despite wetlands being the dominant macrohabitat available. Preferred habitat can become even more limited in dry years when wetlands dry up. Nevertheless, these wetland habitats are used, especially by juvenile alligators, and management of the water levels in the channels should be a goal. With this in mind, we recommend the following:

1. In the short term:

a. Water level management should consider providing enough water to create relatively deep and more open areas in the channels, especially during times when juveniles are moving and dispersing. This is relatively easy to accomplish, as the channels are the lowest elevation and will be the first portion of the wetland units to fill. Accordingly, even if there is not enough water available to fill a wetland unit, providing enough to fill the channels will still likely be beneficial.

b. Our results showed females had some reference for canopy coverage. The majority of that coverage comes from riparian vegetation. Thus, managing shorelines to include both open areas as well as canopy-covered areas would be useful. It should be noted that ODWC personnel have been managing riparian vegetation at RSWMA recently through removal of what is considered excess willow growth, especially along the levees (primarily to maintain integrity of the levees). This action is likely to maintain a mix that includes both open area and canopy-covered areas. Because this management action is already occurring, we have listed it in the short-term category.

2. In the longer term:

a. Consider altering and maintaining the channels to ensure they remain relatively deep and open. This may include a combination of periodic dredging for depth and vegetation control for maintaining open water. It should be noted that simply maintaining sufficient water depth is a viable method for controlling vegetation, though other forms of vegetation control (mechanical removal, herbicides, and periodic strategic water drawdowns) are viable and may be necessary.

b. Over time, RSWMA is showing increased and dramatic vegetation encroachment of all the reservoirs and wetland units. In years past, the shallow areas would typically become completely inundated by vegetation, but the channels would stay relatively open. In recent years, even the channels are becoming completely inundated, and there is often little to no open water by late summer. Control of vegetation is more efficacious in the wetland units, as they frequently get dry enough to desiccate the vegetation, and allow various direct approaches for control, such as prescribed fire and mechanical removal via brush-hogging and disking. However, the channels will often hold water year-round, thus do not get the benefit of setting back vegetational succession. For this reason, management actions that target the water depth and vegetation in the channels specifically are needed.

3. As with management recommendation number 3 under objective 2, there is likely room for coordination of management efforts that benefit both avifauna and alligators. RSWMA is managed for a diverse avifaunal community, thus, maintaining deeper and more open water in the channels will also benefit several species of birds.

Objective 4: Describe survival among various age and size classes of alligators at RSWMA.

Most alligator mortality at RSWMA appears to occur in early life stages. As reported in our results section, 50% of nests failed (i.e., no successful hatching) in 2023 and 100% failed in 2024.

Nests are especially vulnerable to predation and camera data and direct evidence suggest raccoons are the main predator, though we have also detected some predation by feral hogs. In addition to predation, we documented some nests failing due to inundation by water, and some due to invasion by fire ants. Simply getting successful hatching is the first step in enhancing the alligator population at RSWMA. However, once hatching occurred, we still saw very high mortality rates among hatchlings and throughout their first 1-2 years. Despite maternal guarding, hatchlings continue to be vulnerable to predation, and freezing temperatures (especially those that result in ice-over conditions) also present a high risk of mortality for young alligators. Once an alligator reaches 2-3 years of age, their size is likely to provide a significant safeguard against predation and against freezing. Thus, management efforts that focus on enhancing hatching success and recruitment would likely greatly enhance the population.

As stated, predation and freezing temperatures appear to be the primary sources of mortality. Predator control can be impractical, and we have no ability to control temperatures. However, there are some management actions that can mitigate these factors. We suggest the following:

1. We have identified two potential avenues for reducing nest predation.

a. Consider the use of predator guards over nests. However, such a device is inherently problematic; such a guard would have to prohibit predators from digging into the nest, but the mother alligator needs to be able to excavate the nest when the eggs hatch. Unless the guard is placed early, then removed before hatching, it would not likely be effective. There is also the possibility that the presence of such a guard would cause the mother to abandon the nest. We have not conducted a literature search to determine if such a method has been tested. At this point, we don't recommend this approach, but it may be worth further consideration.

b. Consider time and area restricted trapping, specifically, setting traps only at nest sites and during the nesting period. This approach would not likely reduce overall predator abundance appreciably, but may have the desired spatial and temporal effect, and may target the individual predators that have learned to target alligator nests. Relatively small leg-hold traps would be effective at capturing raccoons and similar sized meso-predators, and potentially deterring feral hogs, while not likely to capture or hold the mother alligator if she were to trip one. Small box traps would also potentially be effective for capturing meso-predators but should be small enough that a mother alligator would not likely become entangled.

2. We are unable to control environmental variables such as freezing temperatures, but this can be potentially mitigated with habitat. Alligators typically spend their first two years in and near a den and accompanied by their mother. These dens are comprised of a hole in the bank, and it has been suggested that these holes are often initiated as beaver excavations that have been further excavated by adult alligators. At RSWMA, these are most commonly along the man-made levees and adjacent to the deeper water channels described previously. These seem

to be ideal for protecting alligators from freezing conditions during their first two winters, when they are most vulnerable and when most mortality appears to occur. However, anecdotally, we observed some dens in which the alligators must emerge from the hole to breathe, suggesting the den cavity may be completely inundated with water. Such frequent emergence makes them vulnerable to freezing conditions and to predation, and because their metabolism is low due to cold temperatures, they are especially vulnerable to predation. For example, we documented great blue herons stalking den entrances and capturing hatchlings as they emerged. We also documented the mortality of numerous small alligators due to ice-over, resulting in mortality due to freezing or drowning as they were prohibited from reaching the surface. Among other dens, we anecdotally observed that they were being used (we saw hatchlings emerging to bask on warmer days) but did not require frequent emergence that might be associated with breathing. This suggests the den cavity is not completely inundated with water and there is an air gap that allows them to stay in the den for long periods. This would provide a significant advantage to thermoregulation and predator avoidance, greatly enhancing over-winter survival and potentially recruitment. However, it is difficult to identify specific management actions that would enhance the availability of den cavities that are not inundated. This is especially true since the mother is ultimately choosing the den site. Unfortunately, we are not aware of a method to provide dens that have the morphology to provide an air gap. With this in mind, we recommend the following:

a. Continue to survey for nests and document which are successful, then attempt to identify where each successful brood dens as winter approaches.

b. When den locations are identified, these units can be targeted for additional water level management. Specifically, if water levels are kept somewhat low, it is more likely that the den would not be completely inundated with water. However, if water levels are too low, the distance from the den entrance to the water may be too great. It will likely require an element of guesswork to determine what the ideal water level should be. It should be noted that low water levels during winter would not significantly affect habitat conditions for avifauna, as most are migratory, and bird densities are somewhat reduced in winter compared to spring and fall; this is another area in which simultaneous consideration of avifauna and alligators should occur. Also notable is that spring typically brings the highest levels of precipitation, so it would be relatively easy to refill the reservoirs at the outset of winter.

Management Conclusion

Red Slough Wildlife Management Area and Ward Lake were designed to provide habitat for a diverse avifauna. Heavy equipment was used intensively during construction, and the area has continued to receive intensive management efforts by ODWC and other natural resource management entities to maintain its value as wildlife habitat and to provide hunting opportunities. And while American alligators were not a target species for the development or management of RSWMA, they benefitted greatly from the specific management actions. RSWMA and adjacent Ward Lake continue to hold the highest density of alligators in southeastern Oklahoma and numerous visitors to RSWMA report that alligators are one of the attractions. Over the course of the last 20-25 years, researchers saw the number of alligators continue to trend upward. The first alligator nest was found at RSWMA in 2005, and the number of nests also continued to trend upward; however, that number peaked in 2021, then declined in 2023 and 2024. Also, as previously discussed, the amount of open water at RSWMA has continued to go down as a result of inundation by vegetation. That inundation is simply the natural process of ecological succession, and managers at RSWMA have successfully managed that process through the use of various tools such as prescribed fire and mechanical removal in the areas where that has been possible. However, the channels associated with the levees are the last vestiges of open water, and they are also succumbing to inundation. Our research has shown the importance of these deeper, open water habitats for alligators, and it is likely that the loss of these open water habitats is also having a negative effect on the overall diversity of birds. Our research results, along with trends that are apparent in habitat conditions over time, suggest that a passive approach to alligator management at RSWMA may not be effective in the future. A more proactive approach may be necessary. And we further suggest that such actions don't necessarily conflict with the management of avifauna. We encourage a management approach that considers these taxa simultaneously and identifies areas and actions that may benefit both.

4. For Survey projects only: If applicable, does this project continue work from a previous grant? If so, how do the current results compare to prior results? (Recipients may elect to add attachments such as tables, figures, or graphs to provide further detail when answering this question.)
Not Applicable

5. If applicable, identify and attach selected publications, photographs, screenshots of websites, or other documentation (including articles in popular literature, scientific literature, or other public information products) that have resulted from this project that highlight the accomplishments of the project.
Not Applicable

6. Is this a project you wish to highlight for communication purposes?
No

Questionnaire Attachments

Note: Some attachments listed here may not appear in the Appendix due to file incompatibility.

All attachments can be accessed using the links below.

Descriptive Name	Field Tags	Attachment Type
T-126-R SEOSU Alligator Final Report 202...	• Objective Completion Progress	Performance Report / Performance Hard Copy Report

Appendix

FINAL PERFORMANCE REPORT

Federal Aid Grant No. F22AF02099 (T-126-R-1)

An Assessment of American Alligators in Southeastern Oklahoma: Evaluating Presence-Absence, Dispersal, Movements, and Habitat

Oklahoma Department of Wildlife Conservation

Grant Period: July 1, 2022 – December 31, 2024

Report Period: July 1, 2022 – December 31, 2024

FINAL REPORT

State: Oklahoma **Grant Number:** F22AF02099 (T-126-R-1)

Grant Program: State Wildlife Grants

Grant Title: An assessment of American Alligators in southeastern Oklahoma: Evaluating presence-absence, dispersal, movements, and habitat

Grant Period: July 1, 2022 to December 31, 2024

Reporting Period: July 1, 2022 to December 31, 2024

Principal Investigators:
PI: Jake Pruett, Department of Biological Sciences, Southeastern Oklahoma State University.
Co-PI: Tim Patton, Department of Biological Sciences, Southeastern Oklahoma State University.

Executive Summary:
In this report, we provide the results of our study of American alligators (*Alligator mississippiensis*) over the entire project period. We made progress toward meeting all 4 objectives outlined in our proposal. Overall, we conducted surveys at 39 water bodies across 6 counties in southeastern Oklahoma. Alligators were detected in 4 of those counties, but detection rates outside of McCurtain County, and particularly Red Slough Wildlife Management Area (RSWMA), were very low. We used radio telemetry to track the movements and document habitat use of 17 juvenile alligators captured at RSWMA. While individual home range sizes and movement patterns were highly variable, no significant differences were observed between juvenile males and females or between years. We radio tracked 9 adult alligators over the grant period. Individual movement patterns were also variable for adults, but the larger males occupied larger home ranges than females and smaller males. Some individuals of both age classes exhibited site fidelity and very small home ranges. We noted any alligator mortality observed at RSWMA and marked/tagged 79 juveniles and adults and 155 hatchlings for long term population monitoring. Natural sources of mortality were observed for hatchling and adult alligators. Predation and extreme cold weather events are significant sources of mortality for alligators at RSWMA. Below, we provide cursory management recommendations until a final management plan is submitted. All methods were approved by the Southeastern Oklahoma State University Institutional Animal Care and Use Committee.

Objectives:

1. To determine presence-absence of American alligators in southeastern Oklahoma by surveying multiple sites.

2. To describe patterns of dispersal and movement of juvenile alligators at RSWMA.

3. To describe patterns of space and habitat use for adult and juvenile alligators at RSWMA.

4. To describe survival among various age and size classes of alligators at RSWMA

Summary of Progress:

Background:
The original proposal was submitted as a companion to a proposal submitted by Dr. Jared Wood, who assumed a lead role in some aspects (e.g. reproduction and recruitment) of the overall project. Our over-arching aim was to establish a baseline assessment of the alligator population in Oklahoma that will serve to inform future monitoring and management. For our (Pruett and Patton) specific portion of the overall project, we proposed 4 major objectives.

Objective 1: Determine presence-absence of American alligators in southeastern Oklahoma by surveying multiple sites

To meet this objective, we surveyed 39 bodies of water across 6 counties in southeastern Oklahoma. For each location, we conducted one survey during the day and a second survey at night. Nighttime surveys were conducted with spotlights to identify alligators by their distinctive eyeshine. Surveys were conducted on foot, in canoes and kayaks, or in motorized boats depending on the size of the water body and accessibility. We traveled the same route in each survey and recorded the number of alligators observed without backtracking to reduce the likelihood of recording the same individual more than once. Because total length is correlated with snout length (Fig. 1), we visually estimated the snout length of each alligator observed whenever possible. Thus, we were able to classify alligators as either juvenile or adult in some cases.

Objective 2: Describe patterns of dispersal and movement of juvenile alligators at RSWMA

We used radiotelemetry to monitor dispersal and movement patterns of juvenile alligators at RSWMA. We began capture efforts in the early winter of 2022 and continued into the spring and summer of 2024. We used a variety of capture methods included noosing, snagging, opportunistic hand captures, and box traps (Fig. 2A). Juveniles captured were fitted with VHF transmitters (Advanced Telemetry Systems) secured to the top of the tail with subcutaneous wires (Fig 2B). The same juveniles were tracked for objectives 2 and 3. We attempted to locate each individual once per week. Each new location was marked via hand-held GPS. Because of accuracy limitations of GPS and sampling methods for objective 3, we considered a location to be new if it was 5 meters or more from the previous location. Animals were tracked during the winter and spring to document their activity as they move from overwinter sites.

Objective 3: Describe patterns of space and habitat use for adult and juvenile alligators at RSWMA

We also used telemetry to document space and habitat use patterns of adult and juvenile alligators at RSWMA by tracking multiple individuals and measuring several habitat variables at animal locations. We collected the same morphological measurements, used the same tagging/marking procedure, and used the same attachment method regardless of alligator size or transmitter type. We considered animals greater than 6 feet long to be adult size. For adults 6-9 feet in total length, we used VHF transmitters (Fig 2B). For animals 9 feet or longer, we used GPS transmitters (Fig. 2C) also made by Advanced Telemetry Systems. Overall, we collected data for this objective from 17 juvenile (9 male and 8 female) and 9 adult (3 male and 6 female) alligators.

Spatial analyses of home range size were conducted in QGIS to estimate home range sizes. For habitat use, we recorded the major habitat type (i.e. lake, wetland, or creek) and sampled multiple variables at each animal location. Variables included: distance to shore, water depth, canopy cover, percent vegetation cover within 2 meters, percent open water within 2 meters, distance to vegetation if greater than 2 meters, distance to open water if greater than 2 meters. Percent cover was estimated with a sighting tube pointed 50 times within a 2-meter radius plot centered on the animals location. Vegetation was categorized as either emergent (e.g. rushes and cattails), floating (e.g. lotus and water shield), submerged (e.g. coon tail), standing or fallen woody stemmed plants (e.g. buttonbush and willow). We compared data from alligator locations to data collected from random locations in the environment.

Objective 4: Describe survival among various age and size classes of alligators at RSWMA

We monitored nest and den sites at RSWMA with cameras for multiple years including the study period. During the proposed study period, we also noted any mortality of dead alligators that were found away from nest and den sites. Nests were located in annual nest surveys with the assistance of multiple volunteers that included students from Southeastern Oklahoma State University, employees of the Fort Worth Nature Center, the Choctaw Nation, and ODWC.

Results:

Objective 1.

Overall, we had very few alligator detections outside of RSWMA. We surveyed sites in Love (n=2), Marshall (n=6), Johnston (n=3), Bryan (n=10), Choctaw (n=8), and McCurtain Counties (n=12). Of the 39 water bodies we surveyed, we detected alligators at 7 locations. One of those detections occurred on the Marshall and Bryan County line, so the alligator was recorded as one detection for both counties. We recorded a total of 19 alligator detections with 3 occurring during daytime surveys and 16 occurring at night. The total shoreline distance surveyed was 200.7 km for an average of 0.09 alligators per km. For comparison, we conducted nighttime surveys at RSWMA with the same method in May 2023 and recorded 78 total alligator detections over 32.9 km of shoreline for an average of 2.37 alligators per km.

Most alligator detections occurred in McCurtain County (Figure 3). We recorded 14 total alligator detections at 12 sites, but 13 of those occurred at one location, Ward Lake. Ward Lake is just outside the boundary of RSWMA, and alligators can move between the WMA and Ward (see results for objective 2 below). We recorded 2 alligator detections in Choctaw County in 2 different water bodies, but it is worth noting those water bodies were in close proximity on the same parcel of private land close to the Lower Kiamichi River. We recorded 3 detections in Bryan County in bodies of water in and near the north end of Lake Texoma. As mentioned above, one of the alligators observed was an adult located on the Marshall and Bryan County line. No alligators were observed in Love and Johnston Counties.

We surveyed reservoirs, wetlands, ponds/borrow pits, and creeks/old river channels. The majority of our detections occurred in reservoirs, but primarily those within RSWMA (Fig. 4). The only wetland habitat surveyed was within RSWMA, and alligators were commonly observed within that habitat type. No alligators were detected in Oxbows despite surveying 9 oxbow lakes close to RSWMA, Ward Lake, and the Red River.

We proposed surveying river systems in southeastern Oklahoma but have yet to conduct those surveys due to time and logistical constraints. Furthermore, some of the river systems have limited access. We have identified access points and acquired drones to conduct surveys when alligators are most likely to be basking (sunny days in late March to early May based on observations at RSWMA). We plan to conduct those surveys in spring 2025 at no cost to ODWC or this grant.

Objective 2.

We collected data on movements and dispersal of 17 juveniles (9 males and 8 females) captured at RSWMA. One juvenile, a female, was tracked during both years. The dataset includes 4 juveniles captured just prior to and tracked through the winter of 2022/2023, and 3 individuals from a cohort dispersing from their natal den in 2024. Body size of telemetered juveniles ranged from 400-800 mm SVL, but even the largest individual tracked was just under the body size cutoff for what is considered a juvenile alligator.

Movement frequency and transmitter retention varied among individuals. Thus, the number of locations and tracking days was also highly variable (Table 1). The number of locations recorded ranged from 6-24, and tracking durations ranged from 33-186 days. We recorded at total of 200 unique locations that were used in analyses of movement patterns as well as habitat use and home range size (objective 3 results given below). For juveniles tracked in the winter months, very little activity was observed from December-early March. By mid-March, most animals began making short distance movements away from overwintering sites, but one individual remained within and in close proximity to a den until April. For the individuals tracked from the same natal den in project year 2, dispersal from the natal area did not begin until July. Those individuals made independent movements of varying sizes but came back together at a new location after leaving the natal area. After a short second period of association, the siblings began making apparently independent movements again until all three eventually entered Push Creek. At that point, one transmitter detached. The other two juveniles continued to make what appeared to be independent movements, based on travel routes and timing of movements, until they eventually reached Ward Lake.

Movement patterns varied with some individuals moving further from their initial locations than others. Some observed distances between subsequent locations were as small as 7 meters while the greatest distance moved between subsequent locations was 2.7 km. However, we did not find any statistical differences in movement distances between juvenile male and female alligators (Fig. 5). All tracked individuals utilized multiple units within RSWMA, and movement among units may be facilitated by deeper areas alongside levees and Push Creek. It is evident that some overland movements occurred including a few individuals crossing Mudline, Blackland, and

Crystal Hollow Roads. Through both years of tracking, we confirmed that four juveniles dispersed to private lands, including WRP land, adjacent to RSWMA.

Objective 3.

Home range size and habitat use of juveniles

Juvenile home range sizes were variable and ranged from 1.06-159.9 ha (Table 1; Figs. 6 and 7). Small home range sizes were observed in 3 juveniles and excluded from analysis. Qualitatively, one of these home ranges centered around a den in Push Creek that was used during an extended hot and dry period of the summer of 2024. We suspect that juvenile utilized the den as a refugia during this period. The other two juveniles with small home ranges had already dispersed from their natal areas. One of those was captured and tracked in year 1 then again in year 2. The home range for year 2 (2 ha) was considerably smaller than the home range from year 1 (79 ha). The other juvenile was originally captured 2 years prior with presumed siblings at an overwintering den near Bittern Lake. This juvenile was among the largest captured for the study and would potentially reach sexual maturity in the next 1-2 years. Larger home ranges appeared to be in part attributed to long dispersal movements as indicated by the elongated polygons (see Figs. 6 and 7). We found no statistically significant differences between average home range sizes of juvenile male and female alligators in either year 1 or 2 of the study (Fig. 8).

We used satellite imagery to measure the percent area of reservoir, wetland, and creek habitat available at RSWMA. Comparing the relative abundance of these habitat types to our juvenile location data show that reservoirs are more commonly used relative to their abundance (Table 2). While wetlands are used relatively less than their abundance, they remain a critical habitat type for juveniles. Creek locations were often associated with den use. Patterns of den use are similar in the spring, but we presume increased den use was associated with refuge use during a drought in year 2 (Fig. 9). We compared microhabitat data collected at alligator and random locations. A year effect was observed for percent algae and woody vegetation cover (Fig. 10). Drier conditions in year 2 were associated with reduced algae cover in wetlands whereas several juvenile occupied wetland areas with 100% algae cover in year 1. More woody vegetation was available along shorelines of some management units due to tree cutting as part of ODWC management in year 2. Some juvenile occupied areas around downed trees which may have been attracting prey. Juvenile alligators occupied sites with a higher percentage of floating vegetation but a lower percentage of emergent vegetation than was observed at random locations (Fig. 10). However, juveniles used floating and emergent vegetation for cover in both reservoir and wetland habitats. We found strong year effects for other habitat variables that were likely driven by large differences in precipitation. The dry period in year 2 restricted alligator activity to reservoirs and edges of wetlands that were able to retain water while many areas of RSWMA dried out. Thus, distance to open water increased while distance to vegetation cover decreased between years 1 and 2 (Fig. 11). Water depth increased in year 2 despite drier conditions as juveniles utilized reservoirs and the deep areas along the margins of wetlands during the dry periods.

Home range size and habitat use of adults

Capture rates for adult alligators were low over the entire study period, which is often a difficult circumstance of studying crocodilians. We captured and attached transmitters to 9 adult alligators over the total project period. Processing of adult tracking and habitat data is ongoing.

In year 1, we tracked 2 adult males and 4 adult females. We recorded over 30 locations via radio-telemetry and over 50 via GPS tracking. We have provided an example of a simple spatial analysis from a large male (total length = 3.4 meters; mass = 167.8 kg) fitted with a GPS transmitter (Fig. 12). All of the male's activity was restricted to the 2 largest reservoirs at RSWMA (Pintail and Lotus), but some areas within the animal's home range appear to be key "hot spots" of activity. Adult females were observed moving among Pintail, Lotus, and Stork reservoirs. A smaller male and one female also were located in Push Creek and used den sites along the creekbank. One interesting observation from our telemetry work is that dens are used year-round by alligators of various size classes.

In year 2 we tracked 2 adult females and 1 adult male. One smaller female was fitted with a radio transmitter. The other female and the male were fitted with GPS transmitters. The smaller female was capture in Stork but quickly moved to a small pond on private land adjacent to the WMA. She remained there until her transmitter detached in late summer. With landowner permission, we searched the area for signs of alligator nesting but found none. The other female was tracked the previous year. Similar to year 1, she spent a large portion of her time in a den. The female also moved into a private pond between Stork and Pintail, which we did not observe in year 1. The large male exhibited similar movement patterns as shown for the male from the previous year, however, it occupied Otter Lake for most of the tracking period and had a considerable overlap in Pintail Lake with the male tracked in the previous year.

In contrast to juveniles, the vast majority of adult locations were within reservoirs. Four locations were in Push Creek and only one individual moved into a wetland. We recorded microhabitat variables at adult alligator locations that were paired with random sites as we did for juveniles. A preliminary analysis indicated that the major differences between adult alligators and random locations was in water depth. In general, adult alligators were located in deeper water than random paired sites. Only the smallest adults tracked made substantial overland movements onto private land. In these cases, ponds and isolated pools in bottomland forest provided the only available habitat.

Objective 4.

Most alligator mortality at RSWMA appears to occur in early life stages. In particular, nests are vulnerable to predation, inundation by water, and invasion by fire ants. Despite maternal guarding, hatchlings are also vulnerable to predation, but freezing temperatures also present a high risk of mortality for young alligators.

We located 6 nests in 2023 and 7 in 2024. For 2023, 49.9% of nests were not successful (Fig. 13). Three of these nests were inundated by water following large rainfall events. Hatchlings from a nest that hatched in 2023 failed to absorb their egg yolk prior to emerging from the nest and multiple dead hatchlings were found in the area around the nest. One hatchling that appeared uninjured but very lethargic was observed for a few hours before it died. These observations suggest that some problem in development may have led to mortality of many of these offspring. We counted a total of 37 hatchlings born in 2023 which was down from 77 the previous year (Fig. 14). All 7 nests located in 2024 were predated by racoons prior to hatching (Fig. 13), and no hatchlings were located in 2024 (Fig. 14).

A notable challenge for young alligators is freezing events. Alligators at RSWMA were observed across multiple years engaging in their typical icing response (Fig. 15). Data collected from monitoring multiple age classes in 2021 (via research not funded by this grant) suggest that hatchlings are more susceptible to freezing events (Table 3). In December 2022, we observed 100% mortality for a brood of hatchlings during a freezing event. Mortality of the young appears to be attributed to their small body size as even hatchlings engage in the freezing response. However, their entire body is subjected to cold temperatures near the surface whereas the lower portion of larger alligator bodies can reach warmer waters near the bottom. Additional refreezing may close the breathing holes of hatchlings which are substantially smaller than those of adults. Two adults (1 male, 1 female) were found dead at RSWMA in year 2. Cause of death could not be determined but appeared to be of some natural cause and occurred in late winter.

Predation may be higher on nests than on hatchlings, but we did observe predation on hatchlings by otters and great blue herons. Game camera footage indicates that predator encounters are fairly common, and maternal attendance is critical for protection of the hatchlings. While hatchlings are highly vulnerable to predation, risk is thought to decrease with age. Upon reaching dispersal size, larger alligators and poaching become the major threats. We did observe one unsuccessful attempt of predation on a dispersing juvenile by a large male alligator. Longer term mark-recapture work could provide more insight into survival rates.

Preliminary Management Recommendations

As previously stated, the original research proposal and resulting grant awards were divided into two companion projects, including those by Jake Pruett and Tim Patton at Southeastern Oklahoma State University, and Jared Wood at Southwestern Adventist University, now at Fort Worth Nature Center (T-125-R-1). As part of the overall project, the inclusion of comprehensive management recommendations will be addressed by a subcontractor (Dr. Dennis Scarnecchia, University of Idaho) as part of the grant reporting by Jared Wood. Those management recommendations will be based on data analysis from both projects and an extensive literature search. The comprehensive management plan is scheduled for completion near the end of 2025. The following management recommendations are relevant only to the objectives stated in this grant by Pruett and Patton. These recommendations should be considered cursory and will likely be elucidated in the final recommendations submitted by Dr. Scarnecchia and Dr. Wood in the final performance report for grant T-125-R-1, as we intend to contribute to the final management plan.

Objective 1. Determine presence-absence of American alligators in southeastern Oklahoma by surveying multiple sites.

We detected American alligators in only 7 of 39 water bodies surveyed outside of RSWMA. With the exception of Ward Lake, which is adjacent to RSWMA, numbers of alligators detected were very low. We don't know if these low rates of detection are due to actual sparse distributions and low densities of alligators outside of RSWMA, or if they are a function of the survey protocol. If alligator densities are low, detection rates based on two visits (one each, diurnal and nocturnal) are likely to be proportionally low. However, because our rates of detection at RSWMA and Ward Lake were relatively high, we suspect low rates of detection outside of these two areas were due to low densities and high rates of absence. And while we knew going into the project that there was no standardized protocol for surveying for alligators in areas that likely have low densities and high incidences of absence, the intention of this objective was to conduct surveys extensively. That is, to survey a large number of sites but with only two attempts per site, thereby providing a coarse and preliminary view of distribution. We recommend the following:

1. In the short term:
   a. Continue survey efforts across the likely area of alligator distribution in southeastern Oklahoma using an extensive approach.

   b. Consider visiting a subset of sites more than twice to see if detection rates at those sites increase.

2. In the longer term:
   a. Develop a research component to determine the amount of effort needed to detect the presence of alligators at a given site (e.g., the probability of detection based on a single survey, or the number of surveys necessary to meet a 90% probability of detection when alligators are present).

   b. Develop a standardized sampling protocol for alligator surveys. Such an SSP should include three categories of variables, including technical variables (sight selection, mode of transportation specific to the situation, noise control, types of lighting, incorporation of sight distance, etc.), environmental variables (seasonality, time of day/night, air temperature, water temperature, atmospheric conditions, vegetation density, etc.), and personnel variables (number and experience/training levels of surveyors, etc.).

   c. Utilize citizen-based observations and reports of the presence of alligators to assist with determination of distributions. This may include providing opportunities and avenues for citizens to report sightings, as well as some sort of verbal surveys of landowners in areas of likely alligator presence. In our efforts to address objective 1, we anecdotally found such sources to be very useful and reasonably accurate.

d. Utilize ODWC district personnel, or provide contracts to entities outside of ODWC, to conduct periodic surveys for alligators. These surveys may include, for example, surveying X sites per year per district following a standardized sampling protocol, as well as following up on the citizen-based reports.

Objective 2: Describe patterns of dispersal of juvenile alligators at RSWMA

Based on radio tracking of juvenile alligators, patterns were variable. But regardless of the pattern, travel corridors are necessary to facilitate movement, and with respect to juvenile alligators, that centers on water availability. Water level management is likely the single most important management option available at RSWMA. We are not able to control the amount or timing of rainfall, but there is at least some control of water level management within the WMA. Numerous water control structures are in place that allow the capture of water in the reservoirs and the movement of water from the reservoirs to the wetland units. We observed that adult alligators used primarily the reservoirs, whereas the juveniles utilized reservoirs during early development but then often utilized the wetland units for movement and dispersal from natal sites. The wetland units are relatively shallow compared to the reservoirs and are thus much more subject to drying. Water levels in the wetland units are currently managed to optimize spatiotemporal habitat components for various species of waterfowl and shorebirds. Because RSWMA was established primarily for the management of avifauna, we recognize that water levels will continue to be managed primarily for that purpose. However, there is likely a lot of overlap in optimization of habitat for avifauna and alligators. It is beyond the scope of this report to provide highly specific spatiotemporal recommendations for water level management, but we will work with Dr. Scarnecchia to provide information for the final management plan that will include more specific recommendations. Cursorily, we recommend the following:

1. Based on results from this study, use the temporal patterns of movement to identify the optimal times for increasing water levels in the wetland units to facilitate dispersal of juvenile alligators. In general, this is in late summer and early fall.

2. Determine if there is a current, specific water level management plan that is in use for the management of avifauna.

3. Based on optimal times for the two taxa of interest (avifauna and alligators), identify if existing water level management can be modified to optimize movement opportunities without compromising management of avifauna. In other words, consider the effect of water level management for avifauna in the context of optimizing or enhancing juvenile alligator movement and dispersal.

Objective 3: Describe the patterns of space and habitat use for adult and juvenile alligators at RSWMA

Radio-tracking indicated, in general, that reservoirs and areas with deeper water around edges of wetlands are occupied by both adults and juvenile alligators. As a product of the construction of RSWMA for holding water for avifauna, both of the primary habitat types (reservoirs and wetland units) have relatively deep channels adjacent to the constructed levees and decreasing water depths with increasing distance from those levees. Thus, these channel habitats provide much of the preferred habitat among all three classes of alligators addressed in this objective (males, females, and juveniles, though there is some overlap among these classes). Accordingly, management objectives that focus on the utility of the channels are clearly important.

There are five reservoirs; three of the reservoirs (Pintail, Lotus, and Bittern) have levees and corresponding channels on all four sides; the other two reservoirs (Otter and Stork) have levees and corresponding channels on three sides. There are approximately 20 wetland units that hold water for a significant portion of the year. Among these, the number of levees and corresponding channels varies, but most have one or two. Thus, there is less relative area of the preferred habitat in the wetland units compared to the reservoirs despite wetlands being the dominant macrohabitat available. Preferred habitat can become even more limited in dry years when wetlands dry up. Nevertheless, these wetland habitats are used, especially by juvenile alligators, and management of the water levels in the channels should be a goal. With this in mind, we recommend the following:

1. In the short term:

a. Water level management should consider providing enough water to create relatively deep and more open areas in the channels, especially during times when juveniles are moving and dispersing. This is relatively easy to accomplish, as the channels are the lowest elevation and will be the first portion of the wetland units to fill. Accordingly, even if there is not enough water available to fill a wetland unit, providing enough to fill the channels will still likely be beneficial.

b. Our results showed females had some reference for canopy coverage. The majority of that coverage comes from riparian vegetation. Thus, managing shorelines to include both open areas as well as canopy-covered areas would be useful. It should be noted that ODWC personnel have been managing riparian vegetation at RSWMA recently through removal of what is considered excess willow growth, especially along the levees (primarily to maintain integrity of the levees). This action is likely to maintain a mix that includes both open area and canopy-covered areas. Because this management action is already occurring, we have listed it in the short-term category.

2. In the longer term:

a. Consider altering and maintaining the channels to ensure they remain relatively deep and open. This may include a combination of periodic dredging for depth and vegetation control for maintaining open water. It should be noted that simply maintaining sufficient water depth is a viable method for controlling vegetation, though other forms of vegetation control (mechanical removal, herbicides, and periodic strategic water drawdowns) are viable and may be necessary.

b. Over time, RSWMA is showing increased and dramatic vegetation encroachment of all the reservoirs and wetland units. In years past, the shallow areas would typically become completely inundated by vegetation, but the channels would stay relatively open. In recent years, even the channels are becoming completely inundated, and there is often little to no open water by late summer. Control of vegetation is more efficacious in the wetland units, as they frequently get dry enough to desiccate the vegetation, and allow various direct approaches for control, such as prescribed fire and mechanical removal via brush-hogging and disking. However, the channels will often hold water year-round, thus do not get the benefit of setting back vegetational succession. For this reason, management actions that target the water depth and vegetation in the channels specifically are needed.

3. As with management recommendation number 3 under objective 2, there is likely room for coordination of management efforts that benefit both avifauna and alligators. RSWMA is managed for a diverse avifaunal community, thus, maintaining deeper and more open water in the channels will also benefit several species of birds.

Objective 4: Describe survival among various age and size classes of alligators at RSWMA.

Most alligator mortality at RSWMA appears to occur in early life stages. As reported in our results section, 50% of nests failed (i.e., no successful hatching) in 2023 and 100% failed in 2024. Nests are especially vulnerable to predation and camera data and direct evidence suggest raccoons are the main predator, though we have also detected some predation by feral hogs. In addition to predation, we documented some nests failing due to inundation by water, and some due to invasion by fire ants. Simply getting successful hatching is the first step in enhancing the alligator population at RSWMA. However, once hatching occurred, we still saw very high mortality rates among hatchlings and throughout their first 1-2 years. Despite maternal guarding, hatchlings continue to be vulnerable to predation, and freezing temperatures (especially those that result in ice-over conditions) also present a high risk of mortality for young alligators. Once an alligator reaches 2-3 years of age, their size is likely to provide a significant safeguard against predation and against freezing. Thus, management efforts that focus on enhancing hatching success and recruitment would likely greatly enhance the population.
As stated, predation and freezing temperatures appear to be the primary sources of mortality. Predator control can be impractical, and we have no ability to control temperatures. However, there are some management actions that can mitigate these factors. We suggest the following:

1. We have identified two potential avenues for reducing nest predation.
a. Consider the use of predator guards over nests. However, such a device is inherently problematic; such a guard would have to prohibit predators from digging into the nest, but the mother alligator needs to be able to excavate the nest when the eggs hatch. Unless the guard is

placed early, then removed before hatching, it would not likely be effective. There is also the possibility that the presence of such a guard would cause the mother to abandon the nest. We have not conducted a literature search to determine if such a method has been tested. At this point, we don't recommend this approach, but it may be worth further consideration.

b. Consider time and area restricted trapping, specifically, setting traps only at nest sites and during the nesting period. This approach would not likely reduce overall predator abundance appreciably, but may have the desired spatial and temporal effect, and may target the individual predators that have learned to target alligator nests. Relatively small leg-hold traps would be effective at capturing raccoons and similar sized meso-predators, and potentially deterring feral hogs, while not likely to capture or hold the mother alligator if she were to trip one. Small box traps would also potentially be effective for capturing meso-predators but should be small enough that a mother alligator would not likely become entangled.

2. We are unable to control environmental variables such as freezing temperatures, but this can be potentially mitigated with habitat. Alligators typically spend their first two years in and near a den and accompanied by their mother. These dens are comprised of a hole in the bank, and it has been suggested that these holes are often initiated as beaver excavations that have been further excavated by adult alligators. At RSWMA, these are most commonly along the man-made levees and adjacent to the deeper water channels described previously. These seem to be ideal for protecting alligators from freezing conditions during their first two winters, when they are most vulnerable and when most mortality appears to occur. However, anecdotally, we observed some dens in which the alligators must emerge from the hole to breathe, suggesting the den cavity may be completely inundated with water. Such frequent emergence makes them vulnerable to freezing conditions and to predation, and because their metabolism is low due to cold temperatures, they are especially vulnerable to predation. For example, we documented great blue herons stalking den entrances and capturing hatchlings as they emerged. We also documented the mortality of numerous small alligators due to ice-over, resulting in mortality due to freezing or drowning as they were prohibited from reaching the surface. Among other dens, we anecdotally observed that they were being used (we saw hatchlings emerging to bask on warmer days) but did not require frequent emergence that might be associated with breathing. This suggests the den cavity is not completely inundated with water and there is an air gap that allows them to stay in the den for long periods. This would provide a significant advantage to thermoregulation and predator avoidance, greatly enhancing over-winter survival and potentially recruitment. However, it is difficult to identify specific management actions that would enhance the availability of den cavities that are not inundated. This is especially true since the mother is ultimately choosing the den site. Unfortunately, we are not aware of a method to provide dens that have the morphology to provide an air gap. With this in mind, we recommend the following:

a. Continue to survey for nests and document which are successful, then attempt to identify where each successful brood dens as winter approaches.

b. When den locations are identified, these units can be targeted for additional water level management. Specifically, if water levels are kept somewhat low, it is more likely that the den would not be completely inundated with water. However, if water levels are too low, the distance from the den entrance to the water may be too great. It will likely require an element of guesswork to determine what the ideal water level should be. It should be noted that low water levels during winter would not significantly affect habitat conditions for avifauna, as most are migratory, and bird densities are somewhat reduced in winter compared to spring and fall; this is another area in which simultaneous consideration of avifauna and alligators should occur. Also notable is that spring typically brings the highest levels of precipitation, so it would be relatively easy to refill the reservoirs at the outset of winter.

Management Conclusion

Red Slough Wildlife Management Area and Ward Lake were designed to provide habitat for a diverse avifauna. Heavy equipment was used intensively during construction, and the area has continued to receive intensive management efforts by ODWC and other natural resource management entities to maintain its value as wildlife habitat and to provide hunting opportunities. And while American alligators were not a target species for the development or management of RSWMA, they benefitted greatly from the specific management actions. RSWMA and adjacent Ward Lake continue to hold the highest density of alligators in southeastern Oklahoma and numerous visitors to RSWMA report that alligators are one of the attractions. Over the course of the last 20-25 years, researchers saw the number of alligators continue to trend upward. The first alligator nest was found at RSWMA in 2005, and the number of nests also continued to trend upward; however, that number peaked in 2021, then declined in 2023 and 2024. Also, as previously discussed, the amount of open water at RSWMA has continued to go down as a result of inundation by vegetation. That inundation is simply the natural process of ecological succession, and managers at RSWMA have successfully managed that process through the use of various tools such as prescribed fire and mechanical removal in the areas where that has been possible. However, the channels associated with the levees are the last vestiges of open water, and they are also succumbing to inundation. Our research has shown the importance of these deeper, open water habitats for alligators, and it is likely that the loss of these open water habitats is also having a negative effect on the overall diversity of birds. Our research results, along with trends that are apparent in habitat conditions over time, suggest that a passive approach to alligator management at RSWMA may not be effective in the future. A more proactive approach may be necessary. And we further suggest that such actions don’t necessarily conflict with the management of avifauna. We encourage a management approach that considers these taxa simultaneously and identifies areas and actions that may benefit both.

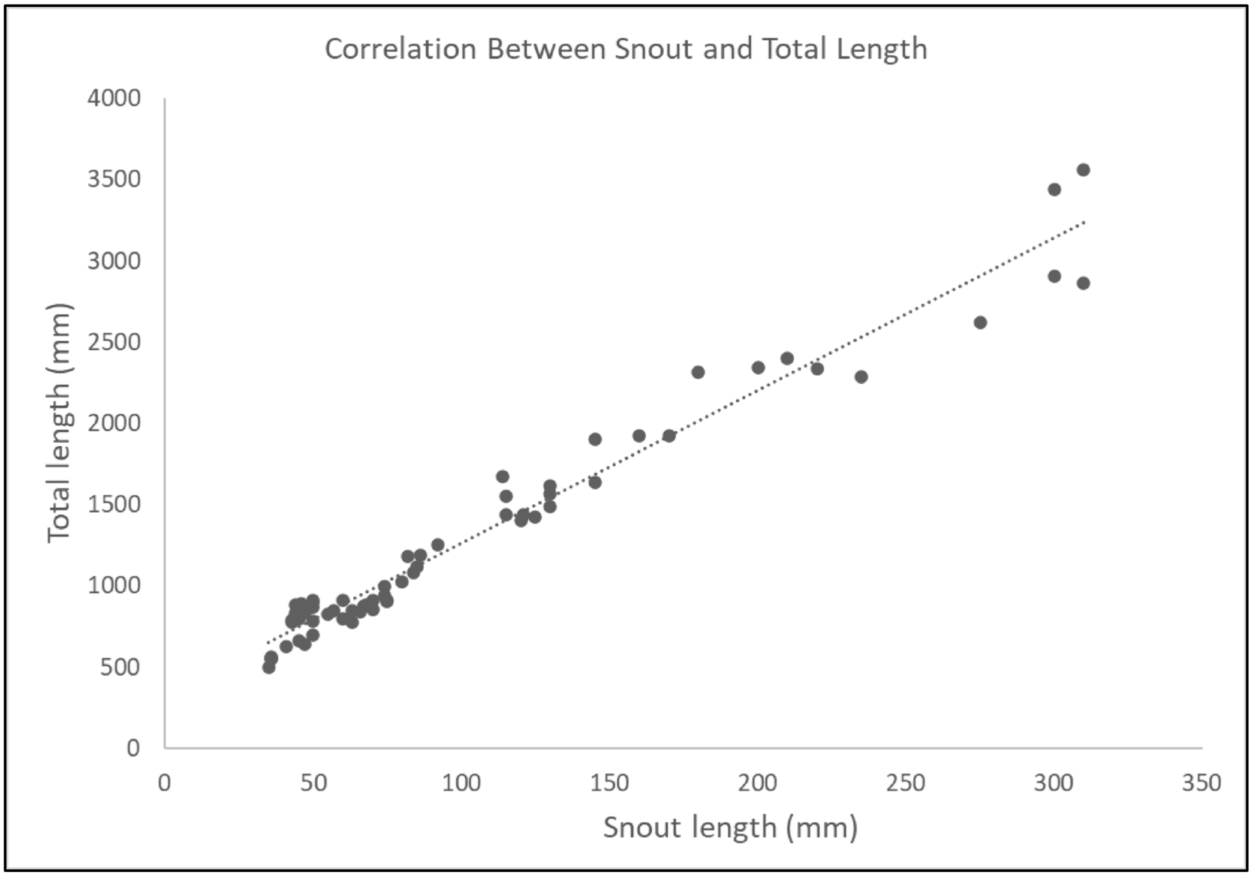

Figure 1. Relationship between snout length and total length of alligators captured and measured at RSWMA. While the entire body of an alligator is not always visible, the correlation in snout and total length allows for visual estimation of size when the animal's head is above water.

Figure 2. A) Box trap with adult American alligator captured at Red Slough Wildlife Management Area in May 2022. B) Photograph of juvenile American alligator from RSWMA with VHF radio transmitter attached. C) Photograph of adult American alligator from RSWMA with GPS transmitter attached.

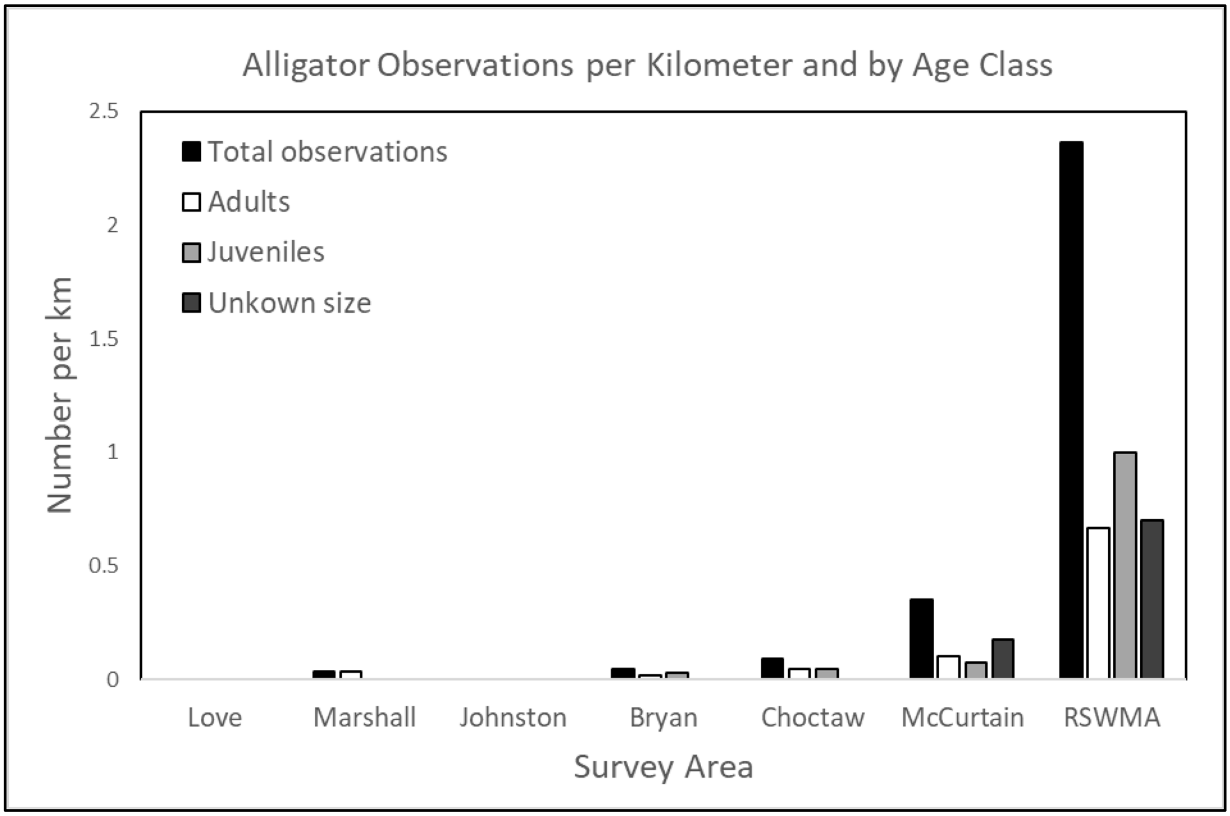

Figure 3. Alligator detections from surveys conducted over the entire study period and from a survey of RSWMA in May 2023. While we detected alligators in 4 counties, detection rates were low and very few individuals were observed outside of McCurtain County. Adults were detected in all counties for which alligators were present, but at very low rates. Note that the one individual detected in Marshall County was an adult located on the Marshall/Bryan County line.

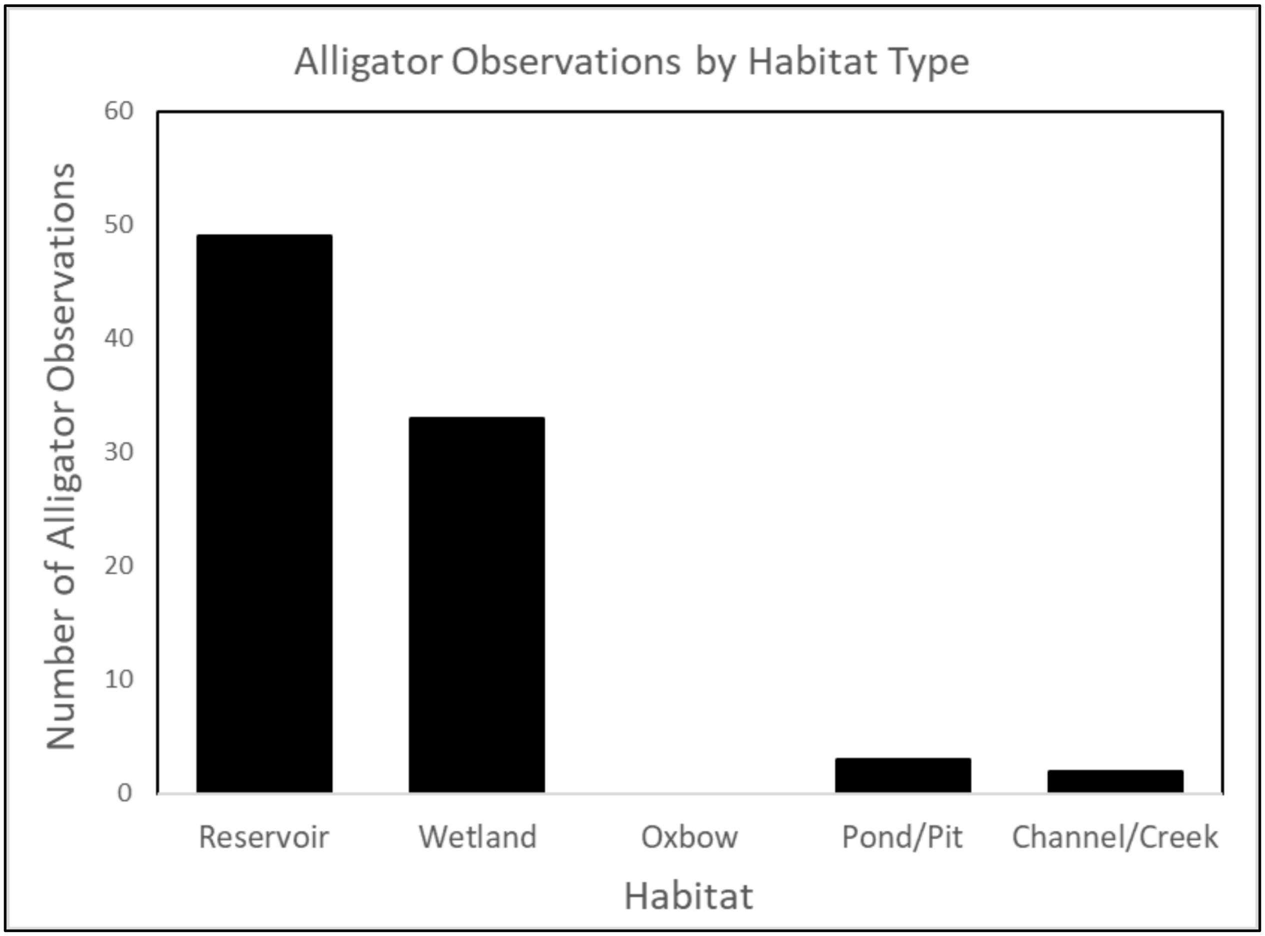

Figure 4. Alligator detections for surveys conducted over the entire study period by habitat type. Note that data is for the entire range including RSWMA. The majority of detections were at RSWMA and Ward Lake. The only wetland habitat surveyed was at RSWMA while pond/pit habitats were exclusively on private lands.

Table 1. Tracking effort and body sizes for male and female juvenile alligators at RSWMA. Year 1 animals were tracked in the period December 2022 to August 2023 while year 2 individuals were tracked in the period March to August 2024. Home range values were measured as minimum convex polygons.

Radio Frequency	Year	Sex	SVL (mm)	Number of Locations	Number of Days tracked	MCP (ha)
150.46	1	F	780	6	35	24.82
150.602	1	F	760	6	50	27.02
150.521	1	F	480	16	139	28.52
150.161	2	M	680	17	146	33.14
150.202	2	M	400	10	65	39.49
150.382	2	M	417	10	74	46.47
150.661	1	F	540	12	152	63.77
150.082	2	F	468	12	86	66.41
150.481	1	F	676	6	40	79.94
150.261	1	M	584	11	83	84.44
150.402	1	M	533	14	149	105.27
150.062	2	F	800	24	186	117.24
150.641	1	M	525	13	152	132.51
150.142	2	M	355	13	113	142.93
150.184	2	M	420	10	93	159.99
150.502	1	M	740	6	39	1.06*
150.581	1	F	715	6	33	1.53*
150.121	2	F	720	8	50	2.70*

*Three individuals had notably smaller home ranges and were excluded from statistical comparisons.

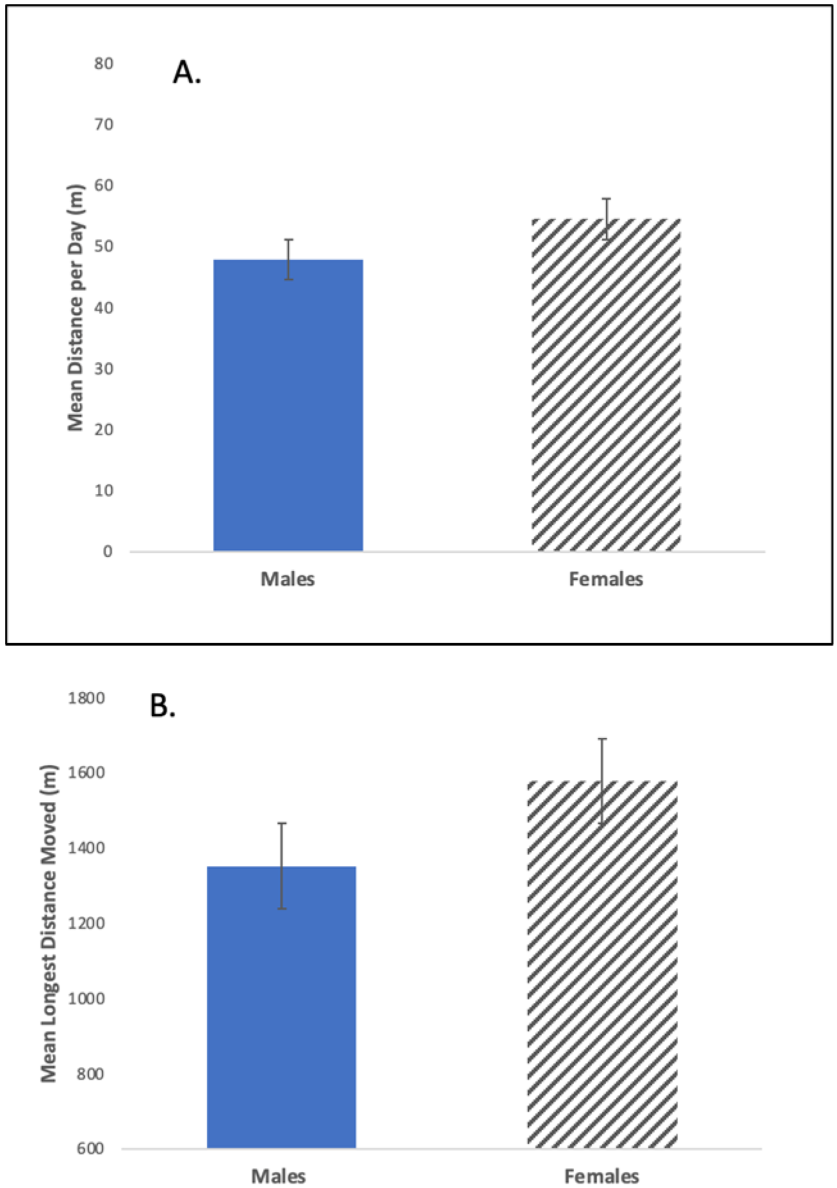

Figure 5. Comparison of juvenile male and female movement patterns from individuals tracked at RSWMA over the entire reporting period. There were no significant differences between juvenile males and females in longest distance moved or distance moved per day.

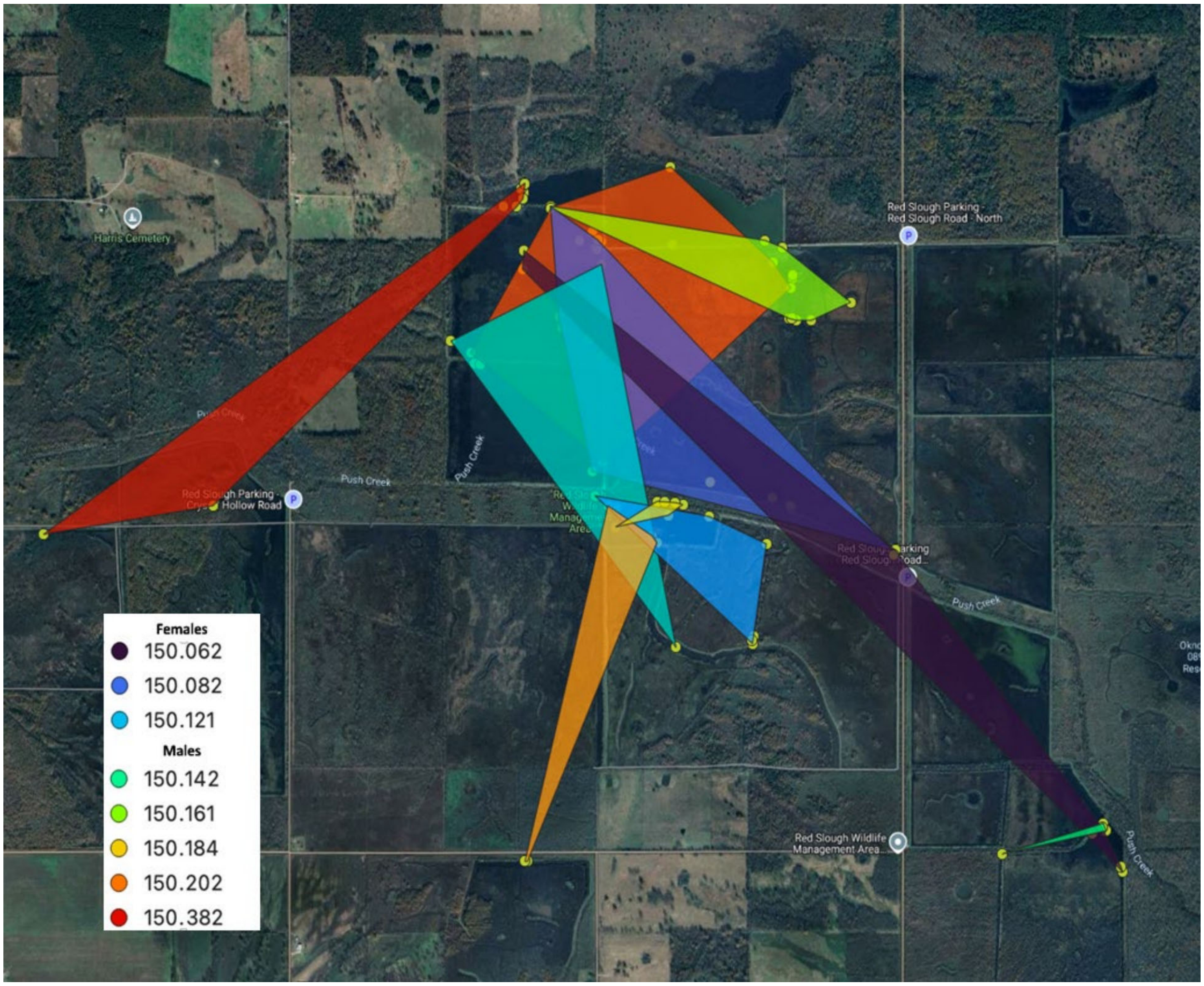

Figure 6. Home ranges displayed as minimum convex polygons for alligators tracked at RSWMA over the first year of data collection. Note that several home ranges are elongated polygons indicating dispersal away from den sites near initial point of capture. Many dispersal movements occurred through wetlands and one individual ventured onto an adjacent WRP property (150.202). It is worth noting that two individuals had very small home ranges. One spent the majority of its tracking period in a den complex in the bank of Push Creek (150.184) and may have been utilizing it as a thermal refugia during the hottest months of the year. The other was the largest juvenile tracked during that year (150.161) and was originally captured just prior to natal dispersal two years earlier near Bittern Lake (approximately in the center of the map). We find it likely that this individual had already established a home range as it might reach sexual maturity in the next 1-2 years.

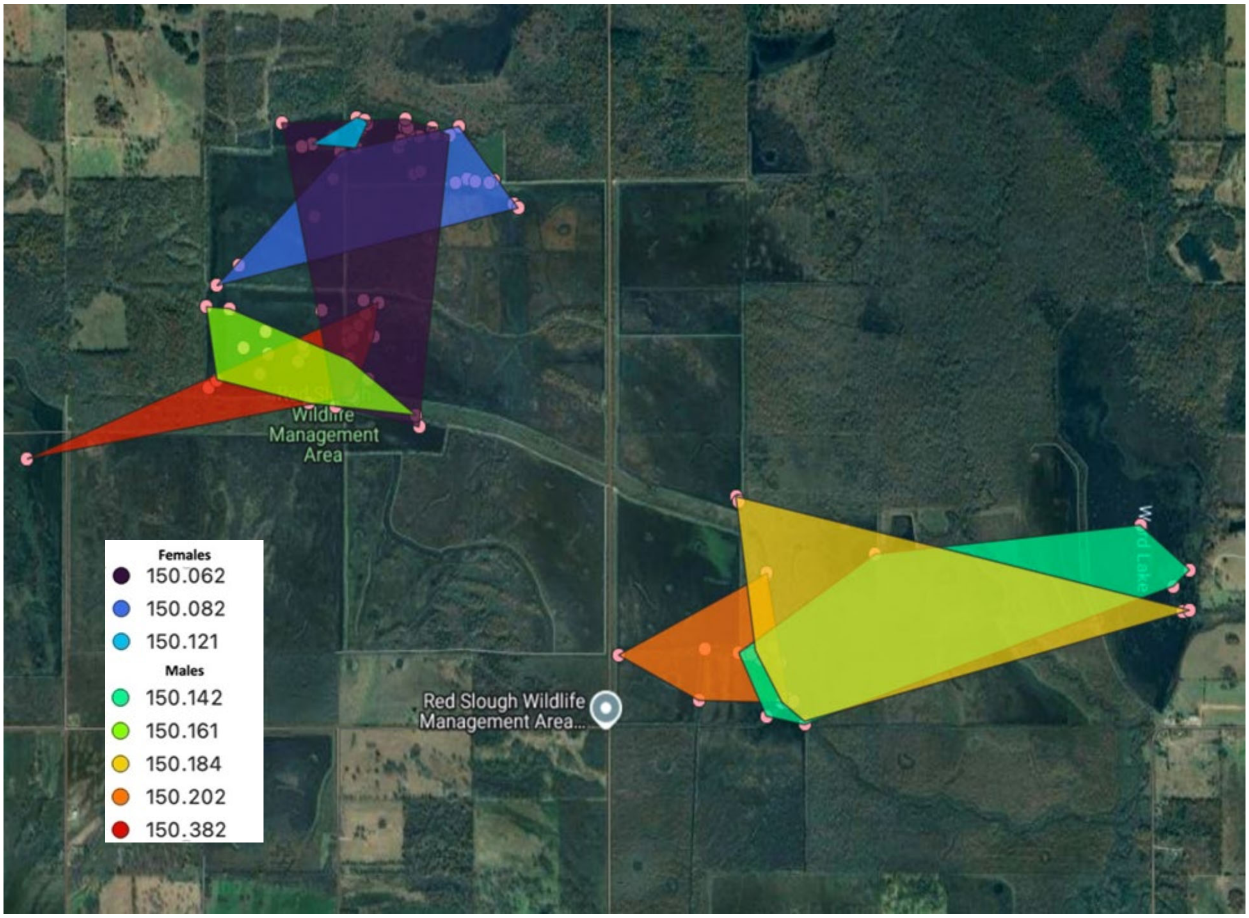

Figure 7. Home ranges displayed as minimum convex polygons for alligators tracked at RSWMA over the second year of data collection. Data show dispersal of 3 cohort members (150.184, 150.142, and 150.202) captured near their natal den. Two of the three dispersed into Ward Lake. Dispersal followed a potential prospecting period in units adjacent to the natal area. One individual (150.121) had a comparatively small home range. The home range for this individual was notably larger in year 1. The majority of locations within the home range of each juvenile where in reservoir or wetland habitat.

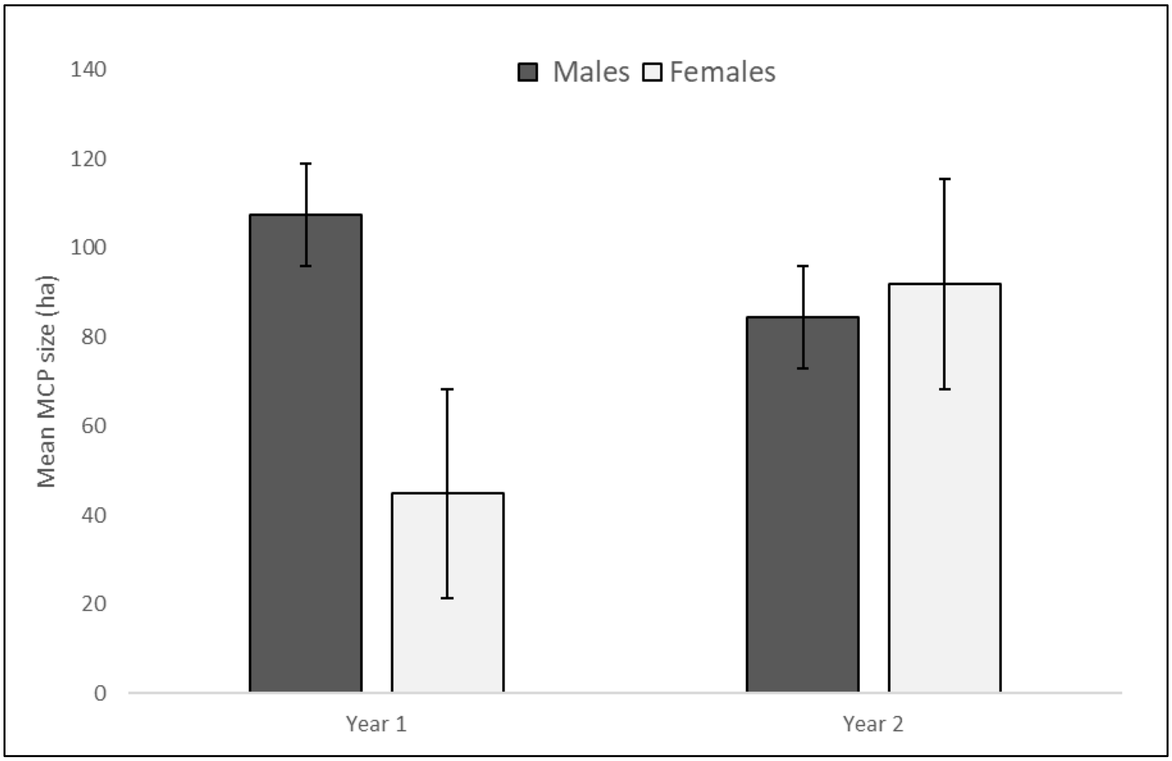

Figure 8. Average home range size measured as minimum convex polygons for juvenile male and female alligators tracked in years 1 and 2 of our study. While males tended to have larger home ranges than females in year 1, the difference was not statistically significant. Neither were there differences between sexes in year 2 or between years 1and 2.

Table 2. Macrohabitat use by juvenile alligators at RSWMA over 2 years of radio tracking. The majority of locations were in reservoir and wetland habitat. Despite many observations of smaller alligators in wetland habitat, radio tracked juveniles spent similar portions of their time in reservoirs and wetlands. Many of the locations in Push Creek were associated with den use.

Water Type	% Available	% of Year 1 Locations	% of Year 2 Locations	Years Combined
Reservoir	14.6	53.1	45.8	49.5
Wetland	84.6	41.7	42.7	41.2
Creek	0.8	5.2	11.5	8.3

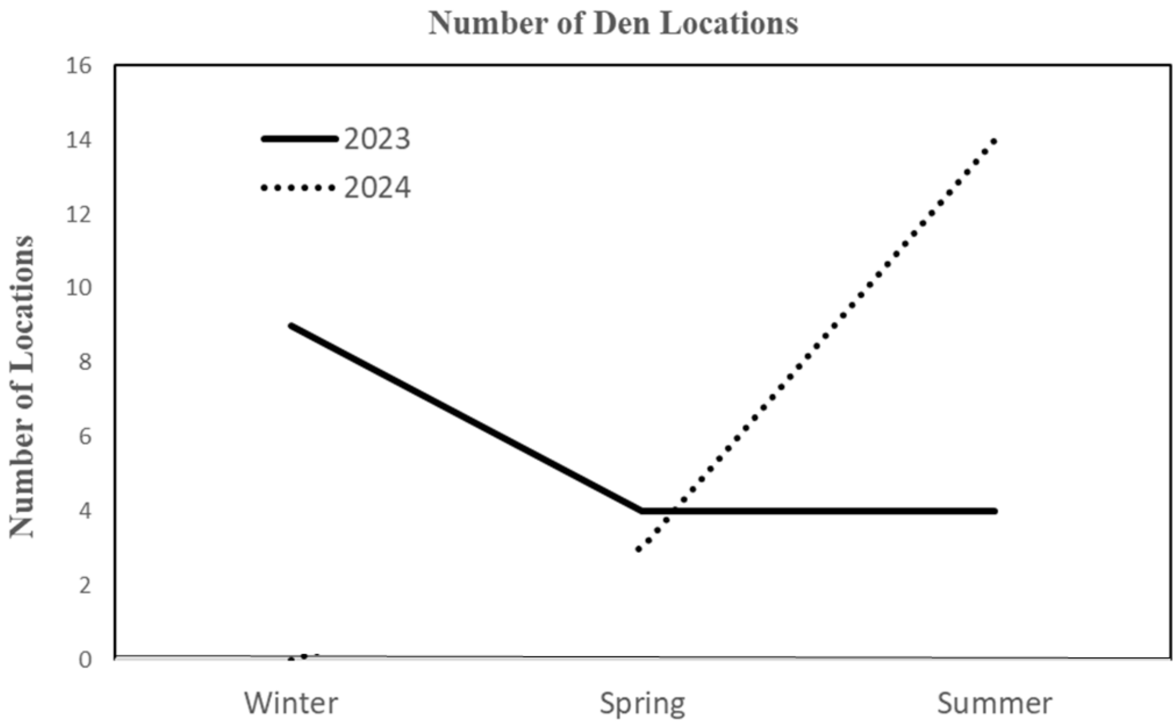

Figure 9. Den locations for radio tracked juveniles over years 1 and 2 of the study. No juveniles were tracked over the winter in year 2. We observed similar frequency of den use in spring months. Increased den use in year 2 may have been associated with an extended hot and dry period that occurred in the summer months.

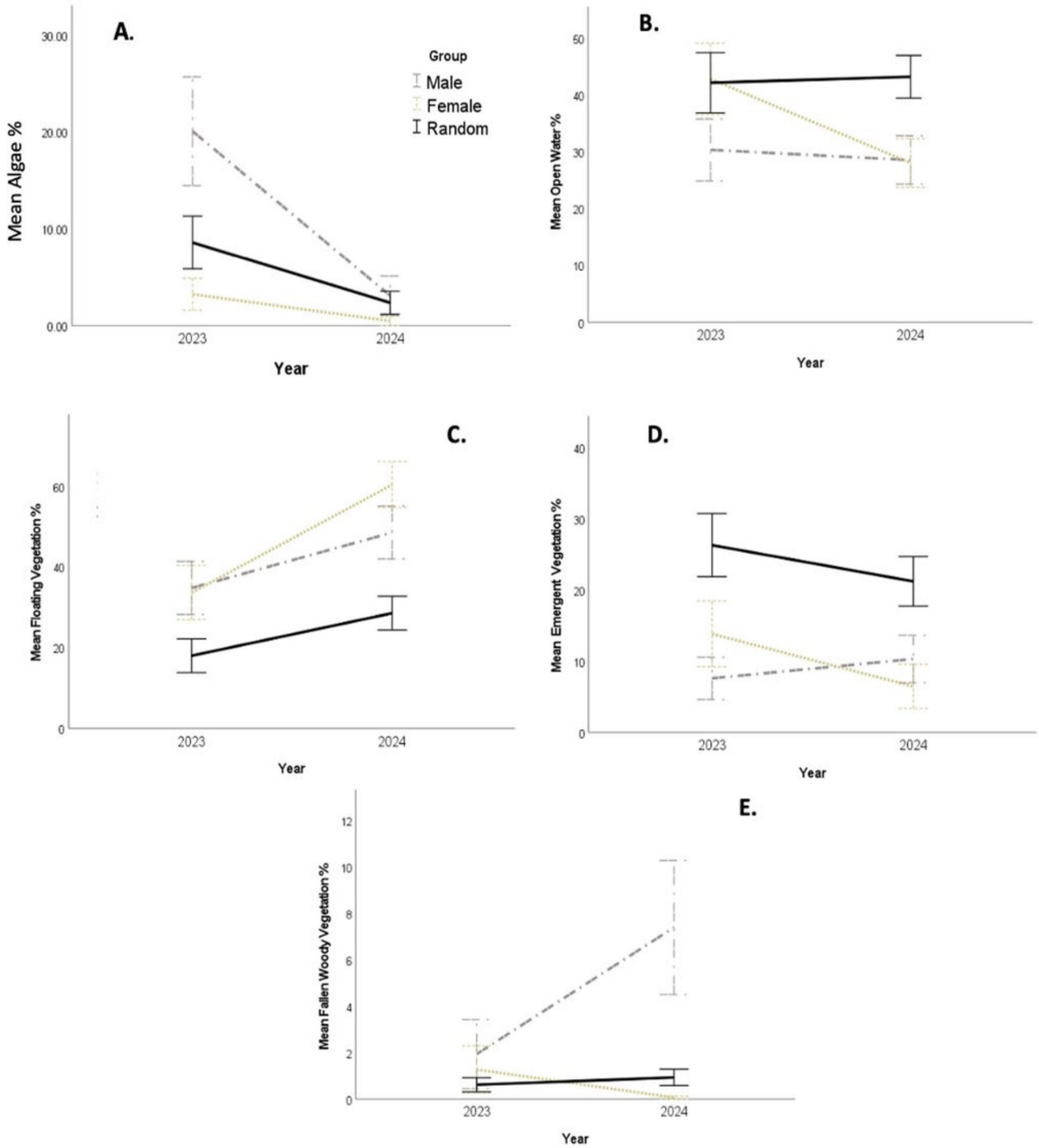

Figure 10. Percent cover for juvenile male and female and random location measured at RSWMA over years 1 and 2 of the study period. A) Percent algae cover B) Percent open water C) Percent floating vegetation D) Percent emergent vegetation E) Percent woody vegetation.

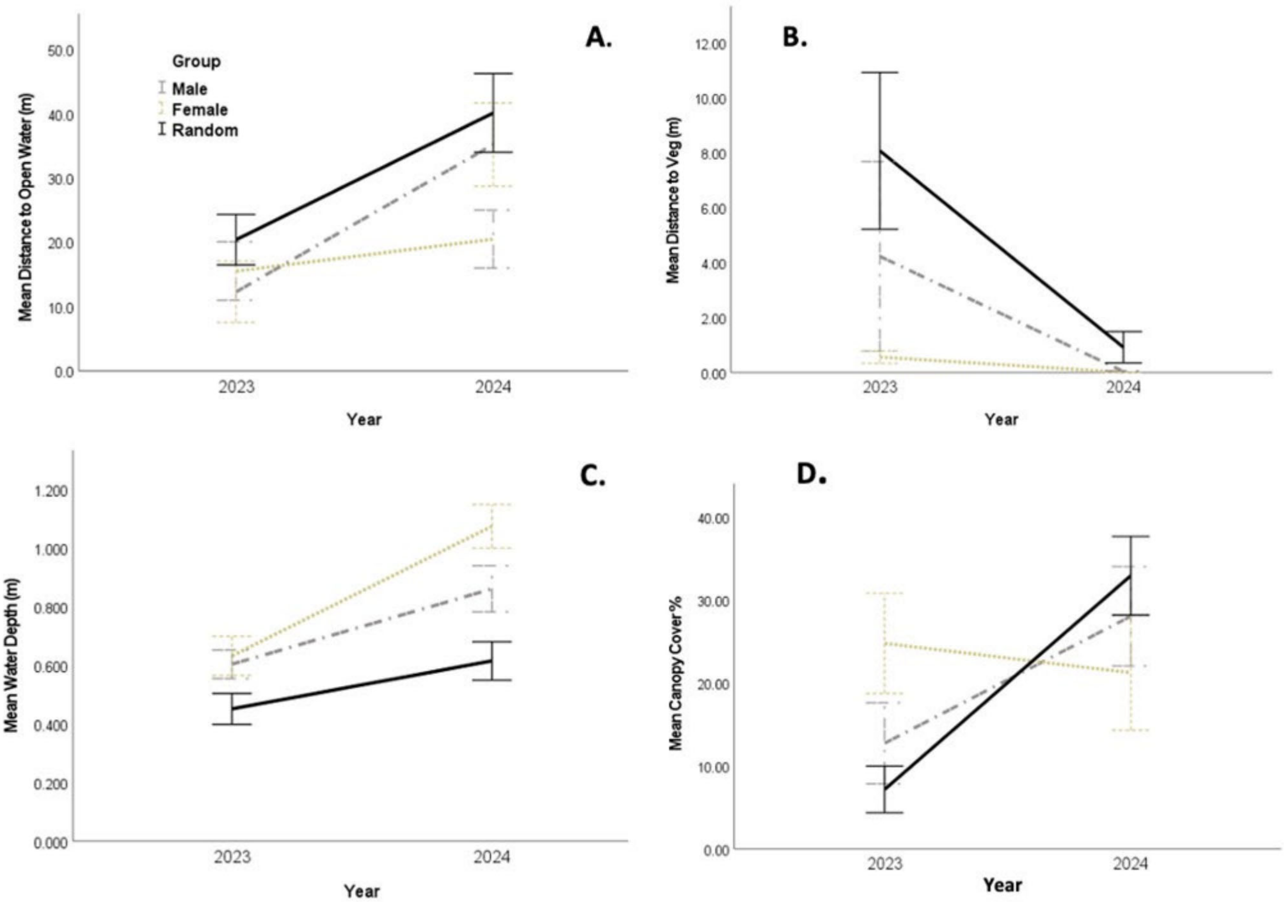

Figure 11. Additional microhabitat variables measured at RSWMA for juvenile male and female alligator and random locations. A) Average distance to open water B) Average distance to vegetation C) Average water depth D) Average canopy cover.

Figure 12. Locations of an adult male American alligator at Red Slough Wildlife Management Area fitted with a GPS transmitter. Each point represents a coordinate for the animal's location transmitted via satellite. The red line marks the boundaries of the home range which had an area of 51.45 hectares. Red circles indicate areas of concentrated activity within the home range. Many of the points in these concentrated areas were transmitted during the breeding season and are likely key sites for territorial displays and mating. Blue arrow indicates North.

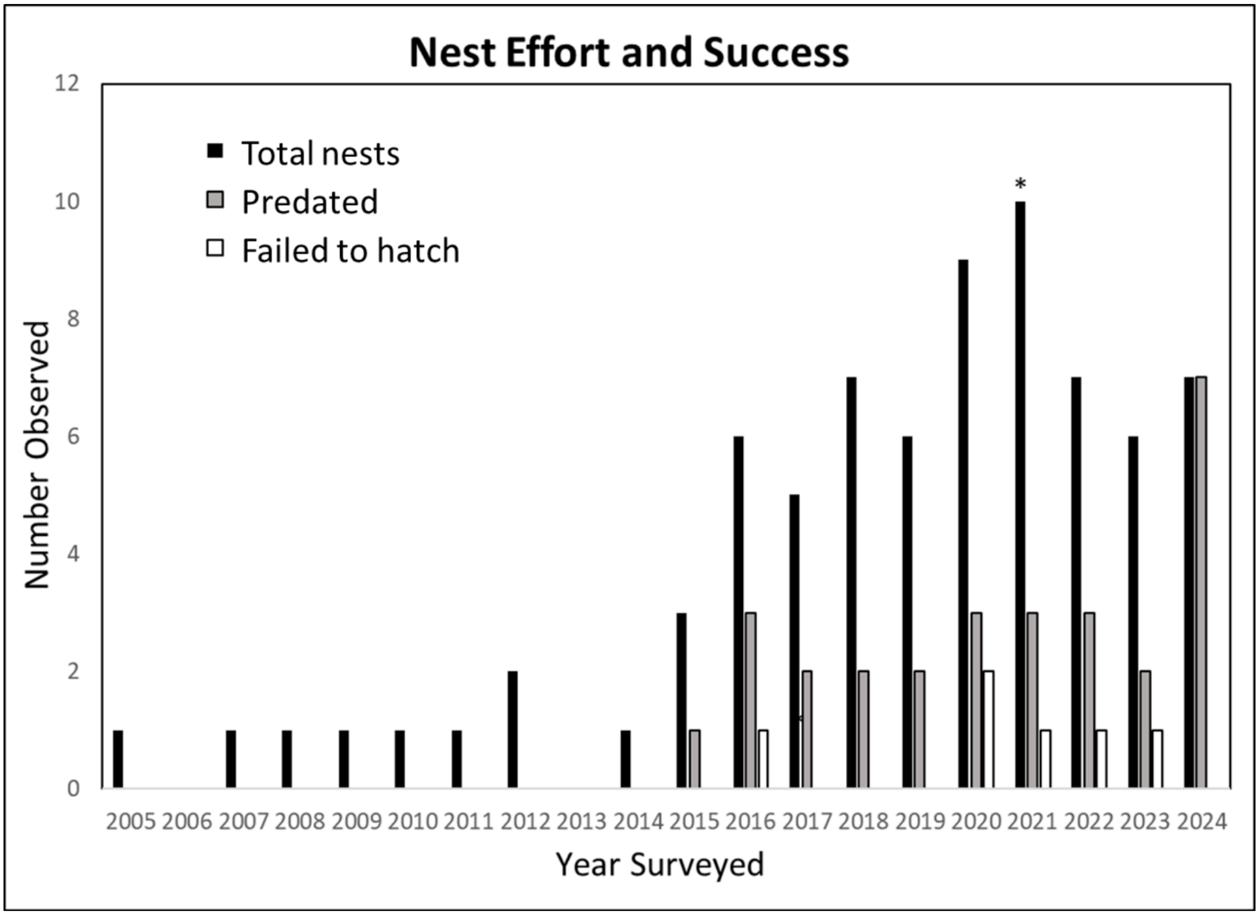

Figure 13. Trends in nesting effort and success at RSWMA over 19 years of monitoring effort. The number of nesting females only began to increase in 2015 and peaked in 2021. Predation remained relatively constant but spiked in 2024 when all known nests were predated. *One nest in 2021 contained two clutches from two separate females who were observed simultaneously guarding the nest.

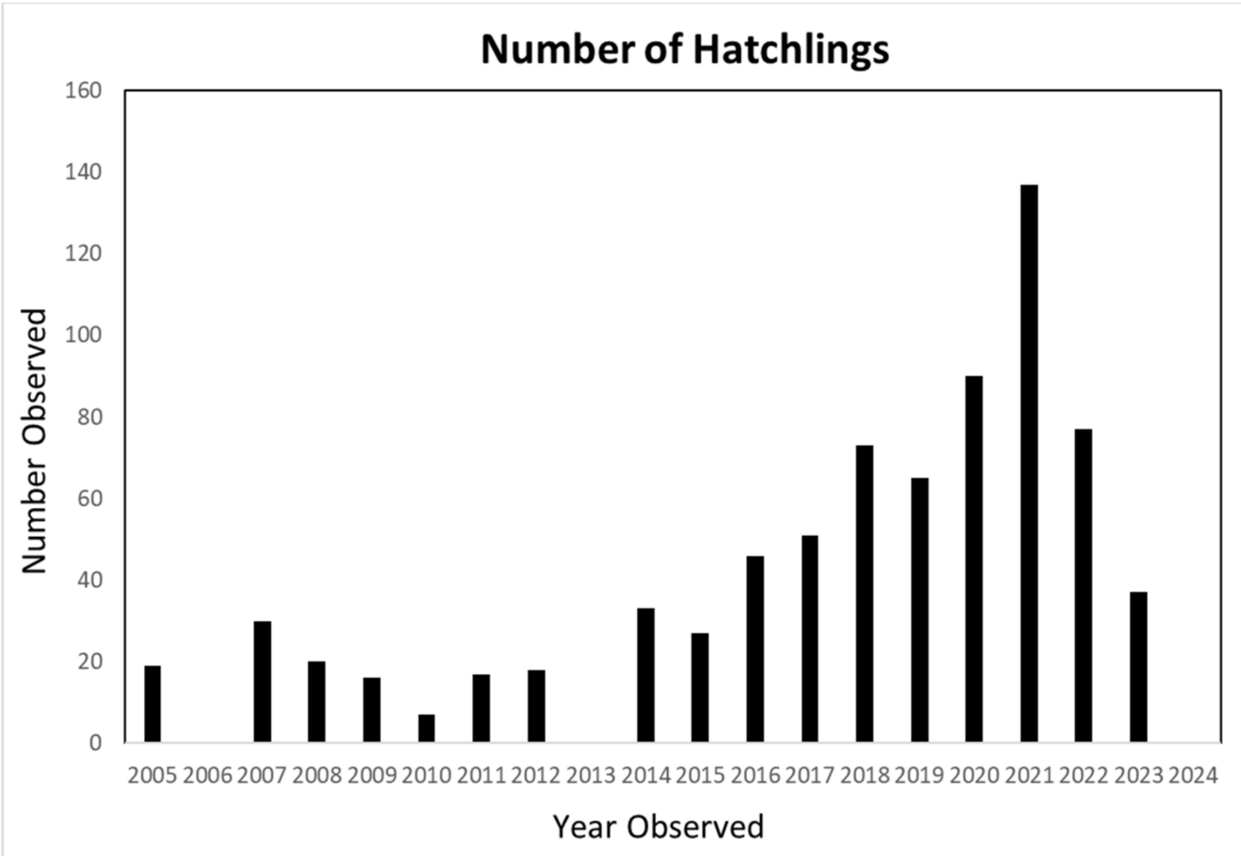

Figure 14. Trends in hatchlings observed at RSWMA since 2005 and for the current reporting period. Longer term monitoring shows a study increase from 2015 to 2021 in the number of hatchlings observed. The decrease in 2022 and 2023 was associated with a decrease in number of nests along with loss of nests due to flooding, fire ants, and racoon predation. No hatchlings were observed at RSWMA during 2024 as all known nests were lost to racoon predation.

Figure 15. Icing response of alligators at RSWMA. This cohort of juveniles were located near their overwintering den in their final winter prior to dispersal. Breathing holes in the ice allow for acquiring oxygen until the ice thaws. All individuals in this photo survived the freezing event, but a cohort of hatchlings experienced 50% mortality while engaged in the icing response in an adjacent management unit.

Table 3. Mortality observed during a freezing event in February 2021 during which we marked and monitored juveniles of various age classes. All mortality was observed in alligators born in the previous fall.

Age class	Marked	Observed dead	Observed alive
0.5	12	6	6
1.5	6	0	6
2.5	13	0	12
Adult	10	0	3

Significant Deviations:
None.

Equipment:
No equipment purchased for this grant.

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Date: March 8, 2025