FINAL PERFORMANCE REPORT

Federal Aid Grant No. F19AF00904 (T-115-R-1)

Habitat Use and Movement Patterns of Western Chicken Turtles Within a Metapopulation in Southeastern Oklahoma

Oklahoma Department of Wildlife Conservation

January 1, 2020 through December 31, 2023

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Grant Program: State Wildlife Grants

Grant Title: Habitat Use and Movement Patterns of Western Chicken Turtles within a Metapopulation in Southeastern Oklahoma

Grant Period: January 1, 2020 through December 31, 2023

Principal Investigators: John D. Willson, Associate Professor, Department of Biology, University of Arkansas
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ABSTRACT:

Western Chicken Turtles (*Deirochelys reticularia miaria*) are a species of conservation concern in nearly every state where they occur and have only begun to receive serious research attention in the last 15 years. They are known to inhabit shallow wetlands and to move among these regularly, but the specific factors that drive wetland occupancy and inter-wetland movement are not well understood. We used occupancy modeling with extensive sampling of a set of wetlands around known Western Chicken Turtle metapopulations to evaluate Chicken Turtle wetland use and evaluated factors that may affect detection and occupancy probability.

Between 19 May 2020 and 24 July 2023, we performed effort-standardized occupancy surveys at 48 wetlands along with additional non-standardized recapture and movement sampling at a subset of these and several other wetlands. Some of these wetlands were sampled in multiple years yielding 68 standardized surveys. Our trapping produced, in total, 7,551 captures of 3,913 individual turtles. Ten species of freshwater turtle were captured, including six that are species of greatest conservation concern in Oklahoma. Thirteen of the 38 wetlands sampled produced at least one Western Chicken Turtle, including five new Chicken Turtle localities. Estimated daily detection probability was 0.454, indicating that our surveys had a 95.2% chance of detecting Chicken Turtles during a 5-day survey bout when they were present. Our current occupancy models did not find any significant effects of habitat covariates on wetland occupancy by Chicken Turtles overall but did find a relationship between male occupancy and a principal component associated with shallow water, low in-wetland canopy closure, and high percentage cover of rush and *Polygonum*. Estimated wetland occupancy probability was 0.346 for males, 0.191 for females, and 0.075 for juveniles. We detected 13 inter-wetland movements and most of these were movements between years rather than within the same year.

OBJECTIVES:

Objective 1: To rigorously assess the distribution and abundance of Western Chicken Turtles within this metapopulation and to identify the wetland and landscape variables that predict occupancy of male, female, and juvenile Chicken Turtles. This information will be determined through repeated sampling of a large number of wetlands within the known metapopulation. Occupancy modeling will be used to identify wetland and landscape variables that best predict occurrence of male, female, and juvenile chicken turtles. Habitat use patterns for adults of each sex and for juveniles will be described in each interim report.

Objective 2: To evaluate occupancy patterns of Chicken Turtles in WRP wetlands and identify ways in which WRP habitats might be managed to promote use by Chicken Turtles. Occupancy models developed through the trapping and habitat assessments of Objective 1 will be used to identify WRP wetlands that are best suited to use by Chicken Turtles and to identify strategies for maximizing their value to the turtles. Our final report will describe such strategies that can be adopted within the WRP program to enhance habitat for chicken turtles in general and for particular demographic groups.

Objective 3: To track the movements of chicken turtles between wetlands and to identify the ecological drivers of those movements, particularly when those drivers vary between sexes or between age classes. State-specific modelling will be used to combine movement observations with wetland and terrestrial habitat characteristics and evaluate support for various hypothesized drivers of inter-wetland movement. The numbers, locations, and movements between wetlands of Western Chicken Turtles will be included in each interim report. Our final report will present any conclusions we have drawn about differences in movement patterns among demographic groups.

INTRODUCTION:

Beginning in 2012, Day Ligon's lab at Missouri State University has been studying the ecology of the Western Chicken Turtle (*Deirochelys reticularia miaria*), a Tier II Species of Greatest Conservation Need in Oklahoma, at the Nature Conservancy's Boehler Seeps and Sandhills Preserve (BSSP) in Atoka County, Oklahoma (Oklahoma Comprehensive Wildlife Conservation Strategy). Initial surveys detected 14 individual chicken turtles (McKnight 2015), but subsequent efforts have raised the number of known individuals to 162, including males, females, juveniles, and hatchlings. Despite this substantial increase in data, we still know relatively little about the true abundance of individuals within this population or its geographic extent. Acquiring a more complete knowledge of the spatial extent and viability of this population requires the continuation and expansion of sampling in the area.

The radio tracking of chicken turtles during previous work has indicated that individuals move among wetlands (sometimes over long distances), suggesting that each inhabited pond is a small piece of a large, interconnected metapopulation (McKnight 2015). If this is an accurate understanding of the system, protecting ponds that currently contain large Chicken Turtle populations may not be adequate to conserve the species. Instead, conservation efforts would need to protect a network of wetlands and the terrestrial corridors that Chicken Turtles use to move between these wetlands. Patterns of pond occupancy have led us to suspect that males may be selecting ponds based on the presence of females, and females on other unknown variables. To determine what these variables are, and whether movements within each demographic group are motivated by mate-seeking, dispersal from over-crowded wetlands, a response to habitat shifts, climate, or other factors, we need to better map these movements and the environments across which they occur.

Chicken turtles are of conservation interest not only in Oklahoma, but also in neighboring Missouri and Arkansas. Gaining an understanding of how these animals move through patchy habitat matrices will have broad applicability in planning habitat conservation across large parts of the species' range. Additionally, leveraging existing wetland protection programs to enhance chicken turtle habitat could present an extremely valuable tool in managing and conserving populations of the species. The Wetland Reserve Program (WRP) provides financial assistance and expertise to landowners interested in preserving wetlands on their properties. More than 60,000 acres of wetland habitat in Oklahoma have been conserved or restored though this program, including over 4,000 acres in Atoka County (Oklahoma's Wetland Program Plan, Wetlands Reserve Program Oklahoma Report). If the management of these wetlands can be made to include maintenance and restoration of habitat suitable for Chicken Turtles, it would provide a meaningful step in ensuring the conservation of the species using existing resources. We have encountered lone chicken turtles in WRP wetlands in the past, which suggests a willingness to inhabit such wetlands at least occasionally.

APPROACH:

Objective 1: Distribution, Abundance, and Occupancy Modeling

STUDY SITES

Over the course of four Chicken Turtle active seasons (May 2020 – July 2023), Ethan Hollender, with the assistance of technicians Amylynn Ephraim (2021), Talon Jost (2022), and Elizabeth Hays (2023) systematically surveyed 38 wetlands for turtles (Figure 1). We surveyed 23 of these only once and 15 in multiple years. These wetlands were selected based on historical presence of Chicken Turtles, proximity to known Chicken Turtle localities, or characteristics (shallow water, abundant emergent vegetation, etc.) that have been associated with the presence of Chicken Turtles during past surveys. Two of these wetlands occur on protected lands at The Nature Conservancy's Boehler Seeps and Sandhills Preserve (Chicken Turtles also are known to occupy wetlands that are protected on Red Slough Wildlife Management Area). The other 36 are on privately held properties. A brief description of each wetland that was surveyed and the surrounding terrestrial habitat can be found in Table 1.

Trapping

At each of the 38 wetlands surveyed, we deployed a standardized array of traps consisting of 15 hoop net traps of various sizes (all with 1-inch mesh) and five steel mesh minnow traps modified to capture small turtles (Vogt 1980; McKnight et al. 2015). Six of the 15 hoop nets were attached to the ends of three leads. These leads consist of a mesh panel supported at the top of the water column with floats and fixed to the wetland substrate with weights. This arrangement ensures that turtle species with low susceptibility to fish-based baits (including Chicken Turtles and River Cooters) are represented in surveys. The size of the hoop traps used in each array varied depending on the depth of the wetland, but all of our hoop traps were of a design that would capture and retain nearly the full range of sizes for all of the turtle species likely to be encountered. In a few of the larger wetlands, we deployed two or three arrays to ensure wider coverage of the available habitat. We left each array in place for five nights and checked traps for turtles daily, replacing bait as necessary (at a minimum of every other day). All turtles were measured, weighed, sexed, and the hard-shelled species were given identifying marginal scute notches with a rotary tool (Cagle 1939). Softshell turtles were individually marked by the injection of a PIT tag (Buhlmann and Tuberville 1998). Chicken Turtles and Common Snapping Turtles were marked with both forms of identification. In addition to this standardized trapping for occupancy analysis, we deployed a variable number of traps in small wetlands that would not accommodate a full array and in some of our longest-running study sites to collect recapture and movement data.

Occupancy Analysis

At each wetland, we measured a variety of habitat covariates including in-wetland canopy cover, terrestrial canopy cover, wetland area, percent wetland surface coverage of several types of aquatic plants, and water depth. Canopy cover was measured with a concave densiometer by walking transects within each wetland and in the upland habitat surrounding each wetland. Wetland coverage by aquatic vegetation was measured by walking four transects within each wetland and visually estimating the percent surface coverage of various species within a 3-meter square every ten meters. Depth also was measured at each of those points and averaged across the wetland. We used satellite imagery combined with on-the-ground observations to measure the distance from each wetland to the nearest permanent body of water as a proxy for wetland isolation. Aquatic habitat covariates were often autocorrelated, and so we used a Principal Components Analysis (PCA) to condense them into uncorrelated composite variables (PCs). The first two PCs accounted for a total of 48.05% of the variation in aquatic habitat among wetlands (Figure 2). Positive values for PC1 (30.9% of aquatic habitat variation) were associated with deeper water, increased canopy closure, and increased open water surface area coverage, while negative values were associated with shallow water, minimal canopy cover, and high percentage coverage by rush (*Juncus* spp.) and knotweed (*Polygonum* spp). Positive values for PC2 (17.14% of aquatic habitat variation) were associated primarily with high percentage coverage of cutgrass (*Zizaniopsis* spp.) and cattail (*Typha* spp.). We used 68 standardized survey bouts in our model. This included some wetlands that were surveyed in multiple years, but as Chicken Turtles (unlike most other species) estivate and overwinter terrestrially, each year does largely represent a new decision by each turtle regarding whether to utilize a wetland. For sites that were used in multiple years, all aquatic habitat variables were measured in each year. Terrestrial canopy cover was only measured in the first year unless significant logging had occurred in a wetland's immediate surroundings between years.

We used the msPGOcc() function in the R package spOccupancy (Doser at al. 2022) to implement a multi-species Bayesian model (Dorazio et al. 2006, Zipkin et al. 2009) in which males, females, and juveniles were treated as separate 'species,' such that what would typically be community-level information in a model of this kind instead applies to Western Chicken Turtles overall. The model included PC1, PC2, percent terrestrial canopy cover, and distance to nearest permanent wetland as site covariates affecting occupancy probability, as well as daily maximum temperature as a detection covariate. The model was run for 80,000 iterations to ensure convergence and posterior predictive checks were run to ensure model soundness. Visual assessments of convergence chain history plots indicated that the model was behaving as expected and Gelman-Rubin statistics for all occupancy and detection covariates were less than
1.1. Bayesian p-values for all groups were between 0.2 and 0.5, well within the recommended range (Hobbs & Hooten 2015). All analyses were performed using a 95% credible interval.

Objective 2: Use of Wetland Reserve Program Properties

Using the methods described in the previous section, we surveyed five wetlands across two privately held WRPs - Mills WRP (MD and MS), Choctaw County, and BC Wetlands WRP (BCWRP2, BCWRP3, and BCWRP4), Atoka County. The Mills WRP is often minimally managed, with beaver regularly clogging drainage culverts such that the two wetlands we surveyed are allowed to flood and dry semi-naturally during this study. The BC WRP is heavily managed for waterfowl, and when we trapped there in July 2023 huge swaths of many wetland cells were completely drained.

Objective 3: Movements Among Wetlands

In cooperation with Day Ligon and Dylan Wichman's concurrent study on the BSSP population of Chicken Turtles (Wichman and Ligon 2022), we used radio-telemetry to monitor the movements of 37 individual Western Chicken Turtles (several of them across multiple years). Detections of individual Chicken Turtles generated by the trapping effort described in the previous sections were combined with pre-existing data (provided by Donald McKnight and Day Ligon) on the past locations of individual turtles to identify movements among wetlands that occurred outside of the times when we were actively monitoring the animals with radio- telemetry.

RESULTS AND DISCUSSION:

Objective 1: Distribution, Abundance, and Occupancy Modeling

TURTLE DISTRIBUTION & ABUNDANCE

Our surveys yielded a total of 7,551 captures of 3,913 individual turtles representing ten species (Table 2), including 93 adult Chicken Turtles and 16 juvenile Chicken Turtles (Table 3). Chicken Turtles were detected at least once in 13 of the 38 wetlands surveyed (Figure 1, Table 4). Of these, five wetlands (BP5, BP9, MMP7, P10, and P1) were subjected to standardized surveys in multiple years and produced Chicken Turtle detections in each year that they were surveyed. Four other wetlands (Mills Swamp, P6, P15, and Boehler Lake) were surveyed in multiple years and produced Chicken Turtle detections in some but not all of those years. The remaining four wetlands where Chicken Turtles were detected were only surveyed in a single year (MMP11, MMP15, MMP16, and P21). One of these wetlands (P15) that had been surveyed in the two previous years yielded a Chicken Turtle for the first time in 2022, though this turtle was captured in BP9 the following day and was almost certainly a transient individual rather than a resident of P15. Mills Swamp (MS), Boehler Lake (BL), and P6 contained multiple Chicken Turtles in the years that they were detected and, given our high daily detection probability, it is likely that these sites underwent genuine changes in seasonal occupancy status during our study.

Of the 13 wetlands where we detected Chicken Turtles, four were new localities that had not been surveyed in the past (Table 4). Of these four, three produced multiple individual Chicken Turtles, suggesting at least the possibility of a resident sub-population (MMP11, MMP16, and P21). One noteworthy wetland was MMP7, which was constructed in 2017 and subsequently colonized, largely by former inhabitants of Halsell Lake (see *Interwetland Movements*), sometime before we first surveyed it in 2021. Three of the wetlands (P21, MMP11, & MMP16) that were only trapped during 2023 produced a total of nine juvenile Chicken Turtles during a week of surveys, far more than we have ever captured in such a small area and brief timeframe. These juveniles (and potentially others in these ponds) could prove extremely valuable for future work on growth and survival in the early life stages of the species.

In addition to Chicken Turtles, we captured 3,804 individual turtles of nine other turtle species (Table 2). These included one Tier I Species of Greatest Conservation Need (SGCN): Alligator Snapping Turtle (*Macrochelys temminckii*) at a single site, and four Tier III SGCN: False (Mississippi) Map Turtle (*Graptemys pseudogeographica*) at eight sites, River Cooter (*Pseudemys concinna*) at 16 sites, Razor-backed Musk Turtle (*Sternotherus carinatus*) at two sites, and Spiny Softshell Turtle (*Apalone spinifera*) at five sites (Oklahoma Comprehensive Wildlife Conservation Strategy 2016, Table 2).

Occupancy Analysis

The estimated daily detection probability for Chicken Turtles was 0.454, with slightly higher values for adult males (0.484) and females (0.493), and slightly lower values for juveniles (0.367, Figure 3). This equates to a detection rate approaching 95% for each five-day survey for the species and for both sexes of adults, giving us very high confidence that our presence/absence data reflect real patterns of Western Chicken Turtle occupancy. The value for juveniles Chicken Turtles equates to a lower 90% survey detection rate, but that is still quite high. Male Chicken Turtles were detected at all of the 13 wetlands where we encountered Chicken Turtles and had an estimated occupancy probability of 0.346. Females were detected at 8 wetlands (estimated occupancy probability was 0.191), which were a subset of those occupied by males. Juveniles were detected at only five wetlands (estimated occupancy probability was 0.075), four of which were also occupied by adults.

The estimated male occupancy (0.346) is much higher than estimated female occupancy (0.191), which suggests that nearly half of wetlands where we detected Western Chicken Turtles are not hosting reproductive populations, but rather are serving as stopover points for wandering males. One very clear case of this, wetland P15, is discussed in Movement Among Wetlands below.

No covariates for either occupancy or detection were significant for Chicken Turtles as a whole (Figures 4, 5). However, male occupancy probability was negatively associated with PC1, indicating that male wetland use is associated with shallow water, high percentage surface cover of rush and polygonum, and minimal in-wetland canopy closure (Figure 6, 7). Although 95% credible intervals overlapped zero, both male and female occupancy appeared to be weakly positively associated with distance to nearest wetland (see Figure 6). This relationship was somewhat unexpected and might reflect preference for more isolated wetlands with drier surrounding uplands, as opposed to lowland wetland complexes where inter-wetland distances are short. The low number of sites where juveniles were detected resulted in extremely wide credible intervals for young Chicken Turtles, such that no conclusions about their unique habitat needs can be drawn at this time.

Maximum daily temperature did not have a significant influence on detection probability for the species as a whole but was associated with increased detection probability for females (Figure 8, 9). Both males and juveniles also appeared to show a weaker increase in detectability as temperatures increased, though the 95% credible intervals overlapped zero. It should be noted that we typically stopped our surveys in early July when the first Chicken Turtles began to migrate to their upland estivation sites, and so were rarely trapped during the warmest periods of the year.
Although detectability shows a positive association with temperature within our timeframe, it is likely that detectability actually follows a quadratic relationship with temperature over the full annual temperature range.

We are optimistic that future surveys of additional wetlands in both Oklahoma and Arkansas will continue to improve the power of our model, and that extraction of new covariates from our existing data repository (such as abundance of various food items) and better incorporation of covariates derived from remote sensing (such as upland cover and topography around wetlands) will allow us to eventually construct and publish a model capable of providing additional information on the habitat needs of the Western Chicken Turtle.

Objective 2: Use of Wetland Reserve Program Properties

Two Chicken Turtles were captured at the Mills WRP wetlands and zero at BC WRP wetlands. This suggests that WRPs can serve as Chicken Turtle habitat, although the small number of WRPs we were able to visit limits our ability to assess how best to enhance their efficacy in that regard. It should be noted that many of the wetlands at Red Slough WMA, outside of the geographic scope of this project, were restored through the WRP program and Chicken Turtles have been documented in at least five WRP wetlands in that area. Although based only on a descriptive association of WRP management habits and Chicken Turtle presence, our observations here suggest that a potentially important factor in managing WRPs in a way that they will serve as habitat for Chicken Turtles is to ensure that there are always some sizeable patches of standing water during the active season (typically early March – early July). It may be that when almost all of the cells at a WRP are drawn down simultaneously during the spring and early summer when Chicken Turtles are active, the ability of Chicken Turtles to persist in the landscape by evacuating to nearby suitable habitat is reduced. Such was the case at the BC WRP complex where all of the wetlands had been drawn down by late June.

Objective 3: Movements Among Wetlands

Our trapping and tracking efforts detected 13 inter-wetland movements by Chicken Turtles within the BSSP-area metapopulation. Twelve were movements made (or at least detected) between years, while only one definitively occurred within an active season (Figure 10). With this small number of movements detected (none of which were made by juveniles), we were unfortunately unable to tease out any differences in the drivers of movement patterns among demographic groups. Of the 13 movements detected around BSSP, 8 were associated with either Boehler Lake or BP5, which are two of the wetlands that have been trapped most consistently, most intensely, and for the longest period of time. It is very likely that any faint patterns we can currently observe are the result of the majority of our marked turtles having been originally captured in those two wetlands, such that it is far more likely for a marked turtle to leave one of those wetlands than to enter it.

We have reason to hope that the continued monitoring of this population of Chicken Turtles will rapidly improve our ability to model movement patterns. During the course of our study, we documented Chicken Turtles in seven BSSP-area wetlands where they had not previously been known to occur (MMP11, MMP15, MMP16, MMP7, P10, P15, and P21) and marked 63 additional individuals in this metapopulation. Although the bulk of known animals have been marked at Boehler Lake and BP5, many have now been marked elsewhere, including 16 juveniles in P21, MP7, MMP11, MMP15, and MMP16. This greatly increases the geographic distribution of known turtles as well as the number of marked individuals available to reveal movement corridors.

A series of incidental cases lets us make some inferences about the movement responses of Chicken Turtles to the rapid drying of their environments. Our high daily detection rate gives us confidence that if we fail to catch any Chicken Turtles during a five-day survey, it is because there are no Chicken Turtles in the wetland. There were two instances where we captured Chicken Turtles in wetlands where they had been known to occur in the past, but we were unable to catch them the following year after precipitous drops in water level. Mills Swamp (WRP) produced two young male Chicken Turtles in 2020 (and Chicken Turtles had been caught there previously in 2018), but after the landowner demolished part of a levee the next year to combat excessive beaver activity, no Chicken Turtles were captured despite the continued retention of a substantial area of water and the persistence of several other species in the system. Boehler Lake itself suffered a ruptured dam in 2015, and no Chicken Turtles were captured there in 2018 or 2020 despite the rapid repair of the dam by the resident beavers. Beginning in 2021, however, Chicken Turtles were again found in Boehler Lake and were captured there in each subsequent year. Along similar lines, when BP9 was trapped originally in 2014, the dam had been deliberately destroyed and the wetland was little more than a flooded field inhabited primarily by Mississippi Mud Turtles. Between that time and 2020, beavers returned to the wetland and repaired the dam. Chicken Turtles were captured there when we trapped it in 2021 and 2022.

Prior to this study, Halsell Lake was the origin of more Chicken Turtle movements than any other site, despite having a smaller historical population than BP5. Between 2012 and 2015, Halsell Lake provided excellent Chicken Turtle habitat and hosted several individuals. However, beavers abandoned the site, and by 2018 the wetland had grown shallow enough that trapping became difficult, and we were unable to trap it at all in 2020, 2022, and 2023. Trapping during a high-water period in 2021 produced no Chicken Turtles, although there were low numbers of several other turtle species still there. Although circumstantial, all of these observations taken together suggests that Chicken Turtles may be quick to abandon a wetland that undergoes a steep decrease in water level, and it may take several years for a wetland to be recolonized even after that wetland has been restored to its former state by beaver activity or human intervention. If this is the case, the preservation of multiple suitable wetlands in close proximity may be particularly important in preserving these populations during times of instability.

RECOMMENDATIONS:

1. Our occupancy analysis suggests that shallow wetlands with minimal tree canopy cover and abundant rush and polygonum are important to at least one demographic group of Western Chicken Turtles and that wetland proximity may also have a weaker effect on Chicken Turtle occupancy. Additionally, wetland proximity is likely to play a role in the ability and willingness of Chicken Turtles to move among wetlands. Wetlands that are closer may have increasing connectivity, gene flow, and improve the ability of turtles to cope with changes in individual wetland conditions by providing alternative habitat. The conservation of this species will require a consideration of whole networks of wetlands, and we therefore recommend prioritizing the creation and maintenance of clusters of shallow, open-canopy, vegetated wetlands, especially in the areas where Chicken Turtles are known to persist. Specifically, we recommend restoration of Halsell Lake at Boehler Seeps & Sandhills Preserve. This wetland was abandoned by beavers and has largely dried up, with the remaining pools too choked with vegetation for turtles to move easily. Several of the Chicken Turtles that once inhabited Halsell Lake remain in a cattle pond 400 m to the east and a restored Halsell would likely be re-colonized quickly.
2. Our observations of Chicken Turtle use of WRP wetlands and Chicken Turtle movements in response to rapid drops in water level tentatively suggest that maintaining heterogeneity of water depth across wetland cells during WRP management may facilitate the use of these complexes by Chicken Turtles. We recommend further investigations into the responses of Chicken Turtles to wetland drying and the effects that different management regimes might have on Chicken Turtle habitat use.
3. Very little is currently known about the earliest years of life for Chicken Turtles, and our model suggests that a very small proportion of wetlands (0.075) contain juveniles, presumably because few wetlands are supporting active recruitment. Our 2023 discovery of a set of wetlands that contained abundant juveniles provides a valuable opportunity to study the growth and annual survivorship of young Chicken Turtles, and we recommend continued monitoring of these wetlands to capitalize on this opportunity.

SIGNIFICANT DEVIATIONS:

We did not detect a sufficient number of inter-wetland movements to model the drivers of those movements in the way that we had hoped. However, we have provided a descriptive account of our observations and our current best interpretation of those movements that we did observe.

EQUIPMENT:

No equipment was purchased.

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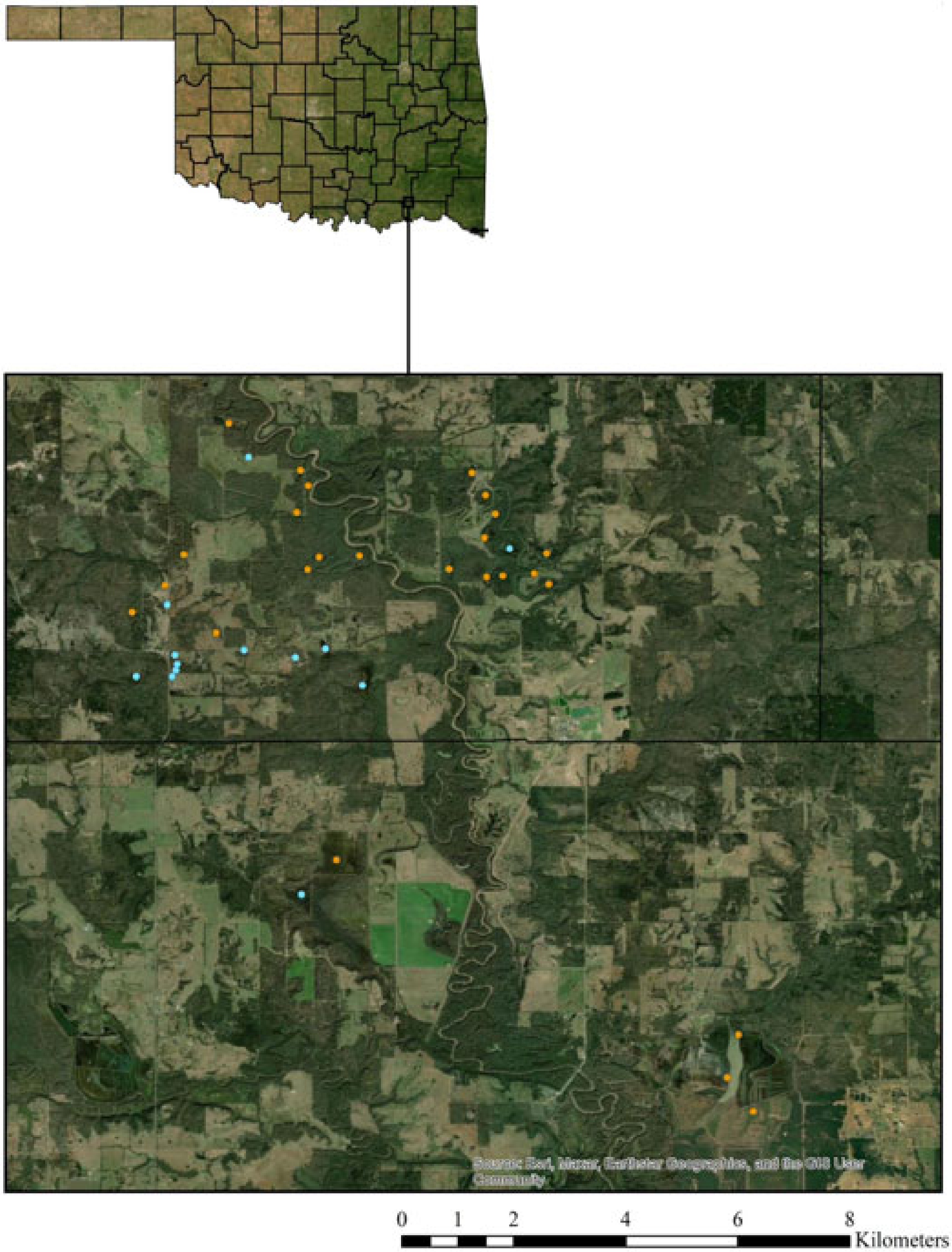

Figure 1: Map of wetlands systematically surveyed 2020 – 2023 at and around Boehler Seeps and Sandhills Preserve (inset). Blue dots indicate wetlands where Western Chicken Turtles were present in at least one year. Orange dots indicate sites where Chicken Turtles were never detected during standardized surveys.

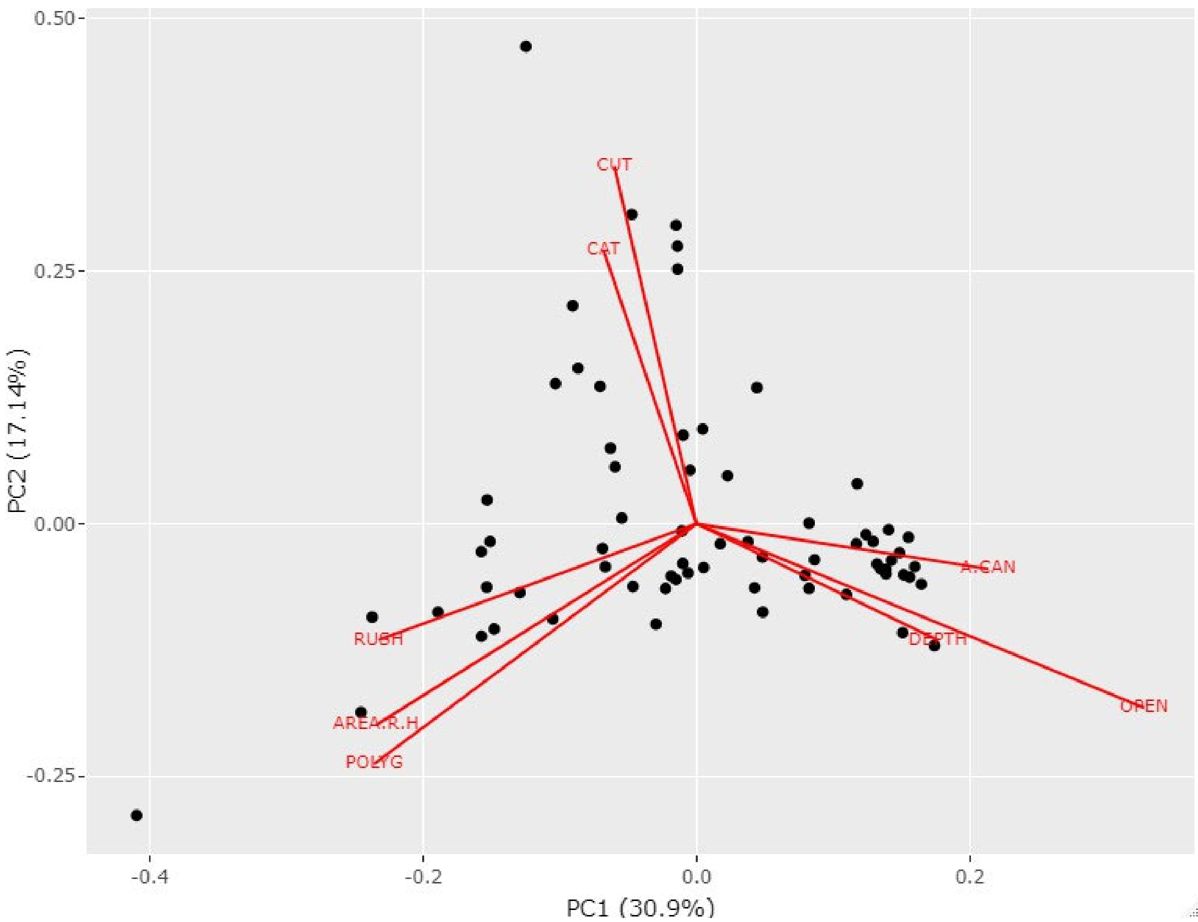

Figure 2: Principal Components Analysis of the suite of aquatic habitat variables we collected. (POLYG = % Polygonum coverage, RUSH = % Rush coverage, CAT = % Cattail coverage, CUT = % Cutgrass coverage, DEPTH = mean wetland depth, OPEN = % open water coverage, A.CAN = % canopy closure, AREA.R.H. = wetland area).

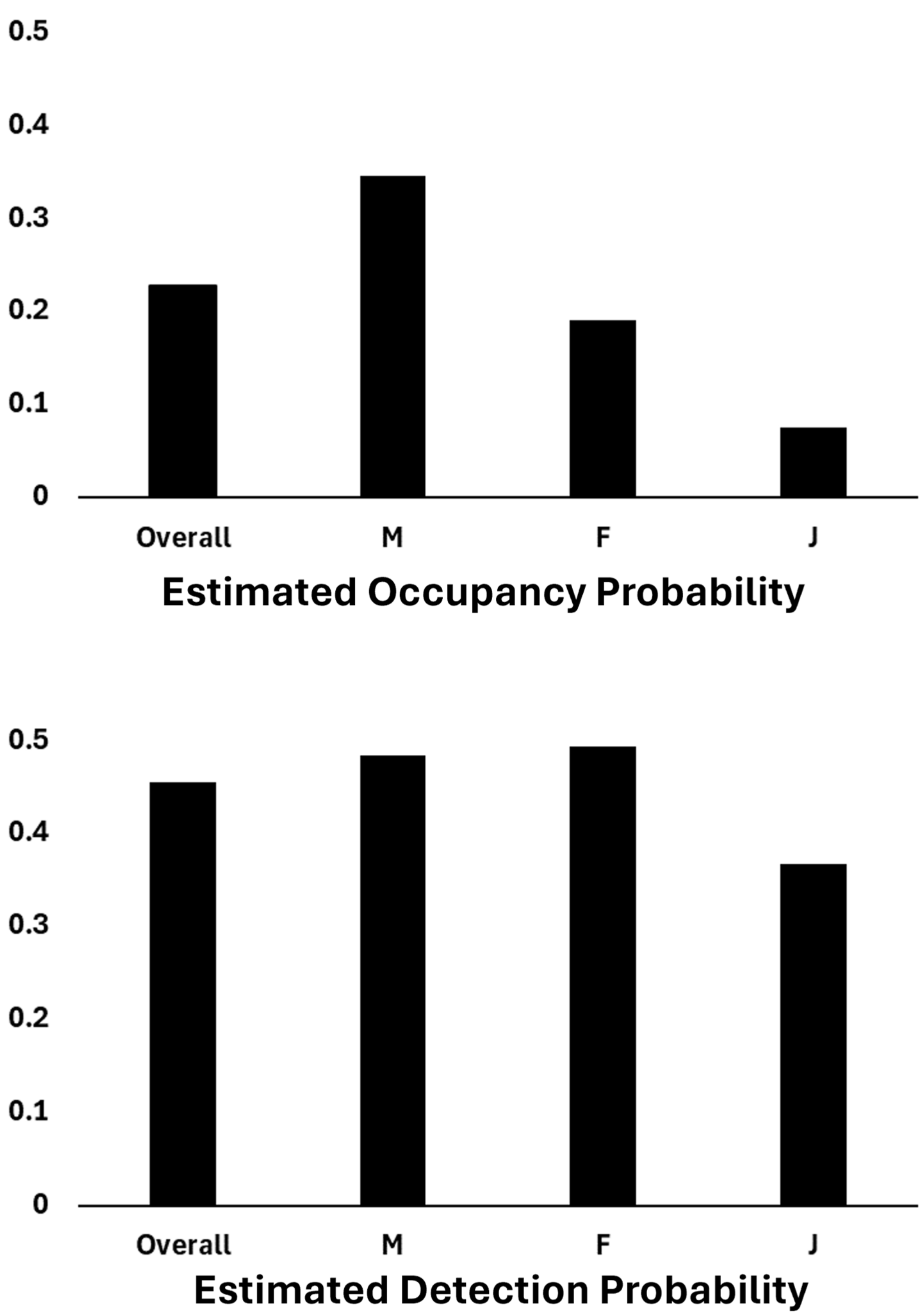

Figure 3: Estimated occupancy (top panel) and detection (bottom panel) probabilities for Western Chicken Turtles overall and for each of the three demographic groups we investigated. (F) = Female, (M) = Male, (J) = Juvenile.

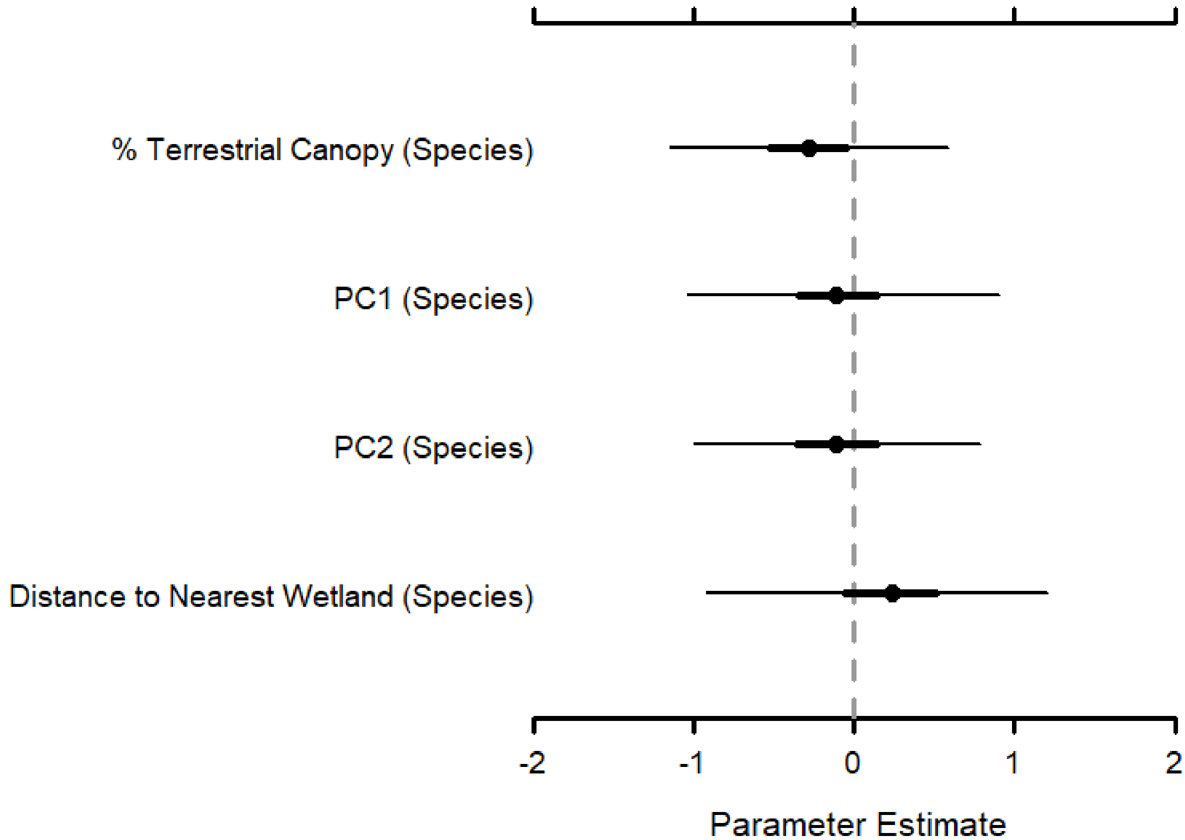

Figure 4: Summary of parameter estimates for habitat covariates of Chicken Turtle wetland occupancy (all demographic groups combined). Bold bars represent 50% credible intervals and narrow bars represent 95% credible intervals.

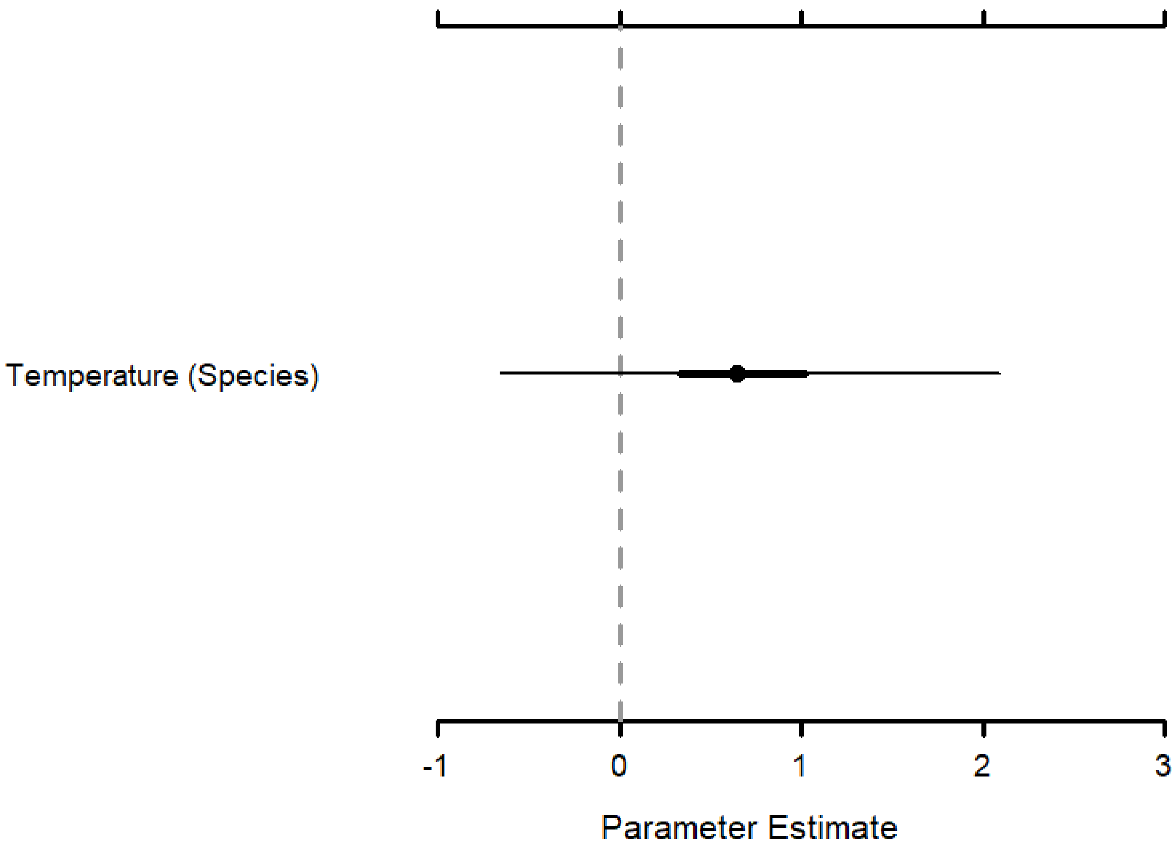

Figure 5: Summary of parameter estimates for survey covariates of Chicken Turtle detection (all demographic groups combined). Bold bars represent 50% credible intervals and narrow bars represent 95% credible intervals.

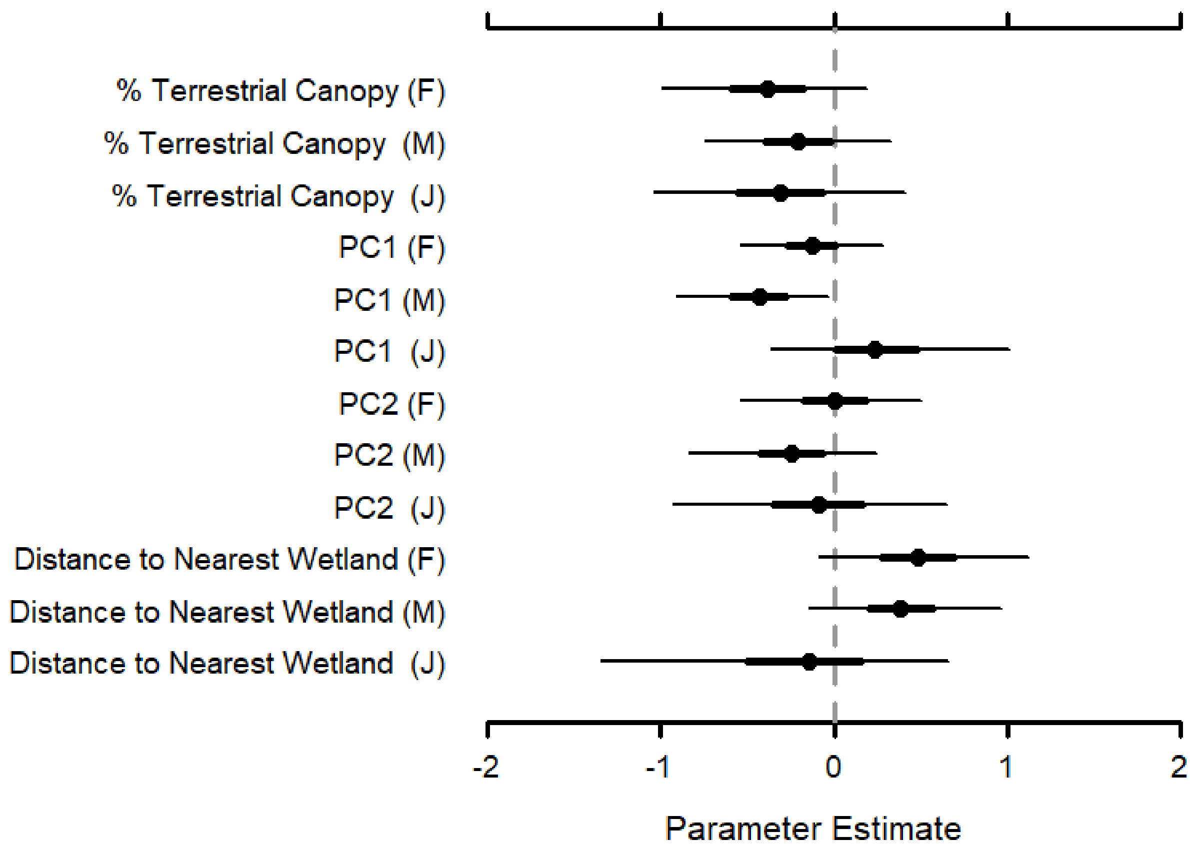

Figure 6: Summary of parameter estimates s for habitat covariates of individual Chicken Turtle demographic group wetland occupancy. Bold bars represent 50% credible intervals and narrow bars represent 95% credible intervals. (F) = Female, (M) = Male, (J) = Juvenile.

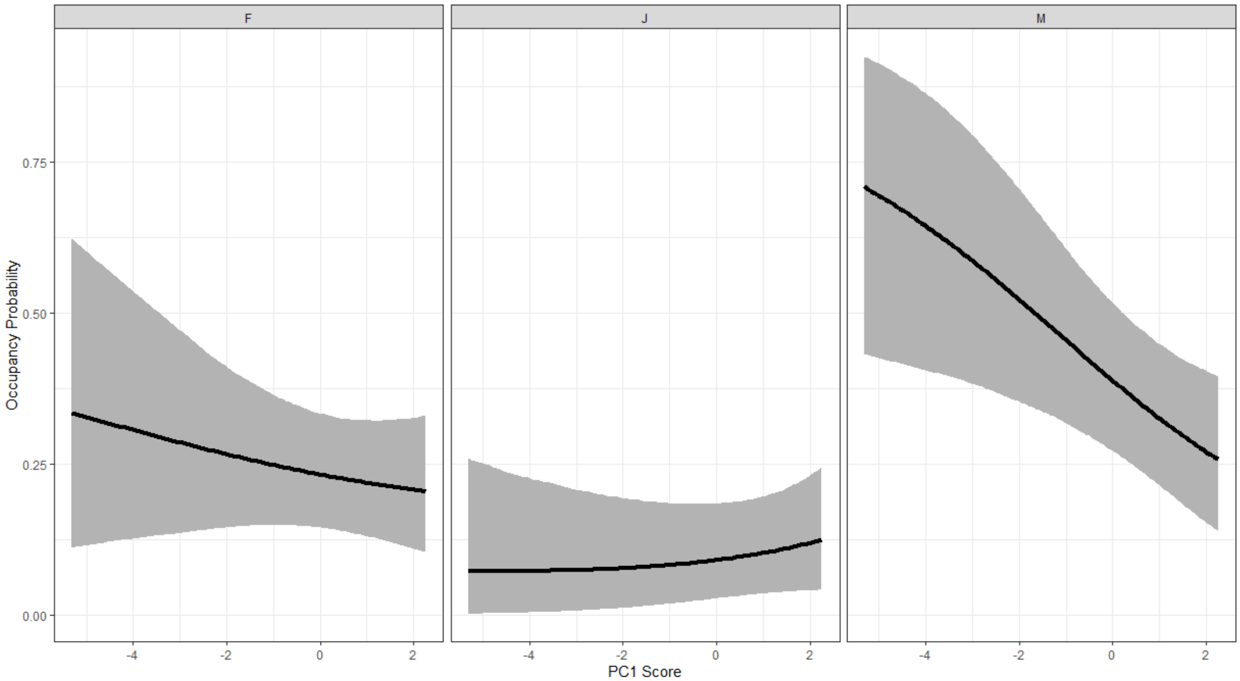

Figure 7: Marginal response plot showing the relationship between PC1 score and wetland occupancy probability when other factors are held constant at their mean. Grey shading indicates 95% credible intervals. (F) = Female, (M) = Male, (J) = Juvenile.

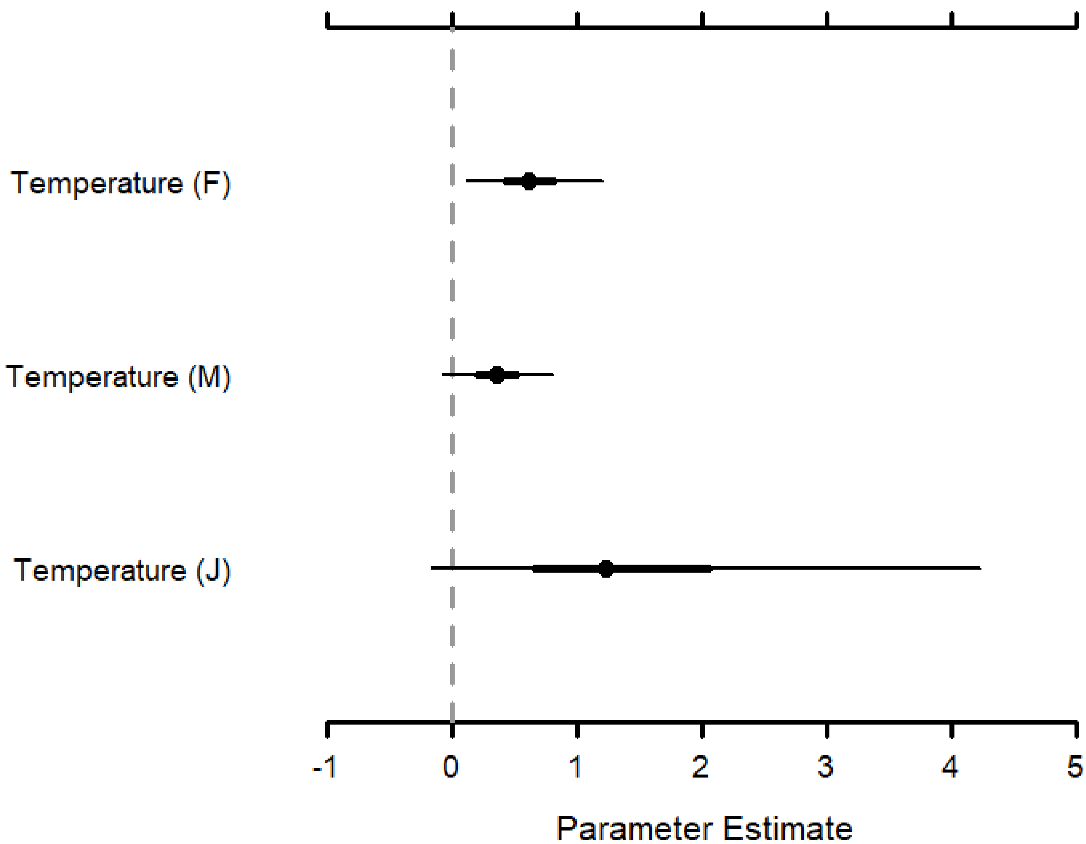

Figure 8: Summary of parameters for survey covariates of Chicken Turtle detection. Bold bars represent 50% credible intervals and narrow bars represent 95% credible intervals. (F) = Female, (M) = Male, (J) = Juvenile.

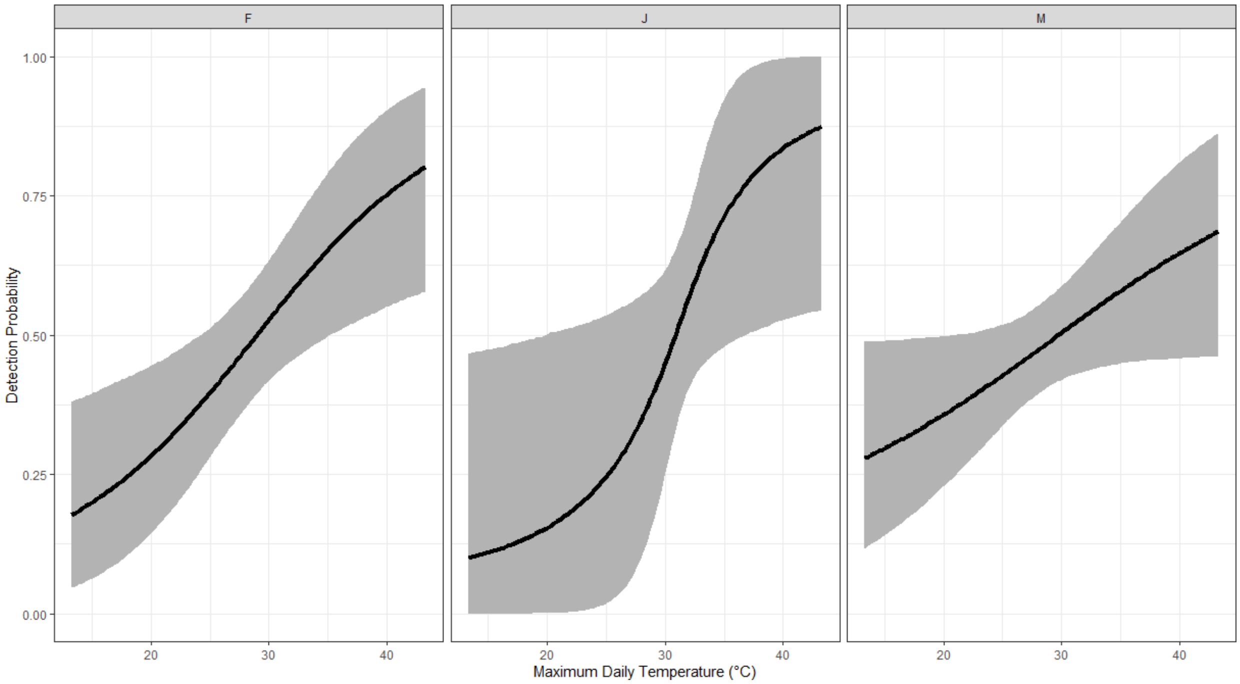

Figure 9: Marginal response plot showing the relationship between maximum daily temperature and Chicken Turtle detection probability. Grey shading indicates 95% credible intervals. (F) = Female, (M) = Male, (J) = Juvenile.

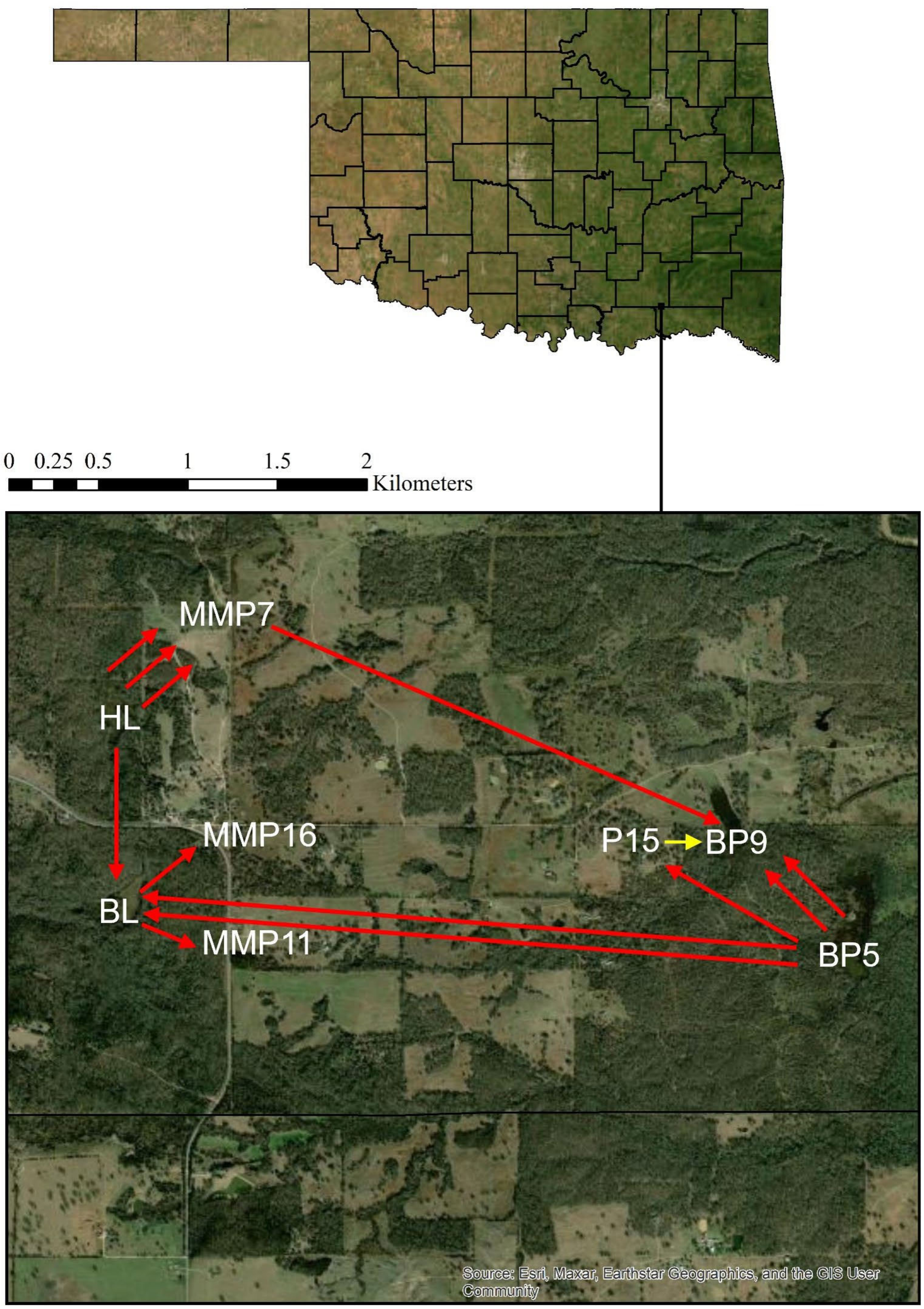

Figure 10: Map of Western Chicken Turtle inter-wetland movements detected at and around Boehler Seeps and Sandhills Preserve in 2020–2023. Red arrows indicate movements that were detected (and presumably occurred) between years. Yellow arrows indicate movements that occurred within a single active season.

Table 1: Summary of general wetland characteristics.

Site	Wetland Description	Emergent Vegetation	Terrestrial Land Use
BL	Beaver Pond	Heavy	Wooded
BP10	Beaver Pond	Heavy	Wooded/Pasture
BP11	Beaver Pond	Variable	Wooded
BP4	Beaver Pond	Heavy	Wooded/Pasture
BP5	Beaver Pond	Heavy	Wooded
BP9	Beaver Pond	Heavy	Wooded/Pasture
Dry Lake	Other (Large)	Heavy	Wooded/Pasture
HL	Beaver Pond	Heavy	Wooded
Mills' Ditch	Managed WRP	Heavy	Wooded
Mills' Swamp	Managed WRP	Variable	Wooded
MMP10	Cattle Pond	Minimal	Pasture
MMP7	Cattle Pond	Minimal	Wooded/Pasture
MMP9	Cattle Pond	Minimal	Wooded/Pasture
OX1	Oxbow	Variable	Wooded/Pasture
P1	Other (Large)	Heavy	Wooded
P10	Other (Small)	Minimal	Pasture
P12	Woodland Pool	Minimal	Wooded
P13	Woodland Pool	Moderate	Wooded
P14	Woodland Pool	Moderate	Wooded
P15	Cattle Pond	Minimal	Pasture/Hayfield
P18	Woodland Pool	Minimal	Wooded
P19	Woodland Pool	Variable	Wooded
P2	Cattle Pond	Moderate	Wooded/Pasture
P20	Beaver Pond	Variable	Wooded
P3	Beaver Pond	Moderate	Wooded/Pasture
P6	Cattle Pond	Heavy	Wooded/Pasture
P7	Other (Large)	Heavy	Wooded/Pasture
S1	Slough/Channel	Minimal	Wooded/Pasture
S2	Slough/Channel	Variable	Wooded/Pasture
S3	Slough/Channel	Minimal	Wooded/Pasture
S4	Slough/Channel	Heavy	Wooded/Hayfield

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Table 1 (continued): Summary of general wetland characteristics.

Site	Wetland Description	Emergent Vegetation	Terrestrial Land Use
BCWRP2	Managed WRP	Moderate	Dry Wetland/Levees
BCWRP3	Managed WRP	Variable	Wooded/Levees
BCWRP4	Managed WRP	Minimal	Dry Wetland/Levees
MMP11	Cattle Pond (Disused)	Moderate	Wooded/Hayfield
MMP15	Woodland Pool	Heavy	Wooded/Hayfield
MMP16	Other (Small)	Moderate	Wooded/Hayfield
P21	Woodland Pool	Moderate	Wooded/Hayfield

Table 2: Summary of individuals of each species captured in each body of water.

	Alligator Snapping Turtle	Western Chicken Turtle	Common Musk Turtle	Common Snapping Turtle	Eastern River Cooter	Mississippi Map Turtle	Mississippi Mud Turtle	Red-eared Slider	Razor-backed Musk Turtle	Spiny Softshell Turtle
BCWRP2			4					67		1
BCWRP3			2	2				28		
BCWRP4							1	7		
BL		6	94	18	16		38	112		
BP10			13	1	2		5	36		
BP11				3		2	10	39		
BP4			92	13	17	1	59	96		
BP5		56	365	15	8		242	332		4
BP9		4	31	8	3		45	135		
DL			6		2	4	13	72		1
HL			1			1	2			
MD			2	3			48	53		
MS		2		10			81	114		
MMP10				1				16		
MMP11		9						30		
MMP15		1					4	16		
MMP16		4		1			9	3		
MMP7		10	3	6	1			44		
MMP9					5			11		
OX1			13	1	3			61		
P1		2	23	5	1		32	82		
P10		3		4	4		13	49		
P12			1				1	4		
P13				1			29			
P14						2	5	29		
P15		1	3		4			53		
P18			2	1			3	4		

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Table 2 (continued): Summary of individuals of each species captured in each body of water.

	Alligator Snapping Turtle	Western Chicken Turtle	Common Musk Turtle	Common Snapping Turtle	Eastern River Cooter	Mississippi Map Turtle	Mississippi Mud Turtle	Red-eared Slider	Razor-backed Musk Turtle	Spiny Softshell Turtle
P19							6	4		
P2			18	1	25		3	109		
P20			4	4			10	69		
P21		8					20	18		
P3			7	2		1	12	34		
P6		3	2	1			18	11		
P7			4	2	1		3	33		
S1	1		19	1	6	13		142	75	39
S2			9				5	3		
S3			1				8	3		
S4			34	3	4	2	18	28	3	2

Table 3: Biometric, location, and capture history data for the 109 Western Chicken Turtles encountered during this study. Many turtles were captured multiple times, often across multiple years, and biometric information for each individual is drawn from the most recent capture event for which such data was collected.

Sex	Carapace length (mm)	Plastron length (mm)	Mass (g)	Recapture from previous years	Site
F	175.2	161.1	950	Y	BL
M	137.0	121.0	390	N	BL
M	149.0	129.5	530	N	BL
M	140.5	124.0	400	N	BL
M	117.5	102.0	225	N	BL
M	169.2	145.6	640	Y	BL - Dead
F	191.0	166.5	1150	Y	BP5
M	128.0	112.5	360	Y	BP5
M	122.5	110.0	280	Y	BP5
M	125.0	112.0	320	Y	BP5
F	165.2	149.4	660	Y	BP5
F	172.0	150.0	760	Y	BP5
F	184.0	163.5	870	Y	BP5
F	161.0	157.0	925	Y	BP5
F	193.0	168.0	1050	Y	BP5
M	146.5	135.5	510	Y	BP5
F	162.0	144.0	660	Y	BP5
M	127.4	112.2	320	Y	BP5
F	184.0	164.0	890	Y	BP5
M	126.0	113.0	320	Y	BP5
M	156.5	135.0	605	Y	BP5
F	168.4	151.1	750	Y	BP5
M	144.0	128.0	455	Y	BP5
M	132.5	115.0	350	Y	BP5
M	123.8	109.4	280	Y	BP5
M	146.5	127.0	460	Y	BP5
M	130.5	113.5	335	Y	BP5
M	143.0	125.0	450	Y	BP5
F	173.5	153.0	765	Y	BP5
F	169.9	153.3	670	Y	BP5
F	179.0	156.5	920	Y	BP5

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Table 3 (continued): Biometric, location, and capture history data for the 109 Western Chicken Turtles encountered during this study. Most turtles were captured multiple times, often across multiple years, and biometric information for each individual is drawn from the most recent capture event for which such data was collected.

Sex	Carapace length (mm)	Plastron length (mm)	Mass (g)	Recapture from previous years	Site
M	123.2	107.4	275	Y	BP5
F	166.0	149.5	665	Y	BP5
F	168.0	151.5	670	Y	BP5
M	121.5	107.0	275	Y	BP5
M	131.0	116.5	345	Y	BP5
F	132.1	119.9	360	Y	BP5
M	113.0	100.5	250	N	BP5
F	166.5	151.0	680	N	BP5
F	142.0	127.0	490	N	BP5
F	162.0	147.0	665	N	BP5
F	184.5	159.5	985	N	BP5
M	140.4	124.3	380	N	BP5
F	161.0	140.0	675	N	BP5
F	157.0	139.0	540	N	BP5
F	146.5	132.0	465	N	BP5
F	140.5	130.0	460	N	BP5
F	165.4	146.5	700	N	BP5
F	129.3	112.0	320	N	BP5
M	160.5	131.0	585	N	BP5
M	110.0	97.5	200	N	BP5
M	146.0	127.0	440	N	BP5
M	151.0	132.5	510	N	BP5
F	163.0	148.0	680	N	BP5
M	119.0	105.0	235	N	BP5
M	132.0	114.5	325	N	BP5
M	156.0	135.0	555	N	BP5
F	110.5	102.0	335	N	BP5
M	164.0	142.0	650	N	BP5
M	151.5	130.0	520	N	BP5
F	162.0	149.0	670	Y	BP5 - Dead
F	178.5	157.0	800	Y	BP5 - Dead

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Table 3 (continued): Biometric, location, and capture history data for the 109 Western Chicken Turtles encountered during this study. Most turtles were captured multiple times, often across multiple years, and biometric information for each individual is drawn from the most recent capture event for which such data was collected.

Sex	Carapace length (mm)	Plastron length (mm)	Mass (g)	Recapture from previous years	Site
M	137.0120.0		385	Y	BP9
M	157.0136.0		580	Y	BP9
M	144.4124.7		425	Y	BP9
M	119.0103.0		270	Y	BP9
M	175.0147.0		690	Y	MMP11
F	114.5103.5		265	N	MMP11
J	56.051.5		32.5	N	MMP11
M	113.0101.5		235	N	MMP11
M	99.089.5		165	N	MMP11
J	56.552.0		33	N	MMP11
F	176.0158.5		825	N	MMP11
J	58.554.5		32.5	N	MMP11
J	51.546.5		26	N	MMP11
J	79.569.0		90.5	N	MMP15
M	153.0134.0		525	Y	MMP16
F	193.0170.5		1175	N	MMP16
J	88.078.5		115	N	MMP16
M	107.593.5		170	N	MMP16
F	206.0184.0		1450	Y	MMP7
F	195.0174.0		1200	Y	MMP7
M	150.5130.5		570	Y	MMP7
M	163.0138.5		655	N	MMP7
J	25.925.3		6.02	N	MMP7
J	28.026.0		6.19	N	MMP7
J	26.724.2		6.27	N	MMP7
J	28.927.9		6.29	N	MMP7
J	30.427.6		7.27	N	MMP7
J	76.570.0		76.5	N	MMP7
M	112.7102.1		210	N	MS
M	110.2100.0		205	N	MS
M	153.0134.0		580	Y	P1
M	143.5125.3		440	N	P1

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Table 3 (continued): Biometric, location, and capture history data for the 109 Western Chicken Turtles encountered during this study. Most turtles were captured multiple times, often across multiple years, and biometric information for each individual is drawn from the most recent capture event for which such data was collected.

Sex	Carapace length (mm)	Plastron length (mm)	Mass (g)	Recapture from previous years	Site
M				N	P10
F				N	P10
M				Y	P10
M				N	P15
M	95.5	84.5	150	N	P21
F	193.5	172.5	1175	N	P21
J	80.0	72.5	89	N	P21
J	79.5	72.0	92	N	P21
J	91.0	80.5	135	N	P21
M	103.5	91.5	170	N	P21
J	81.5	73.5	97.5	N	P21
F	118.5	108.5	305	N	P21
M	139.0	126.0	435	N	P6
M	174.0	145.5	715	N	P6
F	181.0	157.5	945	N	P6

Table 4: Presence/absence matrix depicting annual Western Chicken Turtle status in 38 wetlands. A (1) indicates that the species was detected in that wetland and a (0) indicates that the species was not detected in that wetland. An (X) indicates that the wetland was not surveyed in that year. Survey effort was not necessarily standardized across years and not all detections shown here occurred during surveys included in occupancy models.

Site	2012	2013	2014	2015	2018	2020	2021	2022	2023
BCWRP2	X	X	X	X	X	X	X	X	0
BCWRP3	X	X	X	X	X	X	X	X	0
BCWRP4	X	X	X	X	X	X	X	X	0
BL	1	1	1	1	0	0	1	1	1
BP10	X	X	X	X	X	X	X	0	X
BP11	X	X	X	X	X	X	X	0	X
BP4	0	1	1	X	1	0	0	0	X
BP5	X	1	1	1	1	1	1	1	1
BP9	X	X	0	X	X	X	1	1	X
DL	X	X	0	X	X	X	0	0	X
HL	1	1	1	1	1	X	0	X	X
MD	X	X	X	1	X	0	0	X	X
MS	X	X	X	X	1	1	0	X	X
MMP10	X	X	X	X	X	X	X	0	X
MMP11	X	X	X	X	X	X	X	X	1
MMP15	X	X	X	X	X	X	X	X	1
MMP16	X	X	X	X	X	X	X	X	1
MMP7	X	X	X	X	X	X	1	1	1
MMP9	X	X	X	X	X	X	X	0	X
OX1	X	X	0	X	X	X	X	0	X
P1	X	1	0	X	0	X	1	1	X
P10	X	X	X	X	X	X	X	1	1
P12	X	X	X	X	X	X	X	0	X
P13	X	X	X	X	X	X	X	0	X
P14	X	X	X	X	X	X	X	0	X
P15	X	X	X	X	X	0	0	1	X
P18	X	X	X	X	X	X	X	0	X
P19	X	X	X	X	X	X	X	0	X
P2	P2	X	0	X	X	0	X	0	0
P20	X	X	X	X	X	X	X	0	X
P21	X	X	X	X	X	X	X	X	1
P3	X	X	0	X	X	X	X	0	X
P6	X	X	1	X	X	X	1	1	0
P7	X	X	1	X	X	X	0	0	X

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Table 4 (continued): Presence/absence matrix depicting annual Western Chicken Turtle status in 38 wetlands. A (1) indicates that the species was detected in that wetland and a (0) indicates that the species was not detected in that wetland. An (X) indicates that the wetland was not surveyed in that year. Survey effort was not necessarily standardized across years and not all detections shown here occurred during surveys included in occupancy models.

Site	2012	2013	2014	2015	2018	2020	2021	2022	2023
S1	X	0	0	X	X	0	0	X	0
S2	X	X	X	X	X	X	0	X	X
S3	X	X	X	X	X	X	0	X	X
S4	X	X	0	X	X	X	0	X	X