ORIGINAL ARTICLE

Asian Herpetological Research 2026, 17(2): 157–165
DOI: 10.3724/ahr.2095-0357.2026.0001
CSTR: 32242.14.ahr.2095-0357.2026.0001

Spatiotemporal Habitat Use in Juvenile Chinese Alligators (*Alligator sinensis*): Interactive Effects of Sunlight and Time

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Abstract The fine-scale habitat selection behavior of juvenile Chinese alligators (*Alligator sinensis*) is crucial to understand for *ex situ* environment design and *in situ* habitat restoration, yet how thermal requirements shape their microhabitat use remains unclear. To address this, we studied ten juveniles in a semi-natural artificial pond with four environmentally distinct quadrants during September 2025. Using 24-h video surveillance and systematic sampling, we analyzed their spatial use patterns, diel rhythms, and environmental drivers via temporal trend analysis and generalized linear mixed modeling (GLMM). Results indicated heterogeneous space use across quadrants and spatially distinct diel rhythms. Habitat selection was best explained by an interaction between solar exposure ratio and time of day. The GLMM revealed a significant interaction between solar exposure ratio and time period ($P < 0.05$), with simple slope analysis showing that solar exposure ratio had a strong positive effect on habitat use in the afternoon and night but not the morning. Concealment area also had a consistent positive effect. These findings demonstrate that juvenile Chinese alligators employ a dynamic, thermal-requirement-driven spatiotemporal strategy. This behavioral plasticity is critical for maintaining physiological homeostasis, suggesting that access to thermally heterogeneous habitats may be an important consideration in conservation planning for this species.

Keywords *Alligator sinensis*, behavioral thermoregulation, habitat selection, spatiotemporal patterns, generalized linear mixed model, conservation management

1. Introduction

Climate change is a major threat to global biodiversity. Ectothermic reptiles are especially vulnerable because of their physiological limits and their dependence on environmental temperature (Bickford *et al*., 2010; Yang *et al*., 2024). Within this context, the Chinese alligator (*Alligator sinensis*), a China National Class I protected wildlife species and Critically Endangered (IUCN) crocodilian endemic to China, represents a pivotal focus for conservation biology and population recovery efforts (Ding *et al*., 2003a; Jiang and Wu, 2018; Wu *et al*., 2008). Successful conservation depends on a full understanding of its behavior at all life stages. This includes the important juvenile period and the reproductive stage

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Received: 3 January 2026 Accepted: 29 April 2026
Published Online: 3 June 2026
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where caring for young is essential for population growth (Gao *et al*., 2025). A solid understanding of habitat needs is also very important for conservation. Field studies show that wild Chinese alligators strongly prefer microhabitats with specific features such as dense shoreline plants for hiding and regulating body temperature, stable water bodies, and soft soil for digging burrows (Wu *et al*., 2005). Critically, the survival and behavioral adaptability of juveniles are paramount for population recovery, yet a significant knowledge gap persists regarding the fine-scale behavioral patterns of habitat use during this vulnerable life stage.

The juvenile stage is particularly critical, as survival rates during this period directly impact long-term population viability (Briggs-Gonzalez *et al*., 2017). Juvenile behavior and their adaptive responses to environmental factors, especially fine-scale spatiotemporal patterns of microhabitat selection, are thus fundamental for assessing their fitness, resilience to climate change, and for informing optimal habitat management and conservation strategies. This need is especially acute in managed environments, where enclosure design must cater to the specific, and potentially age-dependent, behavioral requirements to ensure welfare and support natural development (Carter *et al*., 2021), while also considering the potential impacts of stocking density and social interactions on growth and behavior (Brien *et al*., 2016).

In natural settings, habitat selection in reptiles is often governed by many environmental factors. These factors include temperature, sunlight, shelter availability, and food, and the complex interactions between these factors create dynamic patterns across space and time (Boucher *et al*., 2021). As ectotherms, Chinese alligators rely heavily on external heat to regulate their body processes, making behavioral thermoregulation a key driver of their spatial ecology. Effective thermoregulation allows ectotherms to maintain body temperatures near their optimal physiological range (Seebacher and Franklin, 2005). This strategy is crucial for reducing physiological stress, such as oxidative damage (Ritchie and Friesen, 2022). The capacity for such behavioral adjustments can be shaped by prior thermal experience, a process called thermal acclimation (Wu *et al*., 2013). Flexibility in habitat and microhabitat selection can vary by species and context. Generalist species can adjust across a wider array of environmental gradients, while specialists often have stricter requirements (Terán-Juárez *et al*., 2021). This kind of behavioral flexibility is also seen in adult Chinese alligators, which are known to adjust nest attendance in response to human disturbance (Gao *et al*., 2025).

However, crocodilians can be difficult to observe, limiting our understanding of foraging and detailed daily activity patterns (Nifong *et al*., 2014). For critically endangered species like Chinese alligators, there is a lack of detailed studies examining small-scale habitat use over time, a knowledge gap that hampers both *in situ* habitat restoration efforts and *ex situ* environment design. This is especially important as climate change is expected to alter which habitats are suitable for them (Teng *et al*., 2023; Yang *et al*., 2024). Therefore, here we aim to answer two key questions. First, how do young alligators divide their time and space in a complex environment? Second, what main environmental factors drive this behavior?

To answer these questions, this study aimed to systematically investigate the spatiotemporal habitat use of juvenile Chinese alligators in a controlled, semi-natural setting and to identify key environmental drivers. We built an artificial pond with heterogeneous microhabitats varying in sunlight, shade, and shelter structures, stocked it with live prey to simulate a basic ecosystem, and monitored ten healthy juveniles. Specifically, we tested the following hypotheses: (1) juvenile alligator microhabitat utilization intensity varies with environmental factors (especially solar conditions) rather than being random; (2) this utilization pattern exhibits significant diel rhythms; and (3) the interaction between solar conditions and time of day is a key driver of their spatial use dynamics. These observations provide preliminary data on fine-scale habitat use under semi-natural conditions, which may inform enclosure design for juveniles in *ex situ* conservation settings.

2. Methods

2.1. Study site and subjects This research took place between September and October 2025 at the Chinese Alligator Reintroduction Training Base in Guangde City, Anhui Province. The study site was an outdoor 5 m×5 m artificial square pond (Figure 1), featuring a central aquatic zone (4 m× 4 m, 1.5 m deep) and a 0.5 m wide earthen basking platform on each side. A water pump maintained stable water levels. Surrounding vegetation was retained to make the setting more natural. The pond was divided into four square quadrants (southwest, northwest, southeast, northeast). Each quadrant comprised a basking platform and its adjacent water area, forming a complete habitat unit. Two floating bamboo rafts (0.5 m wide) provided additional basking sites. The pond was also stocked with an ample supply of small aquatic organisms, including macroinvertebrates (*Macrobrachium nipponense*, *Palaemonetes sinensis*, and *Cipangopaludina chinensis*) and fish (*Misgurnus anguillicaudatus*), to simulate a natural ecosystem and allow for voluntary foraging by the juvenile alligators.

The subjects were ten juvenile Chinese alligators, aged 2–3 years. All individuals were reared under identical conditions, were in good health, and had no record of

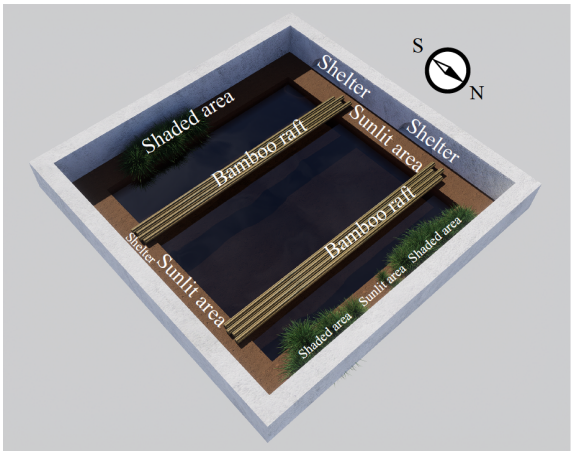


Figure 1 Schematic design of the experimental pond. The enclosure is a 5 m×5 m artificial pond, with a central aquatic zone of 4 m×4 m surrounded by 0.5 m wide earthen basking platforms on all four sides. Two 0.5 m wide floating bamboo rafts were placed on the water surface as supplementary basking sites. Artificial shelters and shaded areas were distributed around the pond to provide concealment. This schematic conveys the spatial layout and key environmental features of the experimental setting.

abnormal behavior. Environmental characteristics of each quadrant were systematically measured, including parameters such as solar exposure ratio, sunlit area, shaded area, concealment area, and number of refuges (artificially provided shelters). Specific measurement protocols are detailed in the caption of Table 1.

2.2. Research methods and data collection We used a 24-h video surveillance system for continuous behavior observation. A camera was installed 3 m directly above the center of the pond, covering the entire experimental area. The video resolution was 1 920 × 1 080 pixels, and night-time observations used infrared mode, ensuring good data quality and continuous observation regardless of time. Ambient temperature was recorded with a thermohygrometer. Measurements were taken every 3 h at the center of the pond and 1 m directly above it. The observation period began in mid-September 2025 and lasted for 15 consecutive days. We used a timed sampling method to collect behavioral data. Each hour was split into three, twenty-minute intervals, with the first 5 min of each interval set as the observation time.

During each observation time, we carefully counted the number of juvenile alligators in each quadrant. The observation time was recorded down to the exact minute. If an alligator was on the line between two areas, we assigned it to the area where the majority of its body was. Over the whole study period, we recorded a total of 4 928 sightings of the ten juvenile alligators.

2.3. Data analysis We analyzed the data for this study using R 4.5.1. Initial data exploration included visualizations (heat maps, LOESS smoothing curves) to examine spatiotemporal patterns. To identify the environmental drivers of space use intensity while addressing potential pseudoreplication, we employed a GLMM with a negative binomial distribution. The model treated the count of alligators per quadrant per observation as the response variable. Fixed effects included solar exposure ratio, concealment area, and time period (morning (6:00–11:00), afternoon (12:00–17:00), or night (18:00–5:00)), as well as the interaction between solar exposure ratio and time period. Date was included as a random intercept to account for temporal non-independence. Model selection was based on Akaike Information Criterion (AIC), which balances complexity and fit. For significant interaction terms, simple slope analyses were conducted using the emmeans package to interpret conditional effects. Odds ratios (OR) with 95% confidence intervals (CI) are reported for fixed effects.

3. Results

Initial examination of the data revealed that the distribution of juvenile alligators across the four pond quadrants was not uniform (see Supplementary Material, Figures S1 and S2, for chi-square goodness-of-fit test and standardized residuals). Given the potential for pseudoreplication in such quadrant-level comparisons, the core of our analysis employed models that treat environmental variables as predictors, as detailed below.

3.1. Descriptive analysis Out of a total of 4 928 observed

Table 1 Environmental characteristics of the four quadrants within the artificial pond. Each quadrant included both a terrestrial basking bank and its adjacent aquatic area. Key parameters included the shelters (number of artificial shelters), concealment area (calculated geometric area offering visual cover), solar exposure ratio (proportion of daytime receiving direct sunlight), sunlit area, and shaded area.

Region	Shelters	Concealment area (m^2)	Solar exposure ratio	Sunlit area (m^2)	Shaded area (m^2)
Southwest	1	0.25	0.6	1	1.25
Northwest	1	0.05	0.6	2.25	0.05
Southeast	1	0.4	0.7	1.5	1.35
Northeast	0	0.15	0.8	2.75	0.75

sightings, juvenile Chinese alligators exhibited markedly different utilization patterns across the four quadrants (Table 2, Figure 2). The Northeast region showed the highest utilization intensity, with an average of 2.49 alligators per observation time point (SD = ±1.69), followed by the Southwest region, which had an average of 2.40 alligators (SD = ±1.98). The Southeast region averaged 2.07 alligators (SD = ±1.85), while the Northwest region had the lowest utilization, averaging only 1.59 alligators (SD = ±1.58). This gradient of utilization intensity (Northeast > Southwest > Southeast > Northwest) indicates spatial heterogeneity within the artificial pond environment, providing a basis for subsequent analysis of environmental drivers.

3.2. Spatiotemporal dynamic patterns Continuous 24-h monitoring and analysis of juvenile Chinese alligators revealed distinct spatiotemporal utilization rhythms (Figures 3 and 4). Analysis of the figures shows that the utilization intensity of each region exhibits regular diurnal variations. Overall, space use exhibited a bimodal diel pattern, with utilization peaks occurring during crepuscular hours.

Visual inspection of the temporal dynamics indicates that different areas were utilized more intensively at different times of day. For instance, the Northeast quadrant appeared to be used more frequently during nighttime hours, while the Southwest quadrant showed relatively stable utilization throughout the diel cycle. These observed patterns suggest that, within the time frame and environmental context of this study, juvenile alligators adjusted their space use in response to temporal changes.

3.3. Driving factor analysis The GLMM (negative binomial distribution) results revealed that juvenile alligator space use intensity was significantly driven by the interaction between solar exposure ratio and time period, after controlling for date as a random effect to address pseudoreplication (Table 3, Figure 5). Specifically, the main effect of solar exposure ratio was not significant (OR = 0.97, 95% CI: 0.42–2.24, P = 0.946), but its interaction with time period was significant (afternoon: OR = 3.56, 95% CI: 1.10–11.56, P = 0.034; night: OR = 4.13,

Table 2 Descriptive statistics of juvenile Chinese alligator utilization across the four pond quadrants. Data are based on 4 928 observation records over 15 days. Abbreviations: SD (standard deviation); SE (standard error); utilization (percentage of total alligator occurrences).

Region	Total alligator count	Mean count	SD	SE	Utilization (%)
Northeast	1 433	2.49	1.69	0.0705	29.10
Southwest	1 384	2.4	1.98	0.0824	28.10
Southeast	1 195	2.07	1.85	0.0773	24.20
Northwest	916	1.59	1.58	0.0659	18.60

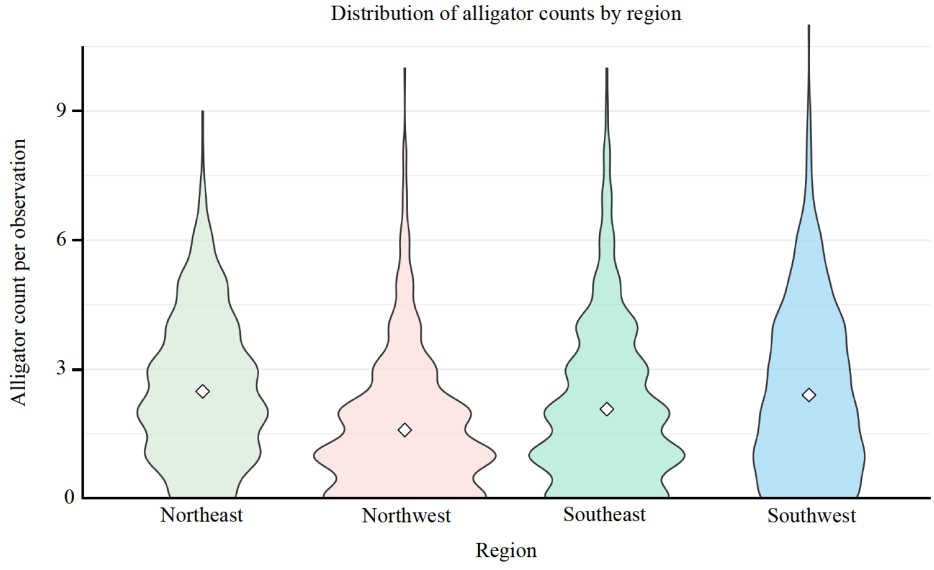


Figure 2 The violin plot illustrates the distribution characteristics of habitat utilization intensity by juvenile Chinese alligators across the four pond quadrants. The shape of each "violin" visually represents the probability density distribution of alligator counts during the observation period, with its width indicating the relative frequency of specific count values. The white diamond indicates the mean value.

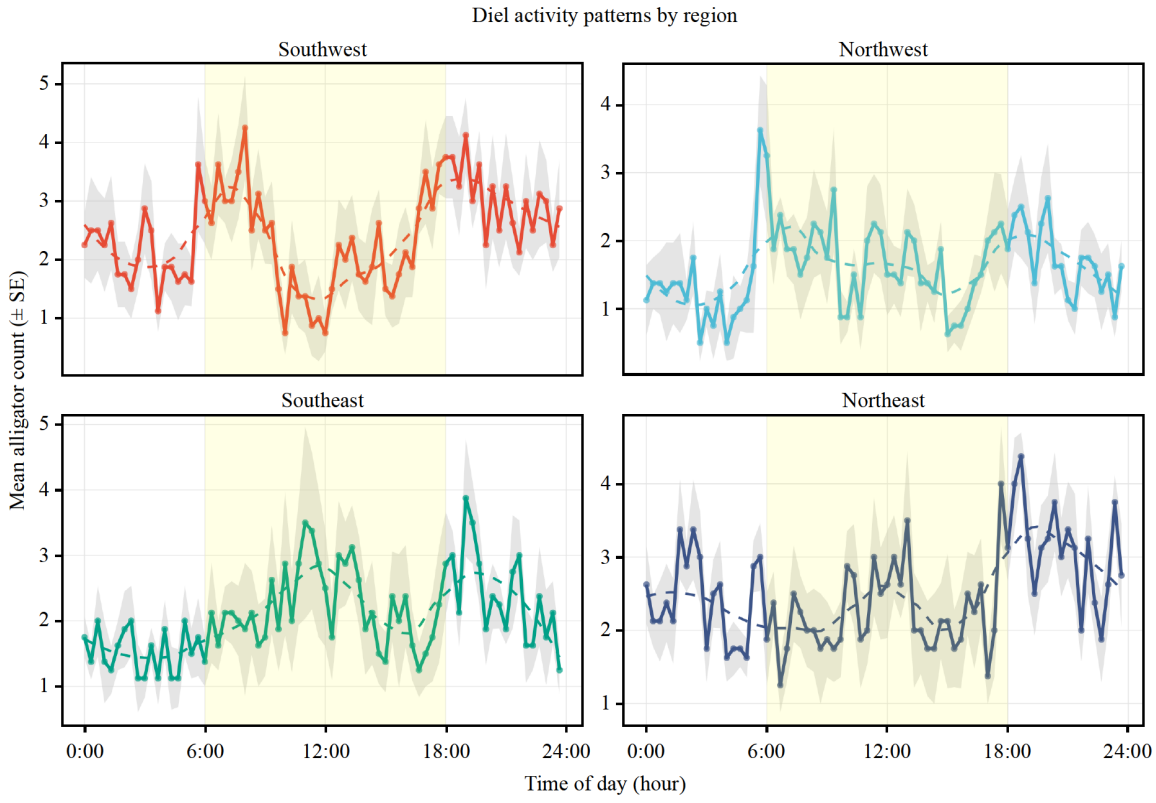


Figure 3 Diel activity patterns across quadrants. LOESS smoothing reveals distinct diurnal peaks, with the Northeast and Southwest quadrants showing higher and more bimodal utilization intensities. The LOESS smoothed curve was fitted with a span parameter of 0.75.

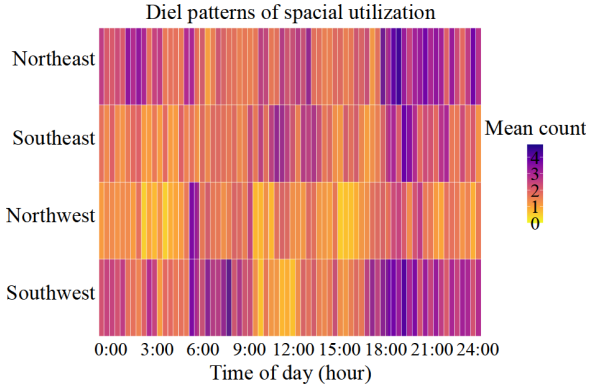


Figure 4 Spatiotemporal heatmap of habitat utilization by quadrant. Color intensity represents alligator count, with darker colors representing higher counts, illustrating clear 24-h rhythmic patterns and regional variations in space use.

95% CI: 1.51–11.29, $P = 0.006$). Simple slope analysis indicated that the effect of solar exposure ratio varied throughout the day, as there was no significant effect in the morning ($\beta = -0.03$, 95% CI: −0.86–0.80), but significantly positive effects in the afternoon ($\beta = 1.24$, 95% CI: 0.41–2.08) and night ($\beta = 1.39$, 95% CI: 0.82–1.96) (Table 4, Figure 6). Concurrently, concealment area had a consistent positive effect on use intensity (OR = 1.47, 95% CI: 1.12–1.93, $P = 0.006$).

4. Discussion

This study presents the first systematic analysis of fine-scale spatiotemporal utilization patterns for juvenile Chinese alligators in a semi-natural environment. Our key findings are threefold. First, descriptive analysis showed a gradient in space use intensity across the enclosure. Second, this spatial use followed distinct diel rhythms, with utilization peaking in a bimodal pattern around crepuscular hour. Third, generalized linear mixed modeling revealed the drivers of habitat selection, showing that selection was not driven by a static spatial orientation (east or west) but rather was primarily driven by the interactive effect of solar exposure ratio and time of day. Taken together, these results show that, under the conditions of this experiment, juvenile alligators use a flexible spatiotemporal strategy closely tied to behavioral thermoregulation.

4.1. Spatial distribution and behavioral budget The

Table 3 Results of the GLMM examining environmental drivers of juvenile Chinese alligator space use intensity.

Predictor	Odds ratio (OR)	95% CI	*P*-value
Solar exposure ratio	0.972	0.42–2.23	0.946
Concealment area	1.469	1.12–1.93	0.006
Time: Afternoon (vs Morning)	0.394	0.18–0.88	0.023
Time: Night (vs Morning)	0.387	0.20–0.77	0.007
Interaction: Solar × Afternoon	3.563	1.10–11.56	0.034
Interaction: Solar × Night	4.127	1.51–11.27	0.006

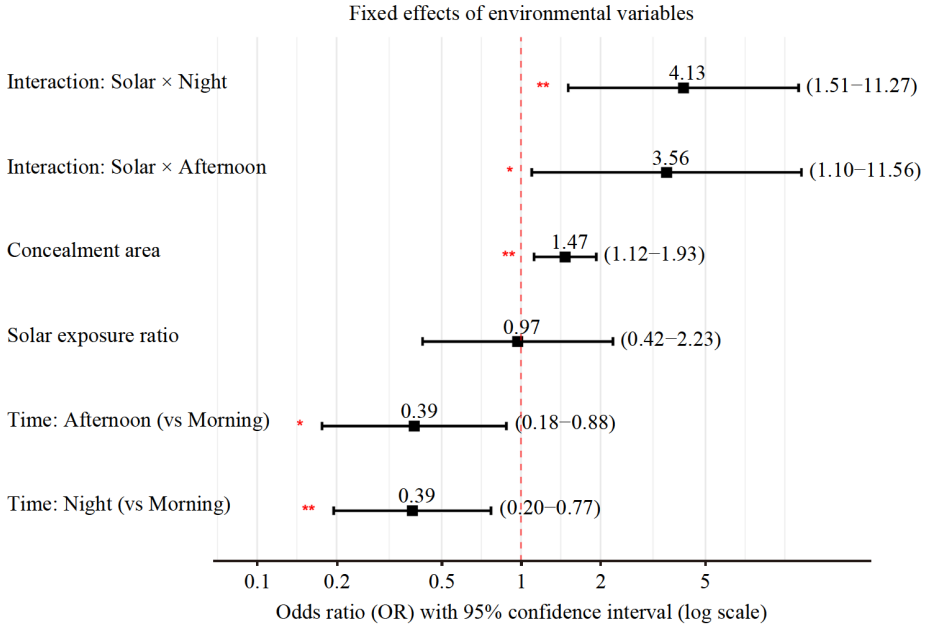


Figure 5 Forest plot of fixed effects from the generalized linear mixed model examining environmental drivers of juvenile Chinese alligator space use intensity. A negative binomial generalized linear mixed model shows the influence of environmental variables on juvenile alligator space use intensity, expressed as odds ratios (OR). The model included Date as a random effect to control for temporal pseudoreplication. Error bars represent 95% confidence intervals. The dashed line (OR=1) indicates the line of no effect. Stars indicate significance (*P < 0.05, **P < 0.01). The significant environment × time interaction indicates that the effect of solar exposure ratio varied dynamically throughout the day.

Table 4 Simple slope of sunshine duration across different time periods.

Time period	Slope (β)	SE	95% CI	*P*-value
Morning	−0.028	0.424	−0.86–0.80	0.946
Afternoon	1.242	0.427	0.41–2.08	0.004
Night	1.389	0.290	0.82–1.96	<0.001

alligators did not spread their time evenly across different behaviors, a typical tendency of crocodilians (Boucher *et al.*, 2021). The high use of the Northeast zone is linked to its high solar exposure ratio, suggesting the alligators spent significant amounts of time basking, a key behavior for controlling body temperature in crocodilians (Boucher *et al.*, 2021). This matches what has been seen in the wild, where Chinese alligators have been documented often basking on land to get heat, especially in cooler seasons when they use certain postures to maximize sun exposure (Zhang *et al.*, 2005). At the same time, the alligators also preferred the Southwest zone, which had more shelter, likely utilizing it for safety, rest, or as a thermal refuge. In contrast, they strongly avoided the Northwest zone, which did not offer good basking or shelter. This avoidance shows that microhabitats that do not meet basic needs for temperature control or safety are ignored, which fits with ideas about optimal energy use in animals (Christiansen *et al.*, 2013). The observed heterogeneity in space

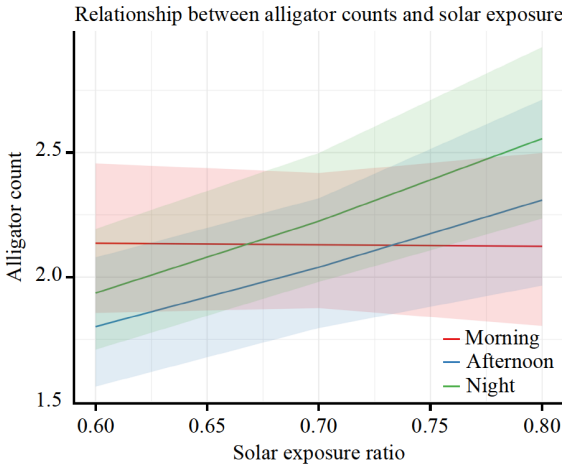


Figure 6 Marginal effect of solar exposure ratio on predicted alligator count across different time periods. The plot illustrates the significant interaction between solar exposure ratio and time period from the GLMM. Lines represent the model-predicted relationship for each time period, with shaded bands indicating 95% confidence intervals. Simple slope analysis confirms that the positive effect of solar exposure ratio is stronger in the afternoon and night compared to the morning.

use is consistent with the central concept of non-random activity budgets in crocodilian ecology (Boucher *et al.*, 2021). The model revealed that areas with higher solar exposure ratio were more intensively used during specific times of day, aligning with the importance of basking for ectotherm thermoregulation (Boucher *et al.*, 2021; Zhang *et al.*, 2005). Concurrently, concealment area had a consistent positive effect, suggesting the use of certain zones as shelter or thermal refuges. This pattern of selective habitat use, driven by environmental features rather than simple spatial proximity, reflects behavioral strategies to optimize energy budgets (Christiansen *et al.*, 2013). It is also important to note that we rarely saw the alligators foraging during the day. This is consistent with other studies that show crocodilian foraging is mostly at night or around dawn and dusk (Boucher *et al.*, 2021; Nifong *et al.*, 2014). This suggests that activity during the day was mostly related to thermoregulation and maintenance activities.

Importantly, the patterns we observed in our study could also be influenced by the spatial arrangement of our group of ten alligators and how they interacted. Studies on other crocodilians have shown that both the number of animals in a space (stocking density) and the makeup of the group can strongly affect their behavior (Brien *et al.*, 2016). Our study did not directly measure social interactions and occurred in a limited, enclosed space, and the potential influence of social dynamics on the observed aggregation patterns cannot be ruled out. It is important to note that the effect of social grouping on thermoregulation is not always simple. Research on young saltwater crocodiles (*Crocodylus porosus*) suggests that when warming up is the main goal, aggressive behaviors might not completely stop individuals from using the best warm spots (Brien *et al.*, 2012). Studies of other crocodilians have also shown that thermoregulating behaviors can be heavily influenced by social interactions (Campbell *et al.*, 2013).

4.2. Behavioral thermoregulation and physiological significance The clear daily activity rhythms we observed, along with the important interaction between solar exposure ratio and time period, provide strong evidence for active and flexible behavioral thermoregulation. This matches a known broader pattern: crocodilians often perform heat-seeking behaviors in response to rising morning temperatures (Nifong *et al.*, 2014). Our model's finding of a significant interaction indicates that the value of solar exposure ratio changes throughout the day, likely reflecting a shift from heat-seeking to heat-avoidance strategies as ambient conditions change, consistent with behavioral patterns in other crocodilians (Boucher *et al.*, 2021; Campbell *et al.*, 2010). Field studies further support this interpretation. For example, they show that water bodies act as important thermal buffers for Chinese alligators, which adjust their behavior in water by diving or changing their floating posture to help maintain a suitable body temperature throughout different seasons (Zhang *et al.*, 2005).

Such precise behavioral adjustments are physiologically crucial for ectotherms (Franklin *et al.*, 2024). Maintaining body temperature near the species-specific optimum enhances performance and fitness while mitigating the energetic and cellular costs of thermal stress, such as oxidative damage (Ritchie and Friesen, 2022). The daily shifts in where the alligators spent their time likely represent an attempt to stay near this ideal temperature throughout the day. Such daily rhythms in temperature preference are common in crocodilians. For example, studies show that young saltwater crocodiles actively keep their body temperature 1–2°C higher during the day (Brien *et al.*, 2012). This connects to a concept called the "Bogert effect," where ectotherms are limited in their long-term ability to evolve greater physiological tolerances to non-ideal temperatures because of the effectiveness of behavioral thermoregulation (Ritchie and Friesen, 2022). A large-scale analysis of 232 ectotherm species shows that the ability to adjust physiological heat tolerance is generally very low (Gunderson and Stillman, 2015). The behavioral plasticity observed under the specific conditions of this 15-day study reflects this buffer mechanism.

4.3 Conservation implications Our findings offer preliminary insights that may inform the design of captive

environments for juvenile Chinese alligators. For artificial habitats, designs must incorporate thermal gradients (varying sun and shade) to support the behavioral thermoregulation (Brien *et al*., 2012), as well as provide suitable nesting sites, such as vegetated flat ground, for adults (Wang *et al*., 2021). In wild habitats, the protection and restoration of fine-scale heterogeneity (e.g., gradients of solar exposure ratio and concealment) is critical, as these features match key natural habitat components like stable water bodies and vegetated banks (Wu *et al*., 2005). Reintroduction programs should select sites with low disturbance and ample resources to support established home ranges (Ding *et al*., 2003b, Gao *et al*., 2025). Finally, monitoring stocking density in captivity is necessary to minimize stress and competition that could disrupt thermoregulation and feeding (Brien *et al*., 2016). Future studies integrating behavior with physiology and telemetry will further refine these strategies (Balaguera-Reina *et al*., 2016).

4.4. Limitations and future directions This study has limitations that chart a course for possible future research. As a case study based on a single social group within one enclosure, we cannot distinguish general thermoregulatory patterns from site- or context-specific effects. Pond-level replication across multiple enclosures is therefore the most critical next step for assessing the generality of our findings. Other limitations include the lack of assessment of density, group size, or seasonal variation on the observed patterns (Boucher *et al*., 2021; Brien *et al*., 2016). Crucially, our study does not address the potential for thermal acclimation to modify these strategies (Wu *et al*., 2013), nor does it measure the physiological consequences (e.g., oxidative stress) of observed space use patterns (Ritchie and Friesen, 2022). Furthermore, to fully understand the species' adaptive capacity, future studies should test juvenile microhabitat selection across environmental gradients (Terán-Juárez *et al*., 2021), in different seasons, and integrate findings with studies on other life stages, such as reproductive behavior (Gao *et al*., 2025). There is also a critical need to integrate micro-scale behavioral and physiological data with macro-scale habitat and population demography modeling. Combining individual body temperature telemetry, oxidative stress markers, and detailed behavioral observation with tools like species distribution models (Teng *et al*., 2023; Yang *et al*., 2024) and spatial ecology techniques (Balaguera-Reina *et al*., 2016) will enable a mechanistic understanding of how climate change impacts individual fitness and population viability.

5. Conclusion

Under the conditions of this study, juvenile Chinese alligators exhibited a pattern of space use consistent with thermoregulatory needs. This observation adds to a growing body of work on Chinese alligator behavior (including studies on adult nesting, site fidelity, and disturbance response), suggesting that behavioral adjustments across life stages may be closely linked to habitat structure.

As a habitat specialist, the Chinese alligator faces ongoing pressures from habitat loss and climate change. While the present study is limited in scope, it points to the potential value of maintaining thermal heterogeneity in both captive and restored habitats. Further research across different populations, seasons, and environmental contexts will be needed to assess the generality and adaptive significance of the patterns observed here.

Acknowledgements This study work was supported by the National Natural Science Foundation of China (No. 32370561 and No. 32470521), the Anhui Provincial Natural Science Foundation (No. 2408085QC099), the Standardized Demonstration Zone Construction Project for the Integration of Chinese Alligator Conservation and Ecological Agriculture (Project No.: Wan [2024] TG01), the Anhui Provincial Department of Education Excellent Young Teacher Training Project, and the 2024 High-end Talent Introduction and Education Action Project: Young Top-notch Talents and Young Scholars. We thank the Anhui National Chinese Alligator Nature Reserve for its support of the sampling effort. We thank the Anhui Alligator Artificial Breeding and Protection National Long-term Scientific Research Base. We also thank anonymous reviewers for their suggestions.

Supplementary information Supplementary information is available at https://doi.org/10.3724/ahr.2095-0357.2026.0001

References

Agresti A. 2007. An Introduction to Categorical Data Analysis. Hoboken, NJ: Wiley-Interscience

Balaguera-Reina S. A., Venegas-Anaya M., Sánchez A., Arbelaez I., Lessios H. A., Densmore III L. D. 2016. Spatial ecology of the American crocodile in a tropical Pacific island in Central America. PLoS One, 11(6): e0157152

Bickford D., Howard S. D., Ng D. J., Sheridan J. A. 2010. Impacts of climate change on the amphibians and reptiles of Southeast Asia. Biodivers Conserv, 19(4): 1043-1062

Boucher M., Tellez M., Anderson J. T. 2021. Activity budget and behavioral patterns of American crocodiles (*Crocodylus acutus*) in Belize. Herpetol Conserv Biol, 16(1): 86-94

Brien M. L., Webb G. J., Gienger C. M., Lang J. W., Christian K. A. 2012. Thermal preferences of hatchling saltwater crocodiles (*Crocodylus porosus*) in response to time of day, social aggregation and feeding. J Therm Biol, 37(8): 625-630

Brien M. L., Webb G. J., McGuinness K. A., Christian K. A. 2016. Effect of housing density on growth, agonistic behaviour, and activity in hatchling saltwater crocodiles (*Crocodylus porosus*). Appl Anim Behav Sci, 184: 141-149

Briggs-Gonzalez V., Bonenfant C., Basille M., Cherkiss M., Beauchamp J., Frank M. 2017. Life histories and conservation of long-lived reptiles, an illustration with the American crocodile (*Crocodylus acutus*). J Anim Ecol, 86(5): 1102-1113

Campbell H. A., Sullivan S., Read M. A., Gordos M. A., Franklin C. E. 2010. Ecological and physiological determinants of dive duration in the freshwater crocodile. Funct Ecol, 24(1): 103-111

Campbell H. A., Sissa O., Dwyer R. G., Franklin C. E. 2013. Hatchling crocodiles maintain a plateau of thermal independence for activity, but at what cost? J Herpetol, 47(1): 11-14

Carter K. C., Hicks J. J., Kane D., Tapley B., Michaels C. J. 2021. Age-dependent enclosure use in juvenile Chinese crocodile lizards, *Shinisaurus crocodilurus crocodilurus*. J Zool Bot Gard, 2(3): 406-415

Christiansen F., Rasmussen M. H., Lusseau D. 2013. Inferring activity budgets in wild animals to estimate the consequences of disturbances. Behav Ecol, 24(6): 1415-1425

Ding Y. Z., Wang X. M., He L. J., Wang Z. H., Wu W., Tao F. Y., Shao M. 2003a. [Wild Chinese alligator (*Alligator sinensis*) burrow entrance site selection]. Zool Res, 24(4): 254-258 (In Chinese)

Ding Y. Z., Wang X. M., Wang Z. H., Wu J. S., Thorbjarnarson J., Shao M. 2003b. Observation of activity in Chinese alligators released during an early period at Hongxing of Anhui. Zool Res, 25(1): 27-31

Franklin C. E., Campbell H. A., Irwin T. R., Baker C. J., Bentley L. K., Frere C. H., Dwyer R. G., Barham K. E. 2024. Cooling down is as important as warming up for a large-bodied tropical reptile. Proc Biol Sci, 291(2034): 20241804

Gao Y. L., Wang D. P., Pan T., Tu G. J., Jiang X. Q., Pang F., Wu X. B. 2025. Investigating the demeanor of the Chinese alligator during the breeding season across different habitats. Behav Ecol Sociobiol, 79(6): 73

Gunderson A. R., Stillman J. H. 2015. Plasticity in thermal tolerance has limited potential to buffer ectotherms from global warming. Proc R Soc B, 282(1808): 20150401

Jiang H. X., Wu X. B. 2018. *Alligator sinensis*. The IUCN Red List of Threatened Species 2018: e. T867A3146005. Retrieved from https://www.iucnredlist.org/species/867/3146005 14/11/2025

Nifong J. C., Nifong R. L., Silliman B. R., Lowers R. H., Guillette Jr L. J., Ferguson J. M., Welsh M., Abernathy K., Marshall G. 2014. Animal-borne imaging reveals novel insights into the foraging behaviors and diel activity of a large-bodied apex predator, the American alligator (*Alligator mississippiensis*). PLoS One, 9(1): e83953

Ritchie D. J., Friesen C. R. 2022. Invited review: Thermal effects on oxidative stress in vertebrate ectotherms. Comp Biochem Physiol A, 263: 111082

Seebacher F., Franklin C. E. 2005. Physiological mechanisms of thermoregulation in reptiles: a review. J Comp Physiol B, 175(8): 533-541

Teng M., Liu J., Lu Y., Cheng X., Wang Y. 2023. [Simulation of the distribution of wild *Alligator sinensis* (Crocodylia: Alligatoridae) in China under climate change]. Acta Ecol Sin, 43: 1-11 (In Chinese)

Terán-Juárez S. A., Pineda E., Horta-Vega J. V., Cedeño-Vázquez J. R., Correa-Sandoval A., Venegas-Barrera C. S. 2021. Habitat use and microhabitat selection of two lizard species with different niche requirements in a resource availability gradient. Stud Neotrop Fauna Environ, 56(1): 40-52

Wang Z. W., Lin J. Q., Zhong G. H., Sun L., Fang S. G. 2021. [Terrestrial habitats in Changxing Chinese Alligator Nature Reserve of Zhejiang and their effects on the egg laying of the female alligators]. J Zhejiang Univ (Agric Life Sci), 47(5): 598-606 (In Chinese)

Wu L. S., Wu X. B., Jiang H. X., Wang C. L. 2005. [Habitat characteristics of wild Chinese alligator (*Alligator sinensis*)]. Biodivers Sci, 13(2): 156 (In Chinese)

Wu M. X., Hu L. J., Dang W., Lu H. L., Du W. G. 2013. Effect of thermal acclimation on thermal preference, resistance and locomotor performance of hatchling soft-shelled turtle. Curr Zool, 59(6): 718-724

Wu X. B., Gu C. M., Zhu J. L. 2008. [Comprehensive study of Anhui National Nature Reserve of Chinese Alligator]. Hefei University Press, Hefei, China (In Chinese)

Yang L. Y., Ling J. N., Lu L. L., Zang D. S., Zhu Y. Z., Zhang S., Zhou Y. K., Yi P. S., Li E., Pan T. 2024. Identification of suitable habitats and priority conservation areas under climate change scenarios for the Chinese alligator (*Alligator sinensis*). Ecol Evol, 14(6): e11477

Zhang F., Wu X. B., Zhu J. L., Zhang S. 2005. [Activity rhythm and behavioral coding of captive-bred Chinese alligators (*Alligator sinensis*) in summer and autumn]. Acta Hydrobiol Sin, 29(5): 488-494 (In Chinese)

Scientific Editor: Bicheng ZHU

How to cite this article:
Miao J. J., Sun K., Ye S. L., Zhou Y. K., Yu Z. P., Li L., Yi P. S., Xia T. S., Tu G. J., Kohler D. B., WU X. B., Pan T. 2026. Spatiotemporal habitat use in juvenile Chinese alligators (*Alligator sinensis*): Interactive effects of sunlight and time. Asian Herpetol Res, 17(2): 157–165. DOI: 10.3724/ahr.2095-0357.2026.0001. CSTR: 32242.14.ahr.2095-0357.2026.0001