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Conspicuous scarcity of small-bodied benthic turtles in Alligator Snapping Turtle-*Macrochelys temminckii* (Troost in Harlan, 1835) dominated systems: bycatch patterns across urban and rural waterways

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Abstract. Targeted hoop-net trapping of Alligator Snapping Turtles (*Macrochelys temminckii*) in two urban Texas bayous (Buffalo Bayou, Little Cypress Creek) and two rural Mississippi streams/bayous (Yazoo, Sunflower) from 2020–2025 yielded 872 total captures. Mississippi range-core sites were dominated by *M. temminckii* (Yazoo: 69.2%; Sunflower: 59.2%), whereas Texas range-edge sites exhibited substantially greater turtle bycatch (Buffalo Bayou: 45.9%; Little Cypress Creek: 56.8%). Small-bodied benthic turtles (genera *Sternotherus* and *Kinosternon*) and the Common Snapping Turtle (*Chelydra serpentina*) were nearly absent across all systems (n = 6 combined). Capture composition differed significantly between site types, with Alligator Snapping Turtles comprising a greater proportion of captures at rural sites and non-target turtle species comprising a greater proportion of captures at urban sites. The consistent scarcity of small-bodied benthic turtles and *C. serpentina* across both urban and rural systems suggests that factors other than urbanization may be influencing community structure. These patterns are consistent with hypotheses of predator-mediated suppression, competitive exclusion, or both, associated with *M. temminckii* dominance.

Keywords. Alligator snapping turtle, bycatch, competitive exclusion, predation, Mississippi, Texas.

Introduction

Urbanization and habitat modification can significantly influence the composition and structure of freshwater turtle communities (Bowne et al., 2018). Channelization, loss of riparian vegetation, altered hydrology, and reduced water quality are common in urban waterways (Paul and Meyer, 2001; Walsh et al., 2005), often favouring disturbance-tolerant generalist species while reducing populations of more specialized or small-bodied taxa (Moll and Moll, 2004; Lindeman, 2013). In addition to physical habitat alteration, urbanization may alter predator–prey dynamics, increase competition with invasive species, and promote pollutant accumulation, all of which can contribute to long-term changes in turtle assemblages (Marchand and Litvaitis, 2004; Selman and Qualls, 2009).

The Alligator Snapping Turtle (*Macrochelys temminckii*) is a large-bodied, primarily benthic species historically associated with slow-moving rivers, oxbows, and deep bayous throughout much of the southeastern United States (Ewert et al., 2006; Ernst and Lovich, 2009). As the largest freshwater turtle in North America and an opportunistic ambush predator, *M. temminckii* consumes a wide variety of fishes, invertebrates, and vertebrates, potentially influencing aquatic communities through predation and competition (Ewert et al., 2006; Elsey, 2006; Ernst and Lovich, 2009). Similar to other apex predators that can structure ecosystems through top-down effects (Paine, 1966; Estes et al., 2011), *M. temminckii* may play an important ecological role within freshwater turtle assemblages, although this

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relationship remains poorly understood. Survey efforts targeting *M. temminckii* frequently produce substantial bycatch of sympatric turtle species, creating a unique opportunity to examine community composition, relative abundance, and assemblage structure across habitats that vary in land use and urbanization (Riedle et al., 2006; Berry, 2019; Haralson, 2021).

In this study, we examined bycatch composition and *M. temminickii* abundance at two urban bayous in Houston, Texas (Buffalo Bayou and Little Cypress Creek), located in the southwestern range of the species, and two rural streams in Mississippi that support high-density of *M. temminckii* populations (Yazoo and Sunflower). Previous studies of these populations were published by Munscher et al. (2020, 2021, 2023) and Garcia et al. (2025) for Texas, and by Pearson et al. (2023) and Delisle (2025) for Mississippi. The Texas sites are physically smaller and highly urbanized, with known threats including habitat loss and mortality from fishing hook ingestion; there is no documented history of poaching in these systems. In contrast, the Mississippi sites are rural waterways with greater riparian connectivity and lower levels of anthropogenic modification that retain some natural sinuosity, although channelization and installation of barriers (i.e., culverts, low-head dams) and diversions have occurred. By analysing *M. temminckii* captures alongside incidental turtle bycatch from these diverse habitats, we aim to (1) quantify differences in turtle assemblage composition between urban and rural systems, (2) evaluate the representation of small-bodied species in standard hoop-net sampling, and (3) identify potential ecological or methodological factors driving observed patterns. These comparisons can improve our understanding of the resilience of *M. temminckii* and inform conservation strategies tailored to different habitat contexts.

Materials and Methods

Trapping sites. From 2020–2025, we trapped turtles in Buffalo Bayou and Little Cypress Creek, Harris County, Texas, and at two Bayou sites in Mississippi in the Yazoo and Sunflower drainages during targeted *M. temminckii* mark-recapture surveys.

Buffalo Bayou is a low-gradient waterway extending approximately 85 km through the Houston metropolitan region, traversing a heterogeneous landscape that includes urban centres, suburban developments, and managed parklands. The bayou drains a watershed of roughly 264 km² within the San Jacinto River Basin (Aulbach, 2012; Harris County Flood Control District, 2013). Urban land cover dominates the watershed, comprising more than 80% of the basin area and supporting a human population exceeding 2.3 million residents as of the 2010 census (Harris County Flood Control District, 2013). As the primary drainage corridor for central Houston, Buffalo Bayou receives flow from numerous tributaries and interconnected waterways, including Brays, Greens, Sims, and Carpenters bayous, as well as Turkey, Soldiers, and Rummel creeks (Harris County Flood Control District, 2013).

Little Cypress Creek is a low-gradient stream system located in northwestern Harris County, Texas, within the larger Cypress Creek watershed. Originating in the prairie landscapes of western Harris and eastern Waller counties, the creek traverses a rapidly developing suburban environment characterized by a mixture of residential communities, remnant prairie habitats, forested riparian corridors, and regional flood-control infrastructure. Despite extensive land-use change throughout the watershed, sections of Little Cypress Creek continue to provide important aquatic and riparian habitat for native fish, turtles, and other wildlife.

The Sunflower site was an intact waterway with several major sources of water connecting the Yazoo River, Sunflower River, and several large lakes and sloughs associated with these rivers and bayous. However, major alterations occurred in the Mississippi River alluvial plain between the 1880s and 1960s which led to these water sources being cut off from the Sunflower site, drastically reducing its upstream drainage area and subsequently its waterflow. Now, it is primarily filled with localized rainfall and agricultural runoff. Water within this system accumulates significantly when the Steele Bayou Water Control Structure is closed to prevent backflow when Mississippi River levels rise above those within. Water levels at the Sunflower site can vary from a few inches deep in drought conditions up to over 6 m deep when the control structure is closed. There are several weirs and culverts constructed at the site limiting movement. During low- and high-water levels, flow is stopped by these structures and the site acts as a lake (lentic); however, during intermediate water levels with the Steele Bayou Water Control Structure open, it flows as a lotic site would. Substrate at this site is primarily mud and detritus, with mud depths often reaching one meter.

After river channel alterations occurred in the 1940s, the Yazoo site waterway now flows through a severalmile section of the old river channel of the Yazoo River. The majority of the Yazoo site has been channelized and/or desnagged to increase drainage and navigability during 1920–1940; however, a portion of the natural river channel consisting of the primary trapping site is still sinuous and acts as a flowing lotic system year-round. Even during drought conditions, water levels at this site can maintain depths of one-half to four meters, and during heavy rain events and floods, water depths can exceed nine meters. Water temperatures are generally cooler at the Yazoo site than at the Sunflower site, likely due to both small groundwater inputs throughout the year and constant flow. Substrates are more variable and can vary from silt, sand, and detritus to hardpan clay shoals.

Trapping setup. We used 90-cm diameter and 120-cm diameter hoop nets with fiberglass hoops, flat (Arkansas-style) throats, and mesh sizes of 4.45 cm (#36 twine). We deployed 120-cm traps at all sampling locations and the 90-cm traps at the Mississippi sites. We included a buoy inside each trap to prevent captured turtles from drowning due to fluctuating water levels. Hoop nets were partially submerged upstream of suitable microhabitat (i.e., log jams, root masses), with the trap tied to metal 2.1-m fence posts or to a PVC pipe secured in the substrate. We baited traps with frozen or fresh fish (e.g., carp, catfish, buffalo), either by hanging them on a tire wire or by placing them in a container made from PVC pipe and rebaiting them daily or as needed. Typical trapping sessions for the Texas study lasted 3 days (setting 4–8 traps), while those for the Mississippi study lasted 4–5 days, with the first day dedicated to setting 20–24 traps.

Statistical analyses. To evaluate whether capture composition differed between urban (Texas) and rural (Mississippi) site types, we pooled captures into two categories, target species (*M. temminckii*) and bycatch, and constructed a 2 × 2 contingency table crossing site type (urban, rural) by capture category (target, bycatch). We used a chi-square test of independence (χ^2) to assess whether the proportion of target to bycatch captures differed significantly between site types. Effect size was quantified using Cramér's V (Ialongo, 2016), with values of approximately 0.10, 0.30, and 0.50 conventionally interpreted as small, medium, and large effects (Cohen, 1988). We described bycatch assemblage structure at the site-type level using two complementary metrics: the Shannon diversity index (Shannon and Weaver, 1949) and the Bray-Curtis dissimilarity (Bray and Curtis, 1957), calculated on untransformed bycatch abundance data pooled by site type, to quantify compositional difference between the urban and rural assemblages. All analyses were conducted in R statistical software v4.4.0 (R Core Team, 2024), with the *vegan* package (Oksanen et al., 2024) used for diversity and dissimilarity calculations. Statistical significance was evaluated at $\alpha = 0.05$.

Results

A total of 872 turtles were captured across four sites (Table 1). Mississippi sites were strongly dominated by *M. temminckii* (Yazoo: $n = 166$ *M. temminckii*, 69.2%; Sunflower: $n = 122$ *M. temminckii*, 59.2%), while Texas sites exhibited substantially higher bycatch (Buffalo Bayou: $n = 159$ *M. temminckii*, 54.0%; Little Cypress Creek: $n = 57$ *M. temminckii*, 43.2%).

Bycatch was dominated by Red-eared Slider (*Trachemys scripta elegans*) and American softshell turtles (genus *Apalone*) across all sites. *Trachemys s. elegans* was abundant in Texas (Buffalo Bayou: $n = 88$, 29.9%; Little Cypress Creek: $n = 57$, 43.2%) but uncommon in Mississippi (Yazoo: $n = 19$, 7.9%; Sunflower: $n = 24$, 11.7%). Spiny Softshells (*Apalone spinifera*) were captured at all four sites (Buffalo Bayou: $n = 43$, 14.6%; Little Cypress Creek: $n = 12$, 9.1%; Yazoo: $n = 39$, 16.3%; Sunflower: $n = 55$, 26.7%), and Smooth Softshells (*A. mutica*) were recorded only at Yazoo ($n = 3$). The Mississippi Map Turtle (*Graptemys pseudogeographica kohnii*) was absent from Little Cypress Creek but present at the remaining three sites (Buffalo Bayou: $n = 2$; Yazoo: $n = 13$; Sunflower: $n = 4$).

Small-bodied benthic taxa were nearly absent across all systems. Razor-backed Musk Turtles (*Sternotherus carinatus*) were recorded only at Little Cypress Creek ($n = 4$), and one Common Musk Turtle (*S. odoratus*) was trapped at Sunflower. Mud turtles (genus *Kinosternon*) were not captured. The Common Snapping Turtle (*Chelydra serpentina*) was represented by a single individual at Little Cypress Creek.

Capture composition differed significantly between urban and rural study sites (Fig. 1). Urban sites yielded nearly equal numbers of *M. temminckii* and bycatch captures (216 *M. temminckii*, 210 bycatch), whereas rural sites were dominated by *M. temminckii* captures (288 *M. temminckii*, 158 bycatch). A chi-square test of independence indicated a significant association between site type and capture category ($\chi^2 = 17.7$, $df = 1$, $p < 0.001$), showing that *M. temminckii* capture was more likely in rural areas. Although the effect size was moderate (Cramér's $V = 0.14$), the pattern

Table 1. Capture numbers (*n*) and proportional representation (%) of Alligator Snapping Turtle (*Macrochelys temminckii*) and bycatch species across four study sites in Texas and Mississippi sampled from 2020–2025. Dashes indicate species not captured at that site.

Species	Buffalo Bayou		Little Cypress Creek		Yazoo		Sunflower	
	n	%	*n*	%	*n*	%	*n*	%
Macrochelys temminckii	159	54.0	57	43.2	166	69.2	122	59.2
Trachemys scripta elegans	88	29.9	57	43.2	19	7.9	24	11.7
Apalone spinifera	43	14.6	12	9.1	39	16.3	55	26.7
Apalone mutica	—	—	—	—	3	1.3	—	—
Graptemys pseudogeographica kohnii	2	0.7	—	—	13	5.4	4	1.9
Pseudemys concinna	2	0.7	1	0.8	—	—	—	—
Sternotherus carinatus	—	—	4	3.0	—	—	—	—
Sternotherus odoratus	—	—	—	—	—	—	1	0.5
Chelydra serpentina	—	—	1	0.8	—	—	—	—
Total	**294**		**132**		**240**		**206**	

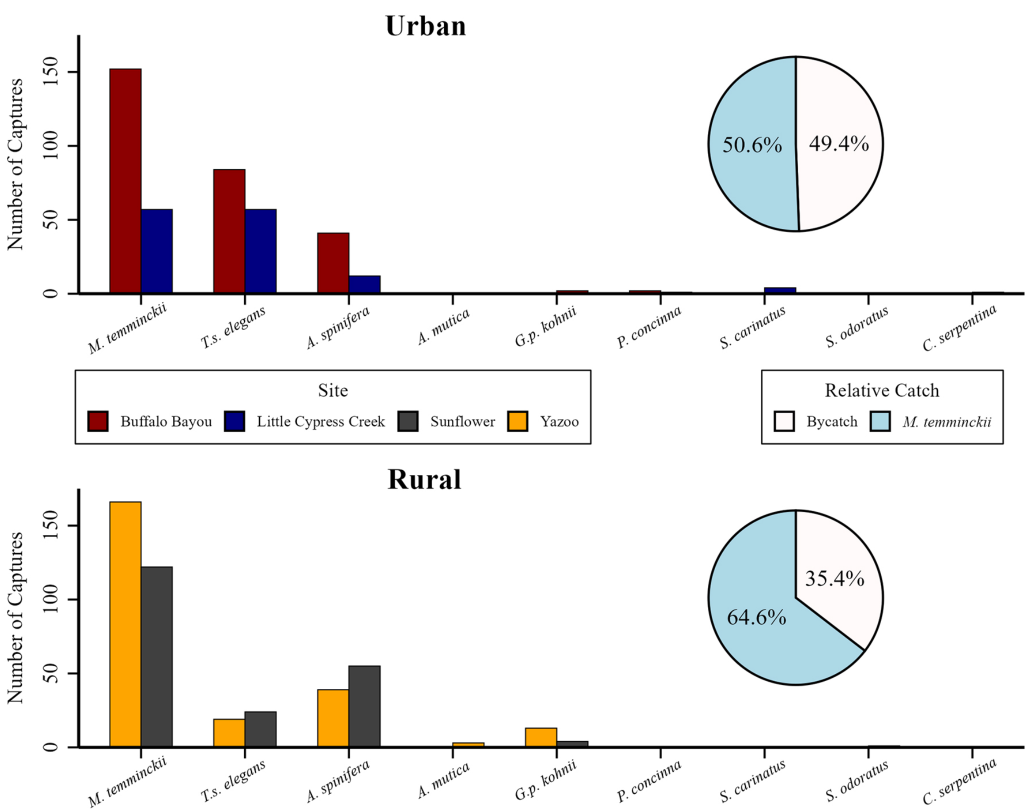

Figure 1. Total captures of Alligator Snapping Turtle (*Macrochelys temminckii*) and all bycatch species at both urban (above) and rural (below) sites with individual sites represented by colour. The overall proportion of *M. temminckii* and bycatch at both urban and rural sites is shown as an inset pie chart.

was consistent across sites, with urban environments producing proportionally greater bycatch relative to rural systems.

Although bycatch species richness was nearly identical between urban and rural systems, community composition differed substantially (Table 2). Urban sites were strongly dominated by *T. s. elegans*, whereas rural sites exhibited greater evenness among multiple taxa. Shannon diversity was higher in rural systems (H' = 0.81) than in urban systems (H' = 0.88), reflecting reduced dominance and more balanced species representation. Bray-Curtis dissimilarity between urban and rural bycatch assemblages was moderate (0.46), indicating meaningful compositional differences despite equivalent richness (Table 2).

Discussion

The near-absence of small-bodied benthic turtles across all four study sites is the most ecologically striking finding of this study, and it was consistent regardless of whether sites were urban or rural. *Sternotherus carinatus* was recorded only at Little Cypress Creek (n = 4), whereas *S. odoratus* was detected only at Sunflower (n = 1). Critically, this pattern cannot be attributed to gear selectivity alone. Identical trap designs deployed in non-Mississippi River tributaries of Mississippi, including the Pearl, Pascagoula, and Tombigbee drainages, have regularly captured species of *Sternotherus* at meaningful relative abundances (Pearl: 10.6%; Pascagoula: 12.8%; Tombigbee: 4.7% for *S. peltifer*; L. Pearson, unpubl. data; Berry, 2019; Haralson, 2021). It is also worth noting that *S. carinatus* has not been documented from the Mississippi River floodplain of western Mississippi, where *S. odoratus* is the only native musk turtle, further contextualizing its absence from the Yazoo and Sunflower sites. The uniformity of the small-bodied species deficit across ecologically distinct settings, including heavily urbanized Texas bayous and rural Mississippi stream systems, suggests a biological rather than methodological explanation. One possibility worthy of further investigation is whether the presence of large densities of *M. temminckii* influences the behaviour, habitat use, or detectability of smaller benthic turtle species. Brown (2023), while targeting *Sternotherus* with crayfish traps, reported frequent bycatch of juvenile *M. temminckii* and noted that musk turtles captured in traps containing *Macrochelys* were often observed clinging to the upper portions of the trap or otherwise avoiding the larger turtle. These observations, coupled with previous evidence of predator-avoidance behaviour in musk turtles, suggest that interactions with alligator snapping turtles may influence space use or trapping vulnerability of small-bodied kinosternids. Although the data presented here cannot directly evaluate this hypothesis, the consistently low abundance of *Sternotherus* at sites supporting robust *Macrochelys* populations warrants further study. Additionally, both *S. odoratus* and *Chelydra serpentina* have been observed in small ponds in the vicinity of Sunflower and Yazoo (Patrick Delisle, personal observation).

The most parsimonious candidate for driving this pattern is *M. temminckii*. As a large-bodied benthic ambush predator, *M. temminckii* occupy the same

Table 2. Bycatch species composition and richness at urban (Houston, Texas) and rural (Mississippi) study sites sampled from 2020–2025, while trapping for the target species *Macrochelys temminckii* (excluded).

Species	Urban (TX)	Rural (MS)
Trachemys scripta elegans	145	43
Apalone spinifera	55	94
Pseudemys concinna	3	0
Graptemys pseudogeographica kohnii	2	17
Sternotherus carinatus	4	0
Sternotherus odoratus	0	1
Apalone mutica	0	3
Chelydra serpentina	1	0
Total Bycatch Individuals	**210**	**158**
Species Richness (S)	**6**	**5**

microhabitat zone as musk turtles and consume other turtles opportunistically, with smaller individuals particularly vulnerable to its powerful jaws (Elsey, 2006; Ernst and Lovich, 2009). Observations of damage consistent with *M. temminckii* bites have been observed on softshells and *Trachemys* at both site groups (E. Munscher and P. Delisle, pers. obs.). Where *M. temminckii* is abundant, repeated predation on co-occurring benthic species, compounded by the relatively slow reproductive rates and high site fidelity typical of freshwater turtles, could plausibly suppress musk turtle populations to below detectable levels over time. Analogous top-down structuring by large reptiles has been documented in crocodilian-dominated systems (Bondavalli and Ulanowicz, 1999), and keystone predation effects on community diversity are well established in other taxa (Paine, 1966; Estes et al., 2011).

The near-complete absence of *C. serpentina* across all sites reinforces this interpretation. *Chelydra serpentina* was represented by a single individual at Little Cypress Creek and was absent from all Mississippi sites, a pattern that mirrors broader survey data from across the state, where *C. serpentina* co-occurs with *M. temminckii* at only six of 77 sites, and five of those six sites had relatively low *M. temminckii* densities (CPUE: 0.015-0.101; L. Pearson, unpubl. data). *Chelydra serpentina* has been documented in the immediate vicinity of the Sunflower site but has never been recorded within the surveyed waterbody itself. Both species are benthic ambush predators with broadly overlapping diets and microhabitat requirements (Ernst and Lovich, 2009), making competitive displacement or predation on juveniles plausible mechanisms that limit *C. serpentina* persistence in *M. temminckii*-dominated systems. Support for this interpretation comes from studies in other portions of the range. Johnston et al. (2012) reported long-term coexistence of *Chelydra serpentina osceola* and *Macrochelys suwanniensis* within the spring-fed Santa Fe River of northern Florida and suggested that interactions between the two species may influence snapping turtle population structure and life-history characteristics. Notably, the Florida snapping turtles in that system attained exceptionally large body sizes relative to most populations across the species' range, a pattern the authors hypothesized could be associated with ecological conditions created by the spring environment or with coexistence alongside *Macrochelys*. Although the Santa Fe River demonstrates that coexistence is possible, it also appears to be facilitated by an unusually productive spring-fed ecosystem that provides abundant thermal refugia and food resources. In contrast, the widespread absence of *C. serpentina* from the Mississippi sites surveyed here, despite the frequent occurrence of *M. temminckii*, suggests that coexistence may be uncommon in many river systems where resources or habitat heterogeneity are more limited. A study conducted in Missouri comparing habitat use of *M. temminckii* and *C. serpentina* likewise failed to capture both species together during 557 trap nights over a two-year period (Lescher, 2013). Competitive exclusion among freshwater turtles has precedent in other taxa (Cadi and Joly, 2003), and juvenile *C. serpentina* would be particularly vulnerable to direct predation by large *M. temminckii*, potentially limiting recruitment even where adults persist nearby.

Bycatch dominated by medium- and large-bodied aquatic species, particularly *T. s. elegans* and *A. spinifera*, was a consistent feature across all four sites, though community composition differed meaningfully between regions. Urban Texas sites were strongly dominated by *T. s. elegans*, whereas rural Mississippi sites exhibited greater evenness across taxa and higher Shannon diversity (H' = 1.02 vs. 0.88). Despite very similar bycatch species richness (S = 6 at urban and S = 5 at rural sites), Bray-Curtis dissimilarity (0.46) confirmed meaningful compositional differences in assemblage structure. The proportionally higher bycatch at Texas sites, where *M. temminckii* represented a smaller fraction of total captures relative to Mississippi, may reflect reduced predator pressure at the range edge, differences in prey base availability in urban waterways, or simply the elevated abundance of generalist species like *T. s. elegans* that thrive under disturbed conditions (Moll and Moll, 2004; Lindeman, 2013). Importantly, even at Texas sites where *M. temminckii* density is lower, small-bodied benthic taxa remained essentially absent, suggesting that even moderate densities of this species may exert disproportionate top-down influence on co-occurring assemblages. The *M. temminckii* populations persisting in Houston's heavily urbanized bayous (Munscher et al., 2020) represent an exceptional natural experiment for studying large-reptile community structuring effects across contrasting environmental contexts.

Several limitations of this study warrant acknowledgment. Trap effort was not standardized across sites: Texas sessions typically deployed 4–8 traps over 3 days, while Mississippi sessions involved 20–24 traps over 4–5 days. Raw capture totals are therefore not directly comparable across regions, and effort-corrected CPUE should be incorporated into future analyses. Additionally, all sampling occurred within defined trapping seasons, leaving open the possibility that small-bodied species exhibit seasonal activity patterns that reduce hoop-net encounter rates during our sampling windows, though the consistency of the pattern across multiple years and two geographically distinct regions argues against this explanation.

Future work should incorporate standardized trap-night effort to enable CPUE comparisons across sites. Complementary gear types, including fyke nets and basking traps, and seasonal replication, and alternative sampling methods, such as camera trapping or observational surveys, would help clarify whether small-bodied species are genuinely absent or merely underdetected in standard hoop-net surveys. Mark–recapture studies targeting *Sternotherus* species at reference sites lacking *M. temminckii* would provide the most direct test of predation and competition-mediated suppression. Such comparisons, paired with the long-term capture data already available from these sites, could meaningfully advance our understanding of how a large benthic predator structures freshwater turtle communities across both urbanized and relatively intact landscapes.

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