

Maximum size, nesting, aestivation, and refugia of the Alligator Snapping Turtle, *Macrochelys temminckii* Troost in Harlan, 1835, in East Texas, USA

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Alligator Snapping Turtles, *Macrochelys temminckii*, are the largest freshwater turtle in North America. This species occurs in drainages of the Gulf of Mexico from the Florida panhandle to East Texas, USA (Ernst et al., 1994). *Macrochelys temminckii*, one of the most aquatic turtle species in the world (Pritchard, 1967), resides in slow-moving waterbodies that feature abundant woody debris, undercut banks, and high amounts of canopy cover (Harrel et al., 1996; Howey and Dinkelacker, 2009; Rosenbaum et al., 2023a; Adams et al., 2024). Individuals are rarely seen out of water, with only adult females regularly making overland movements to nest (Reed et al., 2002; Pritchard, 2006; USFWS, 2021). Furthermore, *M. temminckii* typically occupy turbid waters and are well camouflaged, making them difficult to observe in the wild (Carr et al., 2011; Franklin et al., 2023). Due to these highly aquatic affinities, observations on the natural history and behaviour of this elusive species are not well-documented.

The life history of *M. temminckii* is characterised by several traits (e.g., low fecundity and delayed sexual maturity) that make it difficult for populations to recover from environmental and anthropogenic

stressors (Pritchard, 2006; Rosenbaum et al., 2023a). Commercial harvest, habitat loss, and incidental take from passive fishing gear have resulted in population declines across much of its range (Sloan and Lovich, 1995; Pritchard, 2006; Shook et al., 2023). Although the harvest of *M. temminckii* is now prohibited in all states in its native range, with the exception of Louisiana and Mississippi where recreational harvest is permitted, this species has been proposed to be listed as federally threatened (USFWS, 2021). Because of their large size, *M. temminckii* are often of interest to the public, both as a general curiosity and as part of the cultural heritage of the southeastern United States (Glorioso et al., 2023). However, literature regarding the maximum body size of *M. temminckii* have typically been inconsistent in both measurements and reporting (Johnston et al., 2023). Additionally, the nesting ecology of *M. temminckii* is poorly understood, as much of this knowledge has been gathered from studies on captive individuals or from opportunistic encounters (Thompson and Ligon, 2023).

To address these knowledge gaps, we have been conducting a series of projects across eastern Texas focused on the ecology and conservation of *M. temminckii* since 2020 (Baxter-Bray et al., 2021; Rosenbaum et al., 2023a, 2023b, 2023c, 2024; Adams et al., 2024; Micek unpubl. data). Through our extensive survey efforts across the region, we have accumulated a series of opportunistic observations that contribute to the knowledge of *M. temminckii* natural history. Herein, we report and discuss several of these observations pertaining to the maximum size, nesting, aestivation, and refugia of *M. temminckii* in East Texas, USA. To protect *M. temminckii* individuals documented in this report, we have withheld specific information (i.e., GPS coordinates) on the locales.

Maximum Size. On 13 June 2021, we captured the largest wild individual of the *Macrochelys* genus from

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which complete measurements have been reported in the literature. This male *M. temminckii* was found in eastern Texas during a species status assessment survey that took place in 2020 and 2021 (Rosenbaum et al., 2023a, 2023b, 2023c, 2024). The midline straight carapace length and body mass of this individual were originally reported by Rosenbaum et al. (2023b; Table 4), and were further referenced by Johnston et al. (2023).

This turtle was captured in a single-funnel, finger-throated hoop trap deployed in a tributary of the Sabine River watershed. J. M. Arnett, J. Swanson, and D. Rosenbaum initially set the trap on 11 June 2021, immediately upstream of a logjam and debris pile spanning the width of the tributary (Fig. 1A). Wetted stream width at the trap was 21.2 m, and water depth at the trap entrance was 1.3 m. Both banks at this location featured undercuts. The trap consisted of four 1.2 m diameter hoops and asphalt-coated 2.54 cm mesh, baited

with Common Carp (*Cyprinus carpio*), and rebaited with fresh fish approximately every 24 hr. During our second trap check on 13 June 2021, two nights after initial deployment, we found the turtle in the trap along with one shad (*Dorosoma* sp.) and one Channel Catfish (*Ictalurus punctatus*).

We collected both straight-line and curved length measures of the turtle using a tree calliper and flexible measuring tape, respectively, to the nearest 0.1 cm (Fig. 1B–D). Straight-line measures we collected included midline straight-line carapace length (Method D, Iverson and Lewis, 2018), maximum straight-line carapace length (Method B; Iverson and Lewis, 2018), maximum straight-line carapace width (analogous to Method B of Iverson and Lewis [2018] but measured parallel to the transverse plane), straight midline plastron length (Method H; Iverson and Lewis, 2018), straight maximum head width, and straight head

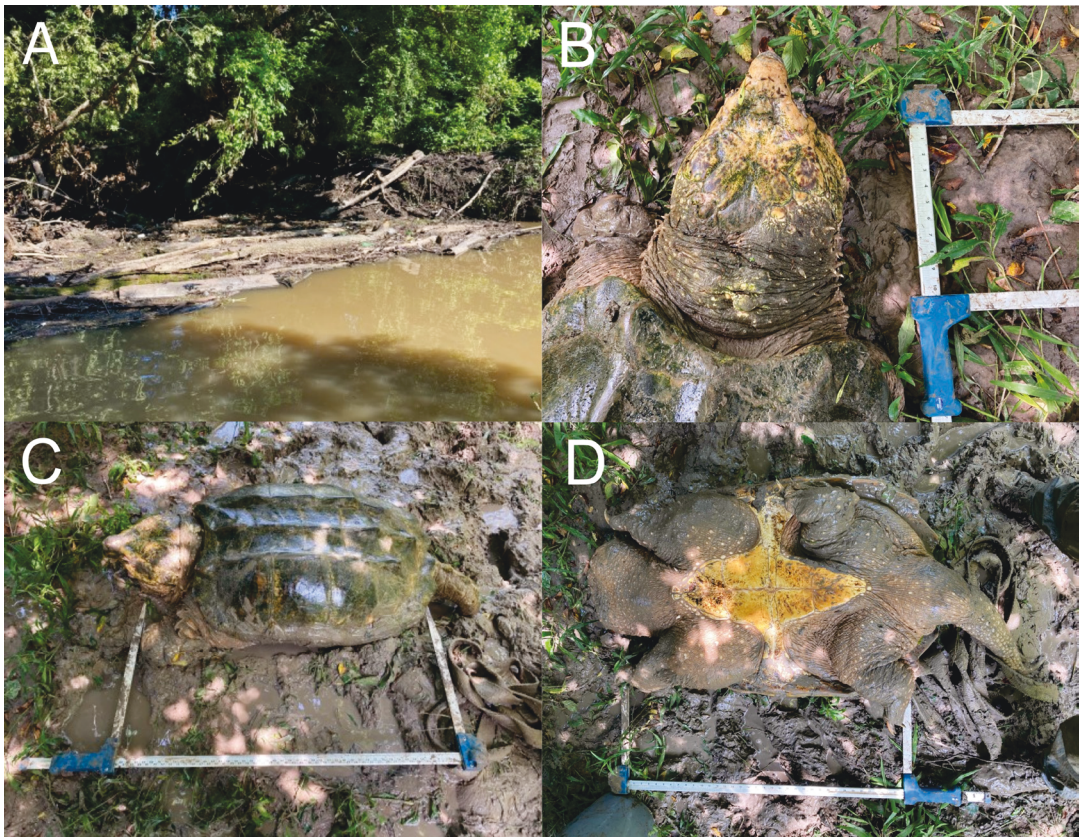


Figure 1. The logjam and woody debris pile (A) immediately downstream from the hoop trap which captured the largest verified wild *Macrochelys temminckii* (B–D) shown with a tree calliper. Note the side of the calliper shown in this photograph is graduated in inches. Photos by David Rosenbaum.

length (from the posterior margin of cranial scutes to the nares). Curved measures we collected included total tail length, pre-vent tail length (from the posterior terminus of the plastron to the cloacal aperture), curved midline carapace length (Method F; Iverson and Lewis, 2018), curved maximum carapace length (Method E; Iverson and Lewis, 2018), and curved carapace width (measured from same marginal scutes from which straight maximum carapace width was measured). To document mass to the nearest 0.1 kg, we suspended the turtle from a hanging digital scale using a 2.5 kg vehicle tow strap. We then suspended both the turtle and scale from a T-post that we lifted to clear the turtle from ground contact, and subtracted the tow strap mass from the scale’s reading.

The turtle’s cranial length and width were 23.7 cm and 23.9 cm, respectively (Table 1; turtle 1). Midline straight-line carapace length was 74.0 cm, maximum straight-line carapace length was 80.3 cm, and midline plastron length was 53.6 cm. Curved midline carapace length was 80.6 cm, and curved maximum carapace length was 85.9 cm. Pre-vent and total tail lengths were 26.6 cm and 71.7 cm, respectively. Mass was 95.8 kg. Following collection of data, we released the turtle immediately upstream from its point of capture.

This turtle was notably larger than all other males documented in eastern Texas by Rosenbaum et al. (2023a). The second largest individual we documented had a body mass of 69.4 kg and midline straight-line carapace length of 63.4 cm, while the individual with the second longest midline straight-line carapace length (66.0 cm) had a mass of 68.6 kg. To illustrate the size difference between the largest turtle and others, we

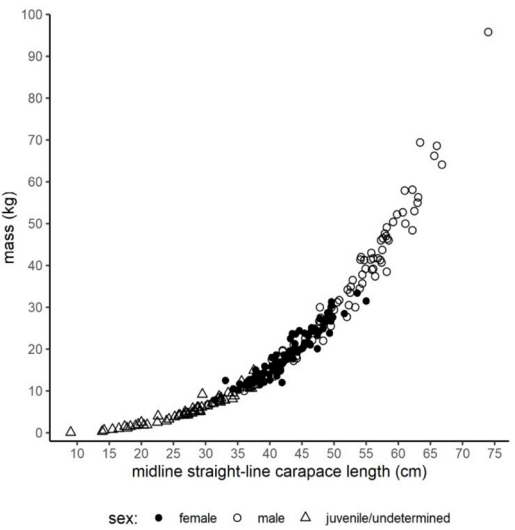


Figure 2. Scatterplot of 260 *Macrochelys temminckii* (Alligator Snapping Turtles) detected during surveys from 1999–2001 and 2020–2021 in Texas, showing the relationship between body size (cm) and mass (kg) (see additional details reported in Rosenbaum et al. (2023a)). The unusually large turtle described in this note is represented by the circle in the upper right corner of the plot.

plotted measures of carapace length against body mass using data from 260 *M. temminckii* documented from two surveys described by Rosenbaum et al. (2023a; Fig. 2).

The large *M. temminckii* individual we documented is accompanied in the literature only by unverified or incomplete morphometric documentations of

Table 1. Morphological measurements of *Macrochelys temminckii* in east Texas, USA. Turtle 1 (designated by the asterisk *) is the largest *M. temminckii* reported in the literature. Turtles 2–4 are the three turtles observed aestivating in log jam during a drought. Measurements include cranial length (CL; cm), cranial width (CW; cm), midline straight-line carapace length (Mid. SLCL; cm), maximum straight-line carapace length (Max. SLCL; cm), straight midline plastron length (Mid. PL; cm), curved midline carapace length (Mid. CCL; cm), curved maximum carapace length (Max. CCL; cm), pre-vent tail length (PVL; cm), total tail length (TTL; cm), and mass (kg).

Turtle	Sex	Straight (cm)					Curved (cm)				Mass (kg)
		CL	CW	Mid. SLCL	Max. SLCL	Mid. PL	Mid. CCL	Max. CCL	PVL	TTL	
1*	Male	23.7	23.9	74.0	80.3	53.6	80.6	85.9	26.6	71.7	95.8
2	Male	15.2	13.7	46.7	50.0	33.5	49.3	51.7	11.6	30.7	19.9
3	Male	15.8	13.7	42.4	46.5	32.4	45.7	47.6	11.2	41.9	16.6
4	Female	11.9	11.7	38.9	42.9	31.3	41.3	43.8	6.3	30.1	14.9

Macrochelys that are of similar or larger size (Pritchard, 2006; Johnston et al., 2023). We would expect subsequent findings of similarly sized turtles to the one described here if the species experiences release from stressors that may impact growth (e.g., reduced habitat quality) coupled with continual scientifically rigorous monitoring efforts throughout the range of the genus.

Nesting. On 18 April 2023 at 11:17 h, a local fisherman observed an adult female *M. temminckii* ovipositing on the accumulated soil of a windthrown oak tree (*Quercus* sp.; Fig 3). The individual was discovered in a tributary of the Neches River, 4.03 air km N of Evadale in Jasper County Texas, USA. Video was taken of the event and the nesting site was revisited to collect general nest microhabitat information. We noted the general habitat of the surrounding area, approximated the distance of the nest from the water line at the time of oviposition, and measured the slope and aspect of the nest site.

The female oviposited in an east-facing direction, with nest construction occurring in loose, damp soil (B. Curtis, pers. obs.) at a 47° slope from nest to waterline. The approximate nest location was 2.1 m above the water line at the time of oviposition. The nest site was approximately 960 m east of the main channel of the Neches River within a natural floodplain with dense overstory consisting of bald cypress (*Taxodium distichum*), Chinese tallow (*Triadica sebifera*), and several oak species (*Quercus* spp.). The surrounding area consisted of intermingling channels with low to

moderate water flow. Under normal river conditions, this nesting site is fairly isolated from nearby land.

After the nest was discovered, we monitored the nest biweekly until its predation by an unknown predator approximately 37 days after oviposition. Predation of the nest was most likely by a mammal since the nest cavity had been completely excavated. Upon examining the excavated cavity, we found no remaining intact eggs. Instead, several small groups of 7–10 ruptured eggshells were found dispersed on and adjacent to the windthrow where the nest was located. The water level had dropped enough to expose muddy areas next to the windthrow where we found evidence of Northern Raccoon (*Procyon lotor*) tracks and scat on other exposed woody debris. We also observed North American River Otter (*Lontra canadensis*) activity within the adjacent waterway in the two weeks before the predation occurred. Due to the condition of the nest when found, it was unlikely any viable eggs remained.

Based on previous studies, *M. temminckii* do not appear to be particularly selective of nesting habitats (USFWS, 2021; Munscher et al., 2023). It has been suggested that females may travel from main river channels to backwater habitats to nest (Jackson and Ewert, 2023), and may prefer sites with steeper bank angles (Woosley, 2005; Miller et al., 2014). The distance from nest to nearest waterbody ranges from 2.5–200 m (Ewert, 1976; Powders, 1978; Jackson and Jensen, 2003; Trauth et al., 2004; Ewert et al., 2006). In



Figure 3. Female *Macrochelys temminckii* (Alligator Snapping Turtle) ovipositing on the accumulated soil of a windthrown oak tree in a bayou of the Neches River in Jasper County Texas, USA. Photo by Brian Curtis.

Texas, Munscher et al. (2023) observed an adult female *M. temminckii* nesting approximately 3.4 m above the water's surface at a bank angle of 63°. Both Munscher et al. (2023) and Franklin et al. (2023) observed diurnal *M. temminckii* nesting in Texas, USA at 09:22 h and 13:00 h, respectively. However, the time of *M. temminckii* oviposition varies among studies of both wild and captive individuals, with both diurnal (Allen and Neill, 1950; Ewert, 1976; Powders, 1978; Pritchard, 2006) and nocturnal (Pritchard, 1989; Ewert et al., 2006; Miller et al., 2014; Thompson and Ligon, 2022; Jackson and Ewert, 2023) nesting being documented. Nesting ecology of *M. temminckii* remains one of the most understudied aspects of its life history (Dobie, 1971; Jackson and Ewert, 2023), and the discrepancies among documented observations highlight the need for further research into their nesting behaviour and habitat requirements.

Furthermore, mammalian nest predation has been

identified as the greatest threat to recruitment of *M. temminckii* juveniles (Holcomb and Carr, 2013). Although low nest survival is typical of *M. temminckii* and other freshwater turtles, population persistence is typically offset by high adult survival and an iteroparous reproductive strategy (Iverson, 1991). The increase of mesopredator populations, which can be attributed to factors such as release from apex predators and resource subsidies from anthropogenic sources (Prugh et al., 2009) may impact juvenile recruitment of *M. temminckii* populations (Holcomb and Carr, 2013).

Aestivation. On 11 August 2023, S. Weiss, E. Menzel, R. Reid, and L. Micek discovered *M. temminckii* tracks in a dried creek bed, during a stream survey at Alazan Bayou Wildlife Management Area in Nacogdoches County, Texas USA. The tracks led to a logjam (Fig. 4A), where three adult *M. temminckii* (two males and one female) appeared to be aestivating (Fig. 4B–D). Multiple dead sunfish (*Lepomis* spp.) and Yellow

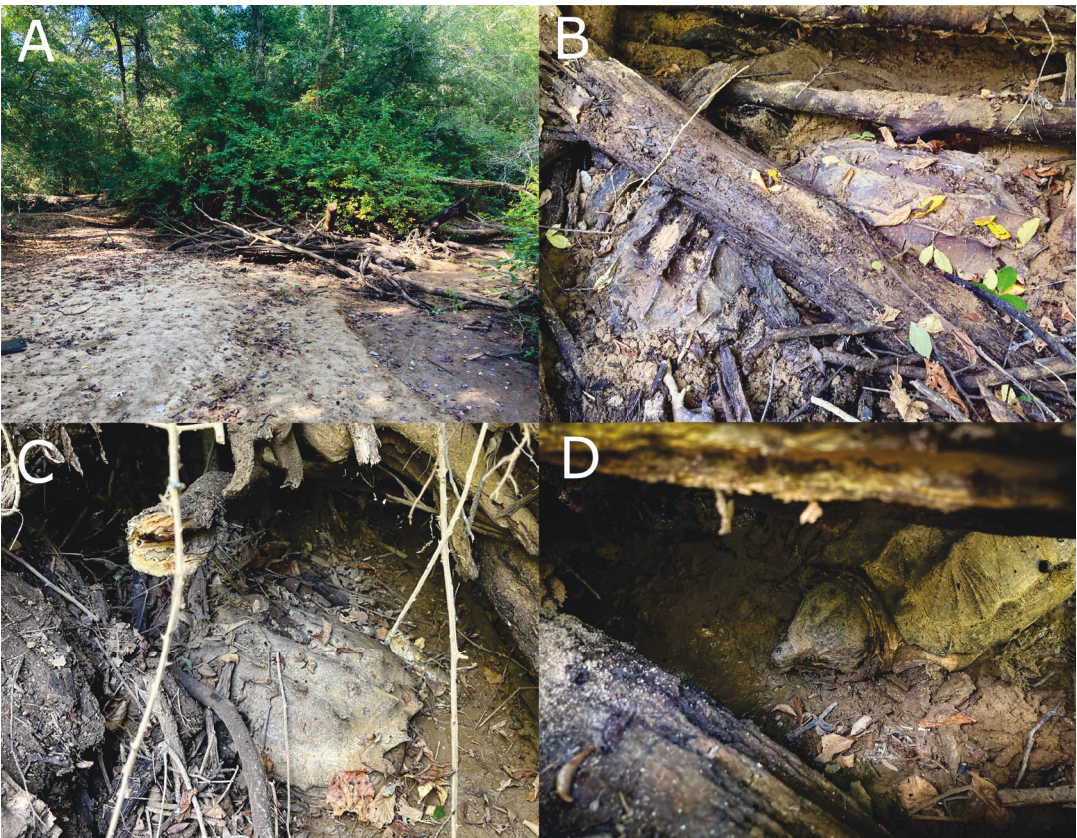


Figure 4. The logjam in the dried creek bed (A) at Alazan Bayou Wildlife Management Area in Nacogdoches County, Texas, USA where three adult *Macrochelys temminckii* (B–D) appear to be aestivating. Photos by Ethan R. Menzel.

Bullheads (*Ameiurus natalis*) were found within the logjam, along with one Northern Cottonmouth (*Agkistrodon piscivorus*; Lacépède, 1789). All three *M. temminckii* were partially buried approximately 12 cm deep in sediment mostly comprised of sand, clay, and detritus, with only their heads and carapaces exposed. It was unclear whether the *M. temminckii* utilised their forelimbs or hindfeet to enter the substrate. Canopy cover surrounding the aestivation site was approximately 89.5% (measured using a spherical densiometre over the centre of the logjam), comprised of River Birch (*Betula nigra*), American Sweetgum (*Liquidambar styraciflua*), and Chinese tallow (*T. sebifera*). The aestivation site was lower in elevation compared to the channel and approximately 37 m downstream from the nearest water source. This logjam may have held water as the creek dried, although it is unclear whether the *M. temminckii* made overland movements to access the aestivation site. Furthermore, the abundance of woody debris in the dried creek bed may have obstructed the path of these turtles to access the nearby water source.

Due to the high abundance of Red-imported Fire Ants

(*Solenopsis invicta*) within the vicinity of the refugia (L. Micek, pers. obs.) and the lack of forecasted precipitation, all three *M. temminckii* were removed from the refuge and translocated 83 m to the nearest connected body of water. Prior to the release, all specimens were weighed, sexed, and measured (Table 1; turtles 2–4). The midline straight-line carapace lengths (Method D; Iverson and Lewis, 2018) of the two male *M. temminckii* were 46.7 and 42.4 cm, while the female carapace length was 38.9 cm. The mass of the two male *M. temminckii* were 19.9 and 16.6 kg, while the mass of the female was 14.9 kg. All three *M. temminckii* did not appear to be emaciated and were active once removed them from the refuge.

Aestivation is a common strategy used by many turtle species, allowing individuals to conserve water in the body during dry or hot seasons (Witherand Cooper, 2010). However, this behaviour has rarely been documented in *M. temminckii* and other Chelydrids (Macip-Rios et al., 2023). Howey and Dinkelacker (2007) observed a male *M. temminckii* located in an exposed American Beaver (*Castor canadensis*) den in Arkansas, USA. This individual remained in the burrow for 33–44 days,

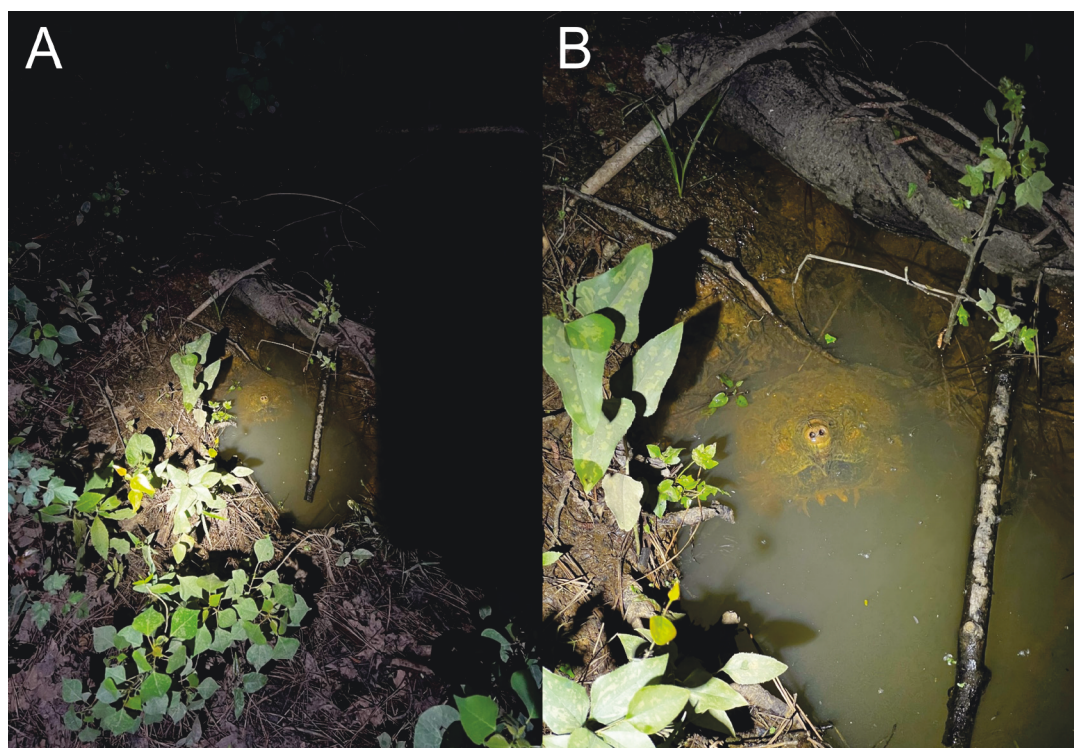


Figure 5. The Nutria (*Myocastor coypus*) burrow (A) at Lake Nacogdoches in Nacogdoches, Texas, USA where one adult *Macrochelys temminckii* (B) sought refuge. Photos by Cory K. Adams.

which was significantly cooler than both air and stream temperatures. George (2010) reported two separate observations of *M. temminckii* buried in mud during low water conditions in Mississippi, USA. However, our observation appears to be the first documentation of communal aestivation of *M. temminckii*.

By 8 August 2023, 70.3% of Nacogdoches County, Texas was in extreme drought and 29.7% in severe drought (USDM, 2023). As global temperatures increase and drought conditions are expected to worsen in the western portion of its range (Kunkel et al., 2013; McNulty et al., 2019), aestivation will become essential for the survival of *M. temminckii* and other freshwater turtle species. Additionally, large woody debris, Beaver dams, and other structures, may provide important microhabitats for this species in low water events, similar to that of regular conditions, and may be of use for researchers to monitor in the future.

Refugia. On 18 April 2024 at 20:07 h, C. K. Adams observed an adult *M. temminckii* using a small hole associated with a Nutria (*Myocastor coypus*) tunnel at Lake Nacogdoches in Nacogdoches County, Texas, USA (Fig. 5A). This individual was discovered facing the surface of the water (Fig. 5B). The hole was approximately 0.51 m long, 0.36 m wide, and 3.3 m deep, and was connected to the lake via an underground tunnel. On 24 April 2024 at 20:27 h, an adult *M. temminckii* (presumed to be the same individual) was resighted in the hole near the water's surface.

This appears to be the first published observation of *M. temminckii* utilising a Nutria burrow, although this species is known to select sites with Beaver dens and dams (Shipman, 1993; Howey and Dinkelacker, 2009). Riedle et al. (2006) observed an adult male *M. temminckii* occupying a Beaver den on several occasions in Oklahoma, USA. These structures may provide refuge from predators and unfavourable environmental conditions, while also containing air pockets (Shipman, 1993; Riedle et al., 2006). In addition to the protection these structures provide, stomach content analyses of *M. temminckii* revealed that Nutria was a frequently consumed prey item at one site in Louisiana, USA (though its unknown if they were scavenged or actively preyed upon; Elsey, 2006).

Acknowledgements. We thank the staff of Alazan Bayou Wildlife Management Area for their cooperation. This research was funded by US Fish and Wildlife State Wildlife Grants through Texas Parks and Wildlife (TPWD), and a McIntire Stennis capacity grant. Survey efforts in 2020–2021 were conducted under TPWD Scientific Permit for Research SPR-0519-087 and IACUC project

approval number 2019-11. Survey efforts in 2023 were conducted under TPWD Scientific Permit for Research SPR-0922-127 and IACUC project approval number 2023-02. This paper was written and prepared in part by U.S. Government employees on official time, and therefore it is in the public domain and not subject to copyright. This research was supported in part by the USDA Forest Service. The findings and conclusions in this publication are those of the author(s) and should not be construed to represent an official USDA, Forest Service, or U.S. Government determination or policy.

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