Five First Records from a Half-Century Wood Turtle (*Glyptemys insculpta*) Communal Nesting Aggregation: Predation, Mortality, Nesting Phenology, and a Decade of Nest Protection

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Abstract.—We describe a half-century communal nesting aggregation of the Wood Turtle (*Glyptemys insculpta*), a species of conservation concern, at a single restored prairie–savanna site along a tributary of the Namekagon River in northwest Wisconsin, USA, monitored since the 1970s and protected with successive structures since 2015, and we report five natural-history findings from the site that are, to our knowledge, first records for the species: (1) nest predation by American Badger (*Taxidea taxus*), the first record for Wisconsin; (2) embryo survival after multi-day nest flooding; (3) egg predation by Prairie Deer Mouse (*Peromyscus maniculatus bairdii*); (4) egg damage and hatchling entanglement, including carapace deformation, caused by the roots of nest-site vegetation; and (5) predation on emerging hatchlings by Broad-winged Hawk (*Buteo platypterus*). The site is used by five turtle species, with Wood and Snapping turtles documented for at least 50 years. From 2014 through 2026, annual Wood Turtle nest counts averaged ca. 25/yr, and sustained nest protection markedly reduced predation, while the concentration of eggs and hatchlings subsidized a broad predator community (>40 individuals of ≥17 vertebrate taxa documented during the 2025 emergence). Daily surveys across the 2026 nesting season (25 May–13 June) recorded 171 turtle sightings, including 143 Wood Turtles arriving in discrete, partly rain-associated pulses; three independent approaches placed the number of nesting females near 40, of the same order as 2014–2015 radio-telemetry results from the site. We situate these first records within the aggregation's nesting phenology, multispecies use, and a decade of nest protection, and argue that the same concentration of eggs and hatchlings that makes a protected communal ground valuable for recruitment also exposes it to a broad and partly novel predator community, requiring active, adaptive protection—sustained here through a durable family–agency partnership.

Key words.—*Glyptemys insculpta*; Wood Turtle; communal nesting; nest protection; nest predation; American Badger; Prairie Deer Mouse; Broad-winged Hawk; root obstruction; nest flooding; nesting phenology; rainfall; prairie–savanna restoration; citizen science; Wisconsin

NEW NATURAL-HISTORY FINDINGS

Over five decades of monitoring and protection at this single site, we and our collaborators have documented five natural-history phenomena that are, to our knowledge, first records for *Glyptemys* *insculpta*. They form the connecting thread of the present account. Three are previously unrecorded predators of the species—American Badger, Prairie Deer Mouse, and Broad-winged Hawk—each exploiting the site at a different point in the nest-to-emergence sequence; one is a physical source of egg and hatchling mortality (obstruction by plant roots); and one is a survival finding (embryo survival after nest flooding). We summarize the five here and report each in detail below (see Results: First records of predation and mortality) and in the associated Notes.

First, in 2015–2016 we documented nest predation by American Badger (*Taxidea taxus*), the first record for Wisconsin, following the first range-wide record from Minnesota (Cochrane et al. 2015; Vraniak et al. 2017; Fig. 1A). Second, following a July 2016 flood we recorded the hatching success of naturally inundated nests, including partial survival of a *Glyptemys insculpta* nest and full survival of a Spiny Softshell (*Apalone spinifera*) clutch, at embryo ages generally assumed lethal—among the few field observations of post-flood hatching success for these species (Vraniak and Geller 2017; Fig. 1B). Third, trail cameras captured Prairie Deer Mouse (*Peromyscus maniculatus bairdii*) carrying off intact wood turtle eggs, the first documentation of *Peromyscus* egg predation in G. insculpta (Vraniak et al., in press; Fig. 1C). Fourth, we found eggs bound and damaged within dense root masses and hatchlings entangled in roots—one with a permanently deformed carapace—the first report of root-caused egg damage and hatchling entanglement in the species (Vraniak and Vraniak, in prep.; Fig. 1D, E). Fifth, Broad-winged Hawk (*Buteo platypterus*) foraged day after day at the structure and was twice seen seizing emerging hatchlings, the first record of B. platypterus predation on G. insculpta (Vraniak and Vraniak, in prep.; Fig. 1F, G).

These findings are unified by the site itself. Sustained protection has produced a large, predictable annual pulse of emergence—an estimated 500–700 hatchlings across five turtle species surfacing at the same location on nearly the same dates each year—and that predictability is itself an ecological resource, a concentrated late-summer food source that recruits a broad predator assemblage (>40 individuals of ≥17 vertebrate taxa in a single two-week peak; Table 3). Three of the five first records are novel predators occupying distinct tiers of the same nest-to-surface gauntlet: the badger works from below, tunneling beneath the fence to buried eggs; the deer mouse works at the smallest scale, slipping through the structure's gaps to remove intact eggs so cryptically that only a camera revealed it; and the hawk works from above, taking hatchlings—and even the egg-seeking mice—at the moment of emergence.

The remaining two findings complicate any simple equation of protection with success. Root obstruction is partly a byproduct of protection itself: the enclosure that excludes large predators also shelters the dense vegetation whose roots bind eggs and deform hatchlings from within. Nest flooding, by contrast, is a riverine stress the structure cannot address at all, and the survival it revealed was unexpected. Together the five records show that a protected communal nesting ground is at once a recruitment engine and an evolving arena of mortality, and that the daily, camera-supported presence sustained at this site is precisely what made the most cryptic of these phenomena documentable.

INTRODUCTION

The Wood Turtle (*Glyptemys insculpta*) is a species of conservation concern throughout its range in northeastern North America and the western Great Lakes region, where populations are limited by low recruitment, road mortality, collection, habitat loss, and high rates of nest and hatchling predation (Lapin et al. 2019; Bougie et al. 2020, 2022). Like many emydid turtles, G. insculpta frequently nests communally, with females migrating from riverine home ranges to traditional, open, well-drained nesting areas where many clutches are concentrated within a small area (Walde et al. 2007). Such communal nesting grounds can be focal points for conservation because protecting a single site can safeguard the reproductive output of many females; for the same reason, the concentration of eggs and hatchlings can attract and sustain a diverse assemblage of nest and hatchling predators (Walde et al. 2007; Bougie et al. 2020).

Long-term, single-site accounts that integrate nesting phenology, multispecies use, and the outcomes of sustained nest protection remain uncommon, particularly those maintained across decades by a resident landowner family in cooperation with state agency biologists—and rarer still are sites that have yielded multiple first natural-history records for the species. Here we describe a communal turtle nesting site on a restored prairie–savanna landscape along a tributary of the Namekagon River in northwest Wisconsin, USA, observed since the 1970s and protected with successive structures since 2015. We report (1) five findings that are, to our knowledge, first records for G. insculpta (summarized above; detailed in Results); (2) the multispecies composition and persistence of the aggregation; (3) annual nesting effort and protection outcomes from 2014 through 2026; (4) fine-scale nesting phenology and a rainfall association documented by daily counts during the 2026 season; and (5) a first approximation of the number of individual Wood Turtles using the site.

MATERIALS AND METHODS

Study site.—The study area comprises ca. 100 ha (250 acres) of prairie, savanna, and associated river and stream wetlands within the Northwest Sands Ecological Landscape, Washburn County, Wisconsin, USA, through which the Namekagon River flows for ca. 1.6 km. The senior author began restoring the property in 1975; restoration has emphasized reestablishing native prairie and savanna vegetation—now comprising over 200 prairie- and savanna-specific plant species—and maintaining the open, well-drained conditions on which the turtles depend for nesting. The primary communal nesting area lies on the east bank of a coldwater tributary (Hay Creek); a second protected nesting structure lies ca. 0.4 km (1/4 mile) to the west along a separate coldwater stream (Spring Creek). Precise coordinates are withheld on account of the conservation status of G. insculpta. During construction of shallow waterfowl ponds and a residence in 1994–1995, clean medium-grained sand was added to the longstanding nesting bank to enlarge the area available to nesting females. In 2014 the site was incorporated into a four-state (IA, MN, WI, MI) riverine turtle habitat and radio-telemetry study (Lapin et al. 2016, 2019).

Nest-protection structures.—Protection of the primary nesting bank progressed through several designs (Table 1; Fig. 3). The first, installed in 2015, was a solar-powered electric fence enclosing a cleared, leveled nesting area (ca. 7 × 11 m), built of vertically set 2 × 4 lumber and metal posts overlain with weed cloth and hardware cloth, with two uncharged wires at ca. 13 and 19 cm and a solar-charged wire at ca. 25 cm above ground. In 2018 the fence was replaced by a wooden structure (ca. 3.7 × 7.3 m) framed so that a single ground-level gap of ca. 3.25 cm admits Wood Turtles but excludes larger mammalian predators, with the remainder wrapped in chicken wire and a screened, hinged top that also excludes avian predators; the gap is reduced to ca. 1 cm after nesting to exclude small predators while still releasing hatchlings. This structure was enlarged in 2020 (the primary structure now measures ca. 4.5 × 19 m; Fig. 3), and in 2022 a second structure of this type was built at the Spring Creek site ca. 0.4 km to the west. Nests laid outside the structures—including those of larger-bodied Snapping (*Chelydra serpentina*) and Blanding's (*Emydoidea blandingii*) turtles, which cannot pass the gap—were individually caged where possible, and problem predators (e.g., raccoons, *Procyon lotor*; striped skunks, *Mephitis mephitis*; and thirteen-lined ground squirrels, *Ictidomys tridecemlineatus*) were live-trapped and removed. Slats were placed on the openings after completion of the nesting season and removed well before hatchling emergence. Rooted vegetation colonizing the nesting substrate within the structures was cleared each summer ahead of emergence. We compared the three protection methods used at the site—solar electric fencing, screened wooden structure, and individual nest cages—with respect to species access, predator exclusion, maintenance, and material cost (Table 2).

Monitoring.—The authors monitored the site in each year from 2014 through 2026 during the spring nesting period (May–June) and the late-summer to autumn hatchling-emergence period (August–September). Monitoring intensity and protocol have varied among years; we therefore distinguish systematically collected counts from opportunistic observations. During the 2025 emergence, the structure and surrounding area were checked each morning, midday, and evening for at least 30 min, and emerging nests and hatchlings were mapped and tallied; predators were documented with direct observation, telephoto photography (Nikon Z9 with an AF-S Nikkor 200–500 mm f/5.6E ED lens), and a Reconyx trail camera programmed to capture images at 5-min intervals and on motion detection. The same emergence-period protocol yielded the observations of root-caused egg and hatchling damage and of Broad-winged Hawk foraging reported below.

Nesting-season surveys, 2026.—During the 2026 nesting season, the nesting area and protection structure were surveyed daily from 25 May (Day 1) through 13 June (Day 20). Each day the area was checked in the morning, at midday, in the late afternoon, and again at 2000 h, and every turtle present at or within the nesting area was counted and identified to species. On most days turtles were present at a single check, so one daily count is reported; on Days 5, 9, and 11, distinct groups arrived at different times of day, with the nesting area standing empty between them, and are reported separately (on Day 11 at 0500, 1500, 1700, and 2000 h). Daily counts represent turtle sightings, not necessarily unique individuals, because females may stage at the site for several days before ovipositing.

Estimating individual abundance.—Because daily counts represent sightings rather than unique individuals, we used three approaches to bound the number of individual Wood Turtles present during the 2026 season: (1) the largest number recorded in any single count, a firm minimum; (2) the sum of the peak counts of the principal, temporally separated activity pulses; and (3) the total Wood Turtle sightings divided by the mean staging interval of 3.3 d reported for female G. insculpta in Québec (Walde et al. 2007). Because that staging interval derives from a different population and across-day recurrence at this site is unquantified, all estimates are approximate, pending mark–recapture confirmation.

RESULTS

Persistence and composition of the aggregation.—Five turtle species have nested at or immediately adjacent to the protected site: G. insculpta (Wood Turtle), *Chelydra serpentina* (Snapping Turtle), *Chrysemys picta* (Painted Turtle), *Apalone spinifera* (Spiny Softshell), and *Emydoidea blandingii* (Blanding's Turtle). Wood and Snapping turtles have been observed using the bank for at least 50 years; Spiny Softshells have nested on the adjacent gravel drive for many years; and beginning in 2022, Spiny Softshells were also observed to nest within the wooden structure.

Annual nesting effort and protection outcomes.—From 2014 through 2025, annual Wood Turtle nest counts ranged from 12 (2014) to 34 (2021), with a mean of ca. 25 nests/yr. Protection markedly reduced predation. In 2014, none of 6 protected nests were depredated, whereas 4 of 6 unprotected nests were lost; 11 hatchlings were confirmed. A solar-powered electric fence was installed in 2015; that year, of 21 nests, 15 were protected (3 depredated by American Badger, *Taxidea taxus*, which tunneled beneath the fence) and all 6 unprotected nests were depredated, and 12 nests produced 93 hatchlings. The wooden turtle-only structure adopted in 2018 reduced mammalian access further. In 2022, 51 nests across all five species produced 563 hatchlings against 78 failed eggs (ca. 88% success), including ≥30 Wood Turtle nests, ≥4 Snapping Turtle nests (172 hatchlings), ≥4 Spiny Softshell nests (90 hatchlings), ≥2 Blanding's nests (18 hatchlings), and ≥1 Painted Turtle nest (8 hatchlings). In 2023 a skunk depredated all nests outside the structure before it was trapped; in 2024 a skunk was trapped before any depredation occurred. At the Spring Creek structure, nest success was consistently high (e.g., 10 of 10 Wood Turtle eggs in a 2023 box nest; near-complete hatching across box nests in 2022 and 2024). Summaries of nest protection methods and outcomes by year are given in Table 1. Juvenile Wood Turtle sightings along the creek near the protection structure have increased over the eleven years of protection (2015–2026), from none in several early years to several in 2026; these are incidental observations rather than results of systematic juvenile surveys.

First records of predation and mortality

Nest predation by American Badger.—Cochrane et al. (2015) reported the first documented predation of G. insculpta nests by American Badger (*Taxidea taxus*), in Minnesota; we document the first such record for Wisconsin. In 2015 and 2016, during the solar-electric-fence era, badgers repeatedly entered the enclosed nesting area by tunneling beneath the electrified fencing—captured on camera-trap by day and at night—to reach the 20–30 G. insculpta and several C. serpentina nests concentrated within; raccoons (*Procyon lotor*) followed the badgers in through the same breaches. In 2015, 3 of 15 protected nests were lost to badger predation despite the fence (Table 1). The record established both a new state predator for the species and a specific failure mode of electric fencing against a fossorial predator (Vraniak et al. 2017; Fig. 1A).

Embryo survival after nest flooding.—Published field observations of hatching success in naturally flooded turtle nests are uncommon. In July 2016 a mid-summer flood submerged nests on the Namekagon tributary under up to ca. 61 cm of water—the A. spinifera and C. serpentina nests for six days (11–17 July) and the G. insculpta nest for five days (12–16 July). Outcomes differed sharply with species and embryo age. A 9-d-old A. spinifera nest ultimately produced live hatchlings from all 13 eggs, contrasting with the experimentally low survival of similarly aged A. mutica eggs inundated for more than four days (Plummer 1976). Six C. serpentina nests (22–38 d old) produced no emergent hatchlings, whereas the 33-d-old G. insculpta nest produced five hatched eggs. The partial survival of the G. insculpta nest is notable because even brief water coverage is generally considered lethal to older embryos, owing to their greater oxygen demand (Lynn and von Brand 1945). This was the first field documentation of post-flood hatching success at the site (Vraniak and Geller 2017; Fig. 1B).

Egg predation by Prairie Deer Mouse.—During the peak of the 2025 emergence (see Hatchling emergence and the predator assemblage, below), a trail camera captured four images of Prairie Deer Mouse (*Peromyscus maniculatus bairdii*) carrying unhatched, apparently intact G. insculpta eggs—removed both from nests exposed by exiting hatchlings and from nests outside the structure (Fig. 1C). *Peromyscus* predation is well established on the nests and eggs of birds (e.g., *Actitis macularia*, Maxson and Oring 1978; *Protonotaria citrea*, Guillory 1987), and small-mammal predation, including by *Peromyscus*, is a documented cause of nest loss in the congeneric Bog Turtle (*Glyptemys muhlenbergii*; reviewed in Knoerr et al. 2021), but to our knowledge this is the first documentation of *Peromyscus* predation on G. insculpta eggs (Vraniak et al., in press). Because mice carry off intact eggs rather than consuming them in place, this loss is nearly undetectable except by camera and is not prevented by exclusion methods designed for larger mammals, suggesting it may be more common than generally recognized.

Egg damage and hatchling entanglement caused by plant roots.—The roots of vegetation colonizing the nesting substrate within the protection structure can bind and damage eggs and entangle emerging hatchlings. Hatchlings had first been observed becoming caught on roots during the 2024 emergence. On 3 August 2025, while clearing rooted vegetation—*Polanisia dodecandra* (Redwhisker Clammyweed), *Berteroa incana* (Hoary Alyssum), and *Erigeron canadensis* (Horseweed)—from within the structure ahead of emergence, we found several damaged G. insculpta eggs bound within dense fibrous root masses (Fig. 1D). On 12 August 2025, two hatchlings were found entangled in roots inside the structure; one exhibited a deformed carapace resulting from prolonged, unsuccessful straining to free itself, and both were released manually (Fig. 1E). Root intrusion into nests, with associated reductions in hatching and emergence success, has been reported for marine turtles—Loggerhead (*Caretta caretta*; Redding et al. 2024) and Leatherback (*Dermochelys coriacea*; Conrad et al. 2011)—but, to our knowledge, this is the first report of egg damage and hatchling entanglement and carapace deformation caused by plant roots in G. insculpta (Vraniak and Vraniak, in prep.). The finding carries a management implication specific to protected sites: the enclosure that excludes large predators also shelters dense vegetation whose root growth becomes an independent source of egg and hatchling mortality, so periodic removal of rooted vegetation before emergence is warranted.

Predation on emerging hatchlings by Broad-winged Hawk.—Of the ≥17 vertebrate predator taxa (>40 individuals) recorded at the structure during the two-week emergence peak (see below; Table 3), the Broad-winged Hawk (*Buteo platypterus*) was the most frequently present, recorded on 9 of 14 days, including two individuals on two days. It perched on a tall Red Pine (*Pinus resinosa*) or an adjacent Bur Oak (*Quercus macrocarpa*) directly across from the structure and circled it (Fig. 1F, G), and was twice observed descending to seize emerging G. insculpta hatchlings and once to capture a P. maniculatus bairdii that was itself seeking eggs at the structure. This directed, day-after-day foraging occurred at no other time of year, indicating that the predictable, concentrated emergence functioned as a localized seasonal food source. Avian predation on emerging turtle hatchlings is known in other species—Snapping Turtle (*Chelydra serpentina*; Palmer 1988) and Hawksbill (*Eretmochelys imbricata*), the latter also taken by a Broad-winged Hawk (Wilmers and Markey 2006)—but we are aware of no prior record of B. platypterus predation on G. insculpta (Vraniak and Vraniak, in prep.).

Hatchling emergence and the predator assemblage, 2025.—In 2025, nesting began on 7 June and the first hatchlings emerged on 4 August; emergence continued through 11 September. Hatchlings were observed emerging from 50 nests (≥21 Wood, ≥13 Snapping, ≥4 Spiny Softshell, ≥3 Painted, ≥1 Blanding's). We directly observed 216 emerging hatchlings (≥58 Wood, 143 Snapping, 11 Spiny Softshell, 4 Painted); because monitoring was intermittent within each day, the number that actually emerged was potentially substantially greater, an estimated 500–700 across all species. During the two-week peak (18 August–3 September 2025) we observed and photographically documented (telephoto and trail cameras) >40 individuals representing at least 17 potential vertebrate nest- and hatchling-predator taxa at and around the structure (Table 3), spanning wading and aerial birds, carnivores, and rodents (including the egg-carrying *Peromyscus* and the emergent-hatchling-taking *Buteo platypterus* described above), as well as invertebrates (e.g., ants). Two thirteen-lined ground squirrels were removed after depredating nests. The Broad-winged Hawk was the single most frequently recorded taxon (Table 3).

Nesting phenology and rainfall, 2026.—Over the 20-d 2026 survey we recorded 171 turtle sightings: 143 G. insculpta, 10 C. serpentina, 10 C. picta, 6 A. spinifera, and 2 E. blandingii (Fig. 2; Table 4). Two Wood Turtles (Days 16 and 17; 9–10 June) and one Blanding's (Day 17; 10 June) were juveniles. Wood Turtle activity came in discrete pulses, several associated with rain. On Days 5, 9, and 11 separate groups arrived at different checks, with the nesting area standing empty between them, so each count recorded a separate arrival. The largest single count of the season was 16 Wood Turtles on the evening of Day 9 (2 June); the largest single-day total was 36 on Day 11 (4 June), when repeated counts spanning a midday rain recorded 9 turtles at 0500, 9 at 1500, 12 at 1700, and 6 at 2000 h. A secondary rise followed on Day 14 (7 June) during morning rain; activity then declined through Days 16–20 despite further heavy rain. Air temperatures during these rain events were 24.4°C (4 June), 25.6°C (7 June), 26.1°C (9 June), and 17.2°C (11 June). Four of the 20 survey days (Days 11, 14, 16, 18) had measurable rainfall; these carried 44 of 143 Wood Turtle sightings, a higher per-day rate (11.0/day) than the 16 dry days (6.2/day), and the largest single-day total coincided with rain. Turtles were nonetheless present on nearly all survey days and, in aggregate, more sightings occurred on dry days than rain days, so this clustering—though consistent with the rainfall associations reported by Walde et al. (2007) and Geller et al. (2022)—is best regarded as suggestive pending a formal test on nest counts.

Estimating individual abundance.—The largest single count (16; Day 9 evening) is a firm minimum; the summed peak counts of the four principal pulses (Days 4, 9, 11, and 14) give a coarse ca. 40; and the 143 sightings divided by the mean 3.3-d staging time (Walde et al. 2007) give ca. 43. These approaches point to roughly 40 nesting females, of the same order as the 2014–2015 telemetry work at this site, in which 44 Wood Turtles were observed and 15 tagged (Lapin et al. 2016). These counts can be placed in the context of baseline abundances and population demographics recently reported for Wood Turtle monitoring sites across Wisconsin (Badje et al. 2024). Because the nesting area emptied between successive groups, the total number of individuals using the site over the season may have exceeded 40; all estimates are approximate pending mark–recapture.

DISCUSSION

These observations document a persistent, multigenerational communal nesting aggregation of G. insculpta, shared with four other turtle species, at a single restored and protected site over a half-century of stewardship—and they establish the site as an unusually productive source of first natural-history records for the species. Five such records emerged here: nest predation by American Badger, embryo survival after nest flooding, egg predation by Prairie Deer Mouse, egg damage and hatchling entanglement by plant roots, and predation on emerging hatchlings by Broad-winged Hawk. Rather than isolated curiosities, they cohere because they share one place, one long-term dataset, and one management intervention.

The connecting mechanism is the site's transformation, under sustained protection, into a large and highly predictable annual emergence. When 500 or more hatchlings reliably surface at the same location on nearly the same dates each year, that predictability becomes an ecological resource—a concentrated late-summer food pulse—and several of the findings can be read as the biological community's response to it. Three of the five are new predator records that occupy different layers of the same nest-to-surface gauntlet: the American Badger attacks from below, the Prairie Deer Mouse works cryptically at the surface and removes intact eggs, and the Broad-winged Hawk takes hatchlings, and even the egg-seeking mice, from above. The badger and hawk records in particular reflect predators keying on a resource made abundant and predictable by protection, exactly the exposure long recognized as inherent to communal nesting grounds (Walde et al. 2007; Bougie et al. 2020). The remaining two records concern physical rather than predatory processes: root obstruction is partly a byproduct of the enclosure that keeps out larger predators, and post-flood embryo survival is a reminder that the site's riverine setting imposes stresses the structure cannot address. Read together, the five underscore both the conservation potential and the mortality exposure of protected communal sites, and the need for active, adaptive protection.

Two additional patterns from the systematic counts are notable. First, female arrival and nesting tended to cluster around rainfall and cool, humid evenings, consistent with the rainfall associations described by Walde et al. (2007) in Québec; at this site, however, the association was suggestive rather than statistically firm and rested heavily on a single large activity pulse, so rain-timed survey scheduling, while promising, warrants confirmation across more seasons. Because rainfall and temperature may act together to cue nesting (Geller et al. 2022), the mild, humid conditions accompanying these events (17.2–26.1°C)—not precipitation alone—were likely an important trigger. Second, three independent estimates (a minimum of 16, a pulse sum of ca. 40, and a staging-corrected count of ca. 43) pointed to roughly 40 nesting females, broadly consistent with the 44 Wood Turtles observed in the 2014–2015 telemetry work; because the turtles arrived in discrete, rain-associated pulses rather than staging for days as in Québec, the number using the site over the season likely exceeded the ca. 40 that nested. These counts tentatively suggest that brief, rain-timed surveys may offer a low-impact index of communal-site use.

Sustained nest protection substantially reduced predation, but the effectiveness and trade-offs of the three methods differed (Table 2). Solar electric fencing admitted all turtle species but required ongoing maintenance and was repeatedly breached by badgers that dug beneath it, drawing in raccoons. The screened wooden structure excluded larger mammalian and aerial predators and required less maintenance; its 3.25-cm gap can nonetheless admit small predators until narrowed to ca. 1 cm after nesting, and it excludes larger-bodied nesters such as Snapping and Blanding's turtles, which continued to nest and be depredated outside it. Individual cages are inexpensive and species-neutral but labor-intensive at scale. No single method is optimal for a multispecies aggregation; in practice the site has relied on a combination, supplemented by targeted removal of problem predators and, as the root-obstruction record shows, by periodic clearing of rooted vegetation from within the structures before emergence.

A phased, multidimensional protection framework.—Viewed across the half-century record, protection at this site is best understood not as a single structure but as a phased system that addresses each spatial dimension of the nesting ground—substrate, underground, above-ground, and aerial—and each successive stage of reproduction, from habitat restoration through nest-laying, egg incubation, hatchling emergence, and juvenile recruitment (Table 5). The five first records reported here map directly onto this framework, each exposing the dimension at which a site remains vulnerable.

At the foundation is habitat restoration. Beginning in 1975, reestablishing native prairie and savanna vegetation—now over 200 species—and maintaining open, well-drained conditions recreated and sustained the nesting habitat itself, while the surrounding restored riparian mosaic along Hay and Spring creeks provides the cover and foraging habitat on which dispersing juveniles depend. The deliberate addition of clean, medium-grained sand to the nesting bank in 1994–1995 was a substrate-level intervention that enlarged and improved the area available to nesting females.

Protection then proceeds by dimension. At the substrate surface, the enclosed, leveled, turtle-accessible nesting area concentrates and safeguards egg-laying, and—as the root-obstruction record makes clear—the substrate must be actively managed, with rooted vegetation cleared before emergence so that root masses do not bind eggs or entangle hatchlings; nest flooding, by contrast, is a substrate-level hydrologic stress the structures do not mitigate. Underground, the principal threat is the fossorial predator: the badger record showed that an above-ground electric fence is defeated from below, prompting the shift to a wooden structure whose single ground-level gap is narrowed to ca. 1 cm and slatted after laying to exclude burrowing and small predators while still admitting females and releasing hatchlings. Above ground, the structure walls and targeted live-trapping exclude and remove the mid-sized mammalian predators—raccoon, skunk, mink, fisher, bobcat—that dominate the surface tier. In the aerial dimension, the screened, hinged top excludes the avian predators that the emergence pulse attracts; the Broad-winged Hawk record, in which a raptor foraged day after day and took emerging hatchlings, demonstrates precisely the exposure this feature is designed to close, and underscores that hatchling protection at emergence is as critical as egg protection during incubation.

These dimensions correspond to reproductive stages. Nest-laying protection is achieved by turtle-only access to a safeguarded substrate; egg protection by exclusion of diggers and burrowers, small-predator exclusion after laying, and clearing of intrusive roots; hatchling protection by the screened top against aerial predators, the retained hatchling-exit gap, the manual release of root-entangled individuals, and the redirection of misoriented hatchlings to water; and juvenile recruitment facilitation by the restored creek-side habitat that receives them—consistent with the increase in juvenile Wood Turtle sightings near the structures over the eleven years of protection. No single feature suffices: the value of the site lies in the integration of restoration and protection across all four dimensions and every reproductive stage, sustained by daily presence (Table 5).

A distinctive feature of this site is that the protection and monitoring described here originated with, and have been sustained by, a resident family rather than an institution. The family's habitat restoration and its deliberate enhancement of the nesting bank (1975–1995) preceded and ultimately prompted agency involvement: it was the landowner who alerted the Wisconsin DNR to the aggregation, leading to its inclusion in the four-state telemetry study in 2014. The continuity of the record reported here rests on a form of citizen science—collecting nesting and emergence data, caging and mapping individual nests, removing problem predators, and redirecting misoriented hatchlings to water. Such intimate, place-based stewardship yields long-term, fine-grained data that episodic agency monitoring rarely captures, and it was precisely this daily, camera-supported presence that made the site's most cryptic findings—the egg-carrying mice, the root-bound clutches, the hawk's day-after-day foraging—documentable at all. We therefore suggest that durable partnerships between resident families or landowners and agency biologists can be a particularly effective model for conserving small, philopatric, site-faithful populations of long-lived species. The transferability of the approach is suggested by early replication: following a site visit, a resident couple installed a structure of the same design on their own restored family property in the Driftless Area of southwestern Wisconsin, where 19 Wood Turtle nests were recorded within and beside it in its first season (2026).

We caution that the model is not the structure alone but the sustained, on-site stewardship around it: because G. insculpta is vulnerable to collection, designs can be shared while precise localities are not; and because a nesting structure concentrates eggs, it can subsidize predators or become an ecological trap unless paired with daily monitoring, predator management, vegetation control, and—where the handling of turtles or eggs is involved—the agency coordination and permitting that effective protection requires. This is an observational account from a single site, with monitoring methods that varied among years; annual nest counts, hatchling estimates, and predator tallies should be interpreted as minima or coarse estimates rather than exhaustive censuses. Nonetheless, the continuity of observation, the multispecies scope, the five first records, and the documented outcomes of successive protection regimes make the site an informative long-term case. Priorities for continued work include a definitive eggshell-based clutch and emergence count, a direct estimate of hatchling survival, and ongoing standardized daily nesting surveys to track the aggregation and its response to weather and protection over time.

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TABLES AND FIGURES

TABLE 1. Chronology of nest protection and annual Wood Turtle (*Glyptemys insculpta*) nesting effort and outcomes at the study site, Washburn County, Wisconsin, 2014–2026. Dashes indicate years for which a standardized nest count was not compiled.

Year	Protection / event	Wood Turtle nests	Outcome
2014	Site enters 4-state telemetry study	12	6 protected: 0 predated; 6 unprotected: 4 predated; 11 hatchlings
2015	Solar-powered electric fence installed	21	15 protected (3 predated by badger); 6 unprotected predated; 12 nests → 93 hatchlings
2016	Electric fence; July flood	—	Badger/raccoon predation in fence; mixed flood survival (Vraniak & Geller 2017)
2018	Wooden turtle-only structure replaces fence	—	Reduced mammalian access
2020	Wooden structure ca. doubled in size	—	—
2021	Wooden structure	34	Highest annual nest count
2022	2nd structure built at Spring Creek	30	51 nests all species → 563 hatchlings (88% success)
2023	Wooden structures + cages	21	Skunk depredated outside nests before trapping
2024	Wooden structures + cages	24	Skunk trapped before any depredation occurred
2025	Wooden structures + cages	21	Emergence from 50 nests; ~216 observed (est. 500–700); >40 predators; deer-mouse, root, and hawk records
2026	Wooden structures + cages	37 (all species) + 3 dug up = 40	20-d counts: 171 sightings, 5 species (Fig. 2)

TABLE 2. Comparison of three nest-protection methods used at the study site. Costs are approximate material costs excluding site preparation and labor.

Attribute	Solar electric fence	Wooden nest box/structure	Individual nest cages
Species access	All turtle species	Excludes turtles too large for 3.25-cm gap (Snapping, Blanding's)	All species (cage per nest)
Predators excluded	Raccoons (skunks variable); badgers dig under	Mammalian + aerial (screened top)	Most diggers; aerial if screened
Maintenance	Higher (charge, weeds, checks)	Lower	Higher at scale (many cages)
Area protected	Large (multiple fenced areas)	Moderate	Nest-by-nest
Material cost	~$700	~$300	Low per unit
Continuous on-site surveillance	Not required	Not required	Required (per-nest effort)

TABLE 3. Potential nest and hatchling predators observed and photographically documented at the primary nest-protection structure during the two-week peak of hatchling emergence, 18 August–3 September 2025. Not all taxa were observed destroying turtle nests; counts are individuals directly observed and represent minima. Broad-winged Hawk was the most frequently recorded taxon. Full detail in Vraniak et al. (in press) and Vraniak and Vraniak (in prep.).

Predator taxon	Individuals
American Bittern (*Botaurus lentiginosus*)	1
Belted Kingfisher (*Megaceryle alcyon*)	1
Green Heron (*Butorides virescens*)	1
Great Blue Heron (*Ardea herodias*)	6
Broad-winged Hawk (*Buteo platypterus*)	9
Red-tailed Hawk (*Buteo jamaicensis*)	1
Cooper's Hawk (*Accipiter cooperii*)	1
Sandhill Crane (*Antigone canadensis*)	2
Turkey Vulture (*Cathartes aura*)	8
American Crow (*Corvus brachyrhynchos*)	1
Common Raven (*Corvus corax*)	2
American Mink (*Neogale vison*)	2
Raccoon (*Procyon lotor*)	3
Striped Skunk (*Mephitis mephitis*)	1
Fisher (*Pekania pennanti*)	1
Bobcat (*Lynx rufus*)	1
Thirteen-lined Ground Squirrel (*Ictidomys tridecemlineatus*)	2
Deer mice — egg removal, trail camera (*Peromyscus maniculatus bairdii*)	+
≥17 vertebrate taxa (plus invertebrates, e.g., ants)	>40

TABLE 4. Daily counts of turtles by species at the communal nesting site, 2026 nesting season (25 May–13 June; Days 1–20), with time of count and weather notes. On most days turtles were present at a single check (time not differentiated, —), whereas on Days 5, 9, and 11 separate groups arrived at different times, the area standing empty between them, and are listed individually. Counts are turtle sightings, not necessarily unique individuals; juv = juvenile. Species: Wood = *Glyptemys insculpta*, Painted = *Chrysemys picta*, Snapper = *Chelydra serpentina*, Softshell = *Apalone spinifera*, Blanding's = *Emydoidea blandingii*.

Day	Date	Time	Wood	Painted	Snapper	Softshell	Blanding's	Notes
1	25 May	—	4					
2	26 May	—	3	2				
3	27 May	—	3	1				
4	28 May	—	6		1			
5	29 May	a.m.	3				1	
5	29 May	p.m.	4					
6	30 May	—	10					
7	31 May	—	10	2	1	1		
8	1 Jun	—	11			1		
9	2 Jun	a.m.	2	1	1			
9	2 Jun	p.m.	16					
10	3 Jun	—	14					
11	4 Jun	0500	9					
11	4 Jun	1500	9					rain mid-day
11	4 Jun	1700	12					
11	4 Jun	2000	6		4	2		
12	5 Jun	—	4	2				
13	6 Jun	—	7		1			
14	7 Jun	—	6		2			a.m. heavy rain
15	8 Jun	—	1	1				
16	9 Jun	—	1 (juv)					a.m., p.m. heavy rain
17	10 Jun	—	1 (juv)				1 (juv)	
18	11 Jun	—	1					rain in p.m.
19	12 Jun	—				2		
20	13 Jun	—		1				
Total			143	10	10	6	2	n = 171

TABLE 5. Phased, multidimensional framework of habitat restoration and nest protection at the study site, organized by spatial dimension, the principal restoration or protection feature at each, the reproductive stage(s) it serves, and the threat or first-record finding it addresses. Finding numbers follow the sequence introduced in the text (1, American Badger; 2, nest flooding; 3, Prairie Deer Mouse; 4, root obstruction; 5, Broad-winged Hawk).

Dimension	Principal restoration / protection feature	Reproductive stage(s) served	Threat or finding addressed
Habitat / landscape	Prairie–savanna restoration since 1975 (>200 native plant species); restored Hay and Spring creek riparian mosaic	Habitat restoration; juvenile recruitment	Habitat loss; provision of juvenile cover and foraging (increasing juvenile sightings, 2015–2026)
Substrate (nesting surface)	Clean medium-grained sand added to nesting bank (1994–1995); leveled, turtle-accessible nesting area; pre-emergence clearing of rooted vegetation	Nest-laying; egg and hatchling protection	Limited nesting substrate; root obstruction of eggs and hatchlings (Finding 4); nest flooding as an unmitigated substrate-level stress (Finding 2)
Underground	Wooden structure with ground-level gap narrowed to ca. 1 cm and slatted after laying; buried hardware cloth and grounding	Egg protection	Fossorial predation—American Badger tunneling beneath fencing (Finding 1); small burrowing predators
Above-ground (surface)	Structure walls with turtle-only ca. 3.25-cm gap; live-trapping and removal of problem predators	Nest-laying; egg protection	Mid-sized mammalian predators (raccoon, skunk, mink, fisher, bobcat); deer-mouse egg removal (Finding 3)
Aerial	Screened, hinged top over the structure	Hatchling protection	Avian predation on emerging hatchlings—Broad-winged Hawk (Finding 5); herons, vultures, corvids

A American Badger, 2016 (Study 1)

B Nest flooding, 12 Jul 2016 (Study 2)

C Prairie Deer Mouse (Study 3)

D Egg among excavated roots (Study 4)

E Hatchling entangled in roots (Study 4)

F Broad-winged Hawk in flight with mouse (Study 4)

G Broad-winged Hawk perched (Study 4)

FIG. 1. Five first natural-history records for *Glyptemys insculpta* documented at the study site, Washburn County, Wisconsin, drawn from four Notes. (A) American Badger (*Taxidea taxus*) within the solar-electric-fenced nesting area, 5 August 2016; badgers tunneled beneath the fence to reach concentrated nests (Study 1; Vraniak et al. 2017). (B) The 12 July 2016 flood inundating the nesting area and creek; several nests were submerged for 5–6 days, and embryo survival after this flooding was documented for three turtle species (Study 2; Vraniak and Geller 2017). (C) Prairie Deer Mouse (*Peromyscus maniculatus bairdii*) at the nest-protection structure; trail-camera images recorded mice carrying off intact wood turtle eggs (Study

3; Vraniak et al., in press). (D) A mass of grass roots excavated from the nesting substrate within the structure, with an unhatched wood turtle egg exposed; fibrous root growth of this kind bound and damaged eggs. (E) A wood turtle hatchling among fibrous roots during emergence; prolonged root entanglement deformed the carapace of one hatchling (Study 4; Vraniak and Vraniak, in prep.). (F) Broad-winged Hawk (*Buteo platypterus*) in flight over the nesting site carrying a Prairie Deer Mouse (*Peromyscus maniculatus bairdii*) taken at the structure, and (G) a Broad-winged Hawk perched on an adjacent snag; this species was the most frequent predator during emergence and was twice observed taking emerging hatchlings (Study 4; Vraniak and Vraniak, in prep.).

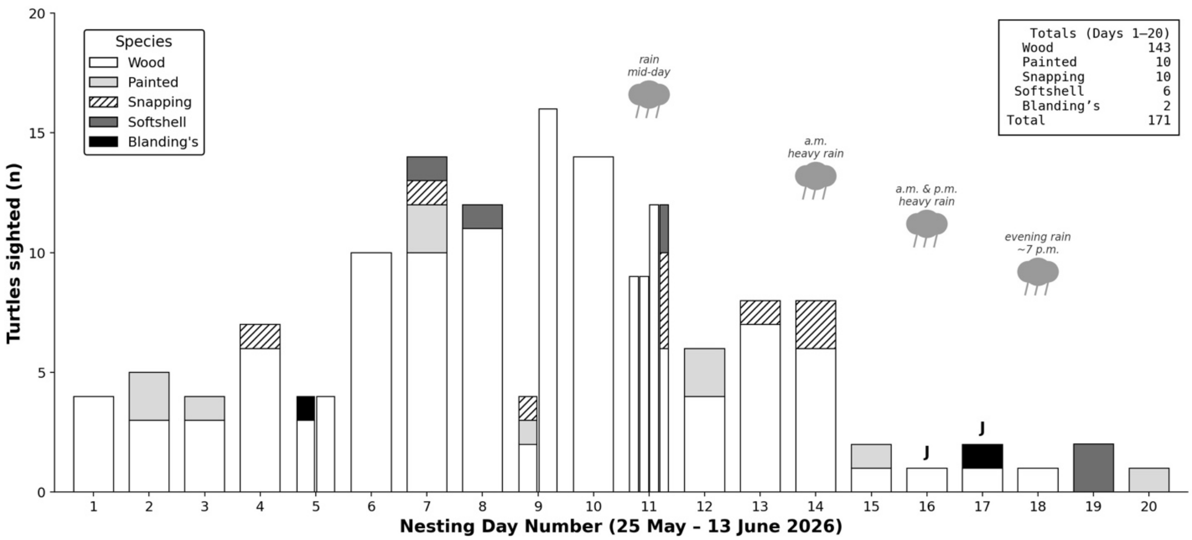

FIG. 2. Number of turtles by species sighted at a communal nesting site, Washburn County, Wisconsin, USA, 25 May–13 June 2026 (Days 1–20). The area was checked each day in the morning, at midday, in the late afternoon, and at 2000 h. On most days a single daily count is shown; on Days 5, 9, and 11—when separate groups arrived at different times—the counts are shown as narrower adjacent bars. Cloud symbols mark days with rainfall (Days 11, 14, 16, and 18); J denotes a juvenile (Day 16, one Wood Turtle; Day 17, one Wood Turtle and one Blanding's Turtle).

FIG. 3. Aerial view of the communal turtle nesting site on a restored prairie–savanna along a tributary (Hay Creek) of the Namekagon River, Washburn County, Wisconsin, USA (exact coordinates withheld on account of *Glyptemys insculpta* conservation status). The primary wooden nest-protection structure (ca. 4.5 × 19 m), with a small ground-level opening, sits on the east bank of the creek; the turn-around and a pond complex used by nesting Painted and Snapping Turtles are visible nearby. A second wooden structure (built 2022) lies ca. 0.4 km west on Spring Creek (not shown). The Namekagon River runs roughly parallel beyond the wooded tree line, ca. 274 m from the nest structure, and is not visible.