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A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group

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Anders G.J. Rhodin, John B. Iverson, Peter Paul van Dijk,
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Graptemys pseudogeographica (Gray 1831) –
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Graptemys pseudogeographica (Gray 1831) – False Map Turtle, Mississippi Map Turtle

Peter V. Lindeman[1] **and Richard C. Vogt**[2,3]

[1]*Department of Biology, Earth, and Environmental Sciences,*
Pennsylvania Western University at Edinboro,
Edinboro, Pennsylvania 16444 USA [plindeman@pennwest.edu];
[2]*Instituto Nacional de Pesquisas da Amazônia (INPA),*
Coordenação de Pesquisa em Biologia Aquática, Manaus, Amazonas, Brazil;
[3]*Deceased*

Summary. – The False Map Turtle, *Graptemys pseudogeographica* (family Emydidae), is a medium-sized, strongly sexually dimorphic freshwater turtle species (males to 14.1 cm midline SCL and 12.1 cm midline PL, to 364 g; females to 26.3 cm midline SCL and 23.9 cm midline PL, to 2952 g). It is common to abundant in large rivers and oxbow lakes within the Mississippi River drainage of the central United States and other western Gulf Coast rivers. Two subspecies are recognized: *G. p. pseudogeographica* and *G. p. kohnii*. The ecology of this species has been relatively well studied. Males mature in their third or fourth year and females later, in their eighth to eleventh year. Typically, three (but up to four) clutches are laid in one year, with clutch sizes averaging 6.6–14.1 eggs in a population but as high as 22 eggs. Hatchlings emerge in the late summer and early fall. Males feed primarily on aquatic insects, bivalve mollusks, and algae, while females feed primarily on bivalve mollusks, snails, aquatic insects, fish carrion, and algae. Populations are fairly robust and the species does not appear to need any specific conservation measures at the present time, although nesting sites along riverine sandbanks are increasingly threatened and populations should be monitored for potential declines.

Distribution. – USA. Occurs in the larger rivers of the Mississippi River Basin, from the St. Croix and Wisconsin Rivers in northern Wisconsin and the Mississippi and Minnesota rivers in Minnesota southward to Louisiana and westward into Missouri, Kansas, and Oklahoma, in the Missouri River northward into North Dakota, and in the Ohio River eastward into the lower Tennessee and lower Cumberland rivers in western Tennessee and Kentucky and the Wabash River in Indiana. Also occurs in isolated river drainages west of the lower Mississippi along the western Gulf Coast: the Mermentau, Calcasieu, Sabine, Neches, Trinity, Brazos, and San Bernard drainages in Louisiana and Texas.

Synonymy. – *Emys pseudogeographica* Gray 1831*, Clemmys pseudogeographica, Graptemys pseudogeographica, Malacoclemmys pseudogeographicus, Malacoclemmys pseudogeographica, Malaclemys pseudogeographica, Graptemys pseudogeographica pseudogeographica, Malaclemys pseudogeographica pseudogeographica, Malacoclemmys kohnii* Baur 1890*, Graptemys kohnii, Graptemys pseudogeographica kohnii, Malaclemys kohni*.

Subspecies. – Two subspecies are currently recognized: *Graptemys pseudogeographica pseudogeographica*, False Map Turtle or Northern False Map Turtle, and *Graptemys pseudogeographica kohnii*, Mississippi Map Turtle.

Status. – IUCN 2023 Red List: Least Concern (LC), assessed 2011; CITES: Appendix II as *Graptemys* sp. (2023).

Taxonomy. — Since its original description as *Emys pseudogeographica* by Gray (1831) from specimens obtained from the Wabash River at New Harmony in Posey County, Indiana, the False Map Turtle has been allocated to five different genera: *Emys*, *Graptemys*, *Clemmys*, *Malacoclemmys.* and *Malaclemys*; however, the majority of the published literature is under the name *Graptemys pseudogeographica*. Between 1830 and 1911, it was variously misidentified as *Emys lesueurii* (Gray 1830) (actually synonymous with *Graptemys geographica*), *Graptemys lesueurii* (Agassiz 1857), *Malacoclemmys lesueuri* (Yarrow 1882), and *Malaclemys lesueuri* (Hurter 1911), while at the same time being referred to as *pseudogeographica* by other authors. The most recent authors to assign the species to the genus *Malaclemys* were McDowell (1964) and Cochran and Goin (1970); Wood (1977) also discussed possible relegation to *Malaclemys*, under a hypothesis of independent origins of *Graptemys* clades from *M. terrapin*.

Figure 1. Adult male *Graptemys pseudogeographica pseudogeographica*, Indiana. Photo by James H. Harding.

Due to its wide range of variable head markings within and between populations and the complexities of variation in polymorphic and sibling species, the False Map Turtle complex has long been a taxonomic quagmire—at various times thought to include the taxa *pseudogeographica*, *kohnii*, *ouachitensis*, *sabinensis*, *versa*, and *caglei*. Only through the study of large samples of ontogenetic series throughout the range of these species did the present taxonomic status become stabilized (Vogt 1978, 1993).

Figure 2. Juvenile *Graptemys pseudogeographica pseudogeographica*, Iowa. Photo by John B. Iverson.

Part of the confusion was due to Baur (1890) stating that the diagnostic feature of the taxon *kohnii* was a complete narrow crescent posterior to each orbit. Series of specimens have shown that a complete crescent is not always present and that crescents, albeit as much wider markings, can appear in *G. ouachitensis* as well (Vogt 1993; Lindeman 2003, 2013; Tumlinson and Surf 2015). These color patterns may be controlled both by incubation temperature and heredity (Vogt 1978, 1993; Ewert 1979).

Two subspecies are currently recognized: *G. p. pseudogeographica* and *G. p. kohnii*. Baur (1890) described the latter as a distinct species, *Malacoclemmys kohnii*, based on two syntype specimens from Louisiana. Baur had not collected the turtles and was unsure of their collecting locality; a third specimen referenced was said to be from

Figure 3. Adult male *Graptemys pseudogeographica pseudogeographica*, Indiana. Photo by James H. Harding.

Figure 4. Adult female *Graptemys pseudogeographica kohnii*, Neches River, Angelina and Houston Counties, Texas; midline PL 195 mm. Photo by Peter V. Lindeman.

Figure 5. Adult female *Graptemys pseudogeographica kohnii*, Strawberry River, Lawrence County, Arkansas. Photo by Stanley E. Trauth.

Florida. Lindeman (2013) designated a taxidermic mount of one of Baur's two syntype specimens (TU 16409, from Bayou Teche in St. Martin Parish, Louisiana) as the lectotype and included a photograph of the specimen; the other syntype (from Bayou Lafourche) could not be located.

Stejneger and Barbour (1917, 1923, 1933, 1939, 1943) synonymized *kohnii* as a subspecies of *G. pseudogeographica*. Ditmars (1936), Carr (1949, 1952), and Schmidt (1953) also followed this taxonomy. On the other hand, Cagle (1952, 1953a,b) thought that *kohnii* might or might not be conspecific with *pseudogeographica*, but ultimately opted to recognize it as a distinct species (Cagle 1954; Blair et al. 1957). It

Figure 6. Juvenile *Graptemys pseudogeographica kohnii*, Lake Hamilton, Garland County, Arkansas. Photo by John B. Iverson.

was also listed as a distinct species, *Graptemys kohnii*, by Conant (1956) and given its own range map separate from that of *Graptemys pseudogeographica* in the first three editions of his popular Peterson Field Guide (Conant 1958, 1975; Conant and Collins 1991). Also separating the two taxa in reference works were Wermuth and Mertens (1961) and Ernst and Barbour (1972, 1989). Vogt (1978, 1993) used multivariate analysis of head patterns, skull characteristics, courtship behavior, and allozymes to support *kohnii* as conspecific with *pseudogeographica*. Ernst et al. (1994, 2009), Lindeman (2013), and the 4th edition of the Peterson Field Guide (Powell et al.

Figure 7. Adult female *Graptemys pseudogeographica kohnii*, Bayou Serpent, Calcasieu Parish, Louisiana, midline PL 178 mm. Almost all specimens in the Calcasieu River drainage show similar dark brown irises rather than the usual yellow or white color (Lindeman et al. 2015). Photo by Peter V. Lindeman.

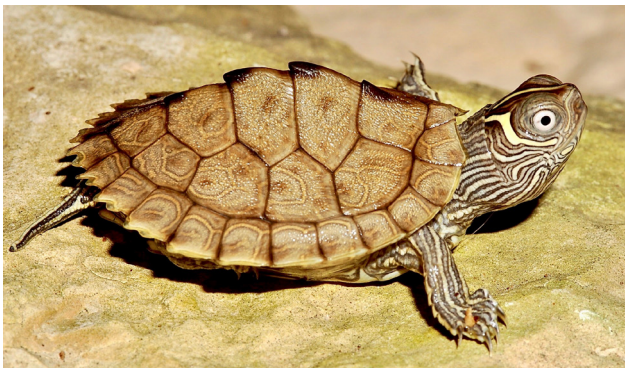

Figure 8. Post-hatching juvenile *Graptemys pseudogeographica kohnii*. No data. Photo by James H. Harding.

2016) have since followed Vogt's taxonomy in listing *pseudogeographica* and *kohnii* as conspecific subspecies.

Conant (1956, 1958, 1975) and Conant and Collins (1991) followed Cagle (1953a) in listing the Ouachita Map Turtle (*Graptemys ouachitensis*) as a subspecies of *G. pseudogeographica*, but Vogt (1978, 1993) separated the taxon as a distinct species. Three additional taxa have been listed as subspecies of *G. pseudogeographica* in the past: *versa*, *oculifera*, and *sabinensis* (Stejneger and Barbour 1917, 1923, 1933, 1939, 1943; Stejneger 1925; Pope 1939; Conant 1956; Wermuth and Mertens 1961), but all three are now considered distinct and separate species, the first two for several decades (see Lindeman 2013).

Molecular genetic evidence largely, albeit imperfectly, supports recognition of *pseudogeographica* and *kohnii* as conspecific subspecies, separate from the other taxa. Lamb et al. (1994) examined mitochondrial DNA in two sequences and at restriction sites and found no variation among the two *pseudogeographica* subspecies and presumptive intergrade specimens, but they were able to distinguish *pseudogeographica* from *ouachitensis* and *sabinensis*. Stephens and Wiens (2003) combined morphological data with the same two mitochondrial gene sequences and obtained similar results. Wiens et al. (2010) examined two mitochondrial and six nuclear gene sequences and showed separation of *kohnii* from *ouachitensis*. Praschag et al. (2017) examined over 3 kbp of mitochondrial DNA and nearly 8 kbp of 12 nuclear DNA loci. They could not distinguish *pseudogeographica* from *kohnii* and found them to be only weakly divergent from *ouachitensis* and *sabinensis*. Thomson et al. (2018) analyzed sequence data from two mitochondrial genes and 18 nuclear genes (over 13 kbp). They recovered *pseudogeographica* and *kohnii* individuals in two separate, weakly differentiated clades, one of which also included *ouachitensis* and *sabinensis* individuals.

Recently, Kiesow and Warcken (2017) identified 10 microsatellite loci for *G. p. pseudgeographica*. These are the first such loci available for any species of *Graptemys*.

Description. — *Graptemys pseudogeographica* is a medium-sized freshwater turtle. Midline straight-line carapace length (SCL) ranges up to 26.3 cm in females (field specimen, Sabine River, Louisiana/Texas border; Lindeman, unpubl. data) and to 14.1 cm in males (field specimen, Tennessee River, Kentucky; Lindeman, unpubl. data). Midline plastron length (PL) ranges up go 23.9 cm in females (CM 95209, Mississippi River in Wisconsin; Lindeman 2008) and to 12.1 cm in males (three specimens: CM 95203, Mississippi River in Wisconsin; field specimen, Tennessee River in Kentucky; and CM 95408, Mississippi River in Tennessee; Lindeman 2008 and unpubl. data). Body mass ranges up to 364 g in males (field specimen, Mississippi River in Wisconsin, Vogt 1980) and 2952 g in females (field specimen, northern Louisiana, Carr 2001). Body sizes as measured by maximum SCL and maximum PL are summarized for Wisconsin (Vogt 1980) and South Dakota (Timken 1968b) populations.

Sexual size dimorphism is pronounced, with adult females having longer shells than adult males by 91%

Figure 9. Adult female *Graptemys pseudogeographica kohnii*, Village Creek, Hardin County, Texas; midline PL 205 mm. Photo by Peter V. Lindeman.

Figure 10. Adult female *Graptemys pseudogeographica kohnii*, Sabine River, Beauregard Parish, Louisiana. Photo by Peter V. Lindeman.

Figure 11. Group of six basking *Graptemys pseudogeographica pseudogeographica*, Missouri River, Hughes County, South Dakota. Photo by Peter V. Lindeman.

on average in western Kentucky (Lindeman 2008), 81% in South Dakota (Timken 1968b), 74% in Louisiana (Carr 2001), and 69% in Wisconsin (Vogt 1980). Adult females were 502% larger than adult males in body mass in Louisiana (Carr 2001) and 488% larger than males in body mass in Wisconsin (Vogt 1980).

The elevated carapace has pointed black knobs on the second, third, and fourth vertebral scutes that are more pronounced in smaller specimens, i.e., juveniles and adult males, but reduced in adult females. The carapace is olive-green, usually with one dark blotch encircled on the posterior border of each scute, a pattern that fades with age. Each scute may have up to six encircled blotches, or none, with only an interconnected pale orange lattice. The hingeless plastron has dark, concentric swirls of alternating yellow and dark green. In hatchlings from Wisconsin, this pattern covers about 75% of the plastron, compared to less than 60% in *G. ouachitensis* (Vogt 1993). In adult females this pattern fades to a yellow-brown mottling.

Head markings vary from a complete yellow or pale orange crescent posterior to each orbit to a broken crescent—essentially a straight vertical postorbital bar that does not contact a supramandibular spot below and anterior to it—allowing as many as six stripes to contact the orbit. Over 90% of the individuals in southern populations in Louisiana, Texas, Arkansas, and Oklahoma had a complete narrow crescent behind and below each eye; these populations are considered to be the subspecies *G. p. kohnii* (Vogt 1978, 1993). In northern populations, complete crescents are represented in less than 1% of the individuals. In the Missouri River a mean of 6 lines reach the eye and in the Mississippi River in Wisconsin the mean is 3 lines; these northern populations are considered to be *G. p. pseudogeographica* (Vogt 1978, 1993). The lower jaw typically is marked with three small spots, one at the front of the chin and the other two below the angles of the jaws; in *G. p. pseudogeographica*, the chin spot and the two submandibular spots are similar in size and shape to the two supramandibular spots, with all five spots being markedly smaller than the eye. Merging of the three spots on the lower jaw to form a transverse chin bar is common but not universal throughout the Calcasieu River drainage in Louisiana (Lindeman et al. 2015).

The underside of the jaw is marked with longitudinal, alternating yellow stripes. The anterior stripes break up into a highly variable pattern. The skull of *G. pseudogeographica* is wider and flatter across the parietals than in *G. ouachitensis*. The skull and jaws become greatly widened in large females in southern populations, with head width being ca. 18% of midline plastron length, a value that is

Figure 12. Adult female *Graptemys pseudogeographica*, Embarras River, Lawrence County, Illinois, exhibiting likely intergradation between *G. p. pseudogeographica* and *G. p. kohnii*, as evidenced by the broken postorbital crescent. Photo by Peter V. Lindeman.

at the upper end of the range for mesocephalic species of the genus *Graptemys* (Vogt 1993; Lindeman 2000a).

Hatchlings are 25–33 mm in carapace length and 1.8–6.6 g at hatching (Vogt 1980). Adult males have elongated 2nd and 3rd foreclaws Their tails are longer than those of females, with the cloacal opening posterior to the rear edge of the carapace; females have the cloaca located even with the rear edge of the carapace (Vogt 1981b).

Eye coloration varies by subspecies and to some extent by river drainage. Whereas *G. p. pseudogeographica* typically has a yellow iris bisected by a thick black stripe, the iris is a striking titanium white color in most populations of *G. p. kohnii*, typically without a stripe, but sometimes with a stripe or dark dots anterior to and/or posterior to the pupil (Lindeman 2003; Tumlinson and Surf 2015). In the lower Sabine River of Texas and Louisiana, individuals often have a white iris suffused with light gray markings, while a dark brown iris almost as dark as the pupil is nearly universal throughout the Calcasieu River drainage of southwestern Louisiana (Lindeman et al. 2015). A yellow iris with a thick black stripe is the most common condition in the Neches River drainage of east Texas (Lindeman, unpubl. data).

The diploid number of chromosomes is 50, with 13 pairs of macrochromosomes and 12 pairs of microchromosomes (Killebrew 1977).

Distribution. — The distribution of *G. pseudogeographica* was reviewed by Lindeman (2013). Information on range extensions discovered since then have been published by Alleman et al. (2015a,b), Brinker (2018a, 2020a,b), Casper (2015), Colvin and Dennison (2015), Daniel et al. (2013, 2015, 2016, 2017, 2018, 2019, 2021, 2022), Davis (2018), Davis and Farkas (2018), Dawson (2019), Garig et al. (2019), Haralson and Pearson (2021), Hubbs (2015, 2016), Hoagland and Smith (2013), Ilgen et al. (2014), Johnson et al. (2021), Jordan (2014), Landry (2014), Lindeman (2016, 2017, 2018, 2019, 2021), Otten (2020), Pearson and Monday (2016), Portofee et al. (2017), Powell (2021), Powell et al. (2021), and Williams (2016).

Graptemys pseudogeographica is found throughout the Mississippi River Basin and its major tributaries, ranging upstream to Hennepin Co., Minnesota, and downstream to northern Plaquemines Parish, Louisiana, 126 river km from the mouth of the Mississippi River. Many tributaries of the upper Mississippi River are inhabited by the species, including the lower St. Croix in Wisconsin and Minnesota; the Chippewa, Cedar, Black, and Wisconsin rivers in Wisconsin; the Minnesota River in southwestern Minnesota; the Iowa and Cedar rivers in Iowa; and the Illinois, Fox, Big Muddy rivers, and Orchard Lake in Illinois. *Graptemys pseudogeographica* is a more western species within the Mississippi River drainage than *G. ouachitensis*, occurring allopatrically in the Missouri River into southcentral North Dakota, as well as two tributaries, the James and Vermillion rivers in South Dakota. Other tributaries of the lower Missouri are inhabited by the species as well: the Platte River and Salt and Logan creeks in Nebraska; the Kansas River and its tributaries, the Big Blue, Saline, and Solomon rivers, in Kansas; and the Osage River and its tributaries, the Marais des Cygnes and Marmaton rivers and Long Creek, in Kansas and Missouri.

In the eastern part of its range, *G. pseudogeographica* occurs in the Ohio River up to about its confluence with the Wabash River, and in two tributaries farther downstream, the Tennessee and Cumberland rivers. Four tributaries of the Wabash River are also inhabited: the Little Wabash and Embarras rivers in Illinois and the Tippecanoe and Mississinewa rivers in Indiana (sites in the latter two are not vouchered with specimens or photographs; Rizkalla and Swihart 2006).

In the southern part of its range, *G. p. kohnii* inhabits five eastern tributaries of the Mississippi River in Mississippi: the Yazoo River and its tributaries, the Big Sunflower, Coldwater, and Yalobusha rivers; the Big Black River and its tributaries, Doaks and Fourteenmile creeks; Bayou Pierre; the Homochitto River; and the Buffalo River. Inhabited western tributaries of the lower Mississippi are the St. Francis and White river drainages of Arkansas and Missouri and the Arkansas River. Inhabited northern tributaries of the Arkansas are the Neosho, Cottonwood, Spring, Verdigris, and Walnut river drainages and Grouse Creek in northeastern Oklahoma, southern Kansas, and southwestern Missouri, while inhabited southern tributaries of the Arkansas are the Canadian, Fourche La Fave, Petit Jean, and Poteau river drainages in western Arkansas and eastern Oklahoma.

Western tributaries of the Mississippi River farther downstream include the Black-Ouachita-Tensas river drainage and its tributaries Bartholomew and D'Arbonne bayous and the Boeuf, Little, Little Missouri, and Saline rivers in southern Arkansas and northern Louisiana. The species occurs in some parts of the Red River upstream into many of its tributaries in Texas, Oklahoma, and Louisiana: Medicine, East Cache, Bois D'Arc, and Coffee Mill creeks, and the Washita, Blue, Clear Boggy, Sulphur, and Little rivers. The Atchafalaya River branches westward from the lower Mississippi River, providing extensive habitat for *G. p. kohnii*, where it has been reported from Bayou Teche (type locality for *G. p. kohnii*), Bayou Courtableau, Little Alabama Bayou, Henderson Swamp, and Butte La Rose Canal. The lower Comite River of Louisiana and other streams of the Lake Pontchartrain basin just to the east of the lower Mississippi River are also included in its range in Louisiana.

In river drainages to the west of the Mississippi drainage, there are sparse specimen records of *G. p. kohnii* from the Mermentau River drainage and more abundant records from the Calcasieu drainage, both in southwestern Louisiana. In the Sabine River drainage that forms much of the Louisiana-Texas border, the species occurs upstream into

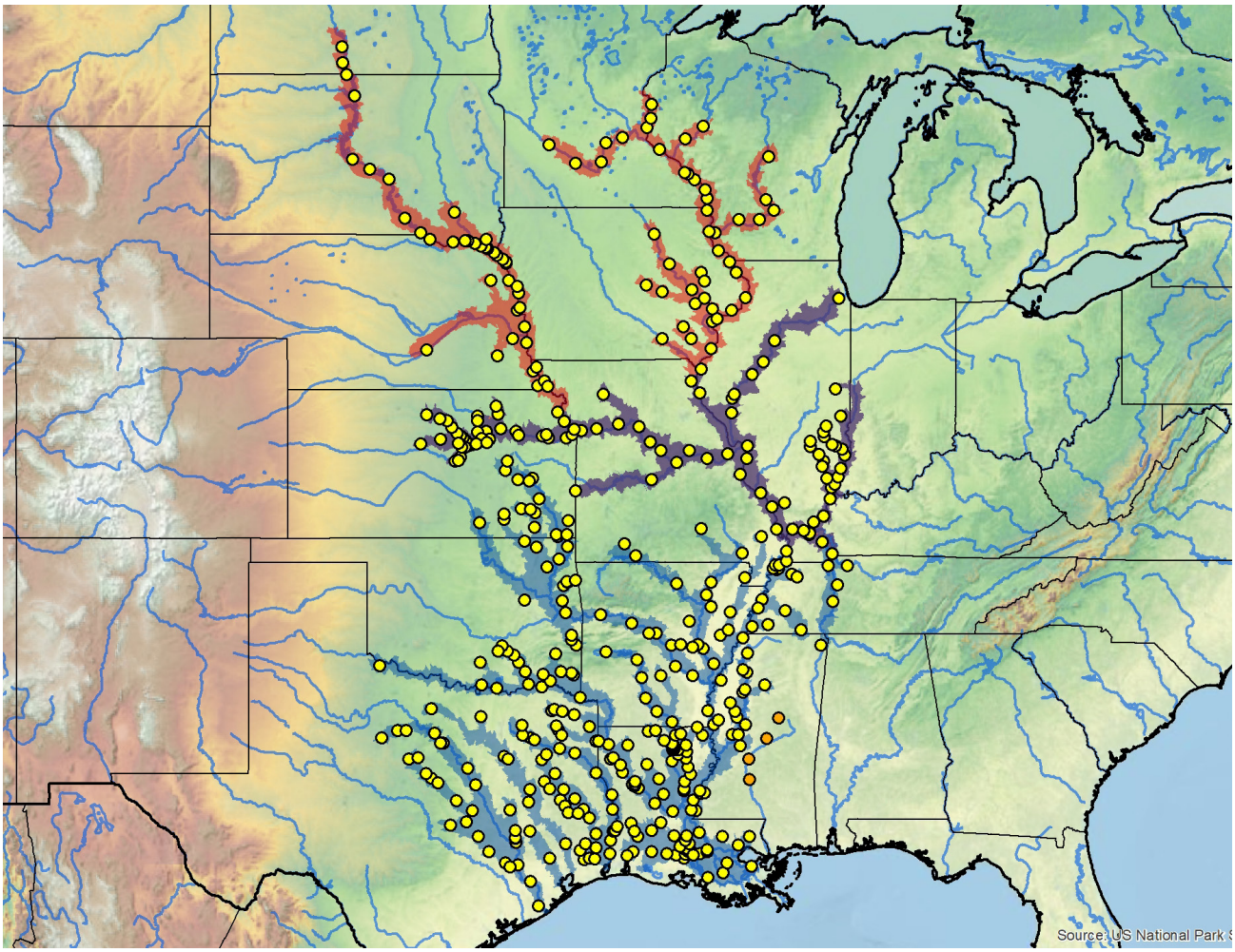

Figure 13. Distribution of *Graptemys pseudogeographica* in the USA. Yellow dots = museum and literature occurrence records of native populations based on Iverson (1992), other more recent literature records (see TTWG 2017, 2021), and authors' additional data; orange dots = possibly introduced or translocated specimens; colored shading = estimated historical indigenous ranges of: 1) *G. p. pseudogeographica* = red, and 2) *G. p. kohnii* = blue; purple-colored overlap areas = presumptive intergrades. Distribution based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments) constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs based on Buhlmann et al. (2009), TTWG (2017, 2021), and data from authors and other sources.

Rains and Van Zandt counties, Texas, with records in its main Louisiana tributary, Bayou Anacoco. In the Neches River drainage, the species occur upstream in the Neches into Smith and Van Zandt counties, Texas, and upstream in its tributary, the Angelina, to Angelina and Nacogdoches counties, Texas; additional localities are in two smaller downstream tributaries, Village Creek and Pine Island Bayou.

The species occurs in the Trinity River from Liberty County upstream to Dallas County, Texas. In the Brazos River drainage, it can be found from Washington County upstream to Young County as well as in many tributaries: the Navasota and Nolan rivers; the Little River and its tributary, the Leon River; the Clear Fork of the Brazos; Pin Oak Creek; Wickson Lake on Allcorn Creek; and Lake Somerville on Yegua Creek. One record exists of its occurrence in the San Bernard drainage.

Farther east of the Mississippi River, specimens have been found in middle reaches of the Pearl River between Jackson and Georgetown (Jones et al. 1992; Smith et al. 2020). Given the fact that the species is not widespread in the Pearl system and exists at very low densities, however, these records are likely the result of anthropogenic translocation. A hypothesis of flood-mediated dispersal from the Mississippi River drainage into the Pearl River drainage (Vogt and McCoy 1992) is unlikely, given the elevational difference that separates the two drainages (Smith et al. 2020).

Habitat and Ecology.—*Graptemys pseudogeographica* is typically found in slower-moving rivers and is also common in backwaters and sloughs. Bodie and Semlitsch (2000b) examined linear home ranges of *G. pseudogeographica* using telemetry; in the lower Missouri River, females had larger home ranges than males (mean linear values, 5.2 km

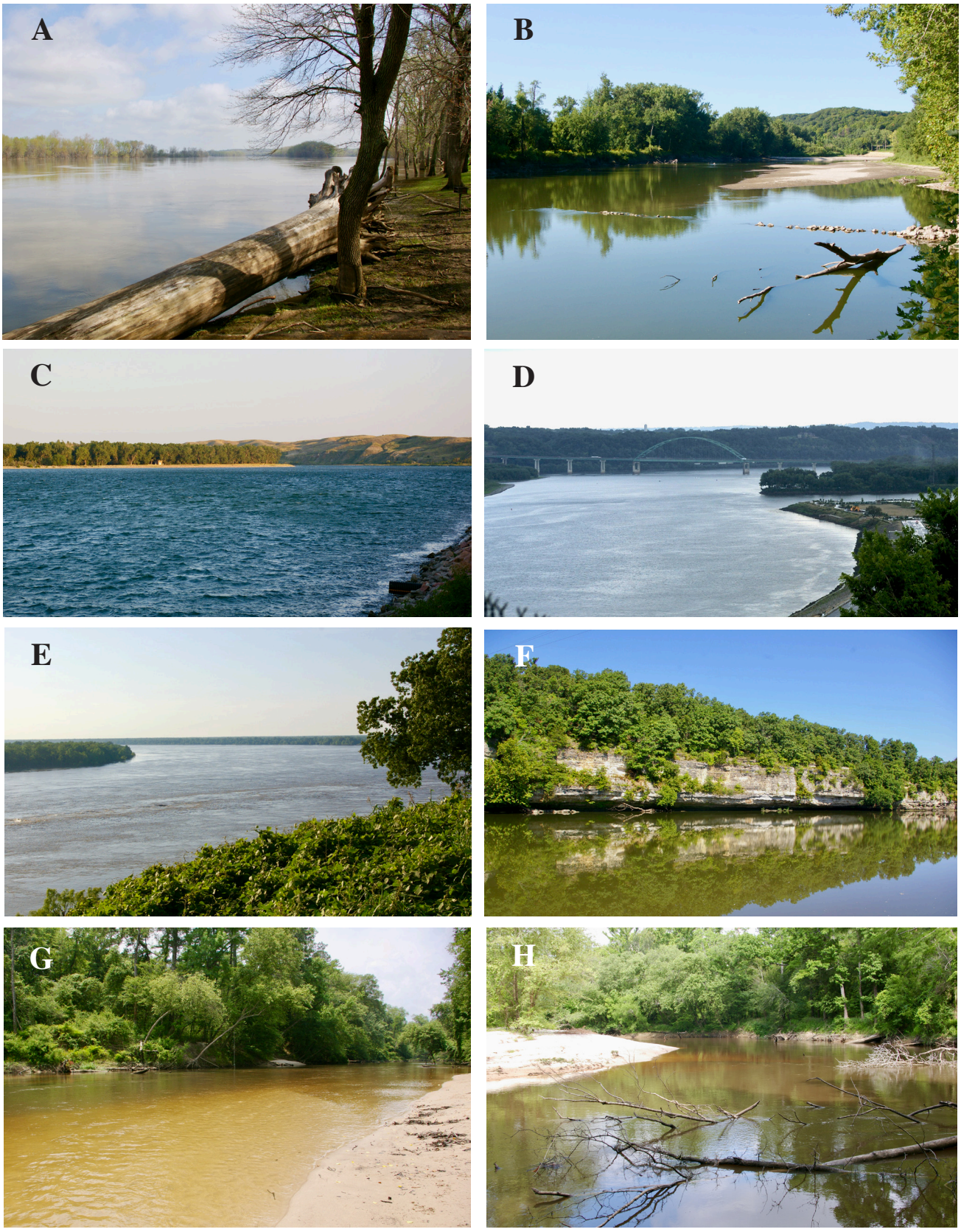

Figure 14. Representative habitats of *Graptemys pseudogeographica*. **A.** Wabash River, between Posey Co., Indiana, and White Co., Illinois (near the restricted type locality). **B.** Minnesota River, Le Sueur and Nicollet Cos., Minnesota. **C.** Missouri River, Hughes Co., South Dakota. **D.** Mississippi River, Dubuque Co., Iowa, and Grant Co., Wisconsin. **E.** Mississippi River, Warren Co., Mississippi, and Madison Parish, Louisiana. **F.** Spring River, Ottawa Co., Oklahoma. **G.** Whiskey Chitto River, Allen Parish, Louisiana. **H.** Village Creek, Hardin Co., Texas. All photos by Peter V. Lindeman.

vs. 3.8 km). Home ranges of both sexes included the main channel of the river as well as backwater habitats such as sloughs, scours, and flooded forests and farm fields; juveniles were also captured in all microhabitats. Use of more lentic habitats was particularly high during warmer months of the year. In eastern Kansas, *G. pseudogeographica* exhibited a preference for mud-bottomed larger rivers with abundant basking sites (Fuselier and Edds 1994).

Basking. — Hatchlings and subadults feed and bask near the shoreline in shallow water, often within brush and driftwood tangles. Adults are more wary, preferring to bask on floating logs or trunks away from the shoreline. False Map Turtles can be found basking from mid-April to October in Wisconsin, often in mixed species groups with *G. geographica* and *G. ouachitensis*. In Kentucky, basking by *G. pseudogeographica* relative to four other turtle species was proportionately highest in early afternoon and in the fall (Lindeman 2000b). In Kentucky and Texas, spring and fall peaks in basking numbers have been reported (Lindeman 2000b; Coleman and Gutberlet 2008). Basking is important in these species for thermoregulation, drying the shell to kill algae, and providing an opportunity for commensal birds (grackles, *Quiscalus quiscula*) to clean leeches from their bodies (Vogt 1979). False Map Turtles can often be found sleeping on submerged branches just beneath the surface of the water at night (Cagle and Chaney 1950; Chaney and Smith 1950).

Diet. — *Graptemys pseudogeographica* typically feeds underwater in 1–2 m of water (Vogt 1981a), eating mollusks, the larvae of caddisflies, mayflies, dragonflies, damselflies, dipteran flies, beetles, butterflies, and moths, as well as snails, clams, crayfish, dead fish, algae, and aquatic plants. In Wisconsin, *G. pseudogeographica* begins feeding during the last week of May and stops feeding by mid-September. Females in Arkansas, Louisiana, and Kentucky have broader heads and wider alveolar surfaces and feed more heavily on mollusks, including Asian clams (*Corbicula* spp.; Vogt 1981a; Shively and Vidrine 1984; Lindeman 1997, 2013). Males have a more exclusively carnivorous diet than females (Vogt 1981; Lindeman 1997, 2013). In Kentucky, females also consumed mayfly larvae, algae, and fish carrion. Smaller females consumed snails, algae, and bryozoans, males fed on chironomid egg cases, algae, Asian clams, and sponges, and juveniles consumed primarily small snails but also ate adult dipteran and caddisfly larvae (Vogt 1981; Lindeman 1997, 2013). Carr (2008) observed terrestrial foraging on herbaceous plants along a Louisiana riverbank. Powell and Powell (2011) reported heavy feeding on adult 13-year periodical cicadas during the peak of their emergence.

Heavy siltation in the Illinois River resulted in the change in a diet high in insects and plants to one of benthic midge larvae, but in the main channel of the river the species fed on caddisfly larvae (Moll 1976; misidentified in the publication as *G. ouachitensis*, Lindeman 2013). Turtles in the Mississippi River in Tennessee fed principally on terrestrial vegetation that was submerged by high water (Moll 1976).

Hibernation. — In Wisconsin, False Map Turtles hibernate from October to mid-April in mixed species groups behind rock piles and wing dams in areas of moving water 5–10 m deep (Vogt 1980, 1981b). Like most turtles in north temperate regions, False Map Turtles go into hibernation with complete sets of enlarged, yolked follicles. They emerge in mid-April and spend several weeks basking, hastening the development and ovulation of the first clutch of eggs in late May.

Maturity and Longevity. — In *G. pseudogeographica*, maturation occurs in the third or fourth year of growth in males and the eighth to eleventh year for females (Vogt 1980; Lindeman 1999a). Growth rings are reliable for estimating the age in this species only up to age 6 in males and 12 in females (Vogt 1980). Males and females grow at similar rapid rates until maturity is reached, then growth continues in adults at slowing rates (Lindeman 1999a). Like most turtles, this species is long-lived, but long-term studies have not been conducted to quantify longevity, other than Freedberg's (2020) observation of two adult females recaptured using a nesting ground 17 years apart (minimum ages ca. 25 years). A male False Map Turtle in the Columbus Zoo was still living at the age of 35 years and 5 months (Snider and Bowler 1992).

Courtship. — Copulation takes place in both spring and fall. Males recognize conspecific females by head markings or cloacal scents (Vogt 1978). After the male determines he is with a conspecific female, he swims around to her head. Like all *Graptemys*, False Map Turtles have a stereotyped, species-specific courtship display: the male drums his foreclaws against the ocular regions of the female in half-second bouts. The frequency, 10.3 beats/bout, is about double that of *G. ouachitensis*. In addition, while titillating the female, *G. pseudogeographica* males bob their heads up and down rapidly (12.8 bobs/sec in bouts of 1½ or 2½ bobs; Vogt 1993).

Nesting. — Mean minimum reproductive potential in Wisconsin is 28 eggs annually, although some individuals can produce 60 eggs in a year (Vogt 1980). Nesting starts in late May and proceeds into July. Females have been found nesting from 0545 to 2030 hrs under various weather conditions on islands in the Mississippi River at Stoddard, Wisconsin. Most nesting occurred between 0630 and 1000 hrs. Sand temperatures later in the day were too high for turtles to leave the water. On overcast days, nesting occurred throughout the day. Cool nocturnal temperatures may inhibit females from leaving the water to nest. Cloacal temperatures of nesting females ranged from 24.6 to 28.2ºC; air temperatures ranged from 21.1 to 32.0ºC during June. From 0430 to 1000 hrs, up to 75 females could be seen floating at the surface of the water 3–15 m from shore, apparently waiting for the right

combination of environmental conditions to leave the water to nest.

Females wandered from 5 to 150 m before attempting to dig a nest cavity. Nests were located in a variety of habitats, from low shrub cover surrounding the beach to open sandy areas. Nests are typically located in sandy soil on islands or within 100 m of the riverbank and may also be placed in cultivated fields (Vogt 1980). Usually, nests were dug adjacent to clumps of sedges (*Carex* spp.) or other plants (Vogt 1980). The nest cavity is dug entirely with the hind limbs; no body pit is dug, even in loose sand, in contrast to Painted Turtles (*Chrysemys picta*) and softshell turtles (*Apalone* spp.) in the same area.

The nest cavity is flask-shaped, 10–16 cm deep, and broadens from 4 to 8 cm beneath the sand surface (Vogt 1980). The eggs are positioned and packed into the nest with one of the hind feet. As an egg is being laid, the female's neck is outstretched fully and her head bobs slightly in the vertical plane. After the last egg is laid, the female fills the hole by scraping and packing sand and nearby debris into the hole with her hind limbs. Once the cavity is filled, the female continues to pack down the nest by alternately raising each hind limb 5 cm above the surface and then slapping the sand with it.

Fresh nests can be readily distinguished by the striking difference in sand particle size between the nest and the surrounding sand surface. The surrounding sand has a coarse mosaic of small pebbles created by wind erosion of the lighter sand, while the nest has a rather uniform small-grained appearance. Within a day or two, if not depredated, wind activity obscures the nest location.

Nest temperatures were monitored from 16 July to 17 August 1972 on an island near the main channel of the Mississippi River at Stoddard, Wisconsin. Daily temperature fluctuations ranged from 2.2 to 12.2ºC in the nests. Mean daily fluctuations for two nests for 28 days was 6.7ºC. Incubation of *in situ* nests ranged from 52–85 days in Wisconsin and was completed more rapidly in warmer microenvironments (Ewert 1979; Vogt and Bull 1984). Hatching success was 95% in 285 nests excavated at this site from 1972–1977.

Sex Determination and Sex Ratio. — Sex of hatchlings is temperature-dependent; more males are produced in cool, shaded nests and in nests laid later in the season, while more females are produced in the warmer, sun-exposed nests (Bull and Vogt 1979; Vogt and Bull 1984). Eggs incubated in the laboratory produced all males at 28ºC and below and all females at 30.6ºC and above, with threshold temperatures of 29.4ºC in Wisconsin and 29.2ºC at Reelfoot Lake, Tennessee (Bull et al. 1982). High carbon dioxide levels at transitional temperatures may shift the sex ratio toward more females (Etchberger et al. 2002).

The adult sex ratio may be affected by incubation temperatures; in the Mississippi River in Wisconsin, the sex ratio of hatchlings in natural nests was 1:3 (males:females), while the operational sex ratio (adults only) for turtles that were captured was 1.0:1.6 (Vogt 1980; Vogt and Bull 1984). Secondary sex ratios in captures and sightings (based on all individuals that can be sexed externally, i.e., including juvenile females as big or bigger than the smallest males) vary widely, from 21% to 73% male (reviewed in Lindeman 2013).

Eggs and Clutch Size. — Four to 22 oblong eggs measuring 19–27 × 25–43 mm (population means 22.4–25.1 × 34.2–36.4 mm) are generally laid. Clutch size, adult female body size, and egg dimensions vary throughout the range of the species. Clutch size is higher in northern localities, as seen from the contrast between three studies in South Dakota (mean 12.3 eggs, range 6–18, Timken 1968a; mean 10.8, range 7–14, Dixon 2009, Dieter et al. 2014; and mean 10.9, range 6–14, A. Gregor, pers. comm.) and two studies in Wisconsin (mean 14.1, range 8–22, Vogt 1980; and mean 12.8, range 8–19, Janzen et al. 1995) as compared to one in Louisiana (mean 6.6, range 4–11; Carr 2001). Females in the Louisiana study were also smaller (to 190 mm PL, mean 168 mm, compared to South Dakota females as large as 238 mm PL, with means of 202 and 206.5 mm). The Louisiana females laid eggs that were narrower in width (mean 22.4 mm, vs. means 23.0–25.1 mm in the northern populations) but longer (mean 36.4 mm, vs. means 34.2–36.1 mm in the northern populations), such that reported means for egg mass suggest little in the way of geographic variation (means 9.9 g and 10.9 g in the two Wisconsin populations vs. mean 10.3 g in the Louisiana population). Clutch size and egg size both increase in larger females of a population (Timken 1968a; Vogt 1980; Carr 2001).

The number of clutches produced annually may be related to size of the female. In South Dakota, large females produced two clutches and smaller ones only one (Timken (1968a). Up to three annual clutches are produced in Wisconsin (Vogt 1980) and Louisiana (Carr 2001) and as many as four in western Tennessee (Freedberg et al. 2005).

Hatchlings usually remain in the nest after hatching until the yolk sac is completely absorbed and begin emerging in late August (Vogt 1980). No evidence of overwintering in the nest was found from over 500 nests excavated from mid-September to November (Vogt 1980).

Predation. — Nests are depredated by Red Foxes (*Vulpes vulpes*), Raccoons (*Procyon lotor*), and River Otters (*Lontra canadensis*). Larval sarcophagid fly predation is also responsible for the mortality of many eggs; larvae enter the pipped eggs or eat their way into the living egg and eat the hatchling turtle alive before it leaves the egg (Vogt 1981c). Nest predators destroyed 36% of nests for *G. pseudogeographica* and *Apalone* spp. on islands in the Missouri River on the South Dakota-Nebraska border (Dieter et al. 2014).

In Wisconsin, nesting on sandbars and islands affords protection for the eggs from most mammalian predators in

the upper Mississippi River; however, Raccoons and Red Foxes often become stranded on islands after the ice melts in the backwaters, resulting in high predation rates of eggs (Vogt 1980). Emergent hatchlings are consumed by many birds, including Ring-billed Gulls (*Larus delawarensis*), American Crows (*Corvus brachyrhynchos*), Common Grackles (*Quiscalus quiscula*), Red-winged Blackbirds (*Agelaius phoeniceus*), and Great Blue Herons (*Ardea herodias*; Vogt 1981b). Once hatchlings reach the water, they must avoid bass (*Micropterus* spp.), catfish (Ictaluridae spp.), and Northern Pike (*Esox lucius*) until they grow large enough to avoid predation. In Tennessee, juveniles are eaten by Rice Rats (*Oryzomys palustris*; Goodpaster and Hoffmeister 1952).

Bald Eagle (*Haliaeetus leucocephalus*) nests have been found to contain the remains of large juvenile female and adult male *G. p. kohnii* (Mabie et al. 1995; Shively 2014). Although Raccoons and Red Foxes probably take occasional adult turtles during the females' nesting excursions, humans may be the main source of adult mortality, via drowning in gill nets, collisions with motor boats, shooting, and setlines (Vogt 1980; Barko et al. 2004). Adult female *G. p. pseudogeographica* have also been harvested for use as biological specimens and the species is popular in the pet trade, particularly *G. p. kohnii*.

Parasites and Pathogens. — Studies of the parasites and pathogens of *G. pseudogeographica* have been largely descriptive reports of species, sometimes with data on prevalence. Reported parasites include apicomplexan protozoans (Wacha and Christiansen 1976); a myxozoan cnidarian (Johnson 1969); various digenean flukes (Barker and Parsons 1914; Stunkard 1915, 1916, 1923; Ward 1921; Horsfall 1935; Byrd 1939; McKnight 1959; Brooks 1975; Brooks and Mayes 1975, 1976), a monogenean fluke (Acholonu 1969b), and an aspidogastrean fluke (Stunkard 1917); a tapeworm (McKnight 1958); spiny-headed worms (Van Cleave 1919; Fisher 1960; Cable and Fisher 1961; Acholonu 1969a); various roundworms (Magath 1919; McKnight 1958; Ash 1962; Acholonu and Arny 1970; Dyer and Wilson 1997; Martínez-Silvestre et al. 2015); a cloacal mite (Bochkov and OConnor 2008); and leeches (Vogt 1979). A survey of *G. pseudogeographica* in South Dakota revealed no incidence of *Ranavirus* (Butterfield 2019).

Population Status. — *Graptemys pseudogeographica* is abundant in many areas across its range and there is no documented suggestion that populations are severely threatened by humans or environmental disturbances. Twenty years of monitoring the population in the Mississippi River near Stoddard, Wisconsin, demonstrated no dramatic population changes (Vogt 1978, 1980; Vogt and Bull 1984; Vogt, unpubl. data). Population surveys throughout its range in Arkansas, Oklahoma, Texas, and Louisiana suggested populations were in good condition in 1974–1976. Especially robust populations were noted in the Brazos, Trinity, and Sabine rivers in Texas; the White River in Arkansas; and Reelfoot Lake in Tennessee in 1978–79 (Vogt and C.J. McCoy, unpubl. data).

Relative abundance of False Map Turtles has been determined via both trapping results and visual surveys of basking turtles. In the Missouri River in South Dakota, *G. pseudogeographica* made up 71% of the five turtle species captured in baited traps (Timken 1968a). To the south in the Mississippi River in Illinois, this species appeared to be much less abundant, at only 1% of all turtles captured in baited traps (Anderson et al. 2002). Gritters and Mauldin (1994) used fyke nets in the Mississippi River in Iowa but could not differentiate between *G. pseudogeographica* and *G. ouachitensis* and lumped them together as 9% of the seven species of turtles captured. False Map Turtles made up 83% of the six species captured in hoop, fyke, and gill nets in the Mississippi River along the border between southern Illinois and southern Missouri (but probably lumped with *G. ouachitensis*, as none of the latter species were reported; Barko et al. 2004). False Map Turtles were the second most abundant of eight species of turtles captured in unbaited hoop nets, fyke nets, and basking traps in the Mississippi River and its floodplain in southern Missouri (Wallace et al. 2007). Bodie et al. (2000) also found *G. pseudogeographica* to be the most abundant species captured in the lower Missouri River and its floodplain, at 46% of six turtle species they captured in baited turtle traps and fyke nets. Winterkill of turtles at three floodplain lakes in their study area was 44% *G. pseudogeographica* and they were the most abundant (60%) of the live turtles of four species captured the following spring (Bodie and Semlitsch 2000a). They were the fifth most abundant species, 6% of the 663 turtles of seven different species, caught in baited traps on the lower St. Croix River in Wisconsin (DonnerWright et al. 1999). False Map Turtles occurred at low relative abundance, only 1% of eight species of turtles captured, in the upper Wabash River drainage and its floodplain wetlands in Indiana (Rizkalla and Swihart 2006).

Graptemys p. kohnii sampled in Louisiana in the 1950s were 7% of the five species caught on the Sabine River and 37% of the six species captured on the Tensas River (Tinkle 1958). Fuselier and Edds (1994) tested different baits in hoop traps in 41 Kansas counties and found Mississippi Map Turtles in only 2% of the sample, ranking seventh in abundance of the ten species captured. Tributary creeks of the Arkansas River in Sequoyah National Wildlife Refuge in Oklahoma were sampled with baited hoop traps, resulting in Mississippi Map Turtles being the 8th most abundant species of the nine species captured, making up only 0.6% of the turtles captured (Riedle et al. 2008). Riedle et al. (2009) found *G. p. kohni* to be the 9th most abundant of 13 species captured in baited hoop traps in eastern Oklahoma, at 0.9% of captures. Mississippi Map Turtles were the fifth in abundance (6%) of nine species captured in baited traps in the Sabine River in Texas (Hively 2009).

False Map Turtles in Kentucky Lake and the Tennessee River below the Kentucky Dam were 17% of all turtles seen in basking surveys and 15% of the turtles captured on the lake in basking traps and fyke nets, ranking third among 11 species in both basking surveys and trapping (Lindeman 1999b, 2013). Mean basking density was 14.3/km of shoreline across all 20 sites, ranging as high as 61/km on average at one site (Lindeman 1998, 1999b). In west Tennessee tributaries of the Mississippi River, *G. pseudogeographica* was the third most abundant turtle of 11 species captured in baited hoop nets (Ennen et al. 2021).

Carr (2001) saw *G. p. kohnii* basking at 16 of the 17 aquatic habitats surveyed in 1998–2000 in northern Louisiana. The species made up 35% of the 929 emydid turtles seen, with similar relative abundances on five rivers and 12 lakes; adjacent to an island in the Red River, however, it made up only 4% of captures in fykenets, tied for second among five species in an assemblage dominated by its congener, *G. ouachitensis* (92% of all turtles). *Graptemys sabinensis* outnumbered *G. p. kohnii* 8.4:1 on the upper Sabine River in east Texas (Coleman and Gutberlet 2008). In the Brazos River, a study of six basking species found that *G. p. kohnii* was the third most abundant species seen basking (5%) and captured in basking traps (3%; Hill 2008; Hill and Vodopich 2013). In the Calcasieu and lower Sabine River drainages of southwestern Louisiana and the Texas border, Mississippi Map Turtles ranked third among 11 turtle species in relative abundance in both basking surveys and trapping using basking traps, fyke nets, and baited hoop nets, at 17% and 9% of all turtles, respectively (Louque 2014; Lindeman, unpubl. data). Basking surveys in the southwestern part of the species' range have yielded highly variable results: 43 *G. p. kohnii* per km of river or reservoir shoreline in northern Louisiana (Carr 2001); 3.2/km in the upper Sabine River (Coleman and Gutberlet 2008), 3.6/km in the middle Brazos (Hill 2008; Hill and Vodopich 2013), and 1.4/km in the Calcasieu and lower Sabine rivers of southwestern Louisiana and the Texas border (Louque 2014; Lindeman, unpubl. data). Just to the east in the small Mermentau River drainage of Louisiana, Mississippi Map Turtles are very nearly an extirpated species: they comprised just 0.2% of all turtles recorded in drainage-wide basking surveys by Ilgen et al. (2014; n = 3189 total turtles) and were not recorded in concurrent efforts by Louque (2014), plus none were captured in trapping efforts of the two studies.

Threats to Survival. — Many adult female *G. pseudogeographica* die inadvertently in the nets of commercial fishermen in the Mississippi River. When the pet hatchling turtle trade flourished, this species was sold by the thousands. Because demand is not high, this trade does not currently appear to be a major threat to the species. The greatest threats to the survival of this species are destruction of nesting habitats and nests by camping tourists and agricultural practices and pollution of the water they live in.

While the dredge spoil banks on the Mississippi River have been important in creating and maintaining nesting habitat for *G. pseudogeographica*, this boon to populations has been undercut by the efforts of the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service to plant grasses conducive to waterfowl nesting on some of the dredge spoil islands. These islands are also used for nesting by seven other species of turtles in the Mississippi River in Wisconsin. Tall dense stands of grasses reduce turtle nesting habitat and are likely to reduce the temperature in any nests placed in such habitat so that more males would be produced.

Bodie (2001) suggested that riverine freshwater turtles in general, but including the *G. pseudogeographica* populations he studied in the Missouri River, would benefit from an ecosystem management approach that would restrict habitat-altering management activities around hibernacula in the winter and nesting beaches in the summer. He also found it critical to riverine turtles that some lotic habitat be maintained where dams produce long, lentic river reaches. He further suggested that a riparian zone of 150 meters be preserved in these lotic reaches in order to maintain critical basking and nesting habitats through natural means.

The shooting of basking turtles as a form of target practice (or simple malicious behavior) has been considered a serious, if unquantified, threat to *Graptemys* species (reviewed in Lindeman 2013). If commonly repeated at a location, it would certainly result in localized population decline of *G. pseudogeographica*.

Conservation Measures Taken. — *Graptemys pseudogeographica* is listed as Conservation Priority III in North Dakota, Threatened in South Dakota, and a Species of Greatest Conservation Need in Wisconsin; it is unlisted in the remaining 14 U.S. states in its range. It has been assessed as Least Concern on the IUCN Red List (van Dijk 2011) and has been listed with all *Graptemys* spp. on CITES Appendix II as of 2023.

In the Upper Mississippi River Wildlife Refuge in Pool 8 between Wisconsin and Minnesota, the U.S. Fish and Wildlife Service (USFWS) has built islands to enhance duck habitat (Vogt, pers. obs., 2011), which also provides nesting habitat for *Graptemys* spp. and other turtles. The islands are built to be long-lasting, with a rip-rap base covered with dredge spoil sand. Most are shaped like crab claws, open at their downstream ends, which offers a physical structure to capture sand and silt to continue the building process, and a shallow backwater area on the downstream end as a nursery for hatchling turtles and ducklings. Map turtles (*Graptemys* spp.) and softshells (*Apalone* spp.) were already nesting on some of the islands that were only a year old. The USFWS was planning on building 50 such islands; 14 had already been completed as of 2011. Dozens more have since been built as of 2020 news reports and more are planned for the near future. Nesting islands isolated from the mainland should

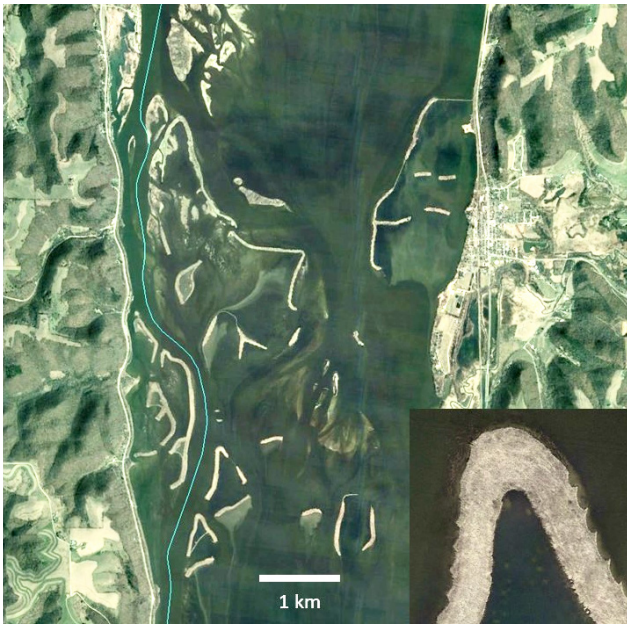

Figure 15. Satellite image (2021) of artificial islands created in the Mississippi River near Stoddard, Wisconsin, to enhance duck and turtle habitat. The inset (lower right) shows detail of the upstream end of one of the structures in the lower left of the main image.

diminish predation of the nesting females, their eggs, and their hatchlings by mammalian predators.

A similar project has been undertaken in the Missouri River along the South Dakota-Nebraska border (Dixon 2009; Dieter et al. 2014), where a large-scale loss of sandy islands to erosion has been brought about by extensive water releases from the dams that regulate the river (Bodie 2001). Open, sandy, artificial islands were constructed by the U.S. Army Corps of Engineers, primarily to benefit two nesting shorebird species, Piping Plovers (*Charadrias melodus*) and Least Terns (*Sternula antillarum*), although the Corps was aware that ancillary benefits to *G. pseudogeographica* and two softshells (*Apalone mutica* and *A. spinifera*) would likely also occur. All three turtle species nested on the artificial islands, which were statistically indistinguishable from remnant natural islands in habitat features (Dixon 2009; Dieter et al. 2014).

River and riparian zone habitat of False Map Turtles is protected in numerous wildlife preserves. The most extensive preserve encompasses 97,000 ha in the Upper Mississippi National Fish and Wildlife Refuge along 420 km of the river in Wisconsin, Minnesota, Iowa, and Illinois. Other National Wildlife Refuges (NWR) granting federal protection to habitat along the Mississippi are Trempealeau NWR in Wisconsin, Port Louisa NWR in Iowa and Illinois, Great River NWR in Missouri and Illinois, and Chickasaw NWR and Reelfoot Lake NWR, both in Tennessee. Major tributaries of the Mississippi have habitat protected in the Boyer Chute NWR and Desoto NWR on the Missouri River in Iowa, Meredosia Lake NWR on the Illinois River in Illinois, Dale Bumpers White River NWR in west-central Arkansas, Sequoyah NWR on the Arkansas River in eastern Oklahoma, Little River NWR in southeastern Oklahoma, Felsenthal NWR on the Ouachita and Saline rivers in southern Arkansas, Caddo (Lake) NWR in east Texas, and Black Bayou Lake NWR, D'Arbonne (Bayou) NWR, Tensas (River) NWR, and Upper Ouachita (River) NWR, all in northern Louisiana. Reaches of isolated rivers in the western part of the species' range are protected in Neches River NWR and Trinity River NWR in east Texas.

The National Park Service protects the St. Croix National Scenic Riverway (406 river km) in Wisconsin and Minnesota, the Missouri National Recreational River (161 river km) along the South Dakota-Nebraska border, and the Big Thicket National Preserve on part of the Neches River in Texas. The U.S. Forest Service manages Land Between the Lakes National Recreation Area, which protects 480 km of reservoir shoreline on impoundments of the lower Tennessee (western edge) and Cumberland (eastern edge) rivers in Kentucky and Tennessee. In addition, some of the southern National Forests (NF) also protect habitat for False Map Turtles: portions of the Current and White rivers in Missouri are within Mark Twain NF; upper portions of the Poteau, Petit Jean, Fourche Lafave, Ouachita, Caddo, and Saline rivers in Arkansas are within the Ouachita NF; the middle Homochitto River in Mississippi lies within Homochitto NF; the headwaters of the Whiskey Chitto River in Louisiana arise in Kisatchie NF; and, in Texas, the west shoreline of Toledo Bend Reservoir on the Sabine River is the eastern border of Sabine NF, parts of the Angelina River lie within Angelina NF, and the west bank of the Neches River is the eastern border of Davy Crockett NF.

The Nature Conservancy manages the Ouachita River Nature Preserve in Arkansas, where bottomland forest along a 10-km stretch of the Ouachita River is protected. They also manage preserves protecting small portions of the Blue River in southern Oklahoma (Oka'Yanahli Preserve) and Caddo Lake and Village Creek in east Texas (Fred and Loucille Dahmer Caddo Lake Preserve and Roy E. Larsen Sandyland Sanctuary, respectively).

In 2004, the Wisconsin Department of Natural Resources prohibited large-scale collecting of animals for sale, particularly turtles, by the biological supply house industry. The agency also limited the use of the number of traps commercial turtle trappers could use, which has effectively eliminated commercial turtle trapping in the state.

Conservation Measures Proposed. — Commercial fishermen using gill nets should be seasonally prohibited from setting nets near turtle nesting beaches in large rivers to avoid drowning adult female turtles. Establishment of a scientific area—e.g., in the upper Mississippi River near Stoddard, Wisconsin—could be used to protect one or more nesting islands. Maintenance of basking logs in deep water near nesting areas would be beneficial, because female *G. pseudogeographica* are very wary and avoid basking on logs or branches connected to the riverbank.

With regard to artificial nesting islands, populations of the species would be increased more rapidly by making more female-producing beaches, with hotter, open beaches that produce female hatchlings disproportionately (Vogt and Bull 1984). Because males can fertilize many females, there should be no problem with the fertility of egg clutches. Finally, education programs could be developed to curtail the shooting of turtles. Posters could be designed with simple diagrammatic terms and drawings explaining why it is beneficial for hunters and fishers not to shoot basking turtles.

Captive Husbandry. — *Graptemys pseudogeographica* grows and reproduces well in captivity at temperatures of 25–30ºC (Vogt, pers. obs.). It thrives on a diet of canned sockeye salmon, but would probably grow equally well on crab or lobster. It can be grown to reproductive size and produce fertile eggs on a diet of Purina trout chow mixed with bone meal, oyster shells, cod liver oil, and multivitamins, all held together in an agar-gelatin base. Vogt maintained 132 hatchlings for 15 years on such a diet. Later the turtles were fed only dry dog food for 5 years. Artner (2001) also used food embedded in gelatin to feed adults and hatchlings of a breeding, captive group that he maintained in a greenhouse.

False Map Turtles are very sensitive to lack of sunlight; if direct sunlight cannot be offered, Vitalite or some other source of ultraviolet radiation must be provided. Basking areas where they can emerge completely out of the water and dry off are also essential for the health of this species in captivity. False Map Turtle hatchlings, as in many turtle species, are highly susceptible to infections of *Citrobacter freundii*; chloromycetin dissolved in the water is an effective treatment of infected hatchlings (Vogt, pers. obs.).

Current Research. — The most recent field studies of *G. pseudogeographica* have been life-history and health studies in South Dakota (Dixon 2009; Butterfield et al. 2019; Madison et al. 2022), a spate of new distributional records (see Distribution section above), and several reports of both subspecies becoming established as exotic species, both outside their range in the United States (Savitzky and Mitchell 2001; Lau and Johnston 2008; Krusling et al. 2010; Johnston et al. 2012; Munscher et al. 2012; Mays 2020; Smith et al. 2020) and outside North America, in western and central Europe (Jelić and Jelić 2015; Di Santo et al. 2017; Ferri et al. 2020; Poch et al. 2020; Foglini 2021; Tietz et al. 2023) and the Korean peninsula (Koo et al. 2020). The species is included in recent freshwater turtle community studies in the upper Trinity River of north Texas (Brinker 2018b) and various streams of west Tennessee (Ennen et al. 2021).

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