Wisconsin Department of Natural Resources

Bureau of Natural Heritage Conservation

Wisconsin Wood Turtle

(*Glyptemys insculpta*)

April 2016

Status Assessment and Conservation Strategy

Photograph by Chris Hamerla

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WISCONSIN
DEPT. OF NATURAL RESOURCES

WISCONSIN WOOD TURTLE (*GLYPTEMYS INSCULPTA*)
STATUS ASSESSMENT AND CONSERVATION STRATEGY

EXECUTIVE SUMMARY

The Wisconsin Department of Natural Resources (WDNR) has developed a statewide conservation strategy for wood turtles. The two significant elements that are contained within the conservation strategy are an assessment of the species' status and a list of proposed conservation measures to ensure species persistence.

STATUS ASSESSMENT

As part of this Wood Turtle Conservation Strategy, the WDNR is following up on a commitment made during Wisconsin's most recent endangered/threatened species list revision process, which was finalized in 2014. At that time, the WDNR retained the threatened status for the wood turtle and committed to re-assess its status following the completion of a Competitive State Wildlife Grant (SWG-C) research project being conducted jointly with Minnesota, Michigan, and Iowa. Based on existing WDNR data, data submitted by external stakeholders, and newly acquired SWG-C data, the legal status of the wood turtle in Wisconsin has been reassessed. The department's recommendation is to move the wood turtle from a state threatened species to a species of special concern and a protected wild animal with no harvest or collection allowed. In addition, the WDNR has established criteria for determining state status in the future.

CONSERVATION MEASURES

One of the primary goals of this Wisconsin Wood Turtle Conservation Strategy is to identify the steps needed to perform effective conservation measures and to reaffirm the department's commitment to ensuring that wood turtles continue to remain an integral and viable part of Wisconsin's natural heritage in perpetuity. Four objectives have been identified to meet this goal:

1. Obtain Additional Distribution and Viability Data
2. Quantify Local, Regional, and Statewide Trends
3. Conduct a Population Viability Analysis (PVA)
4. Prioritize Conservation Actions

This document is intended to be dynamic and will be updated as new scientific data and protocols become available.

RECOMMENDED CITATION

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1. SPECIES BACKGROUND

This species background section has been designed as a summary of the literature that is relevant to wood turtle conservation in Wisconsin. For a comprehensive review of the species' background, refer to the Wisconsin Wood Turtle Species Guidance document listed in Section 6.

1.1 DESCRIPTION

The wood turtle is a medium-sized turtle. In Wisconsin, carapace (upper shell) length ranges from 12 – 24 cm (4.7 – 9.4 in; Vogt 1981). Unlike many species of turtles, mature males are usually 7 – 10% larger than mature females (Lovich et al. 1990). Their low-keeled carapace ranges in color from brown to grayish brown to tan, and is accompanied with black and yellow flecks, at times with yellow rays (Vogt 1981, Ernst and Lovich 2009). Scutes on the carapace have an irregular, pyramidal appearance from the concentric circles that are formed by growth rings and ridges (Figure 1; Vogt 1981, Ernst and Lovich 2009). Dorsal portions of the head, arms, legs, and tail are dark brown, while the neck, throat, and forelegs are yellow, orange, or red (Knudsen 1957, Vogt 1981, Ernst and Lovich 2009). Females are generally pale yellow in color, while pigmentation in males is often bright yellow, orange, or red (Ernst and Lovich 2009). The hingeless plastron (lower shell) has a yellow base with a black blotch on the outer posterior corners of each scute (Breckenridge 1944, Vogt 1981). Wood turtle plastrons are flat in females, whereas they become more concave in sexually mature males. Males have long, thick tails with the cloacal opening posterior to the margin of the shell, and females have shorter tails with the cloacal opening level to or under the carapace margin (Vogt 1981).

Figure 1. Adult wood turtle (photograph by A. B. Sheldon).

1.2 CURRENT DISTRIBUTION

1.2.1 GLOBAL DISTRIBUTION

Wood turtles are native to eastern North America. They range in the northeast from Nova Scotia, New Brunswick, and Maine, southwest along the Atlantic coast to Maryland, Virginia, and West Virginia, northwest to Wisconsin, northeast Iowa, and eastern Minnesota, and north to southern Ontario and southern Québec (Figure 2; Conant and Collins 1998, Ernst and Lovich 2009).

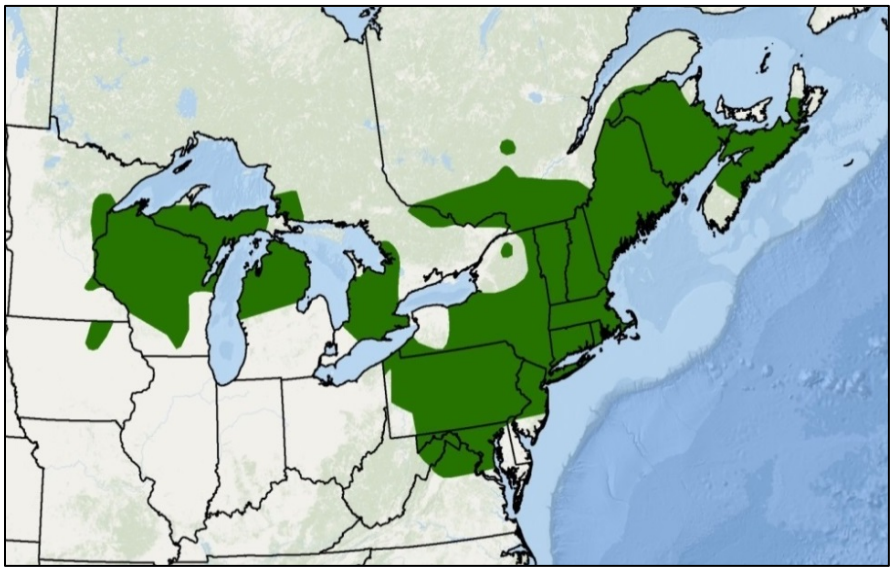


Figure 2. Global range of the wood turtle (*Glyptemys insculpta*; adapted from Ernst and Lovich 2009).

Wood turtles are classified as vulnerable (G3/N3) in both global (2010) and national (United States [2010] and Canada [2011]) assessments (NatureServe 2015). The International Union for Conservation of Nature (IUCN) lists the wood turtle as globally endangered (van Dijk and Harding 2013). Refer to Table 1 for a list of subnational conservation status ranks.

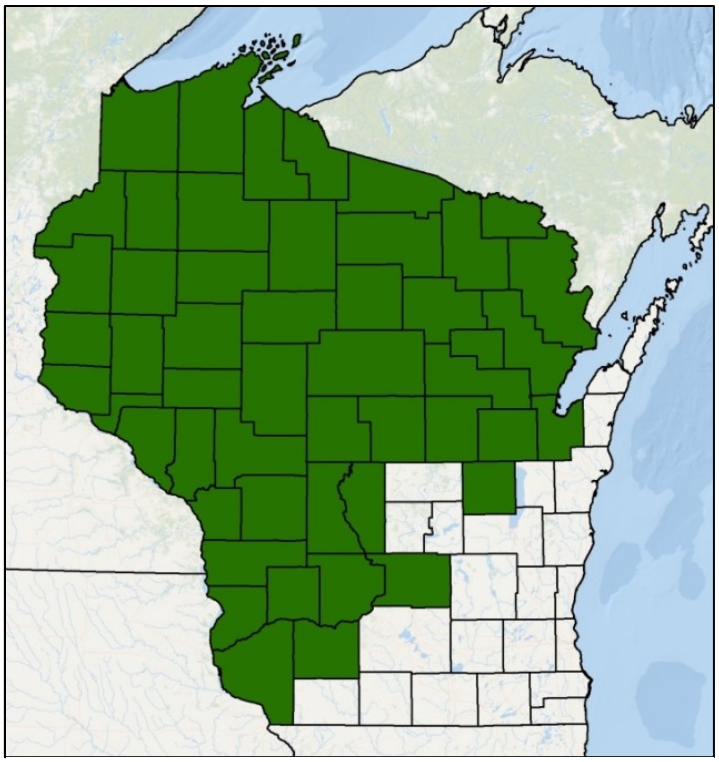
S-Rank	**State/Province**
S4 – Apparently Secure	Maine, Maryland
S3S4 – Vulnerable/Apparently Secure	Pennsylvania
S3 – Vulnerable	Connecticut, Massachussetts, New Brunswick, New Hampshire, New York, Nova Scotia, Vermont, West Virginia, Wisconsin
S2S3 – Imperiled/Vulnerable	Michigan
S2 – Imperiled	Minnesota, New Jersey, Ontario, Québec, Rhode Island, Virginia
S1 – Critically Imperiled	Iowa, Ohio*
SH – Possibly Extirpated	District of Columbia

Table 1. Wood turtle subnational conservation status ranks (NatureServe 2015).

*Uncertainty remains as to whether the few documented wood turtle specimens from northeastern Ohio represent a native population. Existing populations have yet to be recorded in Ohio.

1.2.2 WISCONSIN DISTRIBUTION

Wood turtles are found throughout the northern and southwestern portions of Wisconsin. They are absent from southeast Wisconsin and the southern Lake Michigan drainage. Wood turtles occur as far south as Brown, Winnebago, Columbia, Sauk, Iowa, and Grant counties (Figure 3; Vogt 1981, WDNR 2015). Species occurrences are scattered throughout their Wisconsin range; however, occurrences are most dense in the forested regions of the northern and western portions of the state (WDNR 2016). Their full extent in Wisconsin may not be reflected in our current distribution information because some areas in the state have not been thoroughly surveyed.



1.3 LIFE HISTORY AND ECOLOGY

1.3.1 HABITAT

Wood turtles are most often found in and around clear, moderate to fast moving rivers and streams with sand, gravel, or cobble substrates (Vogt 1981, Harding 1997, Ernst and Lovich 2009). Wood turtles are habitat generalists, using a wide variety of forested habitats that are in close proximity to water (Ernst and Lovich 2009). Forest edges near open canopy habitats are often used for thermoregulation and foraging (Compton et al. 2002). Young mixed forest stands with low to moderate levels of shrub and tree cover are often preferred at the microhabitat level (Compton et al. 2002, Arvisais et al. 2004). Prior to nesting and hibernation (i.e., in the spring and fall when nighttime air temperatures are low), wood turtles are found predominantly near aquatic habitats and alder thickets (Figure 4; Arvisais et al. 2004). Nesting habitat includes moderately sloughing sand banks, sand prairies and barrens, agricultural fields, roadsides, and other areas with disturbed sandy or gravelly substrates that support little or no vegetation (Figure 4; Thayer et al. 2008, WDNR 2015). During mid-summer, wood turtles also use dry and wet meadows, upland fields, pastures, swamps, and bogs (Breckenridge 1944, Harding and Bloomer 1979, Ross et al. 1991). In Wisconsin, summer shelters include rabbit holes, sod overhangs, gullies, hollow logs, and buttressed tree roots (Knudsen 1957). Wood turtles overwinter underwater in rivers and streams within deep pools, under overhanging banks, roots, and logs,

and in beaver lodges and muskrat burrows (Bishop and Schoonmacher 1921, Vogt 1981, Ernst and Lovich 2009).

Figure 4. Wood turtle microhabitat, representing spring basking/foraging habitat (left; photograph by Andrew Badje, WDNR) and nesting habitat (right; photograph by Erik Wild).

1.3.2 ACTIVITY/MOVEMENT

1.3.2.1 PHENOLOGY

In Wisconsin and the Upper Great Lakes Region, the active season for the wood turtle generally begins with the emergence of turtles from streams in April or May, and lasts until September or October as turtles return to their overwintering stream (Figure 5, WDNR 2015). Overwintering typically begins in October (Vogt 1981). Their terrestrial activity varies and is dependent on geographic location and annual fluctuations in weather (Ernst and Lovich 2009). From late June until August, Harding and Bloomer (1979) found females preferring terrestrial sites over aquatic ones. Wood turtles have been found mating from April until November, although mating is more widely documented in the fall (Walde et al. 2003, WDNR unpublished data). In Wisconsin and Québec, females search for nesting habitat and lay eggs from late May until early July, peaking in June (Knudsen 1957, Vogt 1981, Walde et al. 2007, Lapin et al. 2016). In years with sufficient temperatures for embryo development, eggs begin to hatch in Wisconsin throughout August and September (Vogt 1981, Lapin et al. 2016).

Figure 5. Wood turtle phenology typically observed in Wisconsin (adapted from WDNR 2015).

1.3.2.2 DAILY MOVEMENT

Daily movements of wood turtles may vary across local and regional scales, and seem to be related to resource availability, seasonality, and latitude. By tracking wood turtles, Woods (1945) hypothesized a maximum terrestrial travel speed of 0.3 km/hr (0.2 mph). Terrestrial average minimum daily movements in Wisconsin and Pennsylvania have been found to range from 27.4 – 139.0 m (89.9 – 456.0 ft) for adults (Strang 1983, Ross et al. 1991, Ernst 2001a). Terrestrial maximum daily movements of adults from 410 – 900 m (1345 – 2953 ft; Tuttle 1996, Ernst 2001a) have been reported, while aquatic maximum daily movements (i.e., along the shoreline from overwintering to nesting habitat) of 2,940 m (9,646 ft) have been described in Québec (Walde et al. 2007). Average juvenile daily movements of 89.5 m (293.6 ft) were documented in Pennsylvania, while hatchling terrestrial minimum daily movements of 7 – 34 m (23 – 112 ft) have been documented in New Jersey (Ernst 2001a, Castellano et al. 2008).

1.3.2.3 DISPERSAL

Wood turtles remain relatively close to streams and rivers during the spring and fall and often return to the water at night when air temperatures are low. During warmer summer months, they begin to disperse further distances from the water as they forage for food and as females look for suitable nesting areas (Ernst 1986). A large subset of wood turtle telemetry studies throughout their range, including Wisconsin, have documented high proportions of individuals remaining within 300 m (984 ft) of flowing water throughout their active season (Harding and Bloomer 1979, Ernst 2001a, Arvisais et al. 2002, Compton et al. 2002, Tuttle and Carroll 2003, Curtis and Vila 2015, Brown et al. in press, Wilder unpublished data). Juveniles tracked in northern Wisconsin were most frequently found within 3 m (10 ft) of the river channel; however, movements up to 40 m (131 ft) from the waters' edge were recorded (Brewster and Brewster 1991). A small proportion of wood turtles have been found dispersing longer distances (i.e., 400 – 933 m [1,312 – 3,061 ft]) from moving water throughout their range (Compton 1999, Tuttle and Carroll 2005, Remsburg et al. 2006, Jones 2009, Parren 2013, Brown et al. in press). In Wisconsin, turtles have been tracked as far as 1,200 m (3,937 ft) from moving water (WDNR unpublished data, Wilder unpublished data). Wood turtle movements along river corridors are more extensive than perpendicular terrestrial movements. In Vermont, wood turtles regularly travel 130 – 1,602 m (427 – 5,256 ft; Parren 2013) along stream corridors, while in Wisconsin, maximum movements have been reported from 1.6 – 16 km (1.0 – 9.9 mi), and are typically associated with males searching for females or females migrating to nesting habitat (Brown and Lapin in press, Wilder unpublished data).

1.3.2.4 HOME RANGE

Research in Wisconsin suggests wood turtle home ranges can be quite variable. Ross et al. (1991) documented home ranges of 0.08 – 0.91 ha (.20 – 2.25 ac, $n = 7$), using minimum convex polygon (MCP) estimates, while Harding and Bloomer (1979) documented home ranges in Wisconsin of 0.48 – 0.91 ha (1.19 – 2.25 ac, $n = 2$; home range estimator and locality unknown). The average home range size (95% adaptive kernels) for adult male wood turtles in northwest Wisconsin was 17.3 ha (range = 14.8-21.1; $n = 3$), whereas the average home range size for adult female wood turtles was 20.5 ha (range = 1.8-87.6; $n = 6$) in northwest Wisconsin and 7.4 ha

(range = 4.0-12.4; *n* = 7) in northeast Wisconsin (Lapin et al. 2016). Wilder (unpublished data) described home range estimates up to 278.3 ha (687.7 ac) in central Wisconsin (home range estimator unknown). Home range (MCP) in northern Michigan averaged 30.2 ha (74.6 ac) and ranged from 0.2 – 390.0 ha (0.5 – 963.7 ac; Remsburg et al. 2006), while in Québec, home range similarly averaged 28.3 ha (69.9 ac) and ranged from 1.4 – 131.8 ha (3.5 – 325.7 ac; Arvisais et al. 2002). Home ranges are thought to increase with latitude (Arvisais et al. 2002), or as a result of habitat quality and drought (Remsburg et al. 2006).

1.3.3 REPRODUCTION

Wood turtles typically reach sexual maturity around 14 – 18 years of age (Farrell and Graham 1991, Brooks et al. 1992). Harding (1997) also describes that maturation can be as early as 12 years and as late as 20 years. Mating generally takes place in 0.1 – 1.2 m (0.3 – 3.9 ft) of water; however, terrestrial copulation has also been observed (Vogt 1981, Ernst 1986, Walde et al. 2003). Females nest in Wisconsin from 20 May to July 7, though it is quite uncommon after 30 June (Lapin et al. 2016, reviewed by Brown and Lapin in press). Preferred nesting areas include well-drained yet moist soils that are free of rocks and thick vegetation, with direct sunlight exposure, 2.0 – 5.0 m (6.6 – 16.4 ft) above water levels, and within 40 m (131 ft) of flowing water (Harding and Bloomer 1979, Buech et al. 1997). Most nests are located within 10 m (33 ft) of flowing water, but some females have been documented nesting up to 150 m (492 ft) away (Walde et al. 2007). Females will typically lay one clutch a year (occasionally two); however, clutches may not be laid every year (Akre 2002). Clutch sizes in northern Wisconsin range from 3 – 17 eggs (Brown and Lapin in press). Clutch sizes are known to be as high as 20 eggs elsewhere in their range (Walde and Saumure 2008). In Wisconsin, average clutch sizes of 8 (Vogt 1981) and 11 (Ross et al. 1991, Brown and Lapin in press) have also been documented. Higher nesting success is correlated with clutches laid earlier in the nesting season and when clutches contain ≥ 5 eggs (Walde et al. 2007, Brown and Lapin in press). Incubation periods of 77 and 86 days in subsequent years have been reported in Québec (Walde et al. 2007). Hatchlings emerge from the nest between August and October in Wisconsin (Lapin et al. 2016). Hatchlings rarely overwinter in the nest, and are thought to survive terrestrial overwintering only in the warmest of winters (Parren and Rice 2004, Brown and Lapin in press).

1.3.4 POPULATIONS

Over the past century, wood turtles are thought to have experienced population declines throughout their range. A large proportion of current populations are considered small and isolated. Due to these trends, many populations are thought to be quasi-extirpated on a local and regional scale. Population size estimates throughout the species' range, though limited in number, generally range from 66 – 238 individuals per population with estimates as high as 699 individuals (Farrell and Graham 1991, Daigle 1997, Walde et al. 2003). Using Lincoln-Peterson mark-recapture estimator, the population estimate for wood turtles on a 12-mile stretch of river in Oneida County was 105 with a 95% confidence interval of 73 to 138 in 2015. The population estimate for wood turtles on an 11-mile stretch of river in Washburn County was 44 with a 95% confidence interval of 20 to 68 in 2015 (Lapin et al. 2016). There has been no effort to document statewide numbers in Wisconsin or the United States; however, 6,000 – 12,000 individuals are estimated to occur throughout their range Canada (COSEWIC 2007).

Wood turtle densities can fluctuate within a population as well as between populations. Brooks et al. (1992) estimated densities as low as 0.24/ha (0.59/ac) across suitable habitat in Ontario, whereas densities of 19.1/ha (47.2/ac; Niederberger and Seidel 1999) in West Virginia, 52.3/ha (129.2/ac; Jones 2009) in Massachusetts and New Hampshire, and 90/ha (222.4/ac; Foscarini and Brooks 1997) in Ontario represent the highest reported estimates throughout their range. Density estimates have not been described in Wisconsin.

Many studies have described female-biased or male-biased sex ratios for wood turtle populations. Sex ratios reported throughout North America range from 1.6:1 – 1:4.1 (M:F; Farrell and Graham 1991, Quinn and Tate 1991). However, sex ratios are generally closer to 1:1 after search biases (i.e., surveys for nesting females) have been accounted for (Walde et al. 2003), though this may not always be the case. Sex ratios of wood turtles in Wisconsin, all of which include nesting females, range from 1:1.1 – 1:4.7 (Ratner and Anderson 1978, Ross et al. 1991, Lapin et al. 2016, WDNR unpublished data, in Brown and Lapin in press). Adult to juvenile ratios are also highly variable and dependent on numerous environmental and human-related constraints. Caution is urged prior to calculating juvenile to adult ratios: juveniles tend to be less visible, and they may not always use the same habitat (e.g., nesting sites) as frequently as their adult counterparts. Adult to juvenile ratios throughout North America have been calculated to range in extremes from 1.1:1 – 61:1 (Jones and Willey 2013, Berg 2014). Wisconsin populations are likewise found to proportionately favor adults (3.4:1 – 22.8:1; Ross et al. 1991, Lapin et al. 2016, WDNR unpublished data, Brown and Lapin in press). Populations with a higher proportion of adults are typically indicative of unhealthy populations representing poor recruitment (Garber and Burger 1995, Compton 1999).

1.3.5 LONGEVITY

Although scientists utilize growth rings on the plastron to document age, it may only reliably predict the age of a wood turtle up to 15 – 20 years old (Harding and Bloomer 1979). Therefore, recapture studies are considered the best way to assess longevity in wild individuals. Ernst (2001a) reported a wild wood turtle reaching 46 years of age, while Oliver (1955) documented a captive turtle at 58 years old. More recently, Brown et al. (2015) reported recaptures of wild individuals that included a minimum-age male of 48 years old and a minimum-age female of 55 years old.

1.3.6 SURVIVORSHIP

Survivorship in wood turtles is representative of a Type III survivorship curve (Akre 2002). In this curve, mortality of wood turtles is extremely high at the hatchling stage, slowly lessening with age until they reach a survival bottleneck (i.e., threshold size). Once adulthood is reached, mortality from natural causes becomes extremely low. Hatchling survivorship (i.e., nest emergence until first winter dormancy) in Ontario was found to be 11% (Patterson et al. 2012), while in Virginia, a survival rate of 19% was documented under similar circumstances (Dragon unpublished data). Young adult wood turtles are thought to have mortality rates twice as high as old adults (Jones 2009). Akre and Ernst (2006) documented Virginia juvenile and adult survivorship between 0.8 – 0.92 on an annual basis. Wicklow (unpublished data) reported annual adult survivorship of 0.93 over a nine year period in New Hampshire, while Compton (1999)

documented slightly higher adult survival rates of 0.96 – 1.0 in Maine, noting lower rates of 0.92 – 0.96 if lost turtles with transmitters were assumed dead. In two northern Wisconsin populations, the overall Kaplan-Meier (K-M) survival probability for an entire monitoring period of 494 days was 0.734 (*SE* = 0.046). Annual K-M survival probabilities were 0.844 (*SE* = 0.084) for 2014 and 0.762 (*SE* = 0.094) for 2015 (Lapin et al. 2016).

Population viability for the wood turtle has been little studied in comparison to other rare North American turtles. Compton (1999) however created a demographic model for a theoretical population of wood turtles in Maine. Compton modeled the population effects when one, two, and three adults were removed annually from an initial population of 100 individuals. Once reproduction/recruitment approaches zero, the model predicted population extinction would occur in 50 years (removal of three/year), 75 years (removal of two/year), and 100 years (removal of one/year).

1.4 THREATS

1.4.1 HABITAT LOSS

Habitat destruction and modification are widely considered to be the most serious threats to wood turtle populations (Harding 1991, Levell 2000, Ernst 2001b). Urbanization, recreation, some agricultural practices, and flood control (i.e., dams and stream channelization/stabilization) in suitable wood turtle habitat are often associated with localized habitat loss, alteration, and fragmentation (Jones et al. 2015). These threats may eliminate or modify all or a significant portion of the critical habitat wood turtles need for nesting, foraging, and overwintering (Harding and Bloomer 1979, Garber and Burger 1995, Saumure et al. 2007, Castellano et al. 2009). Foraging and nesting grounds often become overgrown by succession due to a lack of natural disturbance (i.e., fire, flooding, and beavers) and are often infiltrated by invasive plants (Thayer et al. 2008, Jones et al. 2015). Flood control measures prevent or slow sand and gravel from distributing downstream to enhance or create new nesting sites (Buech et al. 1997, Bowen and Gillingham 2004). Wood turtles respond to this decline of suitable nesting habitat by searching elsewhere, often finding sandy or gravelly substrates in fragmented habitats near roads and bridges that serve as ecological sinks or traps. Roads also contribute to direct mortality of individuals moving from one fragmented habitat to another, and subsequently provide easier access for predators (e.g., raccoons) and humans to exploit nests and adults (OWTRT 2010). Fragmented habitats also promote further isolation of populations by minimizing natural recolonization attempts into previously extirpated areas and by lessening inter-population exchange of individuals (Harding and Bloomer 1979). Pollution and agricultural pesticides that filter into rivers and streams are also suspected of causing population declines in some areas (Harding and Bloomer 1979, Saumure et al. 2007). It is unclear what effects climate change will have on wood turtles; however, anticipated changes (e.g., increase in storm frequencies, and more pronounced flood and drought intensities) may impact nest success, adult survival, and diminish quality habitat required for basking, cover, food, nesting, and overwintering (WICCI 2011).

1.4.2 ADULT REMOVAL

Wood turtles have low fecundity, delayed maturity, and high hatchling/juvenile mortality levels (Jones et al. 2015). Therefore, the consistent annual removal of one or more adults from a population can be detrimental to future population sustainability (Compton 1999). Road mortality of adult wood turtles is a significant issue in areas with increasing human population pressures (i.e., high road and traffic densities; Harding and Bloomer 1979, Levell 2000, Akre and Ernst 2006). Females make up a higher proportion of road mortality cases, due to their annual upland forays to lay eggs in suitable nesting grounds (Steen et al. 2006, Thayer et al. 2008). Adult turtles, in addition, are found crushed by agricultural and utility equipment in many parts of their global range (Daigle and Jutras 2005, Akre and Ernst 2006, Saumure et al. 2007), although the level of mortality from these sources in Wisconsin has not been quantified. Adult predation by raccoons and humans (illegal shooting/poaching) has been reported in some cases to cause population declines (Harding and Bloomer 1979). Localized declines are also associated with the over-collection of wild individuals for human use. Harding and Bloomer (1979) emphasized that many wild wood turtles were sent to Wisconsin biological supply houses historically or collected for use in food markets; however, individuals now are more typically smuggled into the pet trade industry in states and countries where there are no laws protecting the trade of this species (Harding 1991, Ernst et al. 1994, Levell 2000). Commercial collecting for the pet trade is known to be the single greatest cause of local wood turtle population crashes (Litzgus and Brooks 1996). Adults are also displaced from habitats by flooding events and in areas associated with human recreational usage or urbanization (Garber and Burger 1995, Jones and Sievert 2009). Disease is not yet a major cause of decline in adults, but preventative measures to minimize and control disease spread are emphasized as emerging pathogens are becoming more widespread in herptiles across the globe (Jones et al. 2015).

1.4.3 LOW RECRUITMENT

As a result of extremely low and reduced levels of hatchling/juvenile recruitment, many wood turtle populations display high proportions of adults to young (reviewed by Jones et al. 2015). Nest predation (especially from raccoons and skunks) is common in highly urbanized and fragmented landscapes (Mitchell and Klemens 2000), although high predation rates in non-fragmented and remote locations are also possible. In many populations, unnaturally high nest predation rates are in excess of 80%, and nearing 100% in easily accessible roadside nests (Brooks et al. 1992, Foscarini 1994, Steen et al. 2006). Predators of wood turtle eggs are raccoons, skunks, foxes, coyotes, badgers, opossums, ravens, crows, red squirrels, and chipmunks (Harding and Bloomer 1979, Lapin et al. 2016). Once surviving individuals have left the nest, hatchlings and juveniles are heavily predated by chipmunks, numerous bird species, fish, cats, dogs, raccoons, skunks, and opossums (Figure 6; Harding and Bloomer 1979, Tuttle and Carroll 2005). Low nest success has also been attributed to widespread nest failures in cool years at northern latitudes, delayed nesting timeframes, and from flooding of nests due to upstream modifications of hydrology (Compton 1999, Wesley 2006, Spradling et al. 2010, Lapin et al. 2016). Furthermore, nests laid later in the nesting season have lower rates of success. Later nesting can generally be linked to the inexperience of younger nesting females, females spending more time searching for suitable nesting habitat, or females delaying nesting activities because of

human disturbance (Walde et al. 2007). Late season nesting success is further suppressed by nestlings' inability to overwinter in their nests. Wood turtle eggs need adequate time to develop and subsequently hatch prior to temperatures dropping below certain thresholds (Harding and Bloomer 1979, Brooks et al. 1992, Buech et al. 2004).

Figure 6. Wood turtle hatchlings (photograph by Andrew Badje, WDNR).

1.5 CONSERVATION AND MANAGEMENT

North American wood turtle conservation objectives have focused on increasing knowledge of local and regional distribution and abundance. Natural Heritage programs and herpetological atlas projects (i.e., HerpMapper, Pennsylvania Amphibian and Reptile Survey, Vermont Reptile and Amphibian Atlas, and Wisconsin Herp Atlas) are systems that catalogue wood turtle sightings, consequently contributing to an increased knowledge of current distributions (Bowen and Gillingham 2004, Jones et al. 2015). Wildlife biologists and natural resource managers utilize these occurrences when deciding where to focus presence/absence surveys, long-term monitoring efforts, and ecological, habitat, and demographic research (OWTRT 2010, Jones et al. 2015).

Current land management efforts emphasize habitat restoration and the protection of critical habitat such as overwintering and nesting sites. The creation and restoration of wood turtle nesting grounds has been widely used to combat succession and invasive species that have arisen as a result of the absence of natural disturbances (e.g., fire and flooding; Harding 1991, Buech et al. 1997, Bowen and Gillingham 2004). By enhancing naturally occurring nest sites away from fragmented habitat, females nesting at less suitable habitat (e.g., roads, logging roads, yards, and railroads) can be enticed to relocate to these restored sites that typically exhibit higher nest hatching success rates and are safer for adult females (OWTRT 2010). Artificial nesting mounds have also been used successfully in cases where existing natural nesting habitat is threatened by development (Jones et al. 2015). Nest exclusion cages and electric fencing have been utilized and are shown to increase hatch rates in areas with high nest predation (Levell 2000, Lapin et al. 2016). Experimentation with captive breeding and direct release have also been used in an

attempt to increase juvenile recruitment, augment declining populations, and to reintroduce turtles into previously extirpated habitat (Harding and Bloomer 1979, OWTRT 2010, Jones et al. 2015). Habitat restoration strategies attempt to maintain habitats with a mosaic of wetlands that are adjacent to semi-forested and forested uplands, which contain a balance of open areas and structural diversity for foraging and thermoregulation (WDNR 2015). Public and private conservation groups also use landowner education programs to educate and encourage landowners in suitable wood turtle habitat to use best management practices. Additional efforts have designated regions as "wood turtle emphasis" areas that provide wood turtle-specific management recommendations (Jones et al. 2015).

Conservation biologists use many tactics in an attempt to minimize the removal of adults from wild populations. Most states within wood turtle range have enacted regulatory protection measures that prohibit the collection of this species for the pet trade or for food consumption (Niederberger and Seidel 1999). The wood turtle was also added to Appendix II of the Convention on the International Trade of Endangered Species of Flora and Fauna (CITES) in 1992 to strictly regulate their international trade (Buhlmann 1992, 1993). Despite these regulations, Jones et al. (2015) claim that current regulations are minimal and inadequate in most range states and do not strongly protect critical nesting, foraging, and overwintering habitat. Law enforcement officials are occasionally trained on wood turtle identification to apprehend wildlife traffickers during smuggling events (OWTRT 2010). Education measures regarding the decline of wood turtles have also been widely used in range states to lessen the accidental removal of adults from the wild by uneducated members of the public (Harding and Bloomer 1979).

In areas of high wood turtle road mortality, turtle road crossing signs may be placed to notify passing motorists to slow down and avoid turtles crossing roads (OWTRT 2010). On stretches of road with higher conservation consequences, wildlife friendly underpasses (i.e., bridges and culverts) with adjacent fencing have been constructed and are used to guide wood turtles to safe passage under the road (Kaye et al. 2006, WDNR 2015). Many road maintenance crews in range states utilize exclusion fencing to prevent wood turtles from accessing work areas during planned road maintenance or construction projects (OWTRT 2010). In areas with known agricultural mortality, conservationists urge mower blade heights to be raised to 10.0 – 15.0 cm (3.9 – 5.9 in) on farm equipment (Saumure et al. 2007, Parren 2013). Erb and Jones (2011) further urge the use of sickle bar mowers over rotary mowers to lessen mortality rates.

2. RESEARCH AND CONSERVATION MEASURES IN WISCONSIN

2.1 INVENTORY AND MONITORING

Current systematic inventory and monitoring efforts for wood turtles in Wisconsin have been focused towards population assessments and presence/absence surveys. Population assessments are ongoing in Douglas County, where an annual spring river survey has occurred since 2002, with a permanent capture – mark – recapture (CMR) component which started in 2009. In a separate watershed in Douglas County, a CMR study was initiated in 2015 and will continue in 2016 using Passive Integration Transmitters (PIT) tags to mark individuals and establish a population estimate. In Portage County, an additional CMR study is underway to determine the effectiveness of mitigation and minimization measures on a busy stretch of State Highway through known wood turtle habitat.

The WDNR recently completed a 2-year (2014-2015) wood turtle project funded by a Competitive State Wildlife Grant (SWG-C) from the U.S. Fish and Wildlife Service (Lapin et al. 2016). The project included several components on the Tomahawk and Squirrel rivers in Oneida County and the Namekagon and Totagatic rivers in Washburn and Burnett counties, including the first ever CMR study completed in the state using PIT tags, radio telemetry, nest site restoration and creation, nest protection, and installation of barriers to road access. Project results are covered in more detail in Section 2.3.

Presence/absence surveys have been completed throughout the state and in suitable wood turtle habitat. These include surveys done in conjunction with state lands biotic inventory work performed during the initial stage of the Master Planning process for state properties. Work is performed by qualified contractors or Wisconsin DNR biologists. The U.S. Forest Service also maintains an inventory of wood turtle observations on the Nicolet District of the Chequamegon-Nicolet National Forest in a geo-database format.

In response to an increased awareness of turtle road mortality in Wisconsin, the Wisconsin Turtle Conservation Program (WTCP) was initiated in 2012 by the WDNR. The WTCP, a citizen-based monitoring program, was designed to better catalog dangerous road crossings, nesting areas, and statewide occurrences for Wisconsin's 11 turtle species. The WTCP provides an opportunity for Wisconsin citizens to become more involved and better educated in conserving native turtles. Since the program's inception, volunteers have submitted over 300 turtle reports per year. Data acquired through volunteer submissions subsequently promotes more efficient and effective conservation practices that lessen project costs. The wood turtle has benefitted greatly from the WTCP in that it has served as an educational tool for species conservation, a method to increase knowledge on the species distribution, and to protect them in areas along dangerous road stretches.

2.2 NEST SITE MANAGEMENT

Surveys to inventory potential wood turtle nesting sites have been incorporated into state lands biotic inventory work in support of state property Master Planning. Additional methods for this inventory work include visiting potential nesting sites during the nesting season to document

their use. Following the initial inventory of available nesting sites, threats are assessed and are then forwarded to appropriate property managers to encourage use of appropriate conservation actions. Wood turtle nest site conservation actions in Wisconsin currently include nest site creation (both natural and artificial), the expansion and restoration of sites that are overgrown from natural succession, and the installation of nest cages and/or electric fencing to deter predators and minimize predation levels (Figure 7; see Section 2.3 for results of Nest Site Management conducted as part of the SWG-C Project described above). Much of this work occurs on state-owned wildlife and fisheries areas, state forests, and wild rivers; however, nest site management on private lands is increasing across the state. Similar nest site creation/monitoring work is also occurring on National Forest lands in Oconto and Forest Counties.

Figure 7. Nest cage installed over a wood turtle nest (left; photograph by Carly Lapin, WDNR). Electric fence installed around a wood turtle nest site that is designed to deter predators, but allow for turtle access (right; photograph by Michele Woodford, WDNR).

2.3 COMPETITIVE STATE WILDLIFE GRANT

The WDNR completed a two-year (2014-2015) wood turtle research project in northern Wisconsin that was funded by a Competitive State Wildlife Grant (shared with Minnesota, Michigan, and Iowa for riverine turtle conservation). Using capture-mark-recapture (CMR) and radio telemetry, the WDNR completed the first robust mark-recapture study of wood turtles in the state, and studied the movements of wood turtles in Oneida and Washburn counties to understand threats to wood turtle populations, including nest predation and road crossing locations (Figure 8). In addition, the WDNR tested various conservation strategies including nest habitat restoration in locations away from roads and above flood stage, nest protection devices, and road crossing barriers to prevent road mortality.

Wood turtle surveys were conducted on four river stretches in Oneida, Washburn, and Burnett counties in 2014 and 2015. A total of 99 wood turtles were captured, documented, and PIT-tagged over the course of the surveys, and population estimates for two of the river stretches were derived using the Lincoln-Petersen mark-recapture estimator used by Chapman (1951) with variance and 95% confidence intervals (Seber 1982). For population estimate results see Section 1.3.4.

Wood turtle movements (n = 32) were recorded in all three counties with the use of ultra-high frequency radio-transmitters (model A1-2FM, Holohil Systems Ltd., Carp, Ontario, Canada) and GPS Geolocating Tags (GPS Bugs, Lotek Wireless Fish & Wildlife Monitoring, Newmarket, Ontario, Canada) to help understand threats, including road crossing locations, and document nest sites. Ninety-five percent adaptive kernel home ranges were derived for those animals that had enough visual or high-quality telemetry locations (minimum of 20 locations, 1 per 24 hr period, that had error ellipses ≤20 ha), excluding nesting movements, using ArcView 3.3 with the Animal Movement Extension (Hooge and Eichenlaub 2000). Home range results are summarized in Section 1.3.2.4.

Adult wood turtle mortality was also documented over the course of the study, and adult turtle survival was estimated with the Kaplan-Meier (K-M; Pollock et al. 1989) method in Systat 2.0 (SPSS, Inc., Chicago, IL). Most wood turtle mortalities occurred during the summer months. All of the female mortalities (n = 5) occurred during or immediately after the nesting period (mid-June to early July). There were two male mortalities; one occurred during the winter of 2014-2015, and the other occurred in July 2015. Only one mortality, a female in 2014, was determined to be from unnatural causes (car-kill); all other mortalities appeared to be the result of exposure, predation, and/or drowning. The covariates sex and age had no statistically significant effect on adult turtle survival, so all data was pooled for K-M analyses. Results from annual and overall K-M survival probabilities are discussed more in depth in Section 1.3.6.

Locations for potential nest site restoration were identified along the four river stretches in Oneida, Washburn, and Burnett counties in 2013. Sites were considered suitable if they were away from roads, close to (visible from) the water, above flood stage, relatively free of trees, and had south-, southwest-, or west-facing slopes. The sites were located on state and private properties, and they were prepared by clearing brush and trees by hand, followed by removal of roots and topsoil, either with a rototiller or bulldozer. A strip of vegetation was maintained between the water and the nest site at all locations to prevent erosion and runoff into the waterway. All sites have been continually maintained in a vegetation-free state by hand pulling and mechanical means (rototiller and weed whip). Ten nest sites were restored, totaling 0.81 ha (2.0 ac); wood turtles, as well as snapping and painted turtles, were documented nesting at five of the 10 sites in 2015.

Wood turtle nests were identified with intensive nesting-period monitoring in both years of the study. Approximately half of the nests (52%) were protected with either individual nest cages or by being relocated to a restored nest site protected by electric fencing. The nests were monitored regularly until predation, hatching, or winter freeze-up. Over the course of the two-year project, 69 wood turtle nests were documented. Of these, 17% (6/36) of protected nests and 52% (17/33) of unprotected nests were depredated. All depredations appeared to be caused by mammals. A total of 239 wood turtle hatchlings (an incomplete count) were documented leaving nests in both years of the study.

Within the project areas, 12 locations were identified where wood turtles were crossing roads. Turtle crossing road signs were installed at seven of the locations. Road crossing barriers were installed at four locations in an attempt to prevent wood turtles from accessing the roads, with

mixed results. Barriers are not feasible in all locations and, while they do prevent some turtles from crossing roads, not all turtles are dissuaded.

Figure 8. Wood turtle with ultra-high frequency (UHF) radio-transmitter attached (photograph by Andrew Badje, WDNR).

3. STATE STATUS AND LISTING CRITERIA

3.1 PREVIOUS LISTING STATUS AND STATE CONSERVATION RANK

The wood turtle was listed as a state endangered species by the WDNR in 1975 as a result of a "declining population, limited range, habitat destruction, nest predation, and commercial collection." In 1982, the wood turtle was down-listed to threatened, due to an "increasing population and a larger distribution than originally thought in 1975—a range covering 25 counties throughout the northern ¾ of the state" (Figure 9).

Established in 1985 by the Wisconsin legislature, Wisconsin's Natural Heritage Inventory program (NHI) is responsible for maintaining data on the locations and status of rare species, natural communities and natural features throughout the state. All NHI programs use a standard methodology for collecting, characterizing, and managing data, making it possible to combine data at various scales to address local, state, regional and national issues. The methodology was developed by The Nature Conservancy and is currently coordinated by NatureServe, an international non-profit organization. A key feature of the NHI methodology is a system for assessing rarity of species and communities at the global (G) and state (S) level using a suite of factors to assess the extinction or extirpation risk. NHI programs are responsible for assigning state conservation ranks (SRank) to species found within their boundaries. Because SRanks are dynamic and can reflect changes in population condition and new information quickly, they have proven useful in directing action toward species most in need of conservation. SRanks are independent of a state or federal legal status, but often serve as triggers for reassessing protection status and for designating Species of Conservation Concern. SRanks for extant species typically range from S1 (critically imperiled) to S5 (secure). In 2009, NatureServe developed a Conservation Rank Calculator to support the process of assigning SRanks, which takes into account the number of populations, range extent, area occupied, threats, and trends (see Section 6.0 for additional information on SRanks and the Conservation Rank Calculator). The wood turtle was ranked as a S3 species in Wisconsin in 1993, in 2006 the SRank was recalculated and changed to S2, and in 2012 the SRank was calculated again and returned to a S3 based on current scientific data and additional information that was available at that time.

The Wisconsin NHI Program stores data in a database built specifically for the Heritage Network. Within the NHI database, species (or "element") observations are grouped into element occurrences (EOs). An EO is a locational record representing a single, extant habitat, which sustains or otherwise contributes to the survival of a population. For reptiles, EOs are meant to represent individual populations, and NatureServe maintains criteria for the minimum distances between observation records before they can be considered distinct populations. When the wood turtle was first listed in 1975, 22 EOs were known for this species (Figure 9). When the wood turtle was moved to threatened status in 1982, 75 EOs were documented for this species. This number has continued to increase over the past several decades. In February 2016, 301 EOs were known for this species.

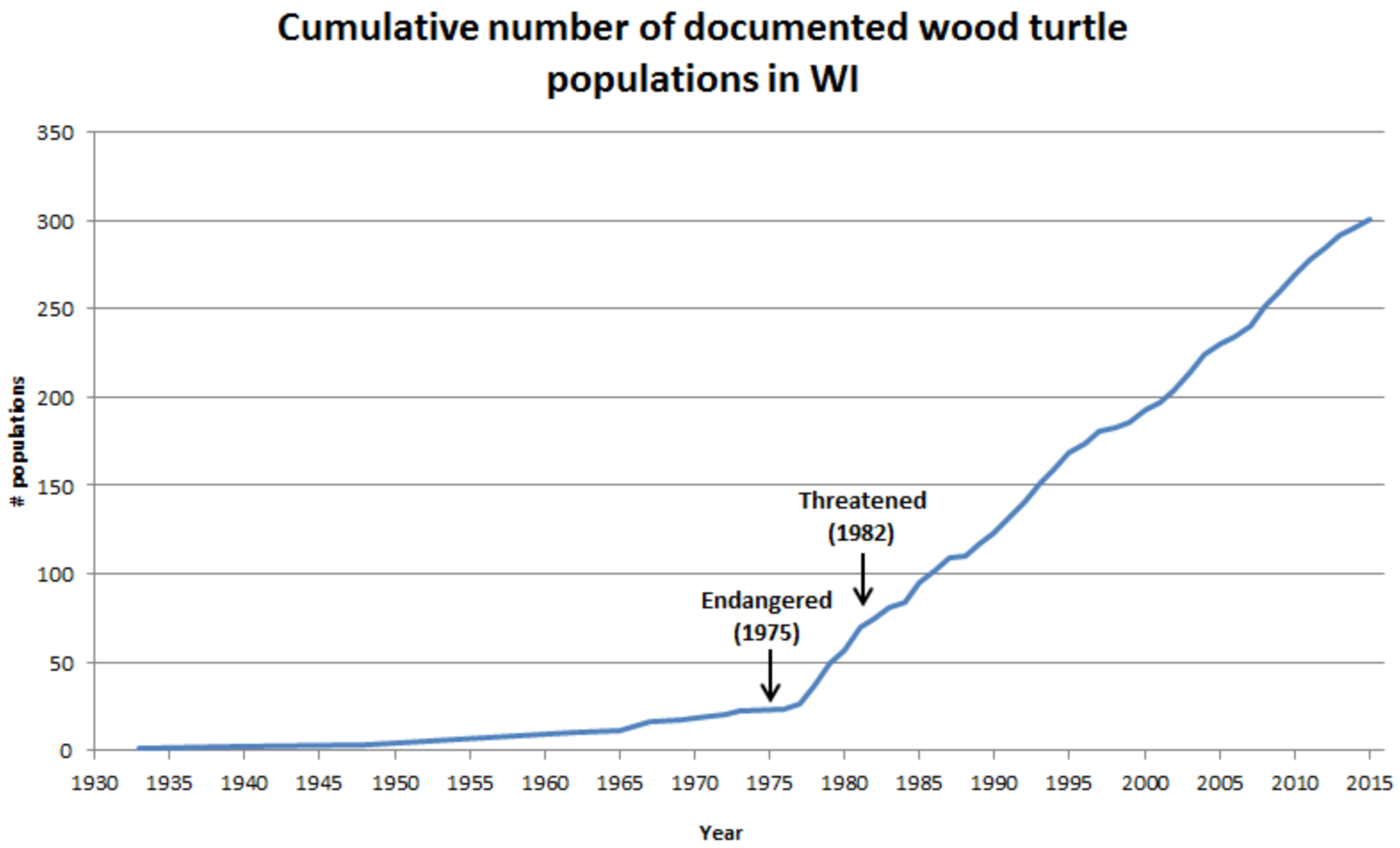


Figure 9. Wood turtle element occurrence (EO) count by year observed through 2016 (WDNR 2016).

3.2 CRITERIA FOR DETERMINING STATE STATUS

The wood turtle's state conservation rank (SRank) will be periodically calculated through NatureServe's Conservation Rank Calculator. The SRank will then be used to determine the state status of the wood turtle according to Table 2. For additional information on SRank and NatureServe's Conservation Rank Calculator see Sections 3.1 and 6.0.

Wood Turtle State Conservation Rank (SRank)	**Proposed Status***
S1 - Critically imperiled in WI due to a very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.	Endangered
S2 - Imperiled in WI due to a restricted range, few populations or occurrences, steep declines, severe threats, or other factors.	Threatened
S3 - Vulnerable in WI due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.	Special Concern, Protected Wild Animal, No harvest/collection allowed
S4 - Apparently secure in WI due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.	Protected Wild Animal, No harvest/collection allowed
S5 – Secure in WI due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.	Standard turtle harvest regulations

Table 2. Wood turtle state conservation rank and associated legal status.

Following the initiation of long-term monitoring and completion of a PVA (see Section 4.0), data collected through these efforts will be used to reassess the State Conservation Rank. Additional triggers that would lead to a reassessment of the wood turtle's status include, but are not limited to, emerging diseases or other large-scale threats.

**Status criteria specifically reference s. 29.604 Wis. Stats. and NR 10.02, 19.275, 21.13, 22.13, 27.03 Wis. Admin Code. Additional regulations regarding sale, possession, etc. may still apply.*

3.3 PROPOSED STATE STATUS

Wisconsin's most recent endangered/threatened species list revision process was finalized in 2014. At that time, the WDNR retained the threatened status for the wood turtle and committed to re-assess its status following the completion of a Competitive State Wildlife Grant (SWG-C) wood turtle research project being conducted jointly with Minnesota, Michigan, and Iowa. The WDNR began the process of drafting this conservation strategy after this SWG-C had been completed in the fall of 2015 (Lapin et al. 2016). In February 2016, the WDNR contacted individuals with scientific knowledge of wood turtles in Wisconsin, requesting data that could be used during the re-assessment of the wood turtle's status in Wisconsin.

The wood turtle's state status was reassessed using existing WDNR data (e.g., increased amount of survey data, site viability and rank information, threats, data submitted by external stakeholders, and newly acquired SWG-C data). NatureServe's Conservation Rank Calculator was used to calculate a base SRank (see Sections 3.1 and 6.0 for additional information on SRanks and NatureServe's Conservation Rank Calculator). The Conservation Rank Calculator assigned a SRank of S3, exhibiting no change since the previous revision in 2012. Following the base calculation, several different scenarios incorporating changes to trend and threat estimates were run through the Conservation Rank Calculator. All resulting scenarios resulted in a SRank of S3.

Legal definitions of endangered and threatened under Wisconsin's Endangered Species Law (*s. 29.604 Wis. Stats.*) were also referenced:

> Endangered Species – any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the department to be in jeopardy on the basis of scientific evidence.
>
> Threatened Species – any species of wild animals or wild plants which appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.

Based on the Conservation Rank Calculator, the wood turtle continues to meet the definition of a S3 species. However, the wood turtle no longer meets the legal definition of an endangered or threatened species in Wisconsin. Therefore the wood turtle has been proposed to be down-listed from a state threatened species to a species of special concern and a protected wild animal (NR 10.02 Wis. Admin Code) with no harvest or collection allowed (NR 19.275, 21.13, 22.13, 27.03 Wis. Admin Code).

4. CONSERVATION STRATEGY

The primary goals of the Wisconsin Wood Turtle Conservation Strategy are to establish a program to monitor wood turtle status into the future, ensure wood turtle populations remain viable, and effectively manage the species throughout the state.

4.1 STRATEGY JUSTIFICATION

The Wisconsin Wood Turtle Conservation Strategy is based on:

- The establishment of a scientifically defensible conservation strategy that defines and prioritizes effective and efficient conservation actions for the wood turtle.
- The WDNR's commitment to maintain the wood turtle as an integral and viable part of Wisconsin's natural heritage indefinitely.

Population declines have been reported throughout the wood turtle's range; however, there are few quantitative studies that document specific declines. Intensive surveys at a subset of strategically chosen populations in Wisconsin will help establish quantifiable baseline data from which population viability and trends can be documented and monitored indefinitely, allowing WDNR to quickly and easily examine the listing status of the species (Section 3.2).

A series of objectives have been defined by the WDNR in order to assess current research needs and to develop a long-term conservation strategy for the wood turtle in Wisconsin.

4.2 CONSERVATION OBJECTIVES

To achieve the overall objective of having sustainable wood turtle populations in Wisconsin, the WDNR has established four objectives:

1. Obtain Additional Distribution and Viability Data
2. Quantify Local, Regional, and Statewide Trends
3. Conduct a Population Viability Analysis (PVA)
4. Prioritize Conservation Actions

4.2.1 OBTAIN ADDITIONAL DISTRIBUTION AND VIABILITY DATA

Wisconsin has substantially added to its distributional knowledge of the wood turtle since the species was first listed as endangered in 1975 (Figure 9). Distributional data have been provided through a variety of survey efforts, WDNR biotic inventory work, verified observations and reports, and various herpetological atlas projects (i.e., HerpMapper, Wisconsin Herp Atlas, and Wisconsin Turtle Conservation Program).

Additional data would help to further document the distribution, demography, and viability of populations throughout the state. Presence/absence surveys in under-surveyed areas (i.e., small

streams and private property) can provide a better picture of population extent and connectivity among adjacent EOs. In addition, many wood turtle EOs in Wisconsin would benefit from more detailed viability data (WDNR 2016). By implementing the following recommended actions, the overall status of wood turtles in Wisconsin can be more accurately and repeatedly assessed.

PRIORITY CONSERVATION ACTIONS:

- Continue to obtain distribution, demographic, and viability data through WDNR and external partner projects.
- Continue to obtain baseline information on population size, demography, and viability for data deficient EOs.
- Develop a presence/absence survey protocol to be utilized within navigable waterways.
- Targeted survey efforts for underrepresented areas (e.g., small streams or streams flowing through private property).
- Work with landowners and external partners to refine the Natural Heritage Inventory's list of viable and non-viable wood turtle populations.

4.2.2 QUANTIFY LOCAL, REGIONAL, AND STATEWIDE TRENDS

In order to better document local, regional, and statewide trends, a network of long-term reference sites encompassing the full range of wood turtle habitat types and qualities in Wisconsin will be established. Reference sites will consist of a diverse subset of ecosystems and watersheds and will include sites that face a variety of threats and sites where conservation actions have been implemented. At the selected reference sites a standardized survey protocol will need to be completed to obtain baseline data and subsequent trend data (e.g., 5–10 year survey intervals).

PRIORITY CONSERVATION ACTIONS:

- Establish long-term reference sites throughout Wisconsin and implement a standardized survey protocol to monitor population trends and response to conservation actions.

4.2.3 POPULATION VIABILITY ANALYSIS

A Population Viability Analysis (PVA) is frequently used in endangered species management for its ability to quantitatively forecast population trends and extinction risk by utilizing information regarding species characteristics and environmental variability. The WDNR has therefore determined that conducting a PVA for wood turtles in Wisconsin is crucial in addressing the overall objective of maintaining sustainable wood turtle populations into the future (see Section 3.2 for PVA implementation into the WDNR’s future listing criteria and status listings). A PVA with limited demographic and census data often results in incorrect or highly variable results and thus makes it difficult to make accurate conservation decisions. Before conducting a PVA, the WDNR intends to expand on existing knowledge, as discussed in Sections 4.2.1 and 4.2.2. Once sufficient data have been retrieved, the WDNR will complete a PVA and use the results to prioritize the threats and subsequent conservation actions for the wood turtle in Wisconsin (see Section 4.2.4). The WDNR anticipates that the wood turtle PVA will lead to future revisions of the Wisconsin Wood Turtle Conservation Strategy.

PRIORITY CONSERVATION ACTIONS:

- Conduct a PVA to quantify wood turtle extinction risk in Wisconsin, ideally within 2-5 years.
- Conduct a PVA to determine critical life stages of the wood turtle, which will assist in identifying threats and associated conservation actions, ideally within 2-5 years.

4.2.4 PRIORITIZE CONSERVATION ACTIONS

The priority conservation actions listed below identify research needs for threats to wood turtles in Wisconsin. This research will utilize a combination of tactics to evaluate and determine which Wisconsin-specific threats are having the most significant impact on wood turtle population persistence and viability in the state. Following the completion of the research listed below, and as new research and information arises (i.e., completed PVA), threats will be prioritized in order to focus on the most effective conservation actions.

PRIORITY CONSERVATION ACTIONS:

- Research the effects of suitable nesting habitat availability on population abundance and viability.
- Continue to research nest survival among nesting sites that encompass a wide range of potential threats and physical properties.
- Research and rank the factors that contribute to unnaturally high predation rates of all wood turtle age classes.
- Research the various impacts climate change may have on wood turtle susceptibility to other stressors.
- Ranking threats to the wood turtle relative to each other in Wisconsin to focus on the most effective conservation actions.

Once threats to the wood turtle in Wisconsin have been prioritized, the WDNR and its external partners will begin to implement conservation actions that reduce high priority threats. Actions that are efficient, effective, and backed by science will be favored over actions lacking scientific validation. In addition, new conservation actions will be researched and evaluated for efficacy prior to their ranking and possible use across Wisconsin.

PRIORITY CONSERVATION ACTIONS:

- Prioritize conservation actions for the wood turtle based on the highest priority threats.
- Implement and measure the effectiveness and success of priority conservation actions.

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6. ADDITIONAL RESOURCES

WOOD TURTLE SPECIES GUIDANCE

Species guidance documents are peer-reviewed publications with comprehensive information for rare species tracked by the Natural Heritage Inventory (NHI) or identified in the Wisconsin Wildlife Action Plan as a Species of Greatest Conservation Need (SGCN). They contain identification, life history, management guidelines, screening guidance and avoidance measures and are intended for a wide variety of users, including resource managers, private landowners, contractors, students, and the general public.

The *Wood Turtle Species Guidance* document is updated frequently as new information becomes available. Please view the online version of this document (http://dnr.wi.gov/files/PDF/pubs/er/ER0684.pdf) for the most up to date version.

NATURESERVE SUBNATIONAL CONSERVATION STATUS RANK (SRANK)

Additional information on SRanks can be found on NatureServe's website (http://explorer.natureserve.org/nsranks.htm).

NATURESERVE CONSERVATION RANK CALCULATOR

NatureServe's website defines their Conservation Rank Calculator as: "a tool that automates the process of assigning a conservation status rank—an evaluation of the level of risk of extinction of species and elimination of ecosystems. It is used extensively by NatureServe and its member programs and collaborators that collect and evaluate data for species and ecosystems of concern using a common methodology. The Rank Calculator tool facilitates the accurate application of this methodology and promotes greater accuracy and consistency of the assessments. It is programmed in Microsoft Excel."

The *NatureServe Conservation Status Assessments: Methodology for Assigning Ranks* and *NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Rank* documents are updated frequently as new information becomes available. View the online version of these documents (http://www.natureserve.org/conservation-tools/conservation-rank-calculator) for the most up to date version.