2020

Virginia Wood Turtle

Conservation Plan

(Photo Credit: S. Krichbaum)

Smithsonian
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2020
Virginia Wood Turtle
Conservation Plan

Prepared by the 2020 Species Conservation Team

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Date: _____

Disclaimer

This is the 2020 Wood Turtle Conservation Plan for the Commonwealth of Virginia. It has been approved by the Virginia Department of Game and Inland Fisheries (VDGIF). It does not necessarily represent official positions or approvals of cooperating agencies and does not necessarily represent the views of all recovery team members who played a role in preparing this plan. This plan is subject to modification following as dictated by new findings, changes in species status, and completion of tasks described in the plan. Goals and objectives will be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints.

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Executive Summary

Current Species Status: The Wood Turtle (*Glyptemys insculpta*) is listed as a state threatened species (Virginia Code 4VAC15-20-130) and afforded protection under Chapter 5, Article 6 of Title 29.1 of the Code of Virginia. The species is not currently listed for federal protection under the Endangered Species Act, but the United States Fish and Wildlife Service is scheduled to assess petitions to extend such protections to the Wood Turtle by 2023 (USFWS 2017). Its range in Virginia is limited to the northernmost portion of the state, distributed across portions of the Potomac and Shenandoah River watersheds. Occurrences have been recorded for Arlington, Fairfax, Loudoun, Clarke, Frederick, Warren, Shenandoah, Page, and Rockingham counties.

Due to the increasing anthropogenic threats of habitat loss, road mortality, and illegal collection, the Wood Turtle appears to have experienced a significant range contraction across its distribution. In Virginia, the expanding metropolitan area has impacted Wood Turtles in the Piedmont to the point that very few known populations remain in the region. There are at least five different Wood Turtle population centers in the Ridge and Valley region of the state (delineated by Hydrological Unit 10 geographic coverage), but each of them has been impacted by the threats outlined above.

Conservation Goal: To maintain a network of ecologically viable populations throughout the western portion of the wood turtle's range in Virginia and to prevent uplisting to endangered status within the Commonwealth. Due to the lack of suitable habitat throughout much of the historic range, delisting from threatened status does not seem feasible at this time.

Actions Needed:

1) Develop spatially explicit Management Units (MUs) to prioritize conservation actions.

2) Develop and establish adaptive long-term monitoring protocols within MUs.

3) Analyze and respond to land use change as it pertains to Wood Turtle habitat.

4) Collaborate with law enforcement to combat the illegal pet trade.

5) Develop and implement Best Management Practices (BMPs) for landowners.

6) Engage in community outreach and education.

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I. Introduction

The Wood Turtle (*Glyptemys insculpta*) is an IUCN listed endangered species that faces numerous conservation threats across its range, including illegal collection for the black market pet trade, habitat loss and degradation, and increased anthropogenic mortality from roads and agriculture practices. As a response to declining populations, the Wood Turtle Working Group was formed within the Northeast Partners in Amphibian and Reptile Conservation in 2011 with the fundamental objective of protecting the evolutionary potential of the Wood Turtle by ensuring the persistence of functional, ecologically viable, and regionally significant populations (Jones et al. 2018). In order to meet this objective, a multi-year collaborative effort funded through a Northeast Association of Fish & Wildlife Agencies' Regional Conservation Needs Grant (RCN) and a U.S. Fish & Wildlife's Competitive State Wildlife Grant (CSWG) collected population, genetic, and landscape data for the creation of the Conservation Plan for the Wood Turtle in the Northeastern United States (Jones et al. 2018) and a Conservation Area Network (CAN) of regionally significant conservation priority sites for the Wood Turtle. The CAN was developed in a multi-tier selection process that divided sites into high priority Focal Core Areas (FCA), secondary priority Management Opportunity Sites (MOS), and non-priority sites. In Virginia, the most southern extent of the Wood Turtle's range, 16 sites were identified as FCA's and four as MOS's; these sites will serve as a foundation upon which a network of Management Units (MU) can be built within the Commonwealth. More information on the regional collaboration and its outcomes, including the regional conservation plan (Jones et al. 2018) upon which this Virginia plan was modeled, can be found at www.northeastturtles.org.

The goal of this Virginia Wood Turtle Conservation Plan is to develop a strategy for the preservation of the Wood Turtle in the Commonwealth of Virginia for the near future and in perpetuity. Ultimately, this means maintaining a landscape-level network of viable, interconnected Wood Turtle populations that preserve the ecological and evolutionary potential of the species throughout its range in the Commonwealth and abroad. The objectives outlined in the section below are intended to serve as a conservation strategy framework through which this goal can be achieved.

II. Conservation Strategy Objectives

The primary objectives of this conservation plan are as follows:

1) Develop spatially explicit Management Units (MU) encompassing the Virginia FCA's and MOS's to prioritize conservation actions related to long-term monitoring and land management;

2) Develop inventory and monitoring protocols for long-term tracking of the status and distribution of the Wood Turtle in the Commonwealth;

3) Analyze and respond to land use change as it pertains to Wood Turtle population connectivity;

4) Collaborate with law enforcement to combat the illegal pet trade and investigate options for potential repatriation;

5) Develop and implement Best Management Practices (BMPs) that will enable land managers and landowners to enact effective conservation measures.

6) Engage in community outreach and education to increase awareness of Wood Turtle conservation in the Commonwealth.

III. Ecology

A. Taxonomy

The Wood Turtle, *Glyptemys insculpta*, has undergone several changes in nomenclature since its first appearance in scientific literature. Originally described under the name *Testudo insculpta* in 1830 (Le Conte), the Wood Turtle was soon reassigned to the freshwater turtle genus *Clemmys* (Fitzinger 1835). In 1857 Louis Agassiz suggested that the Wood Turtle be placed within its own genus, *Glyptemys*, but this convention was largely ignored for over a century. The Wood Turtle retained its designation within *Clemmys* following a major restructuring of the genus in 1964, despite most other members being moved to different genera (McDowell 1964). The remaining four species of *Clemmys* were presumed to be closely related based upon shared morphological traits (McDowell 1964; Gaffney and Meylan 1988) until genetic analysis conducted in the late 1990's (Bickham et al. 1996; Lenk et al. 1999) concluded that the group was paraphyletic. As a result of the discovery of paraphyly within *Clemmys*, the genus name *Glyptemys* was revived and expanded to include both the Wood Turtle (*G. insculpta*) and the Bog Turtle (*G. muhlenburgii*) (Holman and Fritz 2001). Subsequent studies have strengthened the evidence that the Wood Turtle and Bog Turtle form a clade distinct from the species they were previously classified alongside (Feldman and Parham 2002; Sprinks and Shaffer 2009; Wiens et al. 2010).

B. Description

Wood Turtles are a moderately sized semi-aquatic turtle with a broad, vertically compressed carapace that measures up to 234 mm straight carapace length. Since carapacial scutes are retained rather than shed, distinctive pyramidal growth layers develop over time and give the turtles a sculptured appearance (Mitchell 1994). The carapace is a muted grey-brown in color, often with black or yellow lines radiating from the upper posterior corners of the vertebral and pleural scutes. Posterior marginal scutes are strongly flared and serrated. Dark blotches are often present on the undersides of the marginals and on the bridge. The unhinged plastron is yellow, with a large dark blotch on the posteriolateral corner of each scute. The head and dorsal surface of the limbs are dark brown to black in color, with the throat and ventral portion of the limbs presenting vibrant red, orange, or yellow coloration. The snout is nonprojecting, and the upper jaw is medially notched (Ernst and Lovich 2009; Ernst and Barbour 1989; Mitchell 1994).

Wood Turtles display marked sexual dimorphism. Males are 7-10% larger than females and have proportionally larger and broader heads (Akre 2002; Ernst and Lovich 2009; Harding and Bloomer, 1979). Males also have longer, thicker tails than females, and their cloaca is located posterior to the carapacial edge. The males' plastrons are concave and have prominently enlarged scales on their forelimbs. Body color in males is typically orange or red, especially in breeding season, whereas female coloration is usually yellow (Ernst and Barbour 1989; Mitchell 1994).

Hatchlings are gray-brown in color, completely lacking the red, orange, and yellow coloration characteristic of adults (Ernst and Barbour 1989; Ernst and Lovich 2009). Their carapace is keelless, shallow, and nearly circular in shape, measuring an average of 36-37 mm straight carapace length upon hatching; their tail is nearly as long as their carapace (Akre 2003; Ernst and Barbour 1989; Ernst and Lovich 2009; Mitchell 1994).

Figure 1. Carapace and plastron of a male wood turtle in Virginia

C. Distribution

The Wood Turtle's range extends from Virginia across the Northeast and adjacent Canadian Provinces to Nova Scotia and westward across the Great Lakes region of the U.S. to Minnesota and Iowa (Ernst and Barbour 1989; Ernst and Lovich 2009). In Virginia, Wood Turtles are known only from the northernmost portion of the state, distributed across portions of the Potomac and Shenandoah River watersheds. Occurrences have been recorded for Arlington, Fairfax, Loudoun, Clarke, Frederick, Warren, Shenandoah, Page, and Rockingham counties (Mitchell 1994; Akre 2003). The Wood Turtle's range in Virginia has been substantially reduced in recent years as the northern Virginia metropolitan area has expanded; despite a lengthy record of occurrences in the upper Piedmont region of the state, very few known populations remain in the region. There are at least five different Wood Turtle population centers in the Ridge and Valley region of the state (delineated by Hydrological Unit 10 geographic coverage), but each of them has experienced habitat degradation and loss (Akre and Ernst 2006).

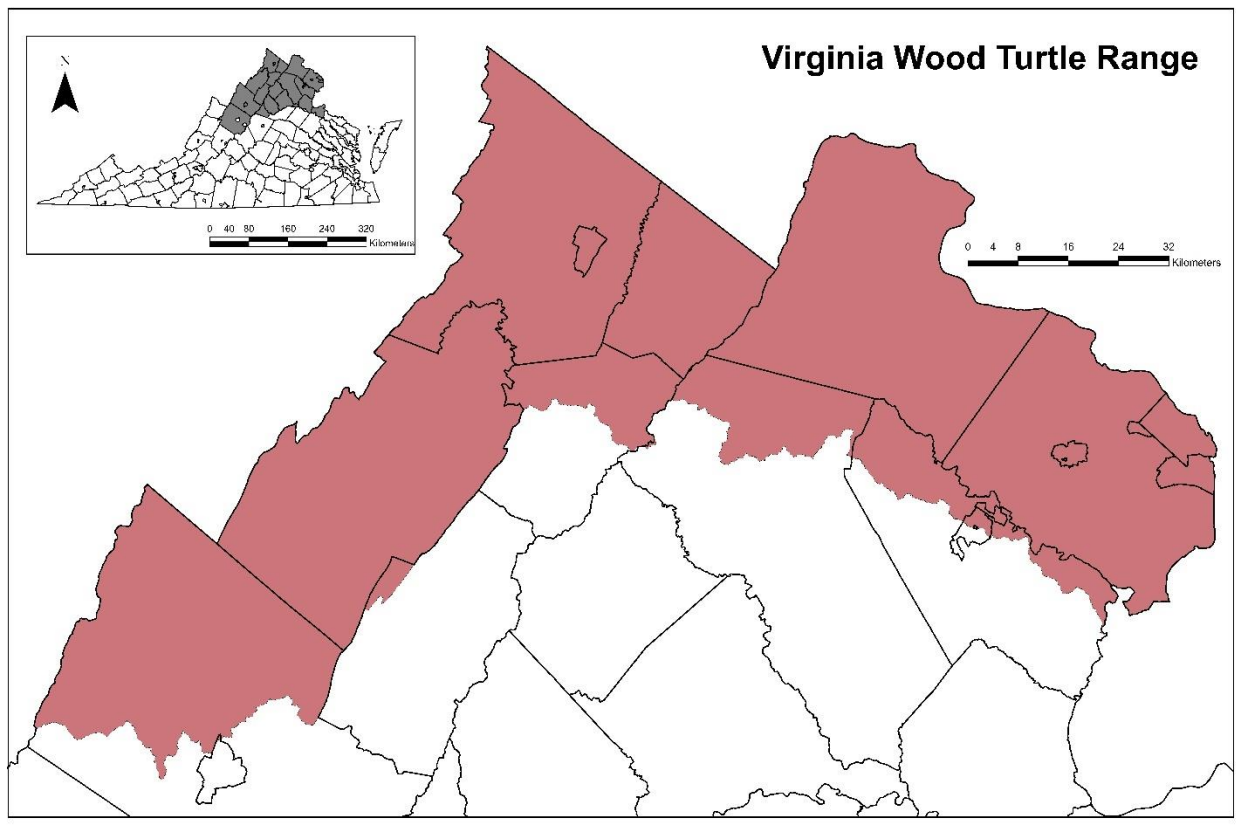

Figure 1: Virginia Wood Turtle range (Arlington, Fairfax, Loudoun, Clarke, Frederick Warren, Shenandoah, Page, and Rockingham counties). The Virginia range was developed using the Hydrologic Unit Code 12 delineations where Wood Turtle occurrences have been reported, including immediately surrounding delineations, with the assumption individuals are capable of dispersing throughout watersheds.

D. Life History

Reproduction

Breeding appears to be opportunistic in Wood Turtles, occurring throughout the active season but peaking in fall and spring when the turtles are congregated in pools and streams for overwintering (Harding and Bloomer 1979). Typically, the male pursues the female and tries to subdue her by nosing or nipping at her carapace and limbs. The female usually flees, but females have infrequently been reported to initiate courtship (Fisher 1945; Harding and Bloomer 1979; Kaufmann 1992a). Receptive females may occasionally turn to face an approaching male, initiating a head swaying display that could last over an hour (Carr 1952; Harding and Bloomer 1979).

The male will attempt to mount the female by lunging onto her carapace and clasping her marginal scutes tightly with his claws. Once securely mounted, the male may gently shake the female from side to side before repeatedly thumping his plastron against her carapace by lifting himself to his full height and pulling himself quickly back down (Harding and Bloomer, 1979; Kaufmann, 1992a). Aggressive biting directed at the female's head and front limbs is common, especially if the female is attempting to move. Since mounting typically takes place in shallow water, the female is sometimes forced to lift the male to the surface in order to breathe. Courtship

can last for hours or even days, with especially long instances recorded for mountings initiated on land. Copulation almost always occurs in the water and lasts only an hour or two (Harding & Bloomer, 1979; Kaufmann, 1992a).

Figure 2. Wood Turtles copulating in a stream.

Nesting occurs from late May to early July in exposed, elevated areas comprised of loose sand, soil, or gravel on south/south-east facing slopes (Akre and Ruther 2015; Harding and Bloomer 1979; Ernst and Barbour 1989; Buech et al. 1997). Mature females typically produce one clutch per season (Powell 1967; M. Ewert, pers. comm. *in* Akre 2003), but they may not reproduce every year (Ross et al. 1991; Akre 2003). There is indirect evidence that some Virginia turtles may produce a second clutch during especially productive years (Akre 2003). An average clutch size in Virginia is 8.9 eggs, with an average egg length of 37.90 mm (range 30.11 - 41.28 mm) and width of 23.96 mm (range 21.50 – 25.80 mm); average egg mass is 12.75 g (range 7.99 - 14.56 g) (Akre 2003).

Figure 3. Protected Wood Turtle nest with emergent hatchlings.

Growth and Development

Hatchlings emerge between late July and early October (Akre and Ruther 2015; Mitchell, 1994; Ernst and Lovich, 2009) after an average incubation period of 70 – 80 days (Ernst & Barbour, 1989). Higher temperatures have been reported to increase development speed in turtle nests (Ewert 1979), and one Virginia population had incubation periods of only 53 – 64 days (J. F. Mcbreen, pers. comm. *in* Mitchell 1994). Sex determination is genetic, as opposed to being temperature dependent, which is unusual among emydid turtles (Bull et al. 1985; Ewert and Nelson 1991).

Neonates are gray-brown in color, completely lacking the red and orange coloration characteristic of adults (Ernst and Barbour 1989; Ernst and Lovich 2009). Hatchling carapace lengths average 35.7 mm (n = 43, range 29.6 – 39.2) in Virginia (Akre 2003). Average hatchling plastron lengths for two Virginia nests were 27.6 (n = 4, range 26.3 - 28.5 mm) and 30.0 mm (n = 7, range 28.1 - 32.4 mm), with average masses of 6.64 g (n = 4, range 5.84 - 6.96 g) and 8.79 g (n = 7, range 8.01 - 9.83 g) (Akre and Ernst 2006).

Growth rates are inversely related to body size, with juveniles in Virginia and West Virginia growing rapidly until they reach 160 mm in carapace length at approximately 9 years of age. Once they reach this size, which is believed to be the minimum size needed to prevent most forms of predation, turtles invest increasingly less energy into growth as they divert their resources into reproduction. By 16 years of age, growth has nearly ceased (Lovich et al. 1990; Niederberger and Seidel 1999; Akre 2003). New annuli are formed on the plastral scutes each year, forming consecutive rings that are considered to be a generally accurate measurement of the age of a Wood Turtle during the early years of its life. Once a turtle reaches 15-20 years of age, slowed growth and accumulated wear make accurately discerning between rings increasingly difficult (Harding and Bloomer 1979; Akre 2003; Ernst and Lovich 2009). Adult males grow slightly faster than females and reach slightly larger sizes. This disparity in growth patterns is not fully understood, but it could be attributed to body size influencing the establishment of dominance hierarchies by males or to preferential selection of larger mates by females (Kaufmann 1992a; Akre 2003).

Population Ecology and Survivorship

It is well established that Wood Turtles can live for 40 years or more in the wild (Lovich et al. 1990; Ernst 2001) and up to 58 years in captivity (Oliver 1955), but the relatively short duration of most studies (Wilson et al. 2003; Jones 2009) and the unreliability of annuli counts in older turtles (Harding and Bloomer 1979; Akre 2003; Ernst and Lovich 2009) mean that such records may significantly underestimate longevity. Recent reports of turtles known to be between 46 and 55 years of age bring the confirmed lifespan of wild Wood Turtles in line with the oldest captive record (Akre, pers. obs.; Brown et al. 2015), and continued long-term monitoring may reveal even greater longevity. One study that utilized patterns of shell wear to age Wood Turtles concluded that they may regularly reach ages of 80 years or more without showing signs of senescence (Jones 2009).

Survivorship data are scarce for Wood Turtle populations, but turtles generally follow a Type III survivorship curve with high juvenile mortality compensated by low adult mortality (Slobodkin 1961; Iverson 1991; Jones et al. 2018). In one Virginia study, only 26% of hatchlings survived their first year of life (Akre and Ruther 2015). It has been suggested that adult survivorship must be very high, possibly upwards of 95%, for Wood Turtle populations to remain stable (Compton 1999; Cochrane et al. 2018). Three populations studied in Virginia from 1999-2002 had estimated annual survivorships of A) 92.1%, B) 91.6%, and C) 80.8%. However, these estimates did not include the effect of detection and did include juveniles, which were notably more common in population C, suggesting that a more robust sample of adults that was corrected for detection would result in higher survivorship estimates (Akre and Ernst 2006). Additionally, the sex ratios varied substantially between sites. Site A had a ratio of 1:0.86:0.27, site B had a ratio of 1:0.72:0.28, and site C had a ratio of 0.97:1.0:0.81 (Akre and Ernst 2006). Other studies have found similarly variable ratios across the Wood Turtle's range (Farrell and Graham 1991; Ross et al. 1991; Brooks et al. 1992; Walde et al. 2003). The 2018 regional survey of Wood Turtles in the northeastern United States reported an average sex ratio of 1.4:1, with juveniles making up only 16% of the turtles reported (Jones et al. 2018).

Population densities are expectedly variable between studies and locations, but density generally appears to be inversely related to latitude (Farrell and Graham 1991; Brooks et al. 1992; Niederberger and Seidel 1999; Ernst 2001; Walde et al. 2003). Sites chosen by experts to serve as high density survey locations during the 2018 regional study produced an average relative density of 47.5 (range 4 – 211) Wood Turtles/km of stream in the northeastern United States, suggesting that population densities are relatively low even in preferable conditions (Jones et al. 2018).

Feeding Habits and Natural Predators

Wood Turtles are opportunistic omnivores that have been observed consuming a wide variety of food items. Commonly consumed items include algae, berries, grasses, leaves, fungi, carrion, insects, mollusks, slugs, tadpoles, worms, and the eggs of ground nesting birds (Surface 1908; Harding and Bloomer 1979; Jones 2018). Wood Turtles are also known to consume newborn mice and hatchling birds (Surface 1908; Harding and Bloomer 1979).

One peculiar feeding behavior that appears to be unique to Wood Turtles is "worm stomping." Wood Turtles have been observed stomping the ground with their forelimbs, alternating between legs every few stomps and occasionally thumping their carapace on the ground. Worms are drawn to the surface by this rhythmic drumming, perhaps because they confuse the vibrations for rain, and are quickly consumed (Zeiller 1969; B. McClelland, in Harding and Bloomer 1979; Kaufmann 1986).

Adult Wood Turtles have few natural predators. Raccoons (*Procyon lotor*) are the most common culprit, especially in urbanized areas (Harding and Bloomer 1979; Farrell and Graham 1991; Mitchell 1994), but otters (*Lontra canadensis*) are also suspected in some studies (Akre and Ernst 2006; Carroll and Ultsch 2006). Incisor marks in the damaged shells of some turtles suggest that beavers (*Castor canadensis*) or porcupines (*Erethizon dorsatum*) occasionally gnaw the shells of adults, potentially leaving them vulnerable to future predation (Harding 1985).

Juvenile and hatchling Wood Turtles are far more vulnerable to predation than adults. In addition to raccoons and otters, coyotes (Canis latrans), foxes (*Urocyon cinereoargenteus*, *Vulpes vulpes*), opossums (*Didelphis virginiana*), ravens and crows (*Corvus* spp.), and skunks (*Mephitis mephitis*) are all known or suspected to eat juveniles, hatchlings, and eggs (Akre and Ruther 2015; Harding and Bloomer 1979; Ernst and Lovich 2009). Nests of some populations may experience 100% mortality in some years, with skunks and raccoons being the primary culprits in nest predation (Harding and Bloomer 1979).

Brumation

Brumation is a hibernation-like state that reptiles often utilize during periods of cold weather. Wood Turtles typically brumate in cold, slow moving streams and rivers beginning between September and November and ending between March and May, depending on the local climate and weather patterns (Harding and Bloomer 1979; Ernst and Lovich, 2009). Unpolluted cold-water streams typically maintain oxygen levels near saturation (Allan, 1995), and dependence on this high oxygen content is believed to be a limiting factor in the turtles' distribution (Grieves and Litzgus 2008). Wood Turtles are capable of limited oxygen exchange in aquatic environments with high levels of dissolved oxygen, which enables them to remain fully submerged throughout brumation without having to endure the physiological stress of prolonged anaerobiosis (Graham and Forsberg 1991; Grieves and Litzgus 2008).

Wood Turtles frequently select hibernacula under banks with overhanging roots and logs, in beaver lodges and muskrat (*Ondatra zibethicus*) burrows, or at the bottom of deep pools atop or just below the substrate (Harding and Bloomer 1979; Greaves and Litzgus 2008; Ernst and Lovich 2009). Potential drivers for hibernacula selection include temperature, dissolved oxygen content, risk of predation, and risk of being washed out during floods (Graham and Forsberg 1991; Greaves and Litzgus 2007 and 2008; Jones 2009). Many Wood Turtles exhibit some degree of site fidelity, although the shifting boundaries of rivers and streams may frequently render favored hibernacula unsuitable (Garber 1989; Grieves and Litzgus 2008; Parren 2013). It is not uncommon for multiple Wood Turtles to share a hibernacula, especially in the southern portions of their range; as many as 70 turtles have been reported using a single hibernacula (Bloomer 1978; Breisch, 2006; Greaves and Litzgus 2008; Niederberger and Seidel, 1999). Exactly why they brumate communally is not fully understood.

Figure 4. Wood Turtle partially concealed beneath leaf litter at the bottom of a pool.

E. Habitat Selection

The Wood Turtle has a biphasic ecology, spending almost an equal amount of time in both aquatic and terrestrial habitats. Forested streams and rivers with clear water, solid substrate, and moderate flow are the most fundamental features of productive Wood Turtle habitat (Compton et al. 2002; Greaves and Litzgus 2008; Ernst and Lovich 2009). Flowing water is essential habitat for both breeding and brumation, so turtles rarely stray far from the shore during their active season except to search for suitable nesting sites (Akre and Ernst 2006; Brown et al. 2016). Females typically have home ranges further upland than their male counterparts even outside of nesting season. One possible reason for this disparity in habitat selection could be that females move further from the streams in search of optimal temperatures and nutrient rich foods to facilitate egg development. Another possibility could be that males opt to stay close to the stream in order to maintain dominance hierarchies and intercept potential mates as the females return to the streams for brumation (Akre and Ernst 2006; Brown et al. 2016).

It has been suggested that Wood Turtles should be viewed as an “edge species,” one that thrives on ecotones that allow them to move between microhabitats to balance their thermal and nutritional needs (Compton et al. 2002; Jones 2009; Kaufmann 1992b). As such, ideal Wood Turtle habitat would include a stream that would course through forested areas interspersed with patches of early successional growth. Although mild levels of ecosystem disturbance may have a positive influence on Wood Turtle populations through the creation of early successional habitat, the tendency of Wood Turtles to utilize agricultural fields on the edges of their territory can lead to high mortality and population decline (Jones 2009, Saumure et al. 2007).

F. Home Range and Movement

Wood Turtle home range size has been found to be highly variable across individuals. Radio-telemetry studies have reported home range sizes from 0.2 ha to 1242.7 ha (Jones 2009; see also Quinn and Tate 1991, Foscarini 1994, Kaufmann 1995, Arvisais et al. 2002, Remsburg et al. 2006). Recently, research using miniaturized GPS tags has reported mean home ranges of 18.96 ha (95% CI [6.09, 31.82]; Thompson et al. 2018) and 20.90 ha (95% CI [15.70, 26.10]; Drescher-Lehman et al. 2019), with individual estimates ranging from 0.3 ha to 100.28 ha and 3.45 ha to 1244.76 ha, respectively. No study to date has tracked an individual turtle for more than three years. These home range estimates and their high variability therefore suggest not only large home ranges across annual cycles but also much larger home ranges across lifetimes.

Based largely on unpublished data and survey results, we are increasingly aware of Wood Turtle movements across the landscape. Male Wood Turtles, for example, have been observed to make long-distance dispersal movements that are often not confined to stream corridors and can exceed 20 km within a single year (Akre unpublished data, Drescher-Lehman et al. 2019, Sweeten 2008). Such movements are thought to be important for gene flow between populations.

Female Wood Turtles are also known to sometimes move long distances, occasionally exceeding 10 km, on their way to and from nesting habitat in late spring and early summer (e.g. Akre and Ruther 2015). During the nesting season, space use and movements of female Wood Turtles significantly increases before tapering off across the rest of the active season. Average male movement does not show this same peak in movement and is more consistent across the year (Drescher-Lehman et al. 2019, Carstairs et al 2018).

G. Protection and Management

The Wood Turtle is currently classified as Endangered by the International Union for the Conservation of Nature (IUCN) (van Dijk and Harding 2011). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists the Wood Turtle as an Appendix II species (CITES 2019a), a designation that indicates a species that may not be immediately endangered, but that nevertheless requires trade regulation to prevent precipitous declines (CITES 2019b).

The Wood Turtle is protected as a Schedule 1 Threatened species in Canada under the Species at Risk Act (SARA 2002), and it is currently being assessed for potential listing (ECOS 2019; Jones et al. 2018) under the United States Endangered Species Act of 1973 (16 U.S.C. §1531 et seq.). Although not currently under federal protection in the U.S., the Wood Turtle is protected by state law throughout most of its range (Ernst and Lovich 2009; Jones et al. 2018). State protections for the Wood Turtle are bolstered by the Lacey Act (18 USC 42-43; 16 USC 3371-3378), which criminalizes transporting animals out of areas in which they are protected. Aquatic habitats utilized by the Wood Turtle are protected under the Clean Water Act (33 U.S.C. §1251 et seq.) in the U.S., but little to no protection is afforded to their terrestrial habitats in much of their range (Akre and Ernst 2006, Jones 2009, Saumure et al. 2007).

The Wood Turtle is listed under Virginia code 4VAC15-20-130 as a Threatened species and granted full protection from "[t]he taking, transportation, possession, sale, or offer for sale within the Commonwealth…" (Va. Code Ann. §§ 29.1-563 - 570). The Wood Turtle is currently a Tier Ia Species of Greatest Conservation Need (SGCN) in Virginia's Wildlife Action Plan, which is a conservation strategy intended to direct efforts to conserve the state's SGCN (VDGIF 2015).

IV. Conservation Concerns

Figure 5. Wood Turtle habitat degradation through deforestation and agricultural activity.

A. Habitat Degradation and Loss

It should come as no surprise that habitat loss and degradation is one of the most prominent threats to the Wood Turtle's survival (Akre and Ernst 2006; Harding and Bloomer 1979; Mitchell 1994; van Dijk and Harding 2011). Intense deforestation from the 1600's to the early 1900's destroyed much of North America's temperate forests (Williams 1989), and anthropogenic activities have substantially altered both the physical and chemical structure of many riverine systems (Allan 1995). Although the net rate of deforestation has stabilized over the past century (Oswalt and Smith 2014; Williams 1989), localized urbanization is still a major threat to many Wood Turtle populations (Akre and Ernst 2006; Harding and Bloomer 1979; Mitchell 1994; van Dijk and Harding 2011). In addition to direct encroachment into crucial forested habitat, impervious surfaces and reinforced stream banks in urban areas also contribute to increased flooding, which could potentially impact Wood Turtle populations far downstream of the altered topography (Jones 2009; Jones and Sievert 2009). As a result of continuous urban development and expansion, the Wood Turtle has been nearly extirpated from the Piedmont and Coastal Plain regions in the northern Virginia metropolitan area (Akre and Ernst, 2006; Ernst and McBreen 1991).

B. Agriculture

Rural areas might seem to be more habitable for Wood Turtles than urban ones, and moderate levels of habitat disturbance may indeed be beneficial for the turtles (Jones 2009; Kaufmann 1992b), but evidence suggests that agricultural fields can actually be ecological traps (Jones 2009; Saumure et al. 2007). Turtles are drawn to open fields in search of basking, foraging, and nesting sites, which results in frequent mortality from farm equipment. Anthropogenic mortality in agrarian landscapes has been recorded in excess of 10% per year in some Wood Turtle populations (Jones 2009; Saumure et al. 2007), with one population reported to have experienced a 50% reduction in population size in only 7 years (Daigle and Jutras 2005). Altering the blade height or the style of mower have been suggested as ways to reduce mortality when mowing fields (Erb and Jones 2011; Saumure et al. 2007), but a significant portion of turtle mortality comes from being run over by the tractor's tires (Erb and Jones 2011; Jones 2009). Creating buffer zones near riparian areas and mowing during the Wood Turtle's inactive season appear to be the only effective methods for reliably reducing mortality in agricultural fields (Erb and Jones 2011; Jones 2009; Saumure et al. 2007).

C. Road Mortality

It is well established that roadways can act as barriers to dispersal and genetic exchange by altering natural behaviors or causing direct mortality (Aresco 2005; Clark et al. 2010; Vos and Chardon 1998). Wood Turtles frequently attempt to cross roads, and they are often unsuccessful (Akre and Ernst 2006; Harding and Bloomer 1989). Various life history traits make turtle populations especially vulnerable to adult mortality (Compton 1999; Cochrane et al. 2018), and models suggest that many road systems in the eastern United States have reached traffic volumes sufficient to cause unsustainable losses in terrestrial and semi-terrestrial turtles (Gibbs and Shriver 2002). This problem is exacerbated by the fact that nesting female turtles appear to make up a disproportional number of road mortalities, resulting in skewed sex ratios (Steen and Gibbs 2004). A strategically placed combination of fencing and culverts can substantially reduce mortality at crucial sites (Aresco 2005; Guyot and Clobert 1997; Kaye et al. 2006), but it may not be financially or logistically feasible to construct these structures on a broad scale (Gibbs and Shriver 2002). As such, road density may be an important limiting factor for the long-term stability of many turtle populations (Gibbs and Shriver 2002).

D. Illegal Collection

The earliest records of Wood Turtle collection come from the 19th century, when exploitation of the turtles as a food resource resulted in perceived population declines (Breisch 1997; Harding and Bloomer 1989). By the mid 1900's culinary interest in Wood Turtles had declined, but biological supply houses continued collecting them at an unsustainable rate (Harding and Bloomer 1989; Jones et al. 2015). The Wood Turtle is now legally protected throughout most of its range (Ernst and Lovich 2009; Jones et al. 2018; SARA 2002), but both incidental and organized collection as pets still poses a serious threat to the species' long-term survival (Akre and Ernst 2006; Compton 1999; Levell 2000).

Incidental collection is known or suspected to occur throughout the Wood Turtle's range, including Virginia (Akre and Ernst 2006; Jones et al. 2015). Though it is believed that only small numbers of turtles are collected incidentally as personal pets, the Wood Turtle is not adapted to recovering from the loss of mature adults (Compton 1999; Cochrane et al. 2018). Demographic modeling suggests that taking just one turtle per year from a population of 100 Wood Turtles would result in a 60% population decline by the end of the century and taking two or three would result in extirpation within 50 and 75 years, respectively (Compton 1999). One study reported that opening protected land for recreational use resulted in extirpation within a decade, with collection for pets suspected as a primary factor in the rapid decline (Garber and Burger 1995). In addition to collection as pets, Wood Turtles in Virginia are also occasionally collected for turtle races; one such event was shut down at the 2019 Frederick County Fair for wildlife violations including the illegal possession of state threatened Wood Turtles (J.D. Kleopfer, VDGIF, pers. comm.).

Organized collection for sale in the illegal pet trade has also been recorded throughout the Wood Turtle's range, with hundreds of turtles confiscated in the last few decades (Jones et al. 2015). In 2008 the Virginia Department of Game and Inland Fisheries confiscated 108 Wood Turtles in a single raid, all of which had been collected from West Virginia to be sold in the illegal pet trade (Hollowell 2011).The illicit Wood Turtle trade has become increasingly lucrative in recent years, perhaps in response to the turtle's perceived scarcity; prices have risen from $20 per turtle in the 1960's to over $300 per turtle in 2018 (Jones et al. 2015). Although illegal collection is believed to occur in Virginia, the extent and frequency at which it occurs are unknown (J.D. Kleopfer, VDGIF, pers. comm.).

Figure 6. Wood Turtles confiscated from an illegal collection.

V. Conservation Strategy Framework

A. Introduction

Background

In 2011 the Wood Turtle Working Group (see Section I above) undertook a region-wide population assessment in order to 1) expand the network of standardized Wood Turtle study sites throughout the Northeast Region, 2) identify factors influencing Wood Turtle abundance at the regional scale, 3) quantify factors impacting Wood Turtle detection rates, 4) identify regionally significant Wood Turtle populations, 5) monitor intensively studied sites to estimate population size, density, and demographic structure, thereby establishing a baseline from which to evaluate populations trends, and 6) conduct population assessments within data-deficient areas throughout the Northeast (Jones et al. 2018).

As a part of this assessment, researchers from the VDGIF and SCBI conducted 265 standardized surveys (48 stream segments) from 2012 to 2017 that yielded a total of 1098 individual Wood Turtles for the regional population assessment and approximately 200 tissue samples for genetic analysis. Virginia's data, in conjunction with data from twelve other Northeast states and the District of Columbia, contributed to the development of the regional conservation plan for the Wood Turtle in 2018 (Jones et al. 2018). The objective of the conservation plan was to protect and maintain the evolutionary potential of the Wood Turtle by facilitating the persistence of functional, demographically stable, ecologically viable, and representative populations throughout the northeastern United States (Jones et al. 2018). As a result of the population and genetic analyses, a Conservation Area Network (CAN) was established for the Northeastern U.S. to support a conservation plan objective of guiding the states in developing state-level conservation plans and actions.

The Conservation Area Network was developed using empirically driven analyses to identify sites that currently support, or have the potential to support, robust Wood Turtle populations and ensure long-term persistence and evolutionary potential. CAN sites were separated into two major tiers: high priority Focal Core Areas (FCA) and lower priority Management Opportunity Sites (MOS) (Figure 7). FCA's represent sites intended to be the primary focus of conservation efforts and land protection resources. MOS's represent sites with several classes of Wood Turtle streams that include areas with a high potential of supporting a viable, functional Wood Turtle subpopulation with concentrated management and mitigation efforts (Jones et al. 2018). In Virginia, 16 sites were identified as FCA's, and four were identified as MOS's (Figures 8 and 9). Of these sites, only three are located primarily within public land and afforded some level of protection from agriculture and development.

The following sections describe a proposed conservation strategy framework for supporting long-term, functional Wood Turtle populations in Virginia using the regional conservation plan for Wood Turtles developed by Jones et al. (2018) as a guideline.

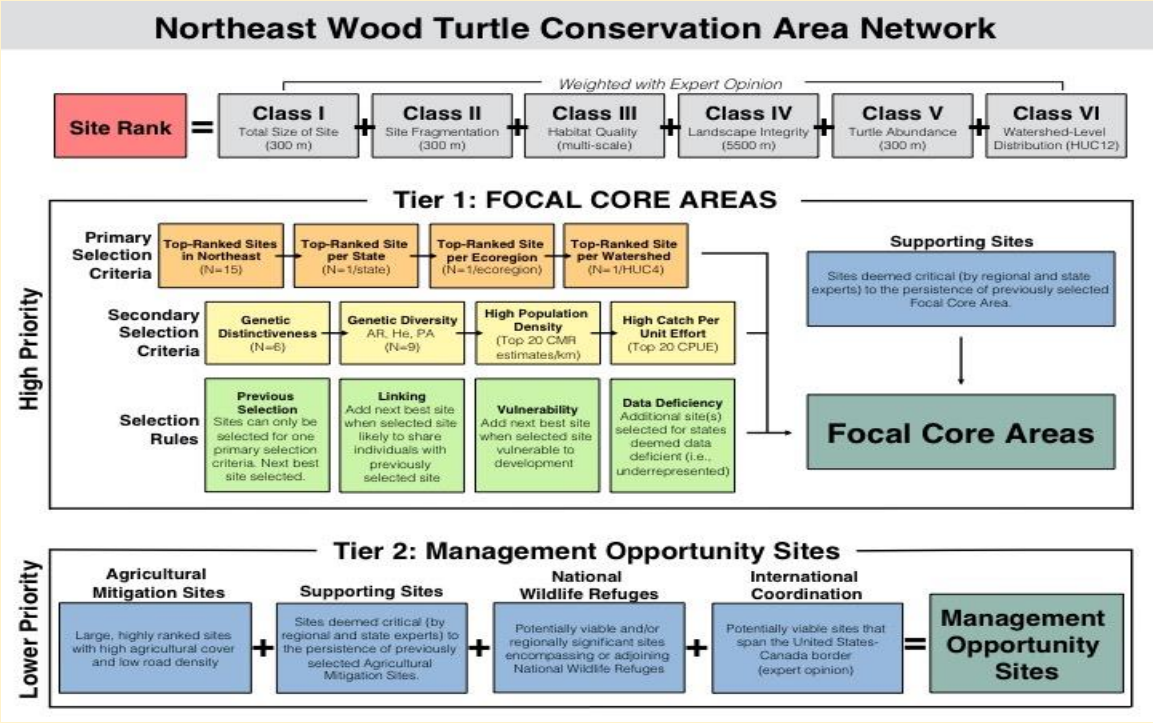

Figure 7. Northeast Wood Turtle Conservation Area Network site selection criteria summary for Focal Core Areas and Management Opportunity Sites (Jones et al. 2018).

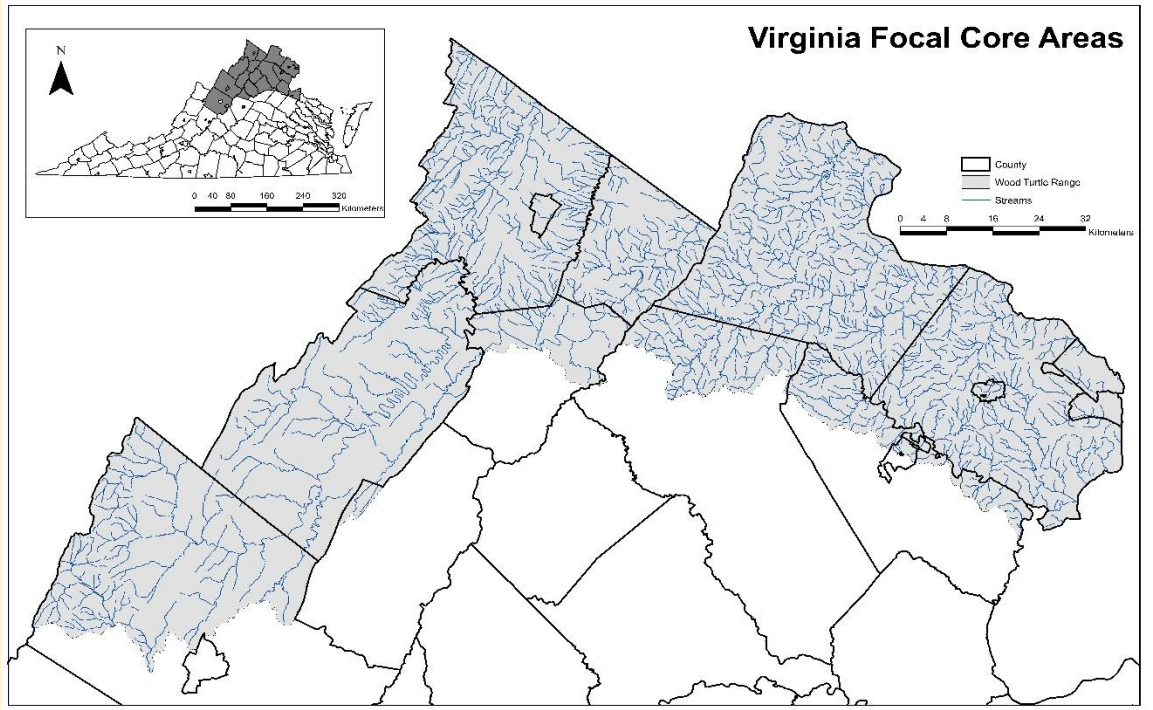

Figure 8. The sixteen FCA's in northern Virginia identified in the regional Conservation Area Network. **Spatial data has been removed to protect location information.

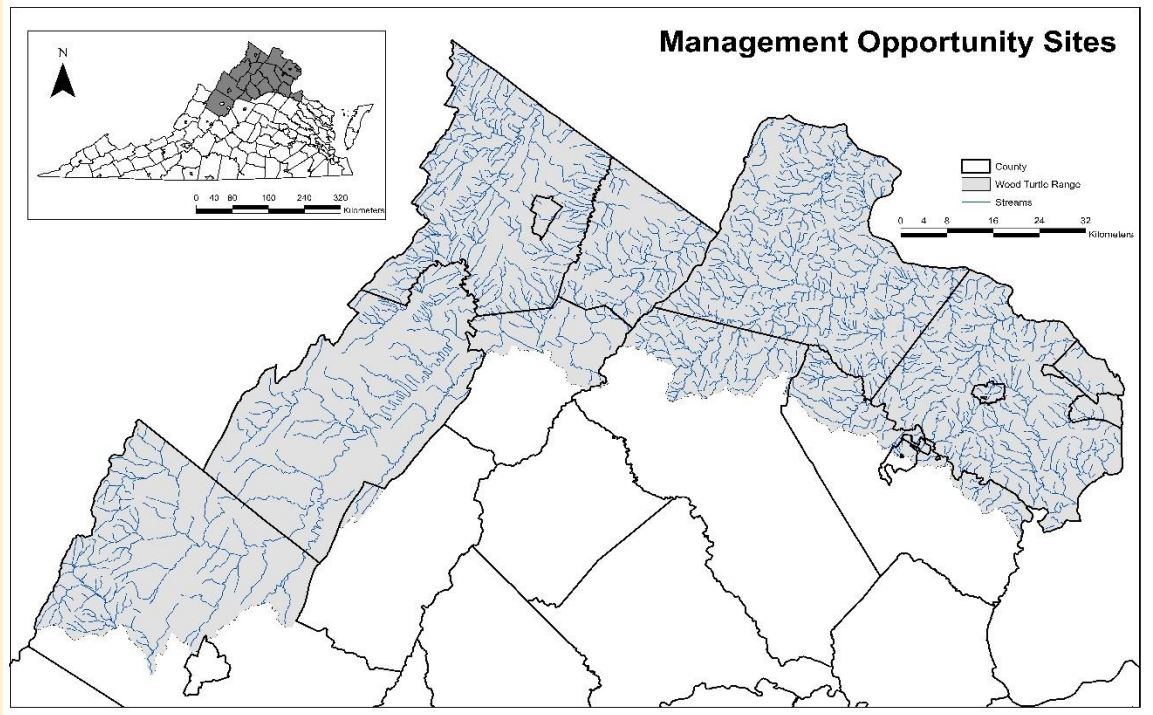

Figure 9. The four MOS's in northern Virginia identified in the regional Conservation Area Network. **Spatial data has been removed to protect location information.

B. Management Unit Delineation

Five Management Units (MU) should be developed that encompass 13 of the Virginia FCA's and all four MOS's developed in the Jones et al. (2018) regional Wood Turtle conservation plan. Due to the high density of development around the Washington D.C. metropolitan area, it is not recommended that the three FCA's in Fairfax County be incorporated into MU's; the landscape surrounding these FCA's is no longer conducive to the long-term survival of Wood Turtle populations. Development of Virginia MUs should utilize hydrologic unit code (HUC) 10 watershed delineation, as this is the most spatially appropriate HUC to group the remaining FCA's and MOS's based on their spatial distribution in watersheds (Figure 10). Additional sites that are beyond the HUC 10 MU delineations but close enough to allow potential genetic exchange between subpopulations should be added to the nearest MU. Each MU will have specific adaptive conservation actions and management recommendations tailored to its most urgent conservation concerns, with emphasis placed on maintaining or increasing connectivity with the surrounding landscape. FCA's should serve as the focal points for their respective MU's, being monitored at the site level following the Site Action Tracking guidelines (Appendix A) set out in the regional conservation plan (Jones et al. 2018) to provide long-term guidance on site-specific conservation actions. MOS's should follow similar tracking guidelines and serve as supplements to the FCA's, providing updates on important subpopulations within the MUs.

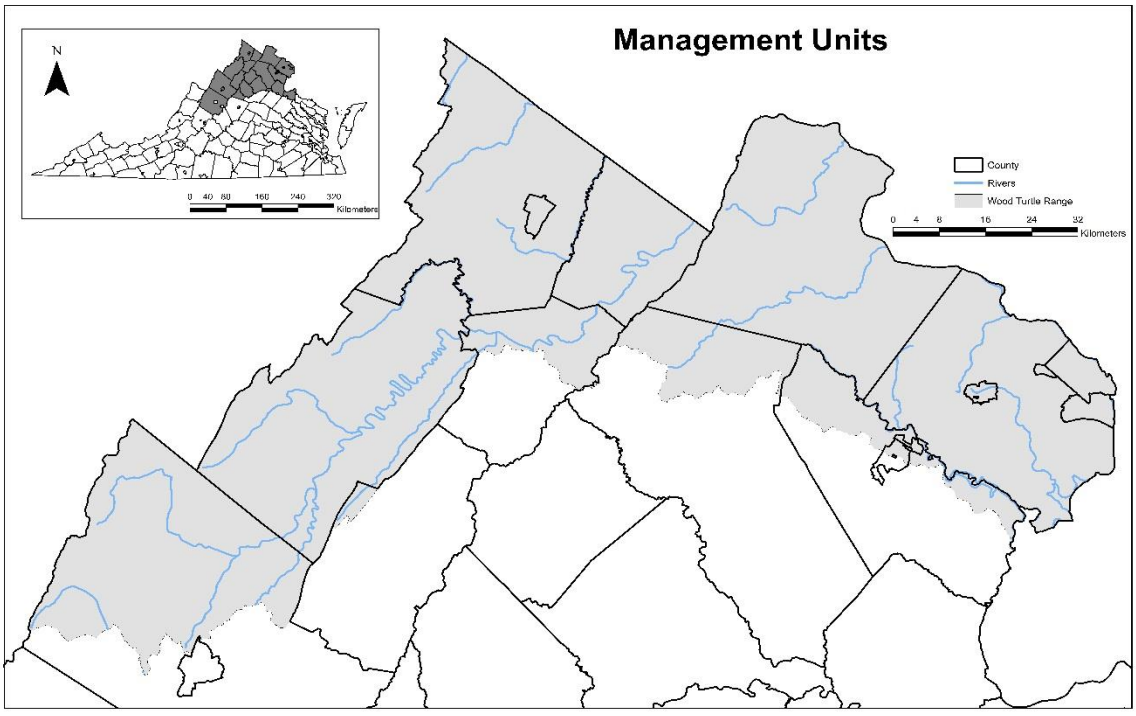

Figure 10. The five proposed Management Units that encompass the identified Focal Core Areas and Management Opportunity Sites in northern Virginia. **Spatial data has been removed to protect location information.

C. Long-term Monitoring

Occurrence Records

Historical and current occurrence records stretch from 1953 to 2018, with a total of 9651 Wood Turtle detections in nine counties (including recaptured individuals) (Figure 11). Detection sources include verified historical records and research initiatives involving visual encounter surveys and radio-telemetry. Standardized long-term monitoring began in 2012 for Virginia via the NEAFWA RCN grant. Between 2012 and 2014, a total of 192 visual encounter surveys were conducted. From 2014 to 2016, 218 visual encounter surveys were conducted for the USFWS CSWG. An additional 24 surveys were conducted between 2012 and 2018 as part of educational trips with Smithsonian-Mason School of Conservation students and other Smithsonian Conservation Biology Institute projects. In total, 434 visual encounter surveys have been conducted to date. Fourteen sites produced a total of 1550 Wood Turtle detections with 56 stream sites surveyed altogether.

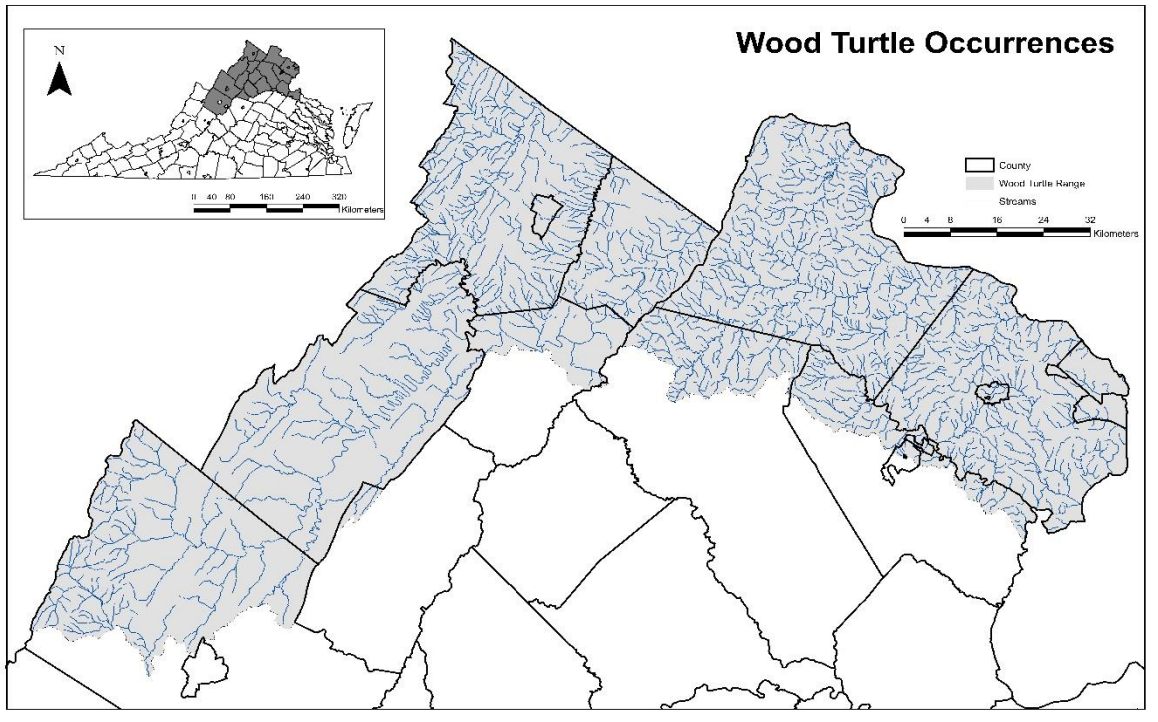

Figure 11. Wood Turtle occurrence records from verified historical records, visual encounter surveys and incidental radio-telemetry captures for the state of Virginia. **Spatial data has been removed to protect location information.

Management Unit Monitoring

Standardized visual encounter survey (VES) guidelines similar to those established by Jones et al. (2018) should be established to ensure quality inventory and long-term monitoring within all MU's. Survey sites should be 1km in length, and the number of surveys sites per MU should be proportional to the size of that MU. Survey site priority should be developed in consultation with state and regional experts, as it is dependent on prioritization of conservation targets at multiple scales; the formation of a Virginia Wood Turtle council (see Section F below) would be expedient in this development. Beginning with the collection of the first season's data at a given site, n-mixture modeling (Royle 2004) could be used to produce abundance estimates. Once 3 seasons of data have been collected from a given site, Capture-Mark-Recapture (CMR) analysis could be used to produce vital rates and population estimates for priority sites. Sites should be monitored for a minimum of five years to evaluate occupancy, abundance, and demography trends within each MU. The data collected could then be used to inform a conservation priority setting exercise for a given MU, with the application of possible interventions drawn from Jones et al 2018. Where appropriate, research should be developed to explore the effects of land use features on the spatial and behavioral ecology of the populations being surveyed.

State Level Monitoring

Updated historical distribution data for Virginia should be used to inform continued exploratory surveying beyond the established MU's. Surveys undertaken beyond MU's should follow the same standardized protocols discussed above, and they should likewise be followed by n-mixture and CMR analyses when appropriate. Additionally, eDNA surveys should be conducted across northern Virginia using the methodology established by Akre et al. (2019) to conclusively demonstrate ghost populations or range contraction. It is recommended that surveys throughout the state make use of Passive Integrated Transponder (PIT) tags alongside other marking techniques when possible. PIT tagging would contribute to the creation of a regional database (Jones et al. 2018) intended to combat the illegal pet trade by making it easier to identify and repatriate confiscated turtles (see Section E below for more details).

Monitoring Status Tracking

All inventory and management actions conducted in all sites across the state (including those in Management Units) should be tracked using the 'Site Tracking Database' developed by Jones et al. (2018) (Appendix A). The database consists of 64 variables within 17 broad categories that aim to guide states in identifying site-specific conservation priorities and developing spatially-explicit geodatabases for best management practices and conservation plans. This database can provide a tracking framework for the evaluation of progress and effectiveness. Yearly reports should also be prepared for VDGIF outlining the progress and updates of the conservation plan implementation.

D. Landscape Knowledge Development

Scenario Analysis

With changes to land use expected throughout the Wood Turtle's range, the population support provided by any site may change in the coming years. The form this change will take cannot be guaranteed, but by planning for multiple scenarios a conservation strategy robust to a high level of uncertainty can be developed. The Smithsonian Conservation Biology Institute's Changing Landscape Initiative (CLI) has completed a scenario planning project that models land use change for a majority of the species' range up to the year 2061 based on five different scenarios of change (Iara Lacher, SCBI, in preparation). These scenarios were derived by local stakeholders identifying high or low population growth and the level of political will to strategically plan for growth as the major drivers of change uncertainty (Lacher et al. 2018). The CLI model quantifies the mechanical influence of the identified drivers and applies that to observed patterns of change; the result is a suite of land use maps equivalent to the National Land Cover Database commonly used for regional scale habitat analysis. Using these maps it would be possible to group CAN sites and watersheds into prioritization categories based on the extent at which development pressure appears in all, some, or none of the scenarios.

Movement Analyses

There is growing evidence of male-biased Wood Turtle dispersal movements within Virginia forests. Photo identification analysis has revealed seven instances of male dispersal (Akre unpublished data) while tracking data has captured an additional seven dispersal events (Drescher-Lehman et al. 2019, Sweeten et al 2008, Akre unpublished data). These movements are not limited stream corridors; turtles often traverse agricultural and urban landscapes, and on multiple occasions they were recorded ascending hundreds of meters to cross ridgelines (Drescher-Lehman et al. 2019) (Figure 12). Such movements are often greater than 10 km and have been observed to exceed 20 km within a single year. These distances are consistent with results presented in the regional conservation plan for Wood Turtles (Jones et al. 2018), which found genetic evidence of siblings separated by over 30 km and 50 km.

Given the prevalence of these dispersal movements and the significant distance by isolation seen in this species (Jones et al. 2018), it is clear that conservation efforts must not focus solely on individual populations but also on the connectivity of adjacent populations. For this reason, land protection efforts should be focused not only on FCA's and MOS's but also on the landscape within and around the MU's. Where possible, fine scale movement data should be used to identify specific movement corridors as well as potential areas of increased threat levels, such as common road crossing sites. Such corridors and hotspots should then be targeted for land protection and other conservation actions, such as road signs, barriers, and underpasses.

Movement studies on Wood Turtles in Virginia have thus far been limited to the George Washington National Forest on the western border of the state. Therefore, efforts to study dispersal behavior should be expanded to include other habitats within the state. Miniaturized GPS tags could be placed on male turtles at priority sites to look for dispersal behavior and corridors. Photo identification analyses should be continued for all captured individuals across all survey sites to identify other dispersal events.

Figure 12. An example of two individual male Wood Turtles dispersing over ridgelines from a long-term study site in Northern Virginia (Drescher-Lehman et al. 2019). **Spatial data has been removed to protect location information.

Network Analysis

As established in earlier sections, male Wood Turtles will occasionally disperse from their natal streams, potentially over long distances. A network connectivity analysis should therefore be conducted to identify areas between CAN sites that would benefit population connectivity if placed under protection or management. Turtle movement preferences gathered from both internal studies and available literature should be utilized to determine the relative "resistance" to movement provided by a variety of environmental variables including land use, slope, and roadways. By summing these resistance values together a cost surface could be generated that, along with the CAN sites serving as population "nodes," would form the primary component for a number of well-established connectivity models like Least Cost Path, Accumulated Cost, and Circuitscape (McRae et al. 2008; Pinto and Keitt 2009; Etherington 2016). Through these models, broad corridors for potential movement could be identified along with individual "pinch points," often associated with roads, which funnel a large portion of potential movement through a narrow space. Identified broad corridors could then inform protected land prioritization efforts while pinch points could direct limited resources towards specific locations that would benefit the most from management efforts.

Land Acquisition

The results of all landscape-level movement and land-use analyses should be used in conjunction with the 20 previously identified CAN sites in Virginia to identify priority populations and landscapes within the state for protection as additional FCA's and MOS's. Cultural, geographical, and political opportunities for Wildlife Management Area (WMA) purchases at these locations should be investigated in coordination with the VDGIF and other local and

regional partners. These sites should then become the focus of conservation actions and continued monitoring and tracking efforts within the state.

E. Law Enforcement and Repatriation

Collaboration with Law Enforcement

In order to preserve Wood Turtles on the landscape, it will also be important to address the growing threat of illegal collection. State and federal law enforcement agencies are becoming increasingly aware of the severity of poaching for non-game species, and collaboration between conservationists and law enforcement will be crucial to combatting the illegal wildlife trade (Cagle and Hall 2019). In addition to providing law enforcement with timely expertise on herpetofaunal ecology and identification, collaborative efforts to PIT tag or otherwise mark animals can help directly combat poaching by giving law enforcement the tools they need to match confiscated animals to their location of origin (Jones et al. 2018; Cagle and Hall 2019).

Stopping wildlife traffickers before they can collect Wood Turtles should always be the standard when combating illegal collection, but there will likely continue to be cases where turtles are recovered only after they have been removed from the landscape (Hollowell 2011; Cagle and Hall 2019; J.D. Kleopfer, VDGIF, pers. comm.). When large numbers of turtles of unknown origin are recovered at once, it is often difficult to determine what should be done with the confiscated animals (Hollowell 2011; Kornilev et al. 2017).

Repatriation

Since captive turtles are no longer contributing to population growth and genetic diversity, and since removal of Wood Turtles from a population can severely threaten its viability (Compton 1999), it would be ideal if confiscated turtles could be quickly returned to their home streams after being thoroughly examined for signs of infectious diseases. In practice, however, the exact stream the turtles were taken from is often unknown. Since maintaining the ecological and evolutionary potential of the species is of the utmost importance, genetic analysis would be necessary before considerations of repatriation were evaluated. In 2018 the Wood Turtle Working Group investigated the efficacy of genetic assignment using over 1,895 tissue samples collected from across the Wood Turtle's range, and they found that current methods matched only 52% of samples with known origins to their respective locations (Jones et al. 2018). Success rates varied between populations, as did the spatial scale to which a match could be narrowed. They cautioned that current methods may have limited application, especially if stream-level accuracy for genetic assignment is desired (Jones et al. 2018).

If the source stream cannot be located for a group of confiscated turtles but the broader population and watershed for the animals is known, any necessary repatriation efforts should focus on habitat that is suitable for Wood Turtles but unoccupied by them. It would be counterproductive to disrupt or displace an established population of Wood Turtles, and it would be equally futile to repatriate the confiscated turtles to a location that cannot sustain them; this almost paradoxical habitat parameter has led to debate about when and if repatriation is a suitable option for reptile conservation (Dodd and Seigel 1991; Burke 1991; Reinert 1991). Since appropriate, unutilized habitat in the Commonwealth is likely scarce, potential locations for future repatriation should be determined through a process that assesses occupancy and potential threats in order to ensure the highest probability of successful repatriation.

F. Best Management Practices

Development

Recommendations for Best Management Practices (BMP) should be developed for each MU by evaluating the most pressing threats to local populations in the context of those BMP's developed by Jones et al. (2018). Recommendations should be prioritized using a guided analysis of expert opinion on threat severity and level of urgency for conservation actions. Guidance for developing recommendations should be supported by forming a Virginia Wood Turtle council that includes state biologists and researchers, stakeholders, and landowners invested in conserving Wood Turtle populations. Many of the regional guidelines for Wood Turtle BMPs outlined in Jones et al. (2018) are applicable to the state of Virginia, including:

- Limiting the use of mowers and other heavy agricultural machinery to winter when possible and providing 30–100m stream buffers in agricultural areas where warm weather operation is unavoidable
- Preventing timber harvesting within 300m of priority Wood Turtle habitat when possible, especially during the Wood Turtle's active season
- Identifying and preserve nesting locations, eradicating invasive plants and thinning native plants as necessary to maintain the habitat
- Preventing the construction of new roads within 300m of priority habitat when possible, and implementing road closures during nesting season (late May to early July) when possible
- Constructing exclusion fences or crossing structures for existing road sections that experience high levels of Wood Turtle traffic
- Upgrading existing culverts such that they do not hinder turtles from passage under roads

Implementation

Given that 85% of Virginia Wood Turtle populations occur on privately owned land (Akre unpublished data), a landowner outreach program should be developed in order to increase the collaborative capacity for conserving Wood Turtle habitat through the implementation of BMPs. Implementation should take place at all spatial scales, prioritizing FCA's and MOS's and then expanding to include the larger MU's. Technical assistance should be made available for guiding land managers and stakeholders in preserving or enhancing habitat on their property in ways that best address the needs of the Wood Turtle populations.

Figure 13. A Wood Turtle survey conducted as a component of landowner outreach.

G. Education and Outreach

In addition to reaching major land managers and stakeholders through the implementation of BMPs, engagement with the general public through education and outreach programs will be crucial for the long-term viability of the conservation actions set forth above. Conservation threats arise from human actions, and it is only by altering human behavior that those threats can be eliminated (Wright et al. 2015). Distributing informational booklets, utilizing flyers or billboards, setting up online resources, giving public presentations, or supporting academic and extracurricular programs for youth have all had varying degrees of success at informing public opinion on conservation issues (Jacobsen et al. 2015). Additionally, despite its potential to distract and disconnect the public from the plight of the natural world, the surging popularity of social media presents promising new opportunities for outreach and engagement (Jacobson et al. 2015; Wright et al. 2015). An effective Wood Turtle outreach plan should make the best use of all available resources, tailoring its approach to best reach its target audiences (Jacobson et al. 2015; Wright et al. 2015).

It is worth noting that the conservation status of the Wood Turtle, and the high demand for the species in the illegal pet trade, requires that discretion be taken with all education and outreach material. Certain methods of outreach that might otherwise be considered, such as involvement with citizen science programs or iNaturalist (Nugent 2018), should be precluded for this reason.

Effective education and outreach will require collaboration. Potential partners should be identified and contacted early in the planning of the education and outreach strategy. Major reptile conservation groups like Partners in Amphibian and Reptile Conservation (PARC) and the American Turtle Observatory (ATO) are ideal, as are governmental agencies like the Natural Resources Conservation Service (NRCS), the Soil and Water Conservation Districts (SWCD), and the United States Geological Survey (USGS) that are already actively involved in habitat restoration and protection. Other potential partners including schools, agricultural associations, and outdoors clubs should be considered when the they are likely to have significant influence within a targeted audience.

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V. Appendices

A. Site Action Tracking Database

Tracking Item	Description
Mapping Considerations	
Full extent of subpopulation known?	Does the site, as mapped, appear to encompass the full range of continuous habitats available to this subpopulation of Wood Turtles?
Adjacent sites to be linked?	Are there sites/populations nearby that should be mapped and managed in conjunction with this site? If, so which?
Truncation needed?	Should this site be made truncated? Indicate where.
Protected Status	
% protected	Percent of the Focal Core Area (300 m buffer) that is protected (initial calculation from USGS layer).
% supporting landscape protected	Percent of the surrounding landscape (5.5 km buffer) that is protected (initial calculation from USGS layer)
Core protected	Based on your knowledge, is the riparian area (to 300 m) sufficiently protected at this site?
Number of high-use areas within site	How many discontinuous high-use (by wood turtles) areas are known in this FCA?
High-use areas protected?	Based on your knowledge, are the critical high-use areas sufficiently protected at this site?
Federal Involvement (USFWS, NPS, NRCS, USFS)	
Percent	Percent of the site that is owned or managed by each respective agency
Acreage	Number of acres owned or managed
Name	Name of the property
Vulnerability	
Development vulnerability	Vulnerability to future development (75th and 90th percentiles indicated)
Climate vulnerability	Vulnerability to climate change (75th and 90th percentiles indicated)
Roads	
Road threat?	0 or 1; Is the site in the top 3rd percentile of a metric reflecting road density and traffic rate?
Road mitigation needed?	Is road mitigation of some form needed for this site?
Agriculture	
Percent agriculture	Percent of the site that is in active agriculture

Tracking Item	Description
Total agriculture (acres)	Approximate number of acres of agriculture within the site (300 m)
Mowing threat?	Is mowing (e.g., of fields, powerlines, etc) a major threat?
Livestock threat?	Are factors associated with livestock a threat to the population? (E.g., habitat degredation, water quality, etc)
Agriculture mitigation needed?	Is agriculture mitigation of some sort needed at this site?
Working Lands Site?	Should this be a target site for programs dedicated to mitigating detrimental land management?
Nesting	
Instream nesting available?	Are natural instream nesting features available?
Instream nesting protected?	Are the available natural instream nesting features protected?
Anthopogenic nesting available?	Are anthopogenic nesting features available?
Anthopogenic nesting protected?	Are the available anthropogenic nesting features protected?
Nest depredation threat?	Is nest depredation a major concern?
Nesting management needed?	Is nesting habitat management needed to create new nesting habitat, augment existing habitat, or protected existing habitat?
Invasive Plant Species	
Invasive management needed?	Is invasive plant management needed?
Demographics	
Juvenile percentage	Percent of turtles captured that were juveniles
Demographic stability (% > 0.25 = stable)	If % juveniles is >0.25 the site is given a 1
Nest protection needed?	Is active nest protection needed to recover the population age structure?
Headstarting urgently needed?	Is the demographic condition and population status such that headstarting is the only means for persistence?
Data Quality	
CMR estimate?	Was a capture-mark-recapture population estimate obtained for this site?
CPUE	Was any catch per unit effort (CPUE) information obtained from this site?
Standardized segment density	How many survey segments per km2

Tracking Item	Description
Last year surveyed	
Year Wood Turtles last observed	
More surveys needed within site?	Based on expert opinion, does this site need more survey segments to evaluate the population status?
More surveys needed outside of site?	Are surveys needed outside of the site's boundaries in order to assess connectivity between sites or establish the biological boundaries of the CAN site?
Data deficient?	Based on expert opinion, is this site data deficient?
Data Sensitivity	
High density?	Based on expert opinion, would you consider this a high-density site within the state?
CMR_rank	Did this site have a regionally high density estimate? (Top 20 sites in the region are indicated)
CPUE_rank	Does this site have a regionally high CPUE estimate? (Top 20 sites in the region ar indicated)
Withold?	Should this site be withheld from any distribution because the potential threats of circulation outweigh the potential benefits?
Poaching risk?	Is this site a poaching risk?
Technical Assistance	
Key landowners identified	Have any key landowners been identified?
Key landowner partnerships	Are partnerships for habitat protection in place?
State agency target for land acquisition?	Is this FCA a target for state agency land acquisition? Indicate which agency.
Land trusts and NGOs updated on FCA	Have Land Trusts and NGOs been contacted and updated about the conservation needs of this FCA?
Species of Greatest Conservation Need	
SGCN expected to occur?	Do any Species of Greatest Conservation Need (SGCN) occur at this site? Indicate species.
SGCN management incorporated?	Are these SGCN incorporated into the management of these sites?
SGCN conflict?	Does management of an SGCN conflict with the management of Wood Turtles? (e.g., mowing for grassland birds)
Game species conflict?	Does management of a game species conflict with Wood Turtle management at this site? (e.g., Pheasant?)
Recreation	

Tracking Item	Description
ORV threat?	Does ORV activity pose a threat to the population? (E.g., extensive trails near stream or evidence of ORV on nesting areas)
Hunting threat?	
Hiking trails?	Does this site host hiking trails that pose a threat via exposure to humans?
Fishing/canoe/kayak?	Is this site frequented by anglers and other recreationists?
Hydrology	
Stream straightening present?	From field surveys or aerial photo interpretation, have significant sections of the stream been anthropogenically straightened?
Bank hardening present?	Has the stream bank been hardened (e.g., with cement or riprap) within or adjacent (2 km upstream) to the site?
Major flood risk?	Is this site likely to experience extreme floods with the potential to displace overwintering turtles?
Other Management	
Other management needs	Are there other management considerations for the site?
Telemetry priority?	
Site Leaders	
Site leaders?	Are there any individuals that could lead oversight and management of this site?