

5. HABITAT

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A summer thunderstorm in Wood Turtle habitat, Massachusetts. MIKE JONES



5.1—Riparian habitat mosaics often include sandy nesting areas, stream-influenced early successional habitats, downed trees, and temporary floodplain pools, juxtaposed with mixed-age floodplain forest. Pictured: Wood Turtle habitat in New England. AMERICAN TURTLE OBSERVATORY

Introduction

Wood Turtles are fluvial (flowing water) specialists and riparian generalists, found primarily in mid-sized streams and rivers that flow through a broad range of upland habitats. Across the Wood Turtle's large geographic range, the major structural habitat components required by the species remain relatively consistent. For example, all functional Wood Turtle populations must have access to: (1) suitable in-stream habitat for overwintering, courtship, and foraging; (2) suitable upland nesting areas; and (3) varied upland habitats (including early-successional habitats) for foraging and thermoregulation. Localized differences in habitat selection, as well as by region, stream size, and physical geography, are relatively minor.

Today, the ideal configuration of habitats for long-term Wood Turtle conservation would include mid-sized streams within a mosaic of high-integrity riparian and upland habitats unfragmented by roads or recreational features. The riparian mosaic would include in-stream nesting areas, stream-influenced early successional habitats, and temporary wetlands, juxtaposed with mixed-age floodplain and upland forest (5.1). Unfragmented sites with supporting disturbance regimes that maintain these characteristics—and minimal human use—are most likely to provide cost-effective conservation outcomes. Multiple streamcourses with independent flow and disturbance regimes, and within a few kilometers of one another, facilitate long-term population connectivity and stability at longer time scales. There is clear evidence that Wood Turtle populations are negatively affected by roads and agriculture even at broad landscape scales, suggesting that wherever feasible, Wood Turtle populations should be managed as part of much larger landscapes of high integrity forests or low-intensity development and land use. This ideal habitat scenario is startlingly rare on the American landscape today. Maintaining the evolutionary potential of representative Wood Turtle populations will require sustained efforts to insulate



5.2—Wood Turtle populations are generally associated with slow-moving sections of clear, cold streams with sand, gravel, rock, or bedrock substrate in woodland and agricultural areas, interspersed among areas of moderate to fast current. *Clockwise from top:* New England; Maryland; New Brunswick; New Jersey ((JOE CROWLEY & MIKE JONES)



5.3—Wood Turtles tolerate a wide range of stream flow conditions, but they are most often associated with mid-sized streams between between 3 and 20 m wide. *Clockwise from top:* New Hampshire; Upper Mississippi watershed; New Jersey; northern Minnesota (MIKE JONES & DONALD BROWN)

functional stream systems from the effects of overuse. And elsewhere, minimizing Wood Turtle population decline will require targeted actions to improve or replace key habitat features missing from the landscape and to lessen the annual mortality risks to individual turtles.

Aquatic Habitat

Wood Turtle populations are strongly associated with relatively slow-moving sections of clear, cold, woodland or agricultural streams—often interspersed with areas of moderate to fast current—and especially those with sand, gravel, rock, or bedrock substrate (Finneran 1948; Vogt 1981; Quinn and Tate 1991; Kaufmann 1992b; Holman and Clouthier 1995; Akre 2002; Arvisais et al. 2004; Ernst and Lovich 2009; Jones 2009; Buhlmann and Osborn 2011) (5.2). Suitable streams are critical to the persistence of most known Wood Turtle populations as they provide essential overwintering habitat (Vogt 1981; White et al. 2010; White 2013) and the preferred context for courtship and mating.

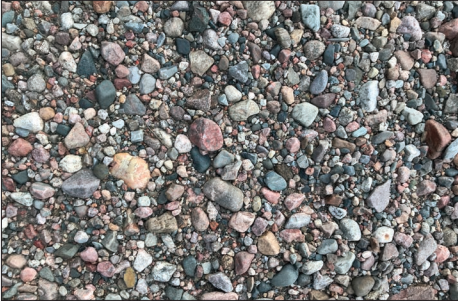
Stream Size

Wood Turtles and Wood Turtle populations can tolerate a wide range of stream flow conditions, but they are most often associated with mid-sized or mid-order streams between about 3 and 20 m wide (Brooks and Brown 1992 in Foscarini and Brooks 1997; Foscarini and Brooks 1997; Arvisais et al. 2004, Breisch 2006; Akre and Ernst 2006; White 2013) (5.3). Wood Turtle populations may occur in even smaller streams (Wright 1918; Akre and Ernst 2006; Jones 2009; Akre, unpubl. data) and much larger streams (Niederberger 1993; Niederberger and Seidel 1999), and the extent to which Wood Turtles reside in both may be as much a function of the availability of key structural features (pools, logjams, cutbanks, root structures, and riparian clearings) as past land-use history in the watershed.

In a number of cases, Wood Turtles have been reported in association with very large rivers (≥ 50 m wide), including major rivers in Ontario (Brown 1947), Québec (Denman and Lapper 1964); Maine (Jones and Willey, unpubl. data); central New Hampshire (NHFG, unpubl.



5.4—Wood Turtles in very large rivers are often associated with braided channels or tributary streams. Algoma District, Ontario. MIKE JONES



5.5—Wood Turtles are often associated with inorganic substrates including clay, sand, gravel, and cobble, although some populations occur in areas of deep organic sediment accumulation. Prevailing substrates associated with Wood Turtle streams are pictured here. *Top left:* Algoma District, Ontario; *Top right:* Minnesota; *Bottom left:* New Hampshire; *Bottom right:* New Hampshire. MIKE JONES

data); Pennsylvania and New Jersey (NJ DFW, unpubl. data; PA NHP, unpubl. data); Maryland (Cooper 1949; MacCauley 1955); Virginia (Henshaw 1907; Brady 1937; Akre and Ernst 2006); and West Virginia (Akre, unpubl. data). In many cases, Wood Turtles in very large rivers appear to be associated with braided channels or tributary streams (5.4). Isolated Wood Turtles have been documented in association with beaches along very large rivers in central Massachusetts, possibly representing nesting animals, although these may have originated from a smaller river nearby (MassWildlife NHESP, unpubl. data; Jones, unpubl. data). A quantitative analysis of stream watershed area is presented by Jones et al. (2015), which suggested that Wood Turtles are associated with stream habitat that is generally of lower gradient, higher sinuosity, and higher flow than randomly available streams, though specific associations vary locally.

Stream Current and Substrate

Wood Turtles are most often associated with streams characterized by variable inorganic substrates including clay, sand, gravel, and cobble, although some populations occur in areas of deep organic sediment accumulation (5.5). White (2013) reported Wood Turtles in Nova Scotia in association with primarily cobble stream substrate. Akre (2002) reported that conditions along a third-order tributary of the Potomac watershed in Fairfax County, Virginia, which flows across the Atlantic Seaboard Fall Line into the Potomac River floodplain, varied from “clear, moderate-current” with “sand-gravel substrate” to “slow-flowing with suspended sediments and clay-gravel substrate.” Breisch (2006) reported that Wood Turtles in West Virginia were associated with sand and rocky stream substrates. By contrast, Parren (2013) reported a population in Vermont associated with calcareous bedrock and silt, and noted that Wood Turtles likely tolerate a wide range of stream conditions. In a series of 5,125 stream locations in Maine, New Hampshire,



5.6—Wood Turtles often overwinter in deep pools, undercut banks, or in association with the root masses of large trees. Known overwintering sites associated with large trees are pictured above. *Top left*: Silver Maple (*Acer saccharinum*) in New Hampshire; *Top right*: Yellow Birch (*Betula alleghaniensis*) in Massachusetts; *Bottom left*: Eastern Hemlock (*Tsuga canadensis*) in Massachusetts; *Bottom right*: American Sycamore (*Platanus occidentalis*) in Massachusetts. MIKE JONES

and Massachusetts, Jones and Willey (unpubl. data) found that stream substrates included sand (40.5%), cobble (17.2%), gravel (14.3%), silty sand (14%), boulders (6.4%), organics and muck (3.1%), silt (3.6%), clay (0.3%), and bedrock (0.3%).

Stream Alkalinity

Parren (2013) reported a Wood Turtle site in Vermont that was associated with calcareous underlying bedrock. McCoard et al. (2016) found a positive association of Wood Turtles with higher soil pH in West Virginia. Most authors do not report stream pH associated with Wood Turtle sites, and it is not well known the extent to which stream pH influences the distribution or abundance of Wood Turtles.

Instream Overwintering Habitat

Wood Turtles spend the coldest months underwater. They primarily overwinter in streams, rivers, or connected floodplain features such as abandoned rivers meanders, oxbows, and tributary streams. Nearly all recent telemetry studies have documented overwintering in streams, rivers, and associated aquatic habitats. Many authors have noted the propensity of Wood Turtles to overwinter in deep pools, undercut banks, or in association with the root masses of large trees such as American Sycamore (*Platanus occidentalis*), Eastern Hemlock (*Tsuga canadensis*), Eastern White Pine (*Pinus strobus*), and Yellow Birch (*Betula alleghaniensis*) (Farrell and Graham 1991;



5.7—Wood Turtles will overwinter in proximity to large logjams, such as this site in New Hampshire. MIKE JONES

Tuttle and Carroll 1997; Niederberger and Seidel 1999; Ultsch 2006; Akre and Ernst 2006; Greaves and Litzgus 2008; White 2013) (5.6).¹

Radio-equipped Wood Turtles in Ontario (Greaves and Litzgus 2008) overwintered entirely in the stream rather than adjacent wetland habitats and generally chose areas with muck substrate, available structure (vegetation, woody debris, and logs), and an average depth of 91.2 ± 34.8 cm. White (2013), in a study of overwintering site selection in Nova Scotia Wood Turtles, reported that most telemetered Wood Turtles overwintered in riverine habitats, although marsh and oxbow habitats were also used, and that Wood Turtles overwintered at a mean water depth of 67 ± 35 cm. Most turtles overwintered in reaches dominated by fine sediment substrates. Wood Turtles often overwintered in close proximity to structures such as log jams, single logs, large branches, woody material, and root balls, as well as undercut banks, underwater rock ledges, and boulders. In northern populations, such structures likely shelter turtles from potentially lethal scouring ice sheet flows and/or being washed downstream during spring run-off events (Jones and Sievert 2009; Saumure, unpubl. data). In Greaves and Litzgus' study (2008), turtles were observed overwintering at dissolved oxygen (DO) concentrations averaging 12.39 ± 0.92 ppm, and in White's (2013) study, the mean DO across all overwintering sites for 20 turtles (year one) and 29 turtles (year two), respectively, was 13.12 ± 1.56 ppm ($n=88$ measurements) and 11.97 ± 3.50 ppm ($n=133$ measurements), although turtles were observed overwintering in an oxbow at DO of 9.65 ± 2.25 ppm.

Graham and Forsberg (1991) reported aquatic oxygen uptake by overwintering Wood Turtles in central Massachusetts, and noted that turtles typically rested on the stream bottom, near submerged logs or rocks, in 0.3–0.6 m of water. In Connecticut, Wood Turtles hibernate in muskrat dens, on the gravel bottoms of pools in woodland streams (Farrell and Graham 1991), and amongst tree roots (Klemens 1993). Farrell and Graham (1991) reported an important overwintering site associated with the roots of a large sycamore at a bend in a stream in Sussex County, New Jersey, and Parren (2013) reported overwintering sites associated with tree stubs and

1 There are a few 19th- and early 20th-Century accounts of terrestrial overwintering or brumation (e.g., Surface 1908).

logs including Eastern Hemlock, as well as the use of small “bank coves” in streams in Vermont. In Virginia, Akre and Ernst (2006) reported a range of key overwintering features including leaf packs in deep pools, undercut banks, logjams, and large deadfalls of tree species such as American Sycamore; an anecdotal association with logjams is evident throughout the range of the species (5.7).

Rare Aquatic Habitats

Tidal Rivers.—Infrequently, Wood Turtle populations may occur outside of a strictly fluvial context. For example, a noteworthy Wood Turtle metapopulation occurs along the fresh-tidal Hudson River in Dutchess, Greene, and Columbia Counties, New York, where a dozen individual turtles were observed in tidal swamps along the Hudson River by researchers in the 1980s and 1990s (Kiviat and Barbour 1996).² In neighboring New Jersey, there is at least one older Wood Turtle record in the lower watershed of the Delaware River (Street 1914) in Beverly, Burlington County, and two historic records from the vicinity of lower Rancocas Creek in 1933 and 1951 (New Jersey Division of Fish and Wildlife 2019). However, in a review of validated New Jersey occurrence records from 1980 to 2019, there are currently known Wood Turtle occurrences within freshwater tidal marshes or tidal rivers (NatureServe 2021).

Records from the mouth of the Susquehanna River in Harford County, Maryland (Cooper 1949) may represent individuals from populations associated with tidally-influenced streams or, more likely, associated with smaller side streams. Several streams on Elk Neck, Cecil County, Maryland, where Wood Turtles were documented between the 1950s and 1970s, are in close juxtaposition with tidal estuaries. Therefore, Wood Turtles likely had access to tidal systems in recent decades. Wood Turtles are known to have occurred in the Potomac River and its tributaries upstream of the Atlantic Seaboard Fall Line, and it is possible that they once occurred in the lower Potomac River in Maryland and Virginia nearly as far as the tidal mouth (Akre and Ernst 2006). In any event, Wood Turtles likely used the tidal Potomac as a corridor because historic populations are known from streams that flow through the fall line into tidal sections where they enter the tidal Potomac in northeastern Virginia (Mitchell and Pilcicki 2000; VDGIF FWIS 2019; Akre, unpubl. data).

Ephemeral Pools.—Wood Turtles appear to be opportunistic or facultative users of temporary, seasonal, or fishless aquatic habitats, especially abandoned river meanders but also vernal and autumnal pools or other confined depressions. Wood Turtles exploit the seasonal availability of vernal pools and ephemeral wetlands (Mitchell et al. 2008, in Calhoun and deMaynadier 2008), but the importance of seasonal or ephemeral pools likely varies regionally. In Massachusetts and New Hampshire, only 80 of 7,348 active season radiolocations (1.1%) were within “vernal pool” habitat, and 117 (1.6%) were within 5 m of vernal pool habitat (Jones and Willey, unpubl. data).

Seeps and Springs.—Akre and Ernst (2006) report consistent use of seepage areas in deciduous forest in Virginia and report that small wetlands may be attractors on the landscape. Springs, vernal pools, and seeps appear to be complementary landscape features that do not support overwintering populations. Wood Turtles were reported from a mountain spring in the Catoctin Mountains of central Maryland (Reed 1956), and Abbott (1884) provided an account of three Wood Turtles congregating at a forest spring near Trenton, Mercer County, New Jersey.

2 French, in Kiviat and Barbour (1996), also reported an observation of a single Wood Turtle from a tidal context in Newbury, Essex County, Massachusetts.

Breckenridge (1958) reported Minnesotan Wood Turtles in “spring holes” and “woods ponds,” as well as wooded streams.

Canals.—Wood Turtles are generally more abundant in naturally sinuous sections of stream, but may occur in lower densities in channelized rivers, and, very rarely, in canal systems. Multiple individual Wood Turtles have been reported from an 1890s canal system associated with the Springfield Reservoir in Hampshire County, Massachusetts (MassWildlife NHESP 2019), and Wood Turtles are associated with portions of the Chesapeake and Ohio Canal system in Maryland (Akre, unpubl. data).



5.8—Alder (*Alnus* spp.), pictured here in New England, is an important tall shrub in Wood Turtle sites throughout the range of the species. MIKE JONES

Lacustrine Habitats.—Although many early authors reported the Wood Turtle to frequent or reside in lakes or “ponds,” these statements appear to be suppositional (Logier 1939). There are many credible accounts (both historic and modern) of Wood Turtles from lentic habitats, though lotic habitats are more the norm for almost all populations studied at length. Jones (1865) reported that Wood Turtles were found in lakes in Nova Scotia. There are documented Wood Turtle occurrences associated with several large lakes in Québec (MDEF, unpubl. data). Quinn and Tate (1991) presented evidence of seasonal lake use in Ontario by at least one individual (although they stated that most aquatic habitats were streams). A head-started Wood Turtle overwintered in a manmade pond at Great Swamp NWR in 2012–2013 (Osborn and Buhlmann, unpubl. data). In Franklin County, Massachusetts, Jones and Sievert (2009) reported that a subpopulation of Wood Turtles resided in the catchment area behind an 1890s power dam that had largely silted in, although radio-tracked turtles primarily used riverine and riparian features within the old reservoir area. Akre (unpubl. data) observed one Wood Turtle overwinter in a farm pond in Virginia.

Beaver-Influenced Habitats.— The relationship between beaver-caused habitat modifications and Wood Turtle spatial ecology is complex and in need of further study.³ At the larger watershed scales in unfragmented river systems, North American Beavers (*Castor canadensis*) are an important driver of structural complexity within Wood Turtle-occupied waterways from Minnesota to Nova Scotia. For example, beavers create openings in northern, coniferous forests through tree removal and flooding, and create deeper pools for overwintering (Saumure, unpubl. data). In states and regions where beavers have been aggressively controlled or hunted, these disturbance regimes are no longer present and can be difficult to replicate. At most of the remote, isolated sites studied by Jones and Willey (2013b), turtles exhibited heavy use of beaver-created openings and clearings. Beaver dams may also play a major role in the creation of suitable nesting habitat in Virginia and elsewhere: as beaver dams deteriorate or are blown out by major rain events, what often remains behind are large sandbars that may be suitable for Wood Turtle nesting (Kleopfer, unpubl. data).

3 Further discussion of the interactions between beavers and Wood Turtles is provided in Chapter 9.



5.9—As much as any other freshwater turtle, if not more, Wood Turtles near their northern range-margin are found in association with northern conifers, including: (clockwise from top left): Northern White Cedar (*Thuja occidentalis*), White Spruce (*Picea glauca*), Red Spruce (*Picea rubens*), Black Spruce (*Picea mariana*), Tamarack (*Larix laricina*), and Balsam Fir (*Abies balsamea*). MIKE JONES

Riparian and Floodplain Habitat

Riparian Habitats

Riparian swales and floodplain wetlands are components of Wood Turtle habitat throughout the region (Vogt 1981; Ernst and McBreen 1991; Akre and Ernst 2006; Jones 2009; Buhlmann and Osborn 2011). In more northerly areas, Wood Turtles are frequently associated with rivers that have well-developed riparian zones encompassing alder swales, marshes, sedge meadows, and emergent and forested wetlands (Quinn and Tate 1991; Compton et al. 2002; Walde et al. 2003).

Grey or Speckled Alder (*Alnus incana*) is an important tall shrub within riparian areas along Wood Turtle streams throughout the species' range (Saumure and Bider 1998; Walde et al. 2003)



5.10—Silver Maple (*Acer saccharinum*), pictured here in flower in Maine in early May, is a common component of floodplain forests throughout the entire range of the species. In more northerly areas, Silver Maple often shares floodplain habitat with American Elm (*Ulmus americana*) or Black Ash (*Fraxinus nigra*). MIKE JONES



5.11—Eastern Cottonwood (*Populus deltoides*) is a dominant component of floodplain forests in southeastern Minnesota, southern Wisconsin, and Iowa, and along larger rivers from New England to Virginia. MIKE JONES

(5.8). Box Elder (*Acer negundo*) is locally abundant in open riparian habitats throughout the southern Great Lakes and St. Lawrence Valley (Saumure and Bider 1998).

Floodplain Canopy Composition

In northern streams, floodplain forests may be composed substantially of conifers, including White Spruce (*Picea glauca*) in the Great Lakes, Maritimes, and extreme northern New England, with Black Spruce (*Picea mariana*) found sparingly throughout the northern range on poorly drained (or nutrient-poor) sites. Red Spruce (*Picea rubens*) is more typically found on upland sites through the Appalachian Mountains but may be a component of floodplain swamps in New York and New England. Other common conifer associates in northern floodplain forests include Balsam Fir (*Abies balsamea*), Tamarack (*Larix laricina*) and localized areas of Northern White-Cedar (*Thuja occidentalis*) (5.9). The northern conifers often give way to floodplain forests of Silver Maple (*Acer saccharinum*), which is a common species in floodplains across much of the Wood Turtle's range (5.10), along with Red Maple (*Acer rubrum*), American Elm (*Ulmus americana*), and Black Ash (*Fraxinus nigra*). Floodplain trees in the western Great Lakes include associations of Silver Maple, Black Ash, Basswood (*Tilia americana*), Swamp White Oak (*Quercus bicolor*), Green Ash (*Fraxinus pennsylvanica*), and River Birch (*Betula nigra*).⁴ Eastern Cottonwood (*Populus deltoides*) is a dominant component of floodplain forests in southeastern Minnesota, southern Wisconsin, and Iowa, and throughout the transitional area (5.11).

In unglaciated Appalachian streams from Pennsylvania to Virginia, floodplain tree species include Silver Maple, Sycamore, River Birch, and Tulip Poplar (*Liriodendron tulipifera*) (5.12). In eastern Virginia, Akre (2002) reported Wood Turtles from a third-order stream near the Potomac River in floodplain forests dominated by Red Maple, Tulip Polar, Ironwood (*Carpinus caroliniana*), Pawpaw (*Asimina triloba*), River Birch, Box Elder, Slippery Elm (*Ulmus rubra*), and ashes (*Fraxinus* spp.).

⁴ Kordiyak (1981) reported floristic associations within Wood Turtle habitat in the Driftless Area of southwestern Wisconsin, noting that Silver Maple, Swamp White Oak, Slippery Elm, River Birch, and Green Ash were dominant canopy trees in the floodplain; these associations are common across central Wisconsin.



5.12—Typical Appalachian forests prevail from near the southern New England coast and throughout Pennsylvania, Maryland, Virginia, and West Virginia. Here, floodplain and riparian tree species include: *Left*: River Birch (*Betula nigra*); *Middle*: Tulip Poplar (*Liriodendron tulipifera*); *Right*: American Sycamore (*Platanus occidentalis*). MIKE JONES

At a complex of sites in Shenandoah and Frederick counties, Virginia, Akre and Ernst (2006) reported that Sycamore, Red Maple, and Tulip Poplar were common in the floodplain, while oaks and hickories occurred on undisturbed floodplain sites. In northern West Virginia, Breisch (2006) reported Wood Turtles from a forested stream with floodplain canopy consisting of Sycamore, Red Maple, River Birch, and rhododendron (*Rhododendron* spp.). Elsewhere in West Virginia, Niederberger (1993) described a similar floodplain forest of Sycamore, Tulip Poplar, and Red Maple, with Red Maple, Black Walnut (*Juglans nigra*) and hickory (*Carya* spp.) increasing at the “outer edge” of the riparian area. The floodplain forest gave way in places to open, savanna-like pastures with Black Walnut canopy.

Upland Habitat

Upland habitats used by Wood Turtles vary by geographic region, season, and spatial scale (Harding and Bloomer 1979; Strang 1983; Quinn and Tate 1991; Compton 1999; Compton et al. 2002; Walde et al. 2003; Arvisais et al. 2004; Jones 2009; Parren 2013). Wood Turtles are often found using upland mosaics of forested and non-forested habitats, both in and out of the riparian floodplain (which may be seasonally dry). Within largely forested landscapes, forest edges provide opportunities to balance thermoregulation and food requirements (Compton et al. 2002).

Upland Canopy Composition

Across their range, Wood Turtles are found in a broad range of upland forest conditions and canopy associations. These can be broadly divided between: (1) the coniferous forests of the northern range-margin; (2) transitional communities of the Great Lakes, New England, and Nova

Scotia); and (3) the southern hardwood and pine assemblages of the central Appalachian Mountains.⁵

Northern Range-Margin.—In a broad swath of the continent from Nova Scotia and New Brunswick, across northern New England, Québec, New York, Ontario, Michigan, Wisconsin, and Minnesota, canopy tree associations may be comprised of northern conifers in the pine (Pinaceae) and cypress (Cupressaceae) families, predominately Red Spruce in the northern Appalachian regions and White Spruce in the upper Midwest and Great Lakes regions. Balsam Fir is present in upland forests from Minnesota to Nova Scotia and south to Massachusetts and northern



5.13—Young or recently disturbed forests in northern regions from Minnesota to Nova Scotia, and south as far as Vermont, may be dominated by stands of Balsam Poplar (*Populus balsamifera*), pictured here in Maine. MIKE JONES

Pennsylvania. Young forests in the boreal regions from Nova Scotia to Minnesota, and south as far as Massachusetts, may be dominated by stands of Black Cherry (*Prunus serotina*), Quaking Aspen (*Populus tremuloides*) or Balsam Poplar (*Populus balsamifera*) (5.13).⁶

Throughout the Great Lakes from northeastern Minnesota to Michigan's Upper Peninsula and Ontario, Wood Turtles occur occasionally within fire-dependent communities dominated by Jack Pine (*Pinus banksiana*) and Red Pine (Greaves and Litzgus 2008) (5.14).

Transitional Communities.—South of the northern coniferous forests, northern hardwood species predominate, including Yellow Birch, Sugar Maple (*Acer saccharum*), and American

5 Wood Turtles in New Haven County, Connecticut, were associated with streams in central hardwood forests (Garber and Burger 1995). In Morris County, New Jersey, Buhlmann and Osborn (2011) reported Wood Turtles from a stream bordered by “riparian hardwood forest” and abandoned pastures with blackberry (*Rubus* spp.) and invasive multiflora rose (*Rosa multiflora*). In Warren County, New Jersey, Castellano et al. (2008) reported Wood Turtles from a deciduous forested landscape interspersed with row crop (mostly corn) agricultural fields. A separate analysis of 1,379 radio-telemetry points representing 70 unique Wood Turtles in New Jersey found that the largest percentage of observations of turtles in non-stream habitats were in deciduous forested wetlands followed by cropland and pastureland (Zarate, unpubl. data). In Cumberland County, Pennsylvania, Strang (1983) reported Wood Turtles in lowland areas dominated by oaks, Black Birch, and Red Maple, but in Centre County, Pennsylvania, Kaufmann (1992a) reported little use of deciduous forest.

6 In the Mauricie region of Québec, Walde et al. (2003) reported Wood Turtles from the boundary of the boreal/Great Lakes St. Lawrence lowland forest (Farrar 1995), where forests are dominated by White Spruce, White Birch, and Quaking Aspen, and floodplains are dominated by Speckled Alder. In the same system, Arvisais et al. (2004) reported a largely forested mosaic of Balsam Fir, poplar, birch, and spruce. In an agricultural area of southern Québec (Brome County), Saumure and Bider (1998) reported Wood Turtle habitat as extensive hayfields and cattle pastures juxtaposed with forest dominated by Box Elder and American Elm with willows (*Salix* spp.) and Speckled Alder prevalent. In Nova Scotia, White (2013) described a mixed agricultural and forested landscape, with forests dominated by northern hardwood species such as Yellow Birch, Red Maple, White Birch, Northern Red Oak, and Black Cherry, with some White Pine, Balsam Fir, and Eastern Hemlock.

Beech (*Fagus grandifolia*) (5.15). Northern Red Oak (*Quercus rubra*) is a locally important canopy tree from New Brunswick to Virginia. Within this transitional area of northern New England, the Berkshires, the Adirondacks region, and portions of Québec, Ontario, and the northern Great Lakes states, younger forests may be composed of birch species (*Betula papyrifera* and *Betula populifolia*).⁷



5.14—Throughout the Great Lakes from northeastern Minnesota to Michigan’s Upper Peninsula and Ontario, Wood Turtles occur occasionally within fire-dependent communities of Jack Pine (*Pinus banksiana*), such as this site in Ontario. MIKE JONES

Central Appalachian Mountains.—The transitional forests of the Great Lakes and New England transition to more typical Appalachian forests near the New England coast and in Pennsylvania, Maryland, Virginia, and West Virginia. A multitude of oaks (*Quercus* spp.) and hickories (*Carya* spp.) are common components in adjacent upland forests. White Pine is nearly ubiquitous in many areas from the Great Lakes and Maritimes to Virginia; Virginia Pine (*Pinus virginiana*) is a more localized component from Pennsylvania to Virginia. Local topography drives forest composition, including the degree to which floodplain tree species dominate over upland species such as oaks, hickories, and pines.

At a complex of sites in Shenandoah and Frederick counties, Virginia, Akre and Ernst (2006) reported oaks and hickories on adjacent slopes, along with Virginia Pine and Pitch Pine (*Pinus rigida*), with White Pine present throughout. At a site in Loudoun County, Virginia, Akre and Ernst (2006) reported an occurrence of Wood Turtles within the Piedmont Hardpan Forest,



5.15—South of the northern coniferous forests, northern hardwood species predominate on upland slopes adjacent to Wood Turtle streams, including: *Left:* American Beech (*Fagus grandifolia*); *Right:* Sugar Maple (*Acer saccharum*) . MIKE JONES

⁷ Quinn and Tate (1991) reported that Wood Turtles in Ontario occur in mixed woods associations of White Pine and Red Pine, poplar (*Populus* spp.), White Birch, Red Maple, and Northern Red Oak, but at finer scales were found frequently in Speckled Alder. In western Vermont, Parren (2013) reported that his study site was surrounded by northern hardwood forest in upland areas.



5.16—Wood Turtles rarely live within the Piedmont Hardpan Forest of eastern Virginia, which supports: *Left*: Sweetgum (*Liquidambar styraciflua*); *Right*: Eastern Redbud (*Cercis canadensis*). MIKE JONES

which supports Virginia Pine, Eastern Redcedar (*Juniperus virginiana*), small oaks, hickories, Redbud (*Cercis canadensis*), and American Sweetgum (*Liquidambar styraciflua*) (5.16).

Within the Wood Turtle’s large range, several historically important canopy tree species have suffered substantial or complete decline within the past two centuries. For example: (1) the American Chestnut (*Castanea dentata*) undoubtedly influenced Wood Turtle ecology from Maine to Virginia before its collapse from the chestnut blight in the early 20th Century; (2) American Elms have been decimated by Dutch Elm Disease; (3) Eastern Hemlocks have suffered declines as a result of Hemlock Woolly Adelgid (*Adelges tsugae*, Foster 2014); and (4) the three native ashes (*Fraxinus* spp.) are facing widespread decline associated with Emerald Ash-Borer (*Agrilus planipennis*) (5.17).



5.17—Several historically important canopy tree species have suffered substantial or complete decline within the past two centuries within the core of the Wood Turtle’s range: *Top left*: American Chestnut (*Castanea dentata*) collapsed due to chestnut blight; *Top right*: American Elms have been decimated by Dutch Elm Disease ; *Bottom right*: Eastern Hemlocks have suffered declines as a result of Hemlock Woolly Adelgid (*Adelges tsugae*); *Bottom left*: the three native ashes, including Green Ash (*Fraxinus pennsylvanica*, pictured here), have been declining due to the Emerald Ash-Borer (*Agrilus planipennis*). MIKE JONES

Nesting Habitat

Wood Turtles require open, well-drained, elevated, exposed areas of sand and/or gravel for nesting (Akre and Ernst 2006; Ernst and Lovich 2009; Jones 2009; Akre and Ruther 2015), although appropriate nesting areas vary by geographic region. Over much of their range, Wood Turtles preferentially select nesting sites in coarse alluvium, poorly graded sand, or fine to medium gravel (Akre and Ernst 2006; Walde et al. 2007; Jones 2009) and sandy loam associated with a very wide range of natural and anthropogenic sites. Of 52 nests reported by Jones (2009) in Massachusetts, 64% were deposited in sand, 29% were deposited in mixed sand and gravel; 6% were deposited in organic materials or mixed organics and sand, and 2% were deposited in gravel (5.18).

Common natural features include sandy point bars on the inside bends of rivers (Buech et al. 1997; Saumure and Bider 1998; Jones 2009; Parren 2013); cutbanks on the outer bend of rivers



5.18—Wood Turtles typically nest in inorganic substrates of sand and mixed sand and gravel. Substrates of known nest locations in New England are pictured. MIKE JONES

(Buech et al. 1997); sand and gravel bar deposits in the stream channel associated with stream obstructions, constrictions, or directional changes in flow (Gilhen and Grantmyre 1973; Vogt 1981; Compton 1999; Akre 2002; Akre and Ernst 2006; Jones 2009; Parren 2013); and areas of overwashed sand in open floodplains (Jones and Willey 2013a) and dry stream beds (Gräf et al. 2003; Jones 2008) (5.19).

Anthropogenic sites include: abandoned, stable, or infrequently disturbed portions of sand and gravel pits (Compton 1999; Tuttle and Carroll 2005; Walde et al. 2007), gravel boat ramps (Compton 1999), powerlines (Jones 2009; Akre and Ruther 2015), roadsides and roadcuts (Saumure and Bider 1998; Akre 2010; Akre and Ruther 2015), farm roads near streams (Jones 2009; Parren 2013), abandoned railroad beds (Vogt 1981; Farrell and Graham 1991), active rail beds (Franek and Ruziecki 2018), gravel and cobble piles (Akre and Ernst 2006), sandy pastures (Jones 2009), junkyards and outdoor storage areas with sand piles (Jones 2009), golf course sand traps (Jones 2009), and corn fields (Castellano et al 2008; Jones 2009). Of 52 nests primarily detected by radio-telemetry in Massachusetts and New Hampshire (Jones 2009), 35% were deposited on beaches along the stream in which the turtle over-wintered, 27% were deposited in gravel pits, 19% were deposited on sand piles or along dirt roads in pastures, 4% were deposited under powerlines, and 2% each were deposited along dirt roads and in a corn field. Wood Turtles also use nesting areas anthropogenically created specifically for turtle nesting (Buhlmann and Osborne 2011) (5.20).

Akre et al. (2012) and Dragon (2014) suggested that roadcut banks may function as ecological traps on the George Washington National Forest in northwestern Virginia, where Wood Turtles occur in small, forested stream systems with limited natural nesting areas. Here, Wood Turtles nest on well-drained substrates with some elevation above the riparian landscape, in areas with good solar exposure and strong southern aspect (Akre and Ruther 2015). In that setting, only 4% (N=9) of 214 nests located by a combination of radio-telemetry, thread-spooling, and surveillance from 2010–2014 were deposited in streamside sand banks, while 96% (N=195) were deposited in anthropogenically created and maintained habitats—the majority of which (55% of 214; N=18) were road cut banks. Compton (1999) also questioned whether anthropogenic nesting areas in Maine may function as ecological traps. However, Akre and Ruther (2015) found that absent predation (i.e., among protected nests), 75% of nests monitored over five years had some hatchling emergence and 66% had 50–100% emergence of hatchlings. The effect of predation on nests in this unusual setting remains to be studied directly.

Vascular plants associated with Wood Turtle nesting areas in New Hampshire include Sweetfern (*Comptonia peregrina*), hawkweeds (*Hieracium* spp.), Little Bluestem (*Schizachyrium scoparium*), and goldenrods (*Solidago* spp., Tuttle and Carroll 2005). These plants are also commonly associated with Wood Turtle nesting areas in New England (Jones, unpubl. data). In Ontario, nesting beaches also support Atlantic Ninebark (*Physocarpus opulifolius*), Field Wormwood (*Artemisia campestris*), and Balsam Poplar. Common Mullein (*Verbascum thapsus*) is often present in anthropogenic and roadside nesting areas throughout the Wood Turtle's range. Sassafras (*Sassafras albidum*) is present in disturbed habitats from New England to Virginia (5.21).

Other Associated Plant Species

Commonly associated herbaceous species in floodplains and streamside habitats include Ostrich Fern (*Matteuccia struthiopteris*), Interrupted Fern (*Osmunda claytoniana*), Trout Lily



5.19—Natural nesting features used by Wood Turtles include sandy point bars on the inside bends of rivers, cutbanks on the outer bend of rivers, sand and gravel bar deposits in the stream channel, and areas of overwashed sand in open floodplains.



5.20—Anthropogenic sites used by Wood Turtles include abandoned sand and gravel pits, powerlines, roadsides and roadcuts, farm roads near streams, abandoned railroad beds, gravel and cobble piles, sandy pastures, junkyards with sand piles, golf course sand traps, and cornfields.



5.21—Some of the many plants associated with Wood Turtle nesting areas include, *clockwise from top left*: Sweetfern (*Comptonia peregrina*); Common Mullein (*Verbascum thapsus*); Atlantic Ninebark (*Physocarpus opulifolius*); Sassafras (*Sassafras albidum*). MIKE JONES

(*Erythronium americanum*), American False-Hellebore (*Veratrum viride*), and Tall Meadow-Rue (*Thalictrum pubescens*). In the Potomac River watershed, Wood Turtles occur occasionally with Golden Club (*Orontium aquaticum*) (5.22). In the Driftless Area of Wisconsin, Canada Nettle (*Laportea canadensis*) is one of the most common herbaceous species. The Common Prickly-Ash (*Zanthoxylum americanum*) is a shrub species commonly associated with Wood Turtle habitat in Driftless Area floodplains (Kordiyak 1981). A radio-telemetry study in the central Appalachians found that Wood Turtle plots were more closely associated with bedstraw (*Galium* spp.) while random points were more closely associated with Reed Canary Grass (*Phalaris arundinacea*) (McCoard et al. 2016). White (2013) described open riparian areas in Nova Scotia dominated by alder, cherry, elder (*Sambucus* spp.), hawthorn (*Crataegus* spp.), serviceberry (*Amelanchier* spp.), and raspberries (*Rubus* spp.).

Noteworthy Plants

Wood Turtles are also frequently associated with plants of regional or conservation interest. Near their western range-margin in southeastern Minnesota, Wood Turtles are associated with the Minnesota Dwarf Trout Lily (*Erythronium propullans*), the Prairie Bush-Clover (*Lespedeza leptostachya*), Green Dragon (*Arisaema dracontium*), and more than 50 additional rare or protected species in Minnesota (MNDNR 1979). In northern Maine, Wood Turtles occur in relatively close proximity to significant populations of Furbish Lousewort (*Pedicularis furbishae*), Labrador Indian Paintbrush (*Castilleja septentrionalis*), Bird's-Eye Primrose (*Primula mistassinica*), Alpine Sweetvetch (*Hedysarum alpinum*, var. *americanum*), and at least seven other unusual or rare plants (Richards 1976; Jones, unpubl. data), and elsewhere occur with Canadian Burnet (*Sanguisorba canadensis*). Wood Turtles in New Hampshire are occasionally associated



5.22—Commonly associated herbaceous species in floodplains and streamside habitats include, *clockwise from top left*: Ostrich Fern (*Matteuccia struthiopteris*); Interrupted Fern (*Osmunda claytoniana*); Trout Lily (*Erythronium americanum*); American False-Hellebore (*Veratrum viride*); Tall Meadow-Rue (*Thalictrum pubescens*); Golden Club (*Orontium aquaticum*). MIKE JONES



5.23—Some noteworthy plants of local or regional conservation interest that are associated with Wood Turtle streams include, *clockwise from top left*: Dwarf Scouring-Rush (*Equisetum scirpoides*); Threadfoot (*Podostemum ceratophyllum*); Canadian Burnet (*Sanguisorba canadensis*); Butternut (*Juglans cinerea*). MIKE JONES

with rare floodplain forests of Butternut (*Juglans cinerea*, Jones, unpubl. data). In Massachusetts, some noteworthy plants that occur in association with Wood Turtles include Arctic Sweet Coltsfoot (*Petasites frigidus*), Threadfoot (*Podostemum ceratophyllum*), Dwarf Scouring-Rush (*Equisetum scirpoides*), Canadian Burnet, and Balsam Poplar (5.23). Noteworthy streamside species associated with important Wood Turtle sites in the Potomac watershed include Atlantic River Harperella (*Ptilimnium viviparum*).

Noteworthy Faunal Associates

Insects.—Wood Turtles occur in comparable and overlapping habitats with a multitude of rare or at-risk insects. For example, Wood Turtle populations may co-occur with several species of dragonflies and damselflies (Odonata) including the Green-faced Clubtail (*Gomphus viridifrons*) in Maryland and Virginia; the Spine-Crowned Clubtail (*Hylagogomphus abbreviatus*) in Maine, Massachusetts, and Maryland; the Boreal Snaketail (*Ophiogomphus colubrinus*), Pygmy Snaketail (*Ophiogomphus howei*), Cobra Clubtail (*Gomphurus vastus*), and Arrow Clubtail (*Stylurus spiniceps*) in Maine. Wood Turtles also share riparian habitats with rare beetles (Coleoptera) throughout the Northeast including the White Mountain or Appalachian Tiger Beetle (*Cicindella*



5.24—Wood Turtles share riparian habitats with the rare Cobblestone Tiger Beetle (*Cicindella marginipennis*) from New Brunswick to Massachusetts. JONATHAN MAYS



5.25—Wood Turtles share aquatic habitats with freshwater mussels, some of which are of local or regional conservation interest, including, *clockwise from top left*: Plain Pocketbook (*Lampsilis cardium*); Pink Papershell (*Potamilus obiensis*) (MIKE JONES); Eastern Floater (*Pyganodon cataracta*); Brook Floater (*Alasmidonta varicosa*) (AMY MAYNARD); Triangle Floater (*Alasmidonta undulata*) (CHRIS BUELOW); Eastern Pearlshell (*Margaritifera margaritifera*) (CHRIS BUELOW).

ancocisconensis) and the Cobblestone Tiger Beetle (*C. marginipennis*). Wood Turtles have been reported from one of the remaining sites for Puritan Tiger Beetle (*C. puritana*) (5.24). Wood Turtles overlap with the Tomah Mayfly (*Siphonisca aerodromia*, order Ephemeroptera) in Maine and New York.

Mussels.—Wood Turtles co-occur with a wide array of freshwater mussels, including several of regional conservation interest (5.25). Wood Turtles co-occur with Green Floater (*Lasmigona subviridis*) in New Jersey, Maryland, and Virginia, and with Brook Floater (*Alasmidonta varicosa*) in Nova Scotia, New Brunswick, Maine, New Hampshire, Massachusetts, Connecticut, New York, Pennsylvania, Virginia, and West Virginia. Wood Turtles co-occur with Triangle Floater (*Alasmidonta undulata*) in New England, and may be found in association with Dwarf Wedgemussels (*Alasmidonta heterodon*) or Eastern Pondmussels (*Sagittunio nasutus*) in New Hampshire, Massachusetts, Connecticut, and Virginia. Wood Turtles co-occur with Eastern Pearlshell (*Margaritifera margaritifera*) over most of their range in Nova Scotia and New Brunswick, and in high-quality coldwater habitats from Maine to Connecticut. In the upper



5.26—Wood Turtles are very often found in association with Eastern Elliptio (*Elliptio complanata*), so often that they are occasionally found with Elliptios attached to their feet. MIKE JONES

Mississippi River watershed, Wood Turtles co-occur with Plain Pocketbook (*Lampsilis cardium*) and Pink Papershell (*Potamilus obiensis*). Over much of their range, Wood Turtles are found in frequent association with Eastern Floater (*Pyganodon cataracta*) and Eastern Elliptio (*Elliptio complanata*), which occasionally attach themselves to Wood Turtles' feet (Jones et al. 2020) (5.26).

Fish.—In certain areas of the Northeastern United States, Wood Turtles may co-occur with the following fish species of local or state-level conservation interest: American Brook Lamprey (*Lethenteron appendix*), American Eel (*Anguilla rostrata*), Bridle Shiner (*Notropis bifrenatus*), Eastern Brook Trout (*Salvelinus fontinalis*), Slimy Sculpin (*Cottus cognatus*), Tessellated Darter (*Etheostoma olmstedii*), and Longnose Sucker (*Catostomus catostomus*). On the Ontario shore of Lake Superior, several Wood Turtle streams historically supported breeding Lake Sturgeon (*Acipenser fulvescens*) populations. Anecdotally, the association between Wood Turtles and Eastern Brook Trout seems to be strong. Historically, Wood Turtles co-occurred with spawning Atlantic Salmon (*Salmo salar*) from Nova Scotia and New Brunswick at least as far south as the tributaries of the Housatonic and Connecticut Rivers in New York, Vermont, New Hampshire, Massachusetts, and Connecticut, as well as tributaries to Lake Ontario (Fuller et al. 2020). Today however, the southernmost wild Atlantic Salmon are found in the lower portions of the Penobscot



5.27—Wood Turtles share streamside alder and scrub habitats with nesting American Woodcock (*Scolopax minor*). MIKE JONES

and Kennebec River watersheds of Maine (Gephard and McMenemy 2004; USFWS and NMFS 2018).

Birds.—Wood Turtles are found in association with a wide range of birds, including neotropical migrants and raptors. A brief list follows: American Woodcock (*Scolopax minor*), Louisiana Waterthrush (*Parkesia motacilla*), Willow Flycatcher (*Empidonax traillii*), Blue-Gray Gnatcatcher (*Poliophtila caerulea*), Yellow-Throated Vireo (*Vireo flavifrons*), Northern Harrier (*Circus hudsonius*), Osprey (*Pandion haliaetus*), and Bald Eagle (*Haliaeetus leucocephalus*) (5.27).

Mammals.—In New Brunswick and Maine, Wood Turtles are found in association with Canada Lynx (*Lynx canadensis*) and American Marten (*Martes americana*) (5.28). From Massachusetts to Pennsylvania and New Jersey, Wood Turtle habitat may overlap with that of the Northern Water Shrew (*Sorex palustris*). From Minnesota to the Upper Peninsula of Michigan, Wood Turtles are found in association with Gray Wolves (*Canis lupus*).⁸

Amphibians.—Wood Turtles may locally share habitats with Northern Leopard Frog (*Lithobates pipiens*) and Four-toed Salamander (*Hemidactylium scutatum*) across New England, New York, and much of the northern Great Lakes Region. In northern Maine, New Hampshire, and Ontario, Wood Turtles are often found with Mink Frogs (*Lithobates septentrionalis*). Wood Turtles in Maine are associated with Northern Spring Salamander (*Gyrinophilus porphyriticus*), and are known to co-occur with Hellbenders (*Cryptobranchus alleganiensis*) in Pennsylvania and Maryland (5.29).

Reptiles.—In Minnesota, Wood Turtles are found in close proximity to noteworthy populations of Timber Rattlesnake (*Crotalus horridus*), Massasauga (*Sistrurus catenatus*), and Six-lined Racerunner (*Aspidoscelis sexlineatus*, MNDNR 1979). Over portions of the



5.28—From Minnesota to Nova Scotia, including portions of New York, Maine, and New Hampshire, Wood Turtles occur in proximity to American Marten (*Martes americana*). MIKE JONES



5.29—Wood Turtles locally share riparian habitats with Northern Leopard Frog (*Lithobates pipiens*) and Mink Frogs (*Lithobates septentrionalis*) across much of the Northern Forest from Minnesota to Nova Scotia, including much of the northern Great Lakes, northern New York, and New England. *Top:* Northern Leopard Frog. *Bottom:* Mink Frog. MIKE JONES

Northeastern United States, Wood Turtles may co-occur locally with Eastern Ribbon Snake (*Thamnophis sauritus*, both Common and Northern sub-species), Short-headed Garter Snake (*Thamnophis brachystoma*), Queen Snake (*Regina septemvittata*), and Smooth Greensnake (*Opheodrys vernalis*) (5.30).



5.30—Wood Turtles co-occur locally with Smooth Greensnake (*Opheodrys vernalis*) from Ontario to Nova Scotia, including northern New England. MIKE JONES

Associated Turtle Species

With the exception of a few notable areas in New Brunswick, Maine, and Québec, where Wood Turtles are the only freshwater turtle present in fluvial systems, Wood Turtles generally co-occur with one or more other native freshwater turtle. In fact, Wood Turtles are known to occur naturally in microsympatry with at least thirteen species of freshwater turtle in four families, and in close proximity to at least three additional species, suggesting that there may have been regular contact within the historical period.



5.31—Eastern Box Turtles (*Terrapene carolina carolina*) overlap with Wood Turtles in riparian areas from New Jersey to Virginia. This adult female Box Turtle was found during a Wood Turtle survey in Maryland. MIKE JONES

Emydinae

Perhaps the best-documented associations are those with its most close living relatives, the other genera in the subfamily Emydinae. Wood Turtles historically occurred in the same habitats with their congener the Bog Turtle (*Glyptemys mublenbergii*) from Berkshire County, Massachusetts (Jones, unpubl. data) as far south as Cecil County, Maryland (Cooper 1949), including portions of Sussex and Warren Counties, New Jersey (Zarate, unpubl. data) and much of the lower Hudson Valley and throughout southeastern Pennsylvania (Gipe, unpubl. data).

Wood Turtles co-occur in microsympatry with Eastern Box Turtles (*Terrapene carolina carolina*) over a broad area from Middlesex County, Massachusetts (Jones, unpubl. data) to northern Virginia and West Virginia (Akre and Kleopfer, unpubl. data), and in a small portion of west-central Michigan between Manistee and Muskegon Counties. Wood Turtles may be found with Eastern Box Turtles in Morris County, New Jersey (Buhlmann and Osborne 2011), throughout southern Pennsylvania (Gipe, unpubl. data), and in western Maryland (Akre, unpubl. data) (5.31).

Spotted Turtles (*Clemmys guttata*) co-occur with Wood Turtles in localized areas of southern New England, the Hudson Valley and Finger Lakes of New York, and south to Maryland. Narrow areas of range overlap with Spotted Turtles also occur in western Pennsylvania and west-central Michigan.

Blanding's Turtles (*Emydoidea blandingii*) co-occur with Wood Turtles in east-central New England (Carroll 1991; 1999), eastern Ontario, northern Michigan, and portions of Wisconsin (Badje, unpubl. data), Minnesota (MNDNR 1979), and Iowa (Tamplin, unpubl. data). At the present time, no co-occurring populations of Wood Turtles and Ornate Box Turtles (*Terrapene*



5.32—Notably, Wood Turtles are found in close association with only two Deirochelyine turtle species, the Painted Turtle (*Chrysemys picta*) and the Common Map Turtle (*Graptemys geographica*). *Left:* Painted Turtle. *Right:* Common Map Turtle. MIKE JONES

ornata) are known (Badje, unpubl. data). However, there are documented occurrences of both species in at least four of the same southwestern Wisconsin counties (WI DNR 2019), and it is possible these species overlapped occasionally in the lower Wisconsin River of Wisconsin in historic times.

Deirochelyinae

Notably, Wood Turtles are found in close association with only two Deirochelyine turtle species, the Painted Turtle (*Chrysemys picta*) and the Common Map Turtle (*Graptemys geographica*) (5.32). Wood Turtles may be found in microsympatry with Painted Turtles in every portion of its range except Cape Breton Island, Nova Scotia, northern New Brunswick, and northwestern Maine, and north of the St. Lawrence River in Québec. The two species are usually found using different aquatic habitats within a given watershed (Harding and Bloomer 1979), but are often found sharing nesting areas throughout their range. Wood Turtles are associated with Eastern Painted Turtles (*C. p. picta*) in New England, Midland Painted Turtles (*C. p. marginata*) in Ontario, Québec, and New York, and Western Painted Turtles (*C. p. bellii*) in Iowa (Tamplin, unpubl. data).

Historically, Wood Turtles very likely co-occurred with the Common Map Turtle near the mouths of certain large tributaries of northern Lake Champlain in Vermont, Québec, and New York. Elsewhere in the eastern part of the range, Wood Turtles rarely co-occur with Map Turtles, although they have been observed sharing basking sites (Hartzell 2017) and stream habitats (T. Pluto, unpubl. data, in Jones et al. 2015) in the Susquehanna watershed of Pennsylvania. Wood Turtles occur more regularly with *G. geographica* in the Great Lakes region. In the Upper Mississippi Region of Wisconsin, Minnesota, and Iowa, Wood Turtles may occur with Ouachita Map Turtles (*G. ouachitensis*), and False Map turtles (*G. pseudogeographica*) in addition to *G. geographica*. In southeastern Minnesota, Wood Turtles co-occur with Common Map Turtles and False Map Turtles (MNDNR 1979). In Iowa, Wood Turtles occur in stream systems that harbor Northern Map Turtles, Ouachita Map Turtles, and False Map Turtles (Tamplin, unpubl. data). All three *Graptemys* species occur with Wood Turtles in western Wisconsin (Vogt 1981; Badje, unpubl. data).

Wood Turtles rarely occur in larger streams with Northern Red-bellied Cooters (*Pseudemys rubriventris*) in Virginia and Maryland (Kleopfer and Jones, unpubl. data), but these two species do not co-occur in Massachusetts (Jones, unpubl. data; MassWildlife NHESP 2019). We know

of no co-occurring populations of Wood Turtles and Diamondback Terrapins (*Malaclemys terrapin*), and their strict habitat preferences would seem to preclude them from frequent contact or shared habitats, but they occur in close proximity where small streams reach the eastern shore of Narragansett Bay in Rhode Island and Massachusetts (Yorks and Jones, unpubl. data).

Wood Turtles also co-occur in close proximity to introduced populations of Common Sliders (*Trachemys scripta*) in Massachusetts, New Jersey, and Virginia (Jones, Zarate, and Kleopfer, unpubl. data).

Chelydridae

Wood Turtles co-occur with Common Snapping Turtles (*Chelydra serpentina*) throughout their range with the exception of large areas of northwestern Maine and northern New Brunswick where Common Snapping Turtles are absent (5.33). The two species commonly share nesting areas in New Hampshire (Carroll 1991; Jones, unpubl. data), Massachusetts (Jones, unpubl. data), New Jersey (Buhlmann and Osborn 2011), Virginia (Kleopfer, unpubl. data), Iowa (Tamplin, unpubl. data), and Wisconsin (Badje, unpubl. data).

Kinosternidae

Wood Turtles occur rarely in microsympatry with Common Musk Turtles (*Sternotherus odoratus*) in central and eastern New England (Jones, unpubl. data), in Morris County, New Jersey (Buhlmann and Osborn 2011), in Virginia (Kleopfer, unpubl. data), and elsewhere between these locations. Wood Turtles co-occur with Eastern Mud Turtles (*Kinosternon subrubrum*) in eastern Virginia (Akre, unpubl. data) (5.34).

Trionychidae

Wood Turtles occur in microsympatry with two trionychid turtles, the Smooth Softshell (*Apalone mutica*) and Spiny Softshell (*A. spinifera*), primarily in the Upper Mississippi tributaries of Wisconsin, Minnesota, and Iowa (Tamplin, unpubl. data; MNDNR 1979; Badje, unpubl. data). Wood Turtles may also be found in association with *A. spinifera* in Michigan, Pennsylvania, and possibly western New York (5.35).



5.33—Wood Turtles co-occur frequently with Common Snapping Turtles (*Chelydra serpentina*) throughout their range with the exception of large areas of northwestern Maine and northern New Brunswick where Common Snapping Turtles are absent. An adult male is pictured. MIKE JONES



5.34—Wood Turtles co-occur with Common Musk Turtles (*Sternotherus odoratus*) from New England to Virginia. An adult male is pictured. MIKE JONES



5.35—Wood Turtles occur in microsympatry with two trionychid turtles, the Smooth Softshell (*Apalone mutica*) and Spiny Softshell (*A. spinifera*), in tributaries to the Upper Mississippi River. *Left*: Smooth Softshell. *Right*: Spiny Softshell.
MIKE JONES

Summary

Wood Turtles are uniquely adapted to the habitats in which they occur, the mid-sized flowing streams of North America's eastern forests. Here, they occur with a wide range of species representative of different regions of the North American continent, and often occur with species of conservation interest.

BIOLOGY & CONSERVATION
of the **WOOD TURTLE**

Michael T. Jones
Lisabeth L. Willey

Editors

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Published by Northeast Association of Fish and Wildlife Agencies, Inc., 2021

Printed in USA on FSC certified paper

Designed and typeset by Matthew R. Burne

ISBN: 978-0-9883535-2-7 (Paperback)

ISBN: 978-0-9883535-3-4 (eBook)

Library of Congress Control Number: 2021904217

This publication was supported by State Wildlife Grants, including the Northeast Association of Fish and Wildlife Agencies, Inc. (NEAFWA) Regional Conservation Need (RCN) program and the Competitive State Wildlife Grant program. This project was also made possible by key contributions from American Turtle Observatory (www.americanturtles.org), the Wood Turtle Working Group (www.northeastturtles.org), and Northeast Partners for Amphibian and Reptile Conservation (www.northeastparc.org). Early drafts of portions of this book appeared in Part I of *Status and Conservation of Wood Turtle* (2015).

Publisher's Cataloging-in-Publication data

Names: Jones, Michael T., editor. | Willey, Lisabeth L., editor.

Title: Biology and Conservation of the Wood Turtle / Michael T. Jones ; Lisabeth L. Willey, editors.

Description: Includes bibliographical references. | Petersburg, NY: Northeast Association of Fish & Wildlife Agencies, Inc., 2021.

Identifiers: LCCN: 2021904217 | ISBN: 978-0-9883535-2-7 (paperback) | 978-0-9883535-3-4 (ebook)

Subjects: LCSH Wood turtle. | Turtles--North America. | Forest animals. | Animals--Habits and behavior. | Reptiles--North America. | Natural history--North America. | Wildlife conservation--North America. | BISAC NATURE / Animals / Reptiles & Amphibians

Classification: LCC QL651 .B56 2021 | DDC 597.9/097--dc23



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