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INTRODUCTORY

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Photo courtesy of Jeffrey J. Jackson, University of Georgia, Bugwood.org.

AUTHORSHIP AND CITATION:

Ulev, Elena. 2008. *Crotalus horridus*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2010, February 4].

FEIS ABBREVIATION:

CRHO

COMMON NAMES:

timber rattlesnake
banded rattlesnake
black rattlesnake
canebrake rattlesnake
northern rattlesnake

TAXONOMY:

The scientific name of the timber rattlesnake is *Crotalus horridus* Linnaeus. It is a member of the Viperidae family

(subfamily Crotalidae) [22]. As of 2008, the taxonomic status of the timber rattlesnake was in dispute. Upland and lowland populations of timber rattlesnakes have been recognized by some researchers as subspecies (*C. horridus atricaudatus* and *C. horridus horridus*) [19,52]; however, according to DNA research conducted by Clark and others [14], the 2 subspecies are not valid.

A putative timber rattlesnake × western diamondback rattlesnake (*C. atrox*) hybrid has been identified in Texas [56].

SYNONYMS:

Crotalus horridus atricaudatus Latreille

Crotalus horridus horridus Linnaeus [19,52]

ORDER:

Squamata

CLASS:

Reptile

FEDERAL LEGAL STATUS:

No special status

OTHER STATUS:

The timber rattlesnake is listed as vulnerable, imperiled, or critically imperiled in 20 of the 30 US states in which it occurs [9]. It was determined as extirpated in Canada in 2001 [20]. More information on the state-level protection status of timber rattlesnakes in the United States is available at [NatureServe](#), although recent changes in status may not be included.

WILDLIFE DISTRIBUTION AND OCCURRENCE

SPECIES: *Crotalus horridus*

- [GENERAL DISTRIBUTION](#)
- [PLANT COMMUNITIES](#)

GENERAL DISTRIBUTION:

The range of the timber rattlesnake is from south-central New Hampshire and the Lake Champlain region of Vermont, south to northern Florida, and west to eastern Texas, central Oklahoma, eastern Kansas, southeastern Nebraska, southern and eastern Iowa, and southeastern Minnesota. On Lake Erie Islands, southeastern New England, and north-central North Carolina, populations of timber rattlesnake are patchy and isolated. Timber rattlesnakes are absent from southwestern Louisiana [9,21,25,70]. [NatureServe](#) provides a distributional map of the timber rattlesnake.

PLANT COMMUNITIES:

In northern portions of its range, the timber rattlesnake occupies upland deciduous forest and mixed deciduous-coniferous forest interspersed with rock outcroppings, rock slides, steep ledges, and riparian areas [1,3,9,28,60,65,70]. Bottomland hardwood forests, swamp borders, cane (*Arundinaria gigantea*) fields and cane brakes, eastern redcedar (*Juniperus virginiana*) brakes, bayheads in flatwoods, oak (*Quercus* spp.), and pine (*Pinus* spp.) plant communities are used in southern portions of its range [70,74,75,78]. Plant communities where timber rattlesnake is common are described below.

New York: In northeastern New York, timber rattlesnakes occupy mixed-hardwood forest communities composed of (in decreasing abundance) red oak (*Q. rubra*), shagbark hickory (*C. ovata*), American hornbeam (*Carpinus caroliniana*), sugar maple (*Acer saccharum*), eastern white pine (*P. strobus*), black cherry (*Prunus serotina*), red

maple (*A. rubrum*), white ash (*Fraxinus americana*), common juniper (*J. communis*), staghorn sumac (*Rhus typhina*), and eastern redcedar [9].

New Jersey: Timber rattlesnakes occupy pine barrens of southern New Jersey, which are dominated by pitch pine (*P. rigida*). Shortleaf pine (*P. echinata*), blackjack oak (*Q. marilandica*), bear oak (*Q. ilicifolia*), and black oak (*Q. >velutina*) [62] are common codominant or associated species in southern New Jersey.

Virginia, West Virginia, Maryland, and Pennsylvania: Along the eastern edge of the unglaciated Appalachian Mountains of northwestern Virginia, eastern West Virginia, western Maryland, and southern Pennsylvania, timber rattlesnakes occupy deciduous forest dominated by oaks [49]. In Berks County, Pennsylvania, timber rattlesnakes occupy forests dominated by chestnut oak (*Q. prinus*), northern red oak, black birch (*Betula nigra*), and red maple [60].

West Virginia: Below 2,789 feet (850 m) elevation, timber rattlesnakes occupy mixed mesophytic and cove hardwood communities dominated by yellow-poplar (*Liriodendron tulipifera*), northern red oak, basswood (*Tilia americana*), cucumber-tree (*Magnolia acuminata*), sweet birch (*B. lenta*), and white ash. Above 2,789 feet, timber rattlesnakes occupy mixed northern hardwood forest dominated by American beech, yellow birch (*B. alleghaniensis*), black cherry, Fraser magnolia (*Magnolia fraseri*), red maple, and sugar maple. Above 3,281 feet (1,000 m), timber rattlesnake occurs in red spruce (*P. rubens*) and eastern hemlock forests on mesic sites, and in forests with chestnut oak, black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), and hickory on xeric sites [1].

Missouri: In St Louis County, timber rattlesnakes occupy upland oak-hickory forests, eastern redcedar glades, bottomland hardwood forests, and prairies [3].

South Carolina: Timber rattlesnakes use a variety of plant communities in South Carolina including upland pine/threawn (*Aristida* spp.) savanna dominated by longleaf pine (*P. palustris*), slash pine (*P. elliottii*), and loblolly pine (*P. taeda*). Commonly associated species include post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), and hickory. Timber rattlesnake habitat also includes mixed pine-hardwood forests dominated by loblolly pine, sweetgum (*Liquidambar styraciflua*), willow oak (*Q. phellos*), and southern red oak (*Q. falcata*); and hardwood bottoms dominated by overcup oak (*Q. lyrata*), willow oak, red maple, sweetgum, southern red oak, black tupelo (*Nyssa sylvatica*), and baldcypress (*Taxodium distichum*) [74,75].

Georgia: In southern Georgia, timber rattlesnakes occupy longleaf pine forest and oak-dominated hardwood hammocks close to riverine plant communities [70].

Texas: In Nacogdoches, Texas, timber rattlesnakes occupy bottomland hardwood forest dominated by oaks, hickories, and sweetgum; and upland forest dominated by oaks, loblolly pine, and shortleaf pine [66].

BIOLOGICAL DATA AND HABITAT REQUIREMENTS

SPECIES: *Crotalus horridus*

- [LIFE HISTORY](#)
- [PREFERRED HABITAT](#)
- [COVER REQUIREMENTS](#)
- [FOOD HABITS](#)
- [PREDATORS](#)
- [MANAGEMENT CONSIDERATIONS](#)

LIFE HISTORY:

Life history characteristics for the timber rattlesnake vary geographically. Timber rattlesnakes in southern portions of their range hibernate for a shorter time, grow more quickly, reproduce at an earlier age, and have shorter reproductive intervals than timber rattlesnakes in northern portions of their range [8,9,49]. [Ontogeny](#) and [phenology](#) may also differ from year to year within a region. Below-average temperatures and above-average precipitation may lengthen reproductive intervals by limiting time for foraging and fat accumulation [49]. The following sections discuss timber rattlesnake ontogeny, phenology, and home range.

Ontogeny—

Mating: Across the timber rattlesnake's range, mating occurs from mid-July to late October [1,2,10,51,65,75]. Onset of the mating season is determined by the follicular yolking cycle and midsummer skin shedding of females, which increase pheromonal attractiveness [4,10,49]. Males locate females for mating by using olfactory cues and prior experience [3]. Timber rattlesnakes are [polygynous](#) [2,9,10].

Reproductive rates: Timber rattlesnakes have low reproductive rates due to long reproductive intervals, late sexual maturity (see [Development](#)), and high reproductive costs [7,8,65]. Females produce litters at 2-year, 3-year, or 4-year intervals. Long reproductive intervals allow time for females to store yolk protein in developing eggs and to gain weight after [parturition](#) [4,7,8,8,27,30,31,49]. Of 30 females trapped in the Adirondack Forest Preserve in northeastern New York, 57% reproduced at 3-year intervals and 27% reproduced at 4-year intervals. Biennial reproduction was not detected but is possible, according to the author [8]. In the Appalachian Mountains of Virginia, Maryland, and Pennsylvania, the mean reproductive interval was 3 years. Females more than 14 years old reproduced at 2-year intervals, and females younger than 7 years old reproduced at 4-year intervals [49]. In Kansas, female timber rattlesnakes reproduce at 2-year or 3-year intervals [27]. A female that reproduces triennially may produce only 3 to 5 litters during a lifetime of 16 to 22 years [7,8].

Gestation and litter size: Fertilization is delayed in females. Once mating has occurred, females store sperm for several months, and ovulation and fertilization occur 4 to 6 weeks after emergence from dens the following spring [4,25,49,51]. Gestation is timed so that parturition occurs during the warmest time of the year (late July to early October) [4,7,30,31,49,51]. Timing of parturition may vary widely from year to year within a region depending on weather [51]. For example, during a year of unusually cool, wet weather in Maryland and Virginia, parturition occurred 4 to 6 weeks later than in years when weather was hotter and drier than average [50].

Timber rattlesnakes are [ovoviviparous](#) [8,25,58,78]. Litter size ranges from 5 to 22 newborns and averages 6 to 8 [4,7,27,30,31,48]. Mothers do not care for newborns [58] but have been observed remaining nearby (within 3 feet (1

m)) for up to 2 weeks after parturition [50,51,62].

Development: Sexual maturity is related to body size and condition and varies across the timber rattlesnake's range [2]. Timber rattlesnakes reach sexual maturity between 4 and 11 years of age [2,8,9,48,49,51]. Males reach sexual maturity sooner than females. In northeastern New York, males reached sexual maturity an average of 5.3 years old [2], and females reached sexual maturity at 8.3 years old [8]. In the Appalachian Mountains, males reached sexual maturity at 4.4 years old [2], and females reached sexual maturity at 6.8 years [49]. In Pennsylvania, sexual maturity for females occurred at 5 to 6 years old (age of males not given) [30,31].

Survival rates and mortality: Life span for the timber rattlesnake is 10 to 20 years and may be up to 30 years [7,8,9,48]. A timber rattlesnake reared in captivity lived for 36.5 years, although after 25 years of age it was no longer capable of killing its own prey [13].

Young timber rattlesnakes experience lower survivorship than adults [9,30]. In Kansas, the survival rate through the fifth year of life was 17.3% ($n=39$) [27]. Causes of mortality for newborns include predation, lack of suitable small-sized prey items, and lack of suitable dens [30]. Newborns may or may not have an opportunity to forage during the short period of time between birth and hibernation, but according to Martin [51], failure to find food before hibernation is probably not a common cause of mortality. After emergence from hibernation, however, starvation may be a major cause of mortality [51].

Most adult mortality is due to human impacts including hunting, collecting for commercial purposes, habitat loss, and habitat fragmentation [1,31,57,65,73,74]. Aggregation of gravid females at basking sites increases susceptibility to human-related deaths [4,30,31] and skews timber rattlesnake populations toward males [9]. Nonhuman causes of mortality include starvation, predation (see [Predators](#)), and freezing during hibernation [30,31]. In northeastern New York, mortality of male timber rattlesnakes was significantly ($P<0.01$) higher than that of females during the mating season due to prolonged mate-searching, which increased exposure time to predators [2].

Phenology—

Daily movements: During the beginning and end of the nondenning season (spring and early fall), timber rattlesnakes are diurnal, but during the heat of the summer they shift to a [crepuscular](#) and nocturnal cycle to prevent overheating [25,26,58].

Hibernation: Timber rattlesnakes are ectotherms and must hibernate below the frost line during winter months to survive [51] (see [Winter denning habitat](#)). In northern latitudes and high elevations, the hibernation period is longer (7.5 months) than in southern latitudes (5 months) [8,9,25,75]. In the Appalachian Mountains, timber rattlesnakes hibernate an average of 6.7 months (range 5.7-7.5 months), from October to late April or early May [51]. Weather conditions may dictate when timber rattlesnakes enter dens in the fall and emerge from dens in spring. During fall, den entry corresponds with the mean date of first frost and the time when ambient temperatures become too low for foraging (52° F (11°C)) [51]. Den ingress and egress may be affected in part by air and soil temperatures [31,51], but the high degree of conformity of denning dates suggests that innate biological rhythms may be partly responsible [30,51].

Adult timber rattlesnakes hibernate communally. Most dens found in Maryland contained around 30 to 60 timber rattlesnakes, but some contained an estimated 120 to 200 individuals [51]. Dens may be shared with other snake species, such as black rat snakes (*Elaphe obsoleta obsoleta*), black racers (*Coluber* spp.), northern copperheads (*Agkistrodon contortrix mokasen*), and eastern gartersnakes (*Thamnophis sirtalis sirtalis*) [4,30,31,51].

Migration: After den emergence in spring, timber rattlesnakes migrate long distances from their dens to summer ranges to forage, mate, and bask. They migrate back to dens in the fall [7,9,30], following chemical trails left from skin secretions of other individuals [62]. Timber rattlesnakes move seasonally within summer ranges to breed and forage [65,75].

Distance of migration varies depending on gender and reproductive condition. Males migrate farther than nongravid

females, and gravid females remain close to dens [11,28,30,40,51,58,62,65]. Migration distances range from 0.5 to 1.0 mile (0.8-1.6 km) for all gender and age classes [7,51], but may be up to 5 miles (8 km) for males seeking mates [4]. Gravid females aggregate at birthing rookeries near the den. At the Tyson Research Center in St Louis County, Missouri, 11 timber rattlesnakes gave birth a mean distance of 807 feet (246 m) from their den. The range was 56 to 2,169 feet (17-661 m) [3]. In the Appalachian Mountains, 14 of 65 rookery sites were located at the den. Forty-two rookeries were located a mean distance of 538 feet (164 m) from the den; the range was 82 to 4,101 feet (25-1,250 m)). The greatest distance from a den to a rookery site that was used more than once was 3,609 feet (1,100 m) [51].

Spring migration: After emergence from the den in spring, timber rattlesnakes spend a limited amount of time basking on rocks to reach a blood temperature of approximately 85° F (47° C). After reaching this temperature, males and nongravid females migrate to lowlands, pasture edges, the banks of streams and rivers [58], and brushy or wooded sties [51].

In studies in the Appalachian Mountains and New York, males migrated farther than females. In the northern Appalachian Mountains, spring migration coincided with the onset of the first warm, humid evenings, from mid-May to early June. Exposed rocks were frequently used by all age and gender classes [51]. In Warren County, New York, gravid females migrated the shortest distance from dens compared to nongravid females and males [11]. Mean migration distances of timber rattlesnakes are shown below.

Mean migration distances of timber rattlesnakes in the northern Appalachian Mountains and New York						
	Northern Appalachian Mountains [51]			Warren County, New York [11]		
	<i>n</i>	\bar{x}	Range	<i>n</i>	\bar{x}	Range
Males	48	1.28 km	0.4-2.8 km	1	1.20 km	not applicable
Nongravid females	30	1.08 km	0.4-2.6 km	3	0.28 km	0.19-0.43 km
Gravid females	no data	no data	no data	1	0.04 km	not applicable

In West Virginia, the mean migration distance from den sites to summer ranges was 1,687 feet (514 m) for both genders, and the mean maximum distance traveled was 3,642 feet (1,110 m) [1].

Fall migration: Timber rattlesnakes migrate back to dens in the fall for hibernation, in at least some cases following the same routes [1,11]. In the Appalachian Mountains, fall migration begins in late August and lasts until mid-September [51]. In West Virginia [1] and New York [11], the same migratory routes were used for ingress and egress from dens.

Timber rattlesnakes may show fidelity to a particular den site [1,3,7,51]. Of 64 timber rattlesnakes recaptured in the Appalachian Mountains, only 1 young adult female switched dens [51]. Of 82 timber rattlesnakes found at the Tyson Research Center, 96% exhibited fidelity to a particular den site [3], and in West Virginia, 2 of 3 timber rattlesnakes used the same dens for 2 consecutive over-winter seasons [1].

Neonatal migration: After birth, newborns may follow adults' scent trails to denning areas for hibernation [4,62]; however, according to Martin [51], newborns probably do not hibernate communally and instead seek individual shallow shelters. Newborns may or may not have time to forage before hibernating. Those born at the average time (early September) in the Appalachian Mountains foraged in wooded areas near dens for approximately 2 weeks before hibernation. Newborns born later immediately dispersed to dens without foraging [51].

Seasonal movement patterns: After a long-distance migration to summer ranges, timber rattlesnakes move short

distances within summer ranges to forage and breed. Males move longer distances than nongravid females and gravid females. For males, distances moved are longer during the breeding season than during the foraging season [65,75].

In hardwood bottomland forest, upland longleaf pine savanna, mixed-pine hardwood forest, and planted pine forests on the coastal plain of South Carolina, movement length between successive radio locations for males was significantly ($P<0.05$) greater during the breeding season (August-October) than during the foraging season (April-August). Movement length for nongravid females did not vary between foraging and breeding seasons [75]:

Average movement (m) (SD) of male and female timber rattlesnakes based on season and reproductive status in South Carolina [75]		
Season	Males ($n=8$)	Nongravid females ($n=9$)
Foraging season	95.05a (34.22)	86.81a (not given)
Breeding season	155.65b (45.29)	91.42a (not given)

Different letters within columns indicate a significant difference ($P<0.05$).

In bottomland hardwood forest dominated by oaks, hickories, and sweetgum and upland forest dominated by oaks, loblolly pine, and shortleaf pine in eastern Texas, patterns of male timber rattlesnake movement differed substantially between the foraging season (1 March-15 August) and the breeding season (16 August-1 November) [65]:

Average daily distance (m) moved by males and nongravid female timber rattlesnakes during the foraging and breeding season in eastern Texas [65]		
Season	Males ($n=3$)	Nongravid females ($n=2$)
Foraging season	27.9	14.0
Breeding season	72.1	17.1

Home range: Home range size for the timber rattlesnake varies depending on gender and season. Home ranges are largest for males and smallest for gravid females [1,62,65,74,75]. Home range size increases for males during the breeding season compared to the foraging season [65,75].

Across the timber rattlesnake's range, males have the largest home ranges and gravid females have the smallest home ranges [1,62,65,74]:

Mean year-round home range sizes (ha) of timber rattlesnakes [1,62,65,74]			
Location	Males	Nongravid females	Gravid females
Hardwood forest, West Virginia	94.3 ($n=3$)	31.2 ($n=2$)	8.5 ($n=2$) [1]
Pine barrens, southern New Jersey	207.4 ($n=2$)	41.6 ($n=3$)	22.2 ($n=2$) [62]
Coastal plain, South Carolina	48.4 ($n=8$)	30.8 ($n=9$)	8.0 ($n=1$) [74]
Gulf coastal plain, Texas	176 (n not given)	19 for all females (n not given) [65]	

Home range size may vary seasonally. In upland longleaf pine savanna, mixed-pine hardwood forest, planted pine forests, hardwood bottoms, and cultivated fields on the coastal plain of South Carolina, home range size for male and nongravid female timber rattlesnakes varied depending on season. Male home range sizes were significantly smaller during the foraging season than the breeding season. Males had significantly larger home ranges than nongravid females during the breeding season [75]:

Mean seasonal home range sizes (ha) of male and nongravid female timber rattlesnakes based
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on season and reproductive status in South Carolina [75]		
Season	Males (<i>n</i> =8)	Nongravid females (<i>n</i> =9)
Foraging season	32.83a	39.73a
Breeding season	80.24a	23.71b

Different letters within rows indicate a significant difference ($P<0.05$).

Male and female home ranges may sometimes overlap with those of other individuals of the same gender. In Randolph County, West Virginia, 3 female home ranges overlapped with the home ranges of other females at or near den sites but not on summer ranges. Home ranges of males overlapped at the den site, and some home ranges of males overlapped in the summer range [1].

PREFERRED HABITAT:

Timber rattlesnakes are associated with contiguous deciduous forest containing a mosaic of high and low canopy closures, thick understory vegetation, large coarse woody debris, and rock outcroppings or rockslides [1,30,31,51,51,58,70,70]. Meadows, pine savannas maintained by fire [75], riverbanks, river bars, uplands adjacent to floodplains [65,78], and manmade fields, hedgerows, and abandoned buildings are also used [78], but forested habitat is preferred most. Timber rattlesnakes may be common in edge habitats which include edges of dirt and old paved roads, railroad embankments, pond edges, creek banks, quarry and field edges, and fence rows [3]. A water source used for drinking is usually found in timber rattlesnake habitat [57,58].

Habitat selection by timber rattlesnakes differs based on gender, reproductive status, and season [9,60,62]. Brown's [9] guide to timber rattlesnake conservation divided habitat used by the timber rattlesnake into 3 types: denning, transient, and summer habitats. Denning habitat is used by all timber rattlesnakes for hibernation. Transient habitat is located close to the den and is used by males and nongravid females for basking before migration to summer habitat. It is used by gravid females for gestation and parturition. Summer habitat is used by males and nongravid females for foraging, mating, and basking [9].

Winter denning habitat: Denning habitat is typically located in rocky areas within closed-canopy forest with open canopy nearby [1,51]. Of 115 timber rattlesnake dens found in the Appalachian Mountains, 47 were located in "heavily shaded" locations, and all dens were within 1,600 feet (500 m) of exposed basking areas [51]. Den site location varies depending on availability of rocky habitat, and suitable den sites are a limiting factor in the occurrence of the timber rattlesnake in northern limits of its range [7]. In the Pine Barrens of New Jersey, timber rattlesnakes hibernate in wet boggy areas near the headwaters of streams [62]. The maximum elevation of timber rattlesnake dens found in the northeastern United States is 2,100 feet (640 m) [48,51].

In Randolph County, West Virginia, timber rattlesnakes tend to den in shrubby areas with high deciduous cover. All faced south. Deciduous cover ranged from 75% to 95%, except in one case, where deciduous cover was 55% [1]. Mountain-laurel, blueberry, common greenbrier (*Smilax rotundifolia*), and great laurel (*Rhododendron maximum*) were common around 6 dens. Additional habitat characteristics around den sites are shown in the table below:

Habitat characteristics of 6 timber rattlesnake den sites in Randolph County, West Virginia [1]								
	Terrain		Forest descriptors		Ground cover			
Forest cover type	Slope (%)	Elevation (m)	Basal area (m ² /ha)	Density (stems/ha)	Rock (%)	Bare ground (%)	Leaf litter (%)	Woody debris (%)
Mixed northern hardwood	46	950.4	34.8	28,500	14.0	72.5	88.8	16.3
Red maple	36	996.4	8.0	81,250	0	99.3	48.7	5.0
Black cherry-red maple	42	1,006.1	31.2	34,250	2.5	88.8	93.8	17.5

	20	961.6	13.5	10,000	40	58.8	83.8	30.0
Chestnut oak	56	983.9	26.7	6,750	33.8	66.3	66.3	5.5
	14	429.5	31.9	7,250	15	83.3	78.8	11.5

In Connecticut, characteristic plants near dens included mountain-laurel (*Kalmia latifolia*), blueberry (*Vaccinium* spp.), and black huckleberry (*Gaylussacia baccata*), and a source of drinking water was always nearby [58]. In West Virginia, mountain-laurel, blueberry, common greenbrier (*Smilax rotundifolia*), and great laurel (*Rhododendron maximum*) were common around dens [1].

On the coastal plain of South Carolina, male and female timber rattlesnakes were more likely to den in mixed pine-hardwood forest than hardwood bottoms or pine savanna. Specifically, males were 143 times more likely to select mixed pine-hardwood forest over hardwood bottoms and 14 times more likely to select mixed-pine hardwood forest over pine savanna. Females were >20 times more likely to select mixed-pine hardwood forest over hardwood bottoms or pine savanna. Mixed-pine hardwood forest was dominated by loblolly pine, sweetgum, willow oak, and southern red oak. Hardwood bottoms were dominated by overcup oak, willow oak, red maple, sweetgum, southern red oak, black tupelo, and baldcypress; pine savannas were dominated by longleaf pine, slash pine, loblolly pine, post oak, blackjack oak, and hickory [75].

In habitat dominated by red oak and shagbark hickory in Virginia, timber rattlesnake dens were spaced 1.1 miles (1.7 km) apart, with a range of 0.2 to 2.8 miles (0.3-4.5 km). In a similar habitat type in Maryland, dens were spaced 1.6 miles (1.0 km) apart, with a range of 0.2 to 2.0 miles (0.4-3.2 km) [51].

Transient habitat: Transient habitat is referred to by Brown [9] as habitat located between denning habitat and summer habitat, and is typically located within 600 feet (200 m) of the den on outcrop knolls. Outcrop knolls in northeastern New York consisted of (in decreasing abundance) red oak, shagbark hickory, American hornbeam, sugar maple, eastern white pine, black cherry, red maple, white ash, common juniper, staghorn sumac, and eastern redcedar. Grass cover was greatest on transient habitats on knoll outcrops. Cover on twenty-five 1-m² plots was as follows [9]:

Relative cover of features in timber rattlesnake habitat on outcrop knolls in New York [9]	
Category	Cover (%)
Grasses	41
Rocks (includes rocks with lichen and moss cover)	19
Leaf and branch litter	16
Shrubs and trees	14
Lichens and mosses (not on rocks)	9

Transient habitat is used by males and nongravid females for basking for short periods of time when migrating away from dens during spring or toward dens in fall. For gravid females, transient habitat is used as summer habitat for gestation and parturition [9].

Spring and summer habitat: Males and nongravid females use spring and summer habitat for foraging and mating; mating occurs in late summer and early fall. Gravid females use spring and summer habitat for gestation and parturition. All timber rattlesnakes prefer a mosaic of open and closed canopies [1,74] within summer habitat; other habitat preferences differ based on gender and reproductive class. In general, males and nongravid females prefer greater canopy closure, thicker surface vegetation, and fewer rocks than gravid females [40,60,61,62].

Summer habitat used by timber rattlesnakes in Randolph County, West Virginia, consisted of "relatively mature" hardwood stands, clearcut hardwood stands, and nonforested stands (roads and edges). Most radiotelemetry locations of timber rattlesnakes occurred in relatively mature hardwood stands, and nearly all timber rattlesnakes were located in a

clearcut stand at least one time [1].

Timber rattlesnakes showed sexual divergence in microhabitat selection in a hardwood forest dominated by chestnut oak, northern red oak, black birch, and red maple located in Berks County, Pennsylvania, and Atlantic coastal pine barrens of southern New Jersey. Males and nongravid females in both locations utilized forested sites with >50% canopy closure, moderate to dense amounts of forest-floor vegetation, and few rocks. Gravid females preferred sparsely forested areas with many rocks and a small amount of forest-floor vegetation. When habitat preferences were compared between the 2 locations, males and nongravid females in pine barrens preferred larger amounts of surface vegetation cover and smaller amounts of fallen log cover than those in hardwood forest. Gravid females in pine barrens preferred more leaf litter, more surface vegetation cover, more fallen log cover, and a higher percentage of canopy closure than gravid females in hardwood forest [60,62]:

Structural characteristics of groundlayer variables of timber rattlesnake habitat in hardwood [60] and pine [62] communities												
Variable	Rock (%)		Leaf litter (%)		Surface vegetation cover (%)		Fallen log cover (%)		Distance to nearest rock* (m)		Distance to nearest log** (m)	
Plant community	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine
Random	8.1	not given	67.0	25.4	22.6	72.5	1.4	1.0	2.7	not given	2.0	3.3
Males	12.4	not given	37.9	24.7	43.9	74.0	5.5	1.1	2.4	not given	2.0	2.7
Nongravid females	27.3	not given	42.9	29.2	27.6	69.9	2.0	0.6	1.6	not given	2.2	6.1
Gravid females	63.1	not given	11.9	42.0	24.5	44.1	0.3	4.7	0.2	not given	4.8	2.6

*Mean distance to nearest rock >10 cm long.
 **Mean distance to nearest log =7.5 cm in diameter.

Structural characteristics of standing vegetation variables of timber rattlesnake habitat in hardwood [60] and pine [62] communities												
Variable	Woody plant density (stems/m ²)		Woody stem height (cm)		Distance to overstory tree* (m)		Mean DBH of overstory trees (cm)		Distance to understory tree** (m)		Canopy closure (%)	
Plant community	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine
Random	11.9	not given	61.6	not given	2.0	2.0	18.6	16.0	2.2	2.5	79.7	63.4
Males	22.6	not given	101.8	not given	2.2	1.4	20.2	14.9	2.2	1.1	68.8	68.4

Nongravid females	11.8	not given	82.3	not given	2.3	1.7	19.1	15.7	2.2	2.2	67.1	54.7
Gravid females	4.0	not given	36.0	not given	4.0	2.5	23.6	13.4	3.5	1.9	21.9	25.9
*Mean distance to nearest tree =7.5 cm DBH.												
**Mean distance to nearest tree <7.5 cm DBH.												

On the coastal plain of South Carolina, male and female timber rattlesnakes differed in habitat preference. Females were positively associated with pine/threawn savanna dominated by longleaf pine, slash pine, loblolly pine, post oak, blackjack oak, and hickory. Male timber rattlesnakes most strongly selected mixed pine-hardwood forest dominated by loblolly pine, sweetgum, willow oak, and southern red oak. Both genders were negatively associated with planted pine forest (loblolly pine, slash pine, or longleaf pine) and hardwood bottomland forest dominated by overcup oak, willow oak, red maple, sweetgum, southern red oak, black tupelo, and baldcypress. The planted pine and hardwood bottomland forests had higher canopy closures and reduced structural complexities compared to the pine savanna, and were used primarily as travel routes [74].

Habitat preference by males and nongravid females may vary between spring and summer. After emerging from dens in spring, males and females focus on foraging for several months. By late summer and fall, they focus mainly mating. During the foraging season on the coastal plain of South Carolina, males were positively associated with hardwood bottoms, nongravid females were positively associated with mixed pine-hardwood forests, and gravid females were associated with fields that were plowed and planted annually. For breeding, males and nongravid females preferred fields. Differences in habitat selection during the foraging season were due to differing foraging strategies between sexes [75]. Gravid females in the Appalachian Mountains foraged during May in wooded areas and moved to rookeries in late May or June [51].

The timber rattlesnake has 2 color morphs: a light and a dark phase [4,9,11,14,25,58,60,78], which may result in different habitat preferences. On the Hawk Mountain Wildlife Sanctuary and state game and forest lands in Berks County, Pennsylvania, light- and dark-colored morphs preferred significantly ($P < 0.01$) different microhabitats. Light morphs preferred sites with heavy leaf litter and closely-spaced overstory trees; darker morphs preferred habitat with fallen logs and widely spaced overstory trees [60].

Rookeries: Gravid females aggregate at rookeries for gestation and parturition during summer [3,51]. Preferred rookery habitat includes grassy ledges and well-drained, sparsely wooded knolls [9] with low canopy cover, small amounts of surface vegetation, and rocks [9,40,60]. For details about rookery microhabitat, see Cover requirements.

COVER REQUIREMENTS:

Timber rattlesnakes have different cover requirements for denning, foraging, gestation, and parturition.

Denning: Timber rattlesnake dens are typically located in south-facing rock outcroppings, rockslides, or rock fissures below the frost line [4,30,31,51,58,70]. Rotten pine and hardwood stump holes, root masses of fallen trees, and nine-banded armadillo (*Dasypus novemcinctus*) burrows may also be used for denning [25,65,75].

Foraging: On the coastal plain of South Carolina, female timber rattlesnakes were positively associated with fields containing piled slash along the edges, which were maintained for game management. The slash provided protective cover and foraging habitat [74].

Gestation and Parturition: Rocks are important habitat features at most birthing rookeries. Gravid females use rocks for basking during morning and late afternoon and for hiding during the heat of the day. Because rocks absorb and reradiate heat at night, gravid females use them to keep body temperature high, thus conserving energy [40]. Gravid females in the Adirondack Forest Preserve used rock outcrops in grassy clearings on lightly wooded knolls near dens [9]. In the Appalachian Mountains, rookeries were located in or near rock ledges, talus, and scree and located at 656 to 3,937 feet (200-1200 m) elevation. The most common locations of birthing rookeries were rock slabs located on ledges, grassy slopes, or flats (40% of rookeries). Favored rock slabs were 4 to 8 inches (10-20 cm) thick with 1 to 2

inches (3-4 cm) clearance. Thirty percent of rookery sites were in talus, scree, or boulder fields, and 28% were in crevices located in rock ledges. One rookery was located in a rock pile in a meadow. All rookeries were exposed to sun for either part of the day or the full day and provided protection from predators, rain, and direct sunlight [51].

In habitat containing few rocks, gravid female timber rattlesnakes may use coarse woody debris, road edges, or other sites for rookeries [1,3,61,62,66]. In eastern Texas, gravid females used debris piles and hollow logs in oak-hickory-sweetgum bottomland forest and oak-loblolly pine-shortleaf pine forest [66]. In the pine barrens of New Jersey, gravid females used the edges of sand roads that were sometimes more than 0.6 mile (1.0 km) from den sites [61,62]. In Randolph County, West Virginia, one rookery was <16 feet (5 m) from a forest road in soil and the rotted remains of a root system of an upturned tree. A second rookery was 97.1 feet (29.6 m) from a forest road in a log landing [1]. At the Tyson Research Center, rookery sites included an old quarry, the top of a bluff overlooking an old quarry, and a sunny road escarpment [3].

FOOD HABITS:

Timber rattlesnakes are opportunistic carnivores, and northern and southern populations may exhibit dietary differences [15]. Foraging behavior and hunting strategies may differ depending on gender, season, and body size [4,40,51,65,75].

The timber rattlesnake diet consists primarily of small mammals and birds [7,12,18,27,40,58,61,78]. Less commonly taken prey include insects, lizards, toads, and small snakes [18,78]. A supply of drinking water is required [58].

In Kentucky, the stomach contents (by volume) of 3 timber rattlesnakes included 80% white-footed mice (*Peromyscus leucopus*), 10% eastern gray squirrels (*Sciurus carolinensis*), and 10% songbirds [12]. In Berks County, Pennsylvania, 15 timber rattlesnake scats contained 65% white-footed mice, 20% southern red-backed voles (*Myodes gapperi*), 5% eastern chipmunks (*Tamias striatus*), 5% eastern cottontails, and 5% an unidentified bird [61]. In Kansas, the timber rattlesnake diet consisted primarily of eastern cottontails (*Sylvilagus floridanus*) [27]. For a complete list of food items eaten by timber rattlesnakes in Kansas, see Fitch [27].

A study of more than 500 timber rattlesnakes showed that diet differed significantly ($P=0.05$) between timber rattlesnakes in northern deciduous forests and those in southern mixed hardwood-pine forests and the southern coastal plain. Timber rattlesnakes in northern regions preyed primarily on New World mice (all *Peromyscus* spp.), voles (*Microtus* and *Myodes* spp.), and eastern chipmunks. Timber rattlesnakes in southern regions also preyed heavily on New World mice; in addition, they relied more heavily on rabbits (*Sylvilagus* spp.) and hispid cotton rats (*Sigmodon hispidus*) than northern regions [15]:

Percent occurrence in stomach contents of mammalian prey consumed by timber rattlesnakes in northern ($n=456$) and southern ($n=134$) geographic regions* [15]			
Prey species	Northern region	Southern region	P value
New World mice	34.9	27.6	not significant
Voles (<i>Microtus</i> spp.)	14.1	0.0	<0.0001
Eastern chipmunks	13.5	0.7	<0.0001
Rabbits	8.6	16.4	0.009
Hispid cotton rats	0.2	22.4	<0.0001
Squirrels (<i>Sciurus</i> spp.)	3.3	5.2	not significant
Southern red-backed voles	4.4	0.0	0.01
Woodland jumping mice (<i>Napaeozapus insignis</i>)	3.3	0.0	0.02
Golden mice (<i>Ochrotomys nuttalli</i>)	0.0	3.0	0.002
Shrews (<i>Sorex</i> spp.)	2.0	3.0	not significant
House mice (<i>Mus musculus</i>)	0.9	6.7	0.0004

Short-tailed shrews (*Blarina* spp.)

0.0

3.0

0.003

*The geographic line dividing northern and southern timber rattlesnakes in the study runs roughly from the border of North Carolina and Virginia, across northern Georgia, Alabama, and Mississippi, through the middle of Arkansas, to the border of Oklahoma and Texas.

Foraging behavior: Foraging behavior differs based on gender, season, and body size. Males spend more time foraging during the active season (generally from May-October) than gravid females [4]. Gravid females forage infrequently, if at all, during later stages of gestation and parturition to conserve reproductive energy [4,31,40,51,61]. In the Appalachian Mountains, males forage actively from den emergence in spring until commencement of the mating season in summer. During the mating season, males seldom forage but resume foraging around mid-September before hibernation. Nongravid females forage continually from mid-May until late September [4,40,51,65].

The timber rattlesnake shows significant ($P=0.05$) ontogenetic variation in diet. Juvenile timber rattlesnakes prey on small items (<0.9 ounce (25 g)) such as shrews (*Sorex* spp.), house mice, and white-footed mice, and adult timber rattlesnakes prey on larger mammals (>1.2 ounces (35 g)), such as eastern chipmunks, hispid cotton rats, squirrels, and rabbits [15].

Hunting strategies: Timber rattlesnakes are sit-and-wait predators and typically hide near logs to ambush prey [16,17,17,18,58,61,75]. Possible mechanisms for detecting prey include vibration, infrared radiation, visual image [61], and/or chemical cues [16,17]. Timber rattlesnakes ambush prey by coiling the body adjacent to a log with the head placed perpendicular to the log's long axis, then attacking rodents using the upper surface of the log as a runway [61]. Once prey is caught, venom is injected. In addition to poisoning prey, venom breaks down the prey's body tissue, aiding in digestion [58]. Hunting occurs most often between 2100 hours and 0800 hours, with an average of 9.7 hours/day spent in the ambush posture [61].

Male and female timber rattlesnakes may use different hunting strategies. In South Carolina, 31% of female foraging strategies observed involved ambush tactics near logs to catch small mammals. Most males (23%) used the ambush posture at tree bases, sometimes facing up the trunk to capture eastern gray squirrels [75].

Timber rattlesnakes sometimes climb trees. Motivation for this behavior is unknown but may include hunting for birds and arboreal mammals, avoidance of terrestrial predators, and escape from flood waters [66,68].

PREDATORS:

Predators of the timber rattlesnake include red-tailed hawks (*Buteo jamaicensis*), foxes (*Vulpes* spp.), owls (Strigiformes), coyotes (*Canis latrans*), and skunks (Mephitidae) [30]. Habitat destruction and human activities such as hunting have the largest negative impact on timber rattlesnake populations [2].

MANAGEMENT CONSIDERATIONS:

Many timber rattlesnake populations have been reduced or exterminated since European colonization of North America. Surveys conducted from the 1940s to the 1990s have shown widespread decline [9], mainly due to human activities (see [Survival rates and mortality](#)). Due to the timber rattlesnake's low reproductive rate and its habit of denning and gestating communally, population growth and recovery after human impacts are slow [7,48]. Humans impact timber rattlesnake populations by causing habitat loss and fragmentation, changing vegetational succession, sport and bounty hunting, commercial collecting, blasting and filling-in of dens, road construction, logging, mining, and creating gas wells [1,9,48,57,58].

According to Perri [57], timber rattlesnake conservation is difficult due to sexual differences in habitat preference and seasonal migrations that cover a variety of habitats. Researchers have offered many recommendations for managing timber rattlesnakes including: 1) educating state and federal employees and the general public about the ecology, conservation, management, laws, and regulations regarding timber rattlesnakes; 2) locating and monitoring den, rookery, and bask sites and maintaining secrecy of those locations except for research or protection purposes; 3) patrolling timber rattlesnake dens during spring emergence, gestation, and parturition to prevent hunting and collecting; 4) requiring permits for in-state hunting, eliminating out-of-state hunting, or outlawing hunting altogether; 5)

conducting research on the effects of logging and mining; and 6) closing road access to dens, rookeries, and basking sites to all-terrain and other vehicles [[1,9,30,31,57](#)].

Caution may be needed when using timber rattlesnake habitat models [[75](#)]. Both sexes of timber rattlesnake exhibit shifts in habitat specificity in response to seasonal changes in behavior (see [Preferred Habitat](#)), an important constraint on use of habitat suitability models. Rittenhouse and others [[63](#)] designed a habitat suitability model for timber rattlesnakes in the central hardwoods region. The following indices were included in the model: early successional forested habitat used for basking and foraging; woody debris used for cover and foraging; proportion of woody debris and foraging habitat using a moving window with a 2,789-foot (850 m) radius; value based on proximity of habitat features to den sites; and reduction of the suitability value of habitat near roads [[63](#)].

Recommended size of protected areas: Protection of timber rattlesnake populations requires protection of the den site and a large surrounding area used during the active season (see [Home range](#) and [Seasonal movement patterns](#)) [[9,32,57](#)]. Perri [[57](#)] suggests using GIS software to prioritize conservation areas for the timber rattlesnake based on land ownership, proximity to dens, and habitat features such as south-facing rocky slopes, mature forest, and proximity to water sources [[57](#)]. According to Brown's [[9](#)] timber rattlesnake conservation guidebook, each area occupied by the timber rattlesnake should be studied to ascertain movement patterns for males and females before determining the size of protected habitat. Once den sites are identified, at least a 1.5-mile (2.4 km) radius around the den should be protected. Habitat corridors between den sites should also be provided to encourage potential genetic interchange between timber rattlesnake populations [[9,57](#)]. In addition to the 1.5-mile radius around dens, Brown [[9](#)] recommends a buffer zone of 1.0 mile (1.6 km), even if the buffer zone is in less than optimal habitat. The buffer zone would accommodate timber rattlesnakes that move up to 2.5 miles (4.0 km) from their den. If possible, protection of up to 4.8 miles (7.2 km) around a den is recommended [[9](#)].

Forest management: According to an Environmental Assessment, logging may have positive and negative indirect impacts on the timber rattlesnake [[71](#)]. Adams [[1](#)] stated that clearcutting may have positive impacts on habitat due to an increase of coarse woody debris used by timber rattlesnakes and their prey. Logging may negatively affect timber rattlesnakes by opening the canopy, which increases rates of avian predation on timber rattlesnakes [[71](#)]. It is uncertain whether thinning at den sites has positive or negative effects on timber rattlesnakes [[1,9](#)]. According to Brown [[9](#)], vegetation that shades den sites can be thinned to increase basking opportunities. Adams [[1](#)], however, suggests that canopy closure at den sites may not pose problems because timber rattlesnakes do not spend a large amount of time there during the active season. Two authors suggest restricting logging to winter months when timber rattlesnakes are hibernating [[9,73](#)].

Steen and others [[70](#)] suggest that a habitat matrix of large intact patches of both hardwood and pine forest may be necessary to manage for timber rattlesnake habitat in the southeastern United States. At the Joseph W. Jones Ecological Research Center (Jones Center) in Newton, Georgia, timber rattlesnakes preferred contiguous hardwood forest within longleaf pine habitat. The area was managed intensively with prescribed fire and thinning of oaks to maintain a longleaf pine/threawn community, a practice that may conflict with protection of timber rattlesnakes [[70](#)].

FIRE EFFECTS AND USE

SPECIES: *Crotalus horridus*

- [DIRECT FIRE EFFECTS ON ANIMALS](#)
- [HABITAT-RELATED FIRE EFFECTS](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)

DIRECT FIRE EFFECTS ON ANIMALS:

Direct mortality of timber rattlesnakes has not been studied; however, research has shown that fire causes little direct mortality for most reptile species [[35,42,43,47,54,67](#)] because reptiles use refugia such as animal burrows, rocky

crevices, and surface objects during fires [[39,54](#)].

Eastern diamond-backed rattlesnakes (*Crotalus adamanteus*) occupy habitat similar to that of timber rattlesnakes in the southeastern United States, so results of fire studies of eastern diamond-backed rattlesnakes may apply to timber rattlesnakes. In 2 studies, direct mortality for eastern diamond-backed rattlesnakes was low following prescribed burning. Of 68 marked eastern diamond-backed rattlesnakes in northern Florida, only 2 individuals were directly killed by annual prescribed burns conducted from late December to late March over a 5-year period. Skin shedding, which hampers sensory perception and the ability to escape fire, may have increased susceptibility of those individuals to fire kill. Following a prescribed fire in late November in Franklin County, Florida, 7 unharmed eastern diamond-backed rattlesnakes were found in smoking ashes. An eighth juvenile snake, which was shedding its skin, was found dead [[54](#)]. Komarek [[42](#)] anecdotally noted that dead eastern diamond-backed rattlesnakes were rarely seen after annual burns on 500,000 acres (200,000 ha) of hunting lands in Thomasville, Georgia, and Tallahassee, Florida, and that burning did not appear to decrease timber rattlesnake numbers [[42](#)].

HABITAT-RELATED FIRE EFFECTS:

Data on habitat-related fire effects for the timber rattlesnake are sparse. Because timber rattlesnakes show a preference for forested habitat (see [Preferred Habitat](#)), fires that reduce or eliminate forest cover could have negative impacts on their populations. However, timber rattlesnakes evolved in habitat with frequent natural disturbances [[35,42,43,47,54,67](#)] such as wind and ice storms, fire, and forest disease [[1](#)] and may adjust to the changes fire causes to landscapes. Despite a lack of information, some inferences on habitat-related fire effects may be possible based on the timber rattlesnake's habitat preferences and cover needs, gender and reproductive status, and season [[9,60,62](#)] (see [Preferred Habitat](#) and [Cover Requirements](#)).

Denning and transient habitats: Fire that occurs in denning and transient habitats may result in few negative impacts on timber rattlesnakes. Most dens are located in rock outcroppings or rock slides [[4,30,31,51,58,70](#)] and would most likely be unharmed by fire. However, dens located in root masses of fallen trees may be destroyed by severe fire. Little time is spent by males and nongravid females in transient habitat before migrating to summer ranges [[1,51](#)], so a decrease in canopy cover may have few negative effects except for increasing visibility to predators. Gravid females typically prefer an open canopy and large rocks for gestation and parturition [[1,60,62,71](#)] in transient/summer habitat, so a postfire decrease in canopy cover may be beneficial in some cases. Some gravid females use debris piles and hollow logs for gestation and parturition [[1,66](#)] and may be harmed by fire-caused loss of coarse woody debris.

Summer habitat: Fires in summer habitat may have more negative impacts on the timber rattlesnake than fires in denning and transient habitats. Male and nongravid female timber rattlesnakes prefer forested areas with a combination of open and closed canopies, leaf litter, thick surface vegetation, and coarse woody debris [[1,60,62,74,75](#)]. Negative effects of fire include potential reduction of overstory and understory vegetation and litter. McLeod and Gates [[53](#)] found that on the Atlantic coastal plain of Maryland, several snake species associated with moist, cool microclimates and leaf litter were significantly ($P < 0.01$) less abundant in burned compared to unburned stands. However, Means and Campbell [[54](#)] found no evidence of population declines for several species of Florida herpetofauna associated with leaf litter and other surface cover after prescribed burning. Coarse woody debris is important for hunting (see [Hunting strategies](#)) [[16,17,17,18,58,61,75](#)] and may be reduced or increased by fire, depending on severity. Positive effects of fire on summer habitat include stimulation of vegetative growth in the understory and improving habitat for small mammals [[43,64,76](#)]. Fire may also increase the availability of basking sites and dens within burned stump holes.

The [Fire Regime Table](#) for timber rattlesnake provides fire regime information on vegetation communities in which timber rattlesnakes may occur.

FIRE CONSIDERATIONS:

Due to the lack of data on fire and timber rattlesnakes, it is difficult to provide fire management recommendations [[43,54,67](#)]. According to a review by Means and Campbell [[54](#)], prescribed fire may restore historical mosaics in most southern forest habitats occupied by reptiles, and any fire-related reptile mortality in these communities is most likely outweighed by maintaining preferred habitat features.

Two studies report timber rattlesnake occurrence after herbicide application and/or burning, but both have limited

scopes of inference. In the first growing season after prescribed burning and/or herbicide treatments on intensively managed loblolly pine plantations in the Interior Flatwoods Resource Area in Kemper County, Mississippi, overall species diversity of herpetofauna (including the timber rattlesnake) did not differ from that in the pretreatment growing season [36]. Eleven years after a plot was treated with herbicide and prescribed fire on the Cross Timbers Experimental Range, Oklahoma, one timber rattlesnake was found. Timber rattlesnakes are uncommon in this area [38].

Prescribed fire may benefit herpetofauna if applied at the appropriate season or frequency [6,53]. Winter burning would most likely minimize direct mortality of timber rattlesnakes because they are hibernating [73]. According to Brockway and Lewis [6], winter burning at 2-year intervals may open the structure of longleaf pine forests in the southeastern United States and may be a useful option for restoring and sustaining the ecosystem. Steen and others [70] suggest managing a habitat matrix of large intact patches of both hardwoods and pines within longleaf pine forests in the southeastern United States to effectively conserve and manage timber rattlesnakes.

APPENDIX: FIRE REGIME TABLE

SPECIES: *Crotalus horridus*

The following table provides fire regime information that may be relevant to timber rattlesnake habitats. Follow the links in the table to documents that provide more detailed information on these fire regimes.

<p>Fire regime information on vegetation communities in which timber rattlesnake may occur, based on the habitat characteristics and species composition of communities timber rattlesnakes are known to occupy. There is not conclusive evidence that timber rattlesnakes occur in all of the habitat types listed, and some community types, especially those used rarely, may have been omitted. For each community, fire regime characteristics are taken from the LANDFIRE Rapid Assessment Vegetation Models [45]. These vegetation models were developed by local experts using available literature, local data, and/or expert opinion as documented in the PDF file linked from the name of each Potential Natural Vegetation Group listed below. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.</p>					
Northern Great Plains Southeast		Great Lakes		Northeast	
		South-central US		Southern Appalachians	
<p>Northern Great Plains</p> <ul style="list-style-type: none"> Northern Plains Woodland 					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
<p>Northern Plains Woodland</p>					
Oak woodland	Replacement	2%	450		
	Surface or low	98%	7.5		
Northern Great Plains wooded draws and ravines	Replacement	38%	45	30	100
	Mixed	18%	94		
	Surface or low	43%	40	10	
<p>Great Lakes</p> <ul style="list-style-type: none"> Great Lakes Grassland Great Lakes Forested 					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)

Great Lakes Grassland					
Mosaic of bluestem prairie and oak-hickory	Replacement	79%	5	1	8
	Mixed	2%	260		
	Surface or low	20%	2		33
Great Lakes Forested					
Northern hardwood maple-beech-eastern hemlock	Replacement	60%	>1,000		
	Mixed	40%	>1,000		
Maple-basswood	Replacement	33%	≥1,000		
	Surface or low	67%	500		
Maple-basswood mesic hardwood forest (Great Lakes)	Replacement	100%	>1,000	≥1,000	>1,000
Maple-basswood-oak-aspen	Replacement	4%	769		
	Mixed	7%	476		
	Surface or low	89%	35		
Oak-hickory	Replacement	13%	66	1	
	Mixed	11%	77	5	
	Surface or low	76%	11	2	25
Northeast					
<ul style="list-style-type: none"> Northeast Woodland Northeast Forested 					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northeast Woodland					
Eastern woodland mosaic	Replacement	2%	200	100	300
	Mixed	9%	40	20	60
	Surface or low	89%	4	1	7
Rocky outcrop pine (Northeast)	Replacement	16%	128		
	Mixed	32%	65		
	Surface or low	52%	40		
	Replacement	10%	78		

Pine barrens	Mixed	25%	32		
	Surface or low	65%	12		
Oak-pine (eastern dry-xeric)	Replacement	4%	185		
	Mixed	7%	110		
	Surface or low	90%	8		
Northeast Forested					
Northern hardwoods (Northeast)	Replacement	39%	≥1,000		
	Mixed	61%	650		
Eastern white pine-northern hardwoods	Replacement	72%	475		
	Surface or low	28%	>1,000		
Northern hardwoods-eastern hemlock	Replacement	50%	≥1,000		
	Surface or low	50%	≥1,000		
Northern hardwoods-spruce	Replacement	100%	≥1,000	400	>1,000
Appalachian oak forest (dry-mesic)	Replacement	2%	625	500	≥1,000
	Mixed	6%	250	200	500
	Surface or low	92%	15	7	26
Beech-maple	Replacement	100%	>1,000		
Northeast spruce-fir forest	Replacement	100%	265	150	300
South-central US					
<ul style="list-style-type: none"> • South-central US Woodland • South-central US Forested 					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
South-central US Woodland					
Oak-hickory savanna	Replacement	1%	227		
	Surface or low	99%	3.2		

Interior Highlands dry oak/bluestem woodland and glade	Replacement	16%	25	10	100
	Mixed	4%	100	10	
	Surface or low	80%	5	2	7
Interior Highlands oak-hickory-pine	Replacement	3%	150	100	300
	Surface or low	97%	4	2	10
Pine bluestem	Replacement	4%	100		
	Surface or low	96%	4		
South-central US Forested					
Interior Highlands dry-mesic forest and woodland	Replacement	7%	250	50	300
	Mixed	18%	90	20	150
	Surface or low	75%	22	5	35
Gulf Coastal Plain pine flatwoods	Replacement	2%	190		
	Mixed	3%	170		
	Surface or low	95%	5		
West Gulf Coastal plain pine (uplands and flatwoods)	Replacement	4%	100	50	200
	Mixed	4%	100	50	
	Surface or low	93%	4	4	10
West Gulf Coastal Plain pine-hardwood woodland or forest upland	Replacement	3%	100	20	200
	Mixed	3%	100	25	
	Surface or low	94%	3	3	5
Southern floodplain	Replacement	42%	140		
	Surface or low	58%	100		
Southern floodplain (rare fire)	Replacement	42%	≥1,000		
	Surface or low	58%	714		
Cross Timbers	Replacement	3%	170		
	Mixed	2%	250		
	Surface or low	94%	6		
Southern Appalachians					
<ul style="list-style-type: none"> • Southern Appalachians Woodland • Southern Appalachians Forested 					
Fire regime characteristics					

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Southern Appalachians Woodland					
Table Mountain-pitch pine	Replacement	5%	100		
	Mixed	3%	160		
	Surface or low	92%	5		
Oak-ash woodland	Replacement	23%	119		
	Mixed	28%	95		
	Surface or low	49%	55		
Southern Appalachians Forested					
Bottomland hardwood forest	Replacement	25%	435	200	≥1,000
	Mixed	24%	455	150	500
	Surface or low	51%	210	50	250
Mixed mesophytic hardwood	Replacement	11%	665		
	Mixed	10%	715		
	Surface or low	79%	90		
Appalachian oak-hickory-pine	Replacement	3%	180	30	500
	Mixed	8%	65	15	150
	Surface or low	89%	6	3	10
Eastern hemlock-eastern white pine-hardwood	Replacement	17%	≥1,000	500	>1,000
	Surface or low	83%	210	100	>1,000
Oak (eastern dry-xeric)	Replacement	6%	128	50	100
	Mixed	16%	50	20	30
	Surface or low	78%	10	1	10
Appalachian Virginia pine	Replacement	20%	110	25	125
	Mixed	15%	145		
	Surface or low	64%	35	10	40
Appalachian oak forest (dry-mesic)	Replacement	6%	220		
	Mixed	15%	90		
	Surface or low	79%	17		
Southern Appalachian high-elevation	Replacement	59%	525		

forest	Mixed	41%	770		
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Southeast

- [Southeast Grassland](#)
- [Southeast Woodland](#)
- [Southeast Forested](#)

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)

Southeast Grassland

Southeast Gulf Coastal Plain Blackland prairie and woodland	Replacement	22%	7		
	Mixed	78%	2.2		

Floodplain marsh	Replacement	100%	4	3	30
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Gulf Coast wet pine savanna	Replacement	2%	165	10	500
	Mixed	1%	500		
	Surface or low	98%	3	1	10

Southeast Woodland

Longleaf pine/bluestem	Replacement	3%	130		
	Surface or low	97%	4	1	5

Longleaf pine (mesic uplands)	Replacement	3%	110	40	200
	Surface or low	97%	3	1	5

Longleaf pine-Sandhills prairie	Replacement	3%	130	25	500
	Surface or low	97%	4	1	10

Atlantic wet pine savanna	Replacement	4%	100		
	Mixed	2%	175		
	Surface or low	94%	4		

Southeast Forested

Coastal Plain pine-oak-hickory	Replacement	4%	200		
	Mixed	7%	100		
	Surface or low	89%	8		

	Replacement	18%	40		500
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Maritime forest	Mixed	2%	310	100	500
	Surface or low	80%	9	3	50
Mesic-dry flatwoods	Replacement	3%	65	5	150
	Surface or low	97%	2	1	8
Loess bluff and plain forest	Replacement	7%	476		
	Mixed	9%	385		
	Surface or low	85%	39		
Southern floodplain	Replacement	7%	900		
	Surface or low	93%	63		
<p>*Fire Severities—</p> <p>Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.</p> <p>Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.</p> <p>Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [34,44].</p>					

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