Timber Rattlesnake Recovery Plan

(*Crotalus horridus*)

Prepared by the
Timber Rattlesnake Recovery Team
for

Minnesota Department of Natural Resources
Division of Ecological Resources

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Timber Rattlesnake Recovery Team

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Executive Summary for the Timber Rattlesnake Recovery Plan

The Timber Rattlesnake Recovery Plan was developed to lay out steps needed to recover this species in Minnesota. This plan spans ten years, at which time it should be reviewed and updated as needed. The first half of the document summarizes the current and historical distribution of timber rattlesnakes in Minnesota, provides life history information, identifies and describes habitat components, and identifies threats to timber rattlesnake recovery. The habitat section discusses an analysis of bluff prairie habitat available to timber rattlesnakes and provides a history of timber rattlesnake conservation work conducted in Minnesota through 2008.

The second half of the plan is broken into three recovery goals: population, habitat and public outreach. These goals outline what the recovery team believes is necessary to recover the timber rattlesnake to a level where placement on Minnesota's Threatened and Endangered Species list is no longer necessary. The following is a brief summary of those goals.

Population Goals: Determining population recovery goals for the timber rattlesnake is difficult because little information is known about the overall size of Minnesota's population. Additionally, these snakes are secretive in nature, making it hard to detect consistently and completely the number of snakes at any one site. Nonetheless, the following steps were taken to develop a measure of population viability:
Step 1: Determine what component of the population dynamics will be measured for recovery.
Step 2: Determine the minimum threshold of that component needed to attain recovery status.
Step 3: Determine the geographic unit over which the population component will be measured.

Based on current literature, and the expertise of the Recovery Team, den viability is the component that will be measured to determine if population goals are met. A den is considered viable if the following conditions are observed at least twice in ten (10) years, at a minimum of five-year increments: Ten (10) snakes are observed at one location during peak spring emergence, following established survey protocol.

The state has been divided into nine recovery units. These recovery units were delineated using major roads that would be considered movement barriers, and the Bluffland subsection boundaries. These recovery units have some biological basis, but also recognize logistical constraints of trying to divide a fragmented habitat into units within which goals can be established and measured. The number of known dens (viable or not) has been identified for each recovery unit, and a minimum number of viable dens required for recovery of that unit has been determined. The minimum number of viable dens per recovery unit is two or five, or the highest known number of viable dens for that recovery unit. This translates to a no net loss of viable dens. None of the known dens has been designated as viable as of January 2009, so a minimum goal has been established until a viability determination is made. These numbers may change as we learn more about timber rattlesnakes and their needs for long-term survival. It is not known if meeting these goals will result in a fully recovered population for the long-term; however, they will be used as a baseline for establishing a measurement of recovery for timber rattlesnakes in Minnesota. As of January 2009, the population recovery goal is to maintain a minimum of 33 viable dens geographically distributed across recovery units.

Habitat Goals: In order to protect the long-term viability of rattlesnakes in Minnesota, a minimum habitat acreage should be protected and restored to its native condition. This minimum threshold is not presently known, but a baseline has been set using current life history knowledge. The habitat recovery goals focus on bluff prairies because the Recovery Team believes that the majority of gravid females in Minnesota depend on them for birthing, which is critical to long-term survival of the species. To meet habitat recovery goals for timber rattlesnakes in Minnesota, a minimum of 2600 acres of bluff prairie habitat that contain active rattlesnake dens, and 2600 acres of bluff prairie habitat within a 3.6 km (2.24 mi) area around active den sites must be restored, and ideally protected. It is hoped that by reaching this goal, we will be able to maintain all dens determined to be viable, and maintain a minimum of one auxiliary den per viable den in the 2600 "buffer" acres to allow for movement and potential colonization of new sites.

Public Outreach Goals: The goal of public outreach is to increase awareness and appreciation of snakes, particularly timber rattlesnakes, in Minnesota. Reaching this recovery goal will be the most challenging as it is the hardest to measure. Nonetheless, the following three factors have been identified as the most important goals for outreach efforts: reduce human-inflicted mortality of timber rattlesnakes as well as other snake species; engage landowners to participate in protecting and restoring habitat for snakes; increase public support for reptile conservation efforts, particularly snakes. Target audiences and recommended actions have been established to meet these goals.

In addition to establishing recovery goals, this plan identifies monitoring protocols for determining population viability and habitat restoration.

While a lot is yet to be learned about timber rattlesnakes and what they need to persist in Minnesota's changing landscape, this plan lays the basic groundwork for a recovery effort over the next ten years.

Background

Scientific name:	Crotalus horridus
Common name:	Timber rattlesnake
Other names:	Velvet tail, banded rattlesnake
Category:	Reptile, venomous
Family:	Viperidae
Global Status:	G4, apparently secure
State Status:	S2, imperiled
State Legal Status:	State threatened
Minnesota Rules:	Chapter 6134, listed timber rattlesnake as "MN threatened" since 1996
Legal Citation:	Minnesota Statute 84.0895

Current and Historical Distribution

The timber rattlesnake occurs in 30 states across the United States, extending from New Hampshire south through the Appalachian Mountains and eastern coastal plains to northern Florida, west through eastern Texas and Oklahoma, and back north through Missouri and along the Mississippi River drainage (Martin, 1992) (Figure 1). Despite the wide range, timber rattlesnake populations are becoming more isolated as a result of local extirpation and habitat changes, particularly in the northern and western fringes of this species' range (Brown, 1993). Michigan is the only state in the Midwest not known to have timber rattlesnakes. Timber rattlesnakes of the Upper Mississippi River Valley are the most northerly distributed population in the United States (Furman, 2007).

Figure 1: Distribution of *Crotalus horridus* in the U.S. (Martin, 1992)

Historically, timber rattlesnakes occurred in eight southeastern Minnesota counties (Oldfield & Moriarty, 1994) (Figure 2). However, recent surveys suggest that many dens in the northern portion of its Minnesota range may be extirpated (Keyler and Fuller, 1999, MNDNR Survey, 2008). The peripheral and current range harbors the 85 recorded timber rattlesnake dens. While some of these dens may be extirpated, others are still very active. The current and peripheral range (since 1980) encompasses Fillmore, Goodhue, Houston, Olmsted, Wabasha and Winona Counties. It should be noted that the Minnesota Natural Heritage Database includes a 1920's record of a timber rattlesnake in Blue Earth county. This location is in south central Minnesota, and is not connected to the Mississippi River Valley population. No other reports of timber rattlesnakes are known from this area.

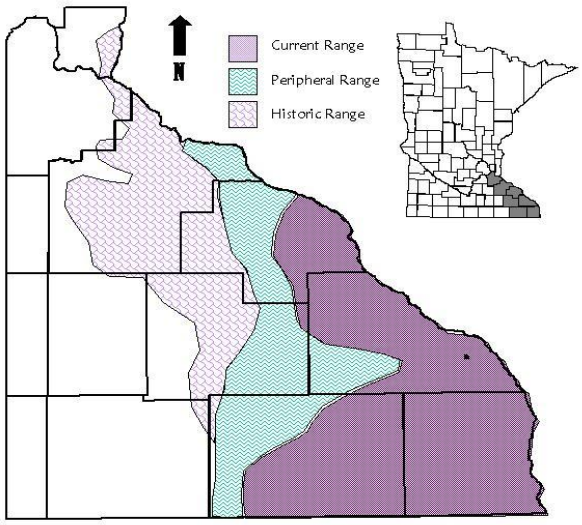

Figure 2: Distribution of *Crotalus horridus* in MN

Description

The timber rattlesnake is a large, heavy-bodied venomous snake with significantly keeled scales. It has a wide, triangular-shaped, unmarked tan head and a narrow neck. As with all venomous snakes, "timbers" have vertically elliptical pupils, similar to cats' eyes, and deep facial pits (loreal pits) between each eye and nostril (Figure 3). The coloration and pattern of timber rattlesnakes is highly variable across its range. The dorsal coloration may be yellow, tan, brown, reddish brown, or, rarely, gray. It darkens toward the posterior, leading into a uniform black tail with a tan rattle. Dark brown or black chevron-shaped cross bands run along the dorsal surface of the snake (Figure 4). However, these bands may be incomplete or broken on the front third of the body (Oldfield and Moriarty, 1994). In dark phase individuals, the cross bands may be less distinct and difficult to see. Many snakes, particularly in the Midwest, have a rust-colored middorsal stripe from the back of the head to the tail. Additionally, some snakes have a dark band or stripe extending at an angle from the eye to the corner of the mouth. The majority of timber rattlesnakes in Minnesota has both a mid-dorsal stripe, and a post-ocular stripe or bar (Keyler & Oldfield, 1992).

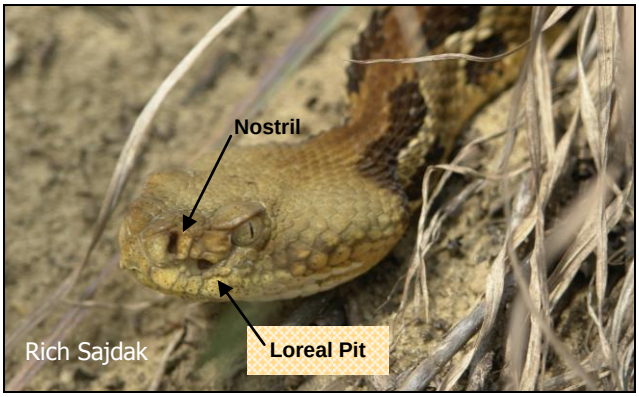

Figure 3: Timber rattlesnake head showing the loreal pit and nostril. The elliptical eye can also be seen in this picture

Figure 4: Chevron-shaped bands along the dorsal surface of a timber rattlesnake

The ventral coloration of timber rattlesnakes is yellowish tan or light gray, with scattered splotches of dark gray to solid black toward the tail. The anal plate is singular rather than divided (Oldfield and Moriarty, 1994). Several other snake species are frequently confused with timber rattlesnakes, including, milksnake (*Lampropeltis triangulum*), western fox snake (*Elaphe vulpina*), and bullsnake, or gopher snake (*Pituophis catenifer*). However, these nonvenomous snakes lack facial pits, wedge-shaped heads, elliptical pupils and a rattle. They commonly shake their tails vigorously in debris or dry leaves, producing a rattle-like sound despite the lack of an actual rattle. This behavior often leads to mistaken identity as a rattlesnake. True rattlesnakes hold their rattle perpendicular to the ground when rattling (Figure 5).


Figure 5: Timber rattlesnake rattle

Juvenile timbers are patterned like the adult. Neonates (newborns) are almost always gray in coloration, but have the same dark cross bands as the adults (Figure 6). They retain this coloration until their first skin shedding, which typically occurs at 10-14 days old. Neonates are born with venom and a prebutton rattle, which gives way to a button (terminal segment of a complete rattle) when the skin is shed for the first


Figure 6: Neonate timber rattlesnakes

time, typically at 8 to 16 days post birth (Martin, 1996). A rattle is gained with each subsequent shedding, about once or twice per year (Oldfield and Moriarty, 1994; Sajdak and Bartz, 2001). Because rattles often break off, they do not provide a reliable method of determining the age of a snake.

Size

Size in timber rattlesnakes varies geographically, with southern snakes typically being larger than northern. Average length (excluding the rattle) ranges from 80 to 122 cm (31.5–48 in). Timbers are sexually dimorphic with females being smaller than males. Adult females average 90 cm (35.5 in) and adult males average 110 cm (43.5 in) (Keyler and Oldfield, 1992a). The largest snake recorded in Minnesota was a male from Houston County that measured 135 cm (53 in) and weighed 1,760 grams (3 lbs 4 oz) (Keyler and Oldfield, 1992). In an ongoing study of timber rattlesnakes in the northeastern U.S., only 2.5% of the snakes measured were 122 cm (48 in) or longer (Brown, 1993).

It is challenging to distinguish male and female timber rattlesnakes with the naked eye. While males are typically heavier and longer, with more space between the vent and the tip of the rattle, these characteristics can be subjective, and do not provide a definitive method to determine gender. The most dependable method for determining gender is to probe the cloaca, or vent, for reproductive organs. This can be a dangerous procedure for the snake, so only trained professionals should conduct this type of evaluation.

Diet and Foraging

Timber rattlesnakes are "sit-and-wait" ambush predators (Reinert et. al., 1984). A snake may coil by a log that serves as a runway for small mammals for hours until a prey species comes along. When prey approaches, the snake's heat-sensing pits (loreal pits) help determine its proximity and direct the snake's strike. The snake will quickly bite, inject venom, and then release the animal, which runs a short distance before succumbing to the effects of the venom. The snake follows the scent trail left by the envenomated prey and swallows it whole. Preferred prey includes small mammals such as mice, shrews, moles, voles, chipmunks, squirrels and small rabbits. Timbers will occasionally eat small birds, insects, and amphibians (Wright and Wright, 1957; Klauber, 1972). Pregnant (gravid) females eat little to no food during the gestation period (Reinert and Zappalorti, 1988a).

Timber rattlesnakes exhibit arboreal behavior throughout their range (Coupe, 2001; Wynn, pers. comm.) In Minnesota and Wisconsin, they have been observed one to two meters (3.3 – 6.6 ft) above ground in cedars and grapevines (Keyler, pers. comm.).

Reproduction

Female timber rattlesnakes reach reproductive maturity sometime between three to nine years in age. Martin (1988) reported females in Virginia have their first litter between the ages of five and nine. Studies in Wisconsin and Kansas reported female maturation at four years of age (Keenlyne, 1978; Fitch, 1985). More recent work in Wisconsin estimates age at first reproduction to be seven years (Sajdak and Berg, 2005), which matches what Brown (1993) has found for timber rattlesnakes in New York. Males reach sexual maturity at four to six years (Aldridge and Brown, 1995). Courtship and mating typically occurs from late July to September, but may also occur in the spring. After fall mating, females store sperm in their bodies over winter for egg fertilization the following spring.

Reproduction in northern timber rattlesnake populations is characterized by low frequency birthing with intervals of two years or longer between reproductive events, along with delayed age of first reproduction. In Virginia, Brown (1991) reported much longer reproductive cycles, with an average interval of three to four years. Additionally, a Wisconsin study indicated females had a triennial or longer reproductive cycle (Sajdak and Bartz, 2001). Reproduction is very physically demanding on females, especially since they eat little to no food when gravid. Thus, a female may only produce three to five litters in her reproductive life (Brown, 1991).

Gestation lasts between 2.5 to 4 months (Martin, 2000, 1993). In northern climates, gravid females give birth to live young from late August through September. Litter sizes can vary geographically, with southern snakes often producing larger litters (10-16 neonates) than northern snakes (3-14 neonates) (Fitch 1985). Litter size and length of newborns reported by Fitch and others are consistent with data from Minnesota (Keyler & Oldfield, 1992). Neonates range from 20 to 36cm (8-14 in) long and remain with the mother for the first 10 to 14 days.

Timber rattlesnake longevity in the wild approaches 35 years (Brown, Keyler and Cochran, 2005). This longer lifespan, coupled with a low reproductive rate, infrequent reproductive events, and high juvenile mortality, leads to a population dominated by older age classes with variable annual recruitment. As a result, the impact of removing a single adult, especially a female, from the population can be significant (Brown, 1993). These characteristics make recovery of depleted timber rattlesnake populations challenging, but not impossible.

Predators

Timber rattlesnakes have few natural predators. Known predators include hawks, owls, foxes, skunks, and coyotes (Galligan and Dunson, 1979), as well as wild turkeys, and white-tailed deer (i.e., stomping). However, humans are their primary source of mortality through the following anthropogenic factors: habitat alteration and destruction (Brown, 1993; Green and Pauley, 1987), development (Brown, 1993; Green and Pauley, 1987), and disturbance (Brown, 1993), wanton killings, rattlesnake roundups and other events, and collection for the pet trade (Brown, 1993; Galligan and Dunson, 1979; Green and Pauley, 1987, Rudolph and Burgdorf, 1997, Rudolph et al. 1998). Unlike adults, young rattlesnakes experience a high mortality rate.

Home range

Timber rattlesnakes have seasonal movements occurring in two phases: egress, or emerging and moving away from the hibernaculum in spring, and ingress, or moving toward the den in fall (Brown, 1993). Migration distances and home range sizes vary by gender and reproductive status (Table 1). Adult males generally stay within 3.6 km (2.17 miles) of the hibernacula, and nongravid females range an average of 2.3 km (1.43 miles) or less (Reinert and Zappalorti, 1988a; Hammerson and Lemieux, 2001). Travel distances are considerably smaller for gravid females, especially since many spend extensive time at birthing rookeries within close proximity of the den. A rookery is an area used for gestating and/or birthing. Martin (1992) reported that some birthing rookeries are located at the den, and those located away from the den were found within a mean distance of 164 m (538 feet), with a range of 25 to 1250 m (82 feet to 0.78 miles). The same pattern is exhibited for size of home range. Adult males use an area that averages 200 hectares (494 acres), and adult females use smaller areas in the range of 30 to 40 hectares (74 to 99 acres) (Reinert and Zappalorti, 1988a; Gibson, 2003). Gravid females preparing to give birth move the least, both in migration distance from the den and in size of summer home range (Brown et. al., 1982; Galligan and Dunson, 1979; Keenlyne, 1972; Martin, 1992; Reinert and

Zappalorti, 1988a, Adams, 2005). The home range of gravid snakes ranges from 8.5 to 22 hectares (21 to 54 acres) (Reinert and Zappalorti, 1988a; Adams, 2005).

Table 1: Travel distance and home ranges for timber rattlesnakes

	Adult Males	Nongravid Adult Female	Gravid Adult Female	Juvenile	Literature Reference
Travel Distance from Den	3.6 km (2.17mi)	<2.3 km (1.43mi)	164m (538 ft)	.49 – 1.57 km (.3 - .98 mi)	Reinhert & Zappalorti 1988a; Hammerson & Lemieux 2001; Martin 1992; Sajdak & Bartz 2001
Home range	200 ha (494 ac)	30-40 ha (74-99 ac)	8.5-22 ha (21-54 ac)		Reinhert & Zappalorti 1988a; Gibson 2003; Adams 2005

A telemetry study in Wisconsin found that young snakes have more variable home ranges and movement patterns than adults (Sajdak and Bartz, 2001). Juvenile snakes in southwest Wisconsin exhibited movements ranging from 0.49 km (0.30 miles) to 1.57 km (0.98 miles), with some snakes moving in opposite directions than the previous year (Sajdak and Bartz, 2001).

Phenology

Timber rattlesnakes exhibit seasonal activity, particularly in northern climates. Snakes, being ectothermic, are affected by changes in temperature, and therefore, hibernate during the winter months. The active period for timber rattlesnakes in the upper Midwest typically goes from mid April through early October, which is shorter than other snakes in the same region.

Egress

For Minnesota, the earliest known egress of timber rattlesnakes is April 15th (Keyler & Oldfield, 2002; Cochran, *In press*). Data collected over a four-year period from 2002 through 2005 in Winona County, Minnesota showed egress occurred in mid May (Cochran, *In press*). Similar dates exist for other states as well (Table 2). Reports from Wisconsin indicate egress of snakes in the DeSoto area as early as April 6th (Sajdak and Berg, 2005), while Brown (1992) reported the earliest in New York as April 8th. Wisconsin and New York are at similar latitudes with SE Minnesota.

Road kill reports in southern Houston County in Minnesota indicate that snakes are starting to disperse by mid May (D. Shaw, pers. comm.).

Ingress

For Minnesota, the latest known published date for ingress is October 10th (Keyler & Oldfield, 2002), with an average ingress date of October 9th (Cochran, *In press*). During a 2008 telemetry study by the MNDNR, snakes were observed as late as October 16th. Keyler (1991) observed neonates still active in late September and into early October along the Root River Trail in central Fillmore County. Dates from other reports indicate average ingress for northern latitudes to be from mid-September to early October (Table 2). In Virginia, egress and ingress dates differ by as much as a month on either end of Minnesota's dates (Martin, 1992). This demonstrates that latitudinal changes can have an effect on snake egress and ingress, which is important to consider in Minnesota, where anecdotal observations appear to show a slight difference in timber rattlesnake seasonal patterns from southern Houston County to northern Fillmore and Winona Counties (J. Edwards, pers. observation; Dave Shaw, pers. comm.). As timber rattlesnakes ingress,

they remain on the surface, within 100 m (within 328 feet) of the den for up to fourteen days (Sealy, 2002).

Table 2: Timber rattlesnake egress and ingress dates.

Category	Minnesota	Wisconsin	New York	Virginia
Earliest Egress	15 Apr	4 April	8 April	8 Mar
General Egress	30 Apr – 20 May	7 May – 21 May	7 May – 21 May	18 Apr – 14 May
General Ingress	6 Sept – 9 Oct	14 Sept – 1 Oct	14 Sept – 1 Oct	1 Oct – 21 Oct
Latest Ingress	10 Oct	19 Oct	16 Oct	5 Nov
Mean Egress T_B		10.8°C (6 dens/1yr) (51 °F)	10.5°C (1den/3 yrs) (51 °F)	12°C (54° F)

(Brown, 1992, 1993; Martin, 1992; Cochran, *In press*; Sajdak and Berg, 2005)

Galligan and Dunson (1979) and Martin (1992) found no obvious relationship between air and ground temperatures and dates of rattlesnake emergence in Virginia. Galligan and Dunson reported temperature to be one factor in spring emergence, but not the primary factor. Martin (1992) reported that air temperature might have more influence on snake dispersal after emergence. He found that when day and night temperatures were 27-30° C (81-86° F) for highs and 11-14° C (52-57° F) for lows, snakes dispersed in about four days. Whereas, dispersal was prolonged over 22 days when day and night temperatures were 6-25° C (43-77° F) for highs and 0-9° C (32-48° F) for lows. Brown (1993) recorded snake emergence and temperature data at dens in New York. He noted that the peaks of snake captures during emergence roughly corresponded to peaks in maximum air temperatures. These peaks were all above 20° C (68° F) in early May.

Although inconclusive, these studies have shed some light on the role of ground and external temperature in the timing of spring emergence. Improved understanding of this relationship could potentially make it possible to develop a formula to predict snake emergence locally based on date and temperature patterns. Knowing a more accurate egress date would help minimize potential impacts to snakes from spring management activities, such as prescribed burning, and limit human-rattlesnake conflicts at denning areas.

There is some evidence that active seasons may be lengthening. Brown (1993) reports a longer active season for snakes he observes in New York. Martin also thinks emergence from 1985-2005 is earlier than during those observed from 1967-1984 (Martin, pers. comm.). With global climate change, it is possible we will see gradual shifts in active periods and in emergence and ingress dates in the northern range of the timber rattlesnake.

Genetics

Maternal DNA shows that there are four major genetic lineages of timber rattlesnakes in the United States. Research conducted by Dr. Dan Keyler indicated that samples of six timber rattlesnake specimens from two counties in Minnesota all belong to the "E" lineage. This genetic line is the most widespread of the four and is the predominant lineage in the Mississippi River Valley. Additionally, there are 20 known haplotypes. Samples from two Minnesota specimens show that there is a 21st haplotype, which has only been found in Fillmore County, Minnesota (Clark, 2003, Keyler, 2000).

Legal Status

The timber rattlesnake is designated a threatened species in Minnesota (Minnesota Rule 6134.0200). This means a person may not take, import, transport, possess or sell a dead or live timber rattlesnake without a permit issued by the Minnesota Dept. of Natural Resources. Furthermore, a person may not possess or sell an article made with any part of the skin, hide or parts of a timber rattlesnake.

The exception to this rule is that a person may capture or destroy a timber rattlesnake without permit to avoid an *immediate and demonstrable threat to human life or property* (Minnesota Rule 84.0895, subdivision 7). Property in this case would refer to livestock, horses, pets, or other living property. If you destroy a timber rattlesnake, you are required by law (Minnesota Rule 6212.2300) to surrender the entire carcass, including the hide, head and rattle, to an agent of the Minnesota Dept. of Natural Resources within 48 hours.

Habitat

As the timber rattlesnake's name implies, it is primarily a snake of forested habitats. However, the habitat varies across its range. In the northeast, the snake is found in remote, mountainous terrain with rocky ledges and outcroppings in deciduous or coniferous forests. In the south, habitat includes hardwood forests of river bottoms as well as upland deciduous woodlands and cane fields (Brown, 1993). In Minnesota and the upper Midwest, the snake lives on steep, rugged bluff prairies and in valleys of the Mississippi River drainage, in both woodland and grassland habitats (Vogt 1981, Oldfield and Moriarty 1994) (Figure 7). Bluff prairies located on steep, south or west-facing hillsides, with rock outcroppings and ledges, are essential habitat components because overwintering dens are often located in these areas. The surrounding matrix of woods, grasslands, and crop fields is used as summer foraging grounds. While habitat requirements vary between sex and age classes of timber rattlesnakes (Reinert, 1984a; Reinert and Zapalorti, 1988a), they can be broken down into three basic components: summer, transient, and winter.

Figure 7: West facing bluff

Summer Habitat

Summer habitat is the area used by timber rattlesnakes during the peak of the active season for foraging and loafing. Summer habitat can range from 300 meters (0.19 miles) to 6.4 km (4 miles) from the wintering habitat, or hibernacula, depending on a snake's gender and age.

Several studies have characterized summer, timber rattlesnake habitat in the eastern U.S. as generally wooded. Adult males and nongravid females were found to use areas with greater than 50% to 60% canopy closure in mixed deciduous forest, thick leaf litter, and little downed woody debris or rocks (Brown and Greenberg, 1992; Reinert, 1984a; Reinert and Zapalorti, 1988a). Similar habitat preferences were documented in Wisconsin. Vogt (1981) reported nongravid females and males using mixed deciduous forests and agricultural fields within a distance of 2.4 km (1.5 miles) of the wintering area (Figure 8). Similarly, a more recent study in Wisconsin showed males and nongravid females using deciduous forests with greater than 58% canopy closure, and woodland edges along agricultural fields (Sajdak, 1999). Young snakes were using more open habitat than adult males,

Figure 8: Summer habitat in the Midwest for adult male and nongravid females.

but not as open as gravid females used (Sajdak, 1999). Common overstory trees documented in occupied habitat included: Red Oak (*Quercus rubra*), Bur Oak (*Quercus* macrocarpa), Shagbark Hickory (*Carya ovata*), Birch (*Betula sp.*), Sugar Maple (*Acer Saccharum*), Cottonwood (*Populus deltoides*), Hackberry (*Celtis occidentalis*), American Basswood (*Tilia americana*), and Eastern Red Cedar (*Juniperus virginiana*). Snakes observed in Minnesota appear to have habitat preferences similar to Wisconsin snakes (MN DNR, survey notes, multiple observers).

Gravid females moved over smaller areas in summer than males. They frequently used areas that were rocky and open (Reinert, 1984a). Canopy closure in summer habitat used by these females averaged less than 25%, and these areas had increased levels of downed woody debris and rock outcroppings (Reinert and Zapalorti, 1988a). In Wisconsin, gravid females were often found using rock outcrops of limestone, sandstone or dolomite, and grassy, open slopes with about 12% canopy closure (Keenlyne, 1972; Sajdak, 1999) (Figure 9). These areas presumably provided higher ground temperatures needed for embryo development in gravid females. The summer habitat of gravid females is also slightly more complex than nongravid females and males because of two critical components: rookery and basking areas. Rookery rocks can be the den entrance itself, or a rock or grouping of rocks near the den. Since gravid females rarely travel far from the den, adequate rookeries need to be within close proximity. A single den could have several rookeries associated with it, and gravid females from two or more dens may share the same rookery (TRCAP draft, 2000). Martin (1989) found that when birthing occurred away from the den, snakes used rookeries within 25 m – 1250 m (0.02 - 0.78 miles) of the den, with a mean distance of 164 m (0.10 miles). Additionally, snakes that used the den opening as the rookery often had alternative rookeries within 100 m – 300 m (0.06 - 0.19 miles) (Martin, 1989).

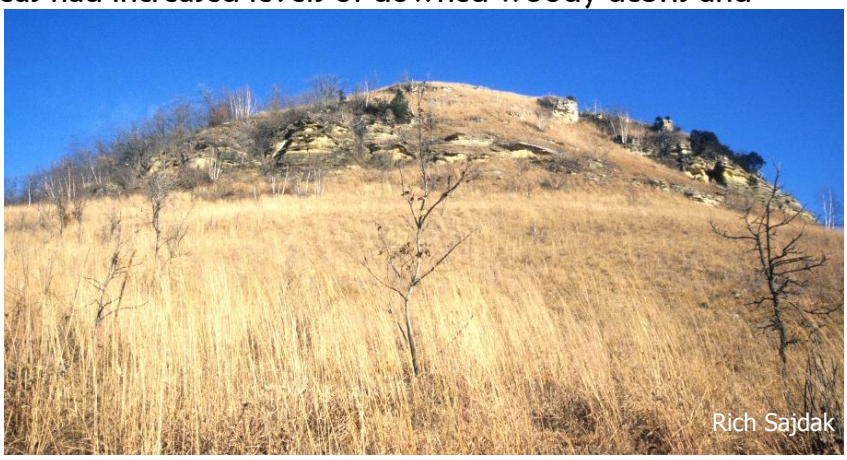

Figure 9: Summer habitat for gravid female timber rattlesnakes.

In the eastern U.S., about 40% of birthing rookeries consisted of a flat or slab-type rock located on a ledge, or grassy slope. Nearly 30% of rookeries were found in talus, scree or boulder fields, and a little more than 28% consist of a crevice on a ledge (Martin, 1989). Common characteristics of rookeries include sun exposure for at least part of the day, and protection from predators and inclement weather, including high temperatures in the middle of summer (Figure 10). Snakes in Virginia showed a preference for horizontal slabs of rock that were 10-20 cm (3.9 in – 7.9 in) thick with 3-4 cm (1.2 in – 1.6 in) clearance (Martin, 1989). Thicker rocks may help moderate temperature during the hottest part of the summer.


Figure 10: Rookery rock in SE MN.

Basking sites have relatively open canopy and expanses of bedrock, or scree. Snakes that use basking areas include "transient and staging snakes that are moving toward or away from a den, pre-molt snakes, including newborn, gestating females and sometimes snakes digesting a meal or attempting to heal an injury" (TRCAP draft, 2000). Basking areas are typically located close to the wintering habitat, but can be found in other areas of a snake's home range. On some occasions, basking rocks are used as rookeries, but frequently basking areas become too shaded later in the year for adequate use as a rookery (Martin, 1989).

Transient Habitat

Transient habitat, also referred to as a staging area, is the area between the summer and winter habitat through which snakes travel as they move toward or away from the winter hibernacula. This area is hard to define precisely, but Brown (1993) indicates it is typically an area close to the den, within 200 meters (0.12 miles). Based on this distance, it may be challenging to differentiate transient habitat from summer habitat. However, time of year can help distinguish the two. In Wisconsin, snakes tended to stage in a location approximately 700 m (0.43 mile) from the den for about one month prior to moving further into wooded habitat for the summer (A. Bartz, pers. com.).

Winter Habitat

A den, or hibernaculum, is the major feature of winter habitat. Snakes in the northern part of the range are dependent on the winter den, as it is critical to the survival and vitality of the population (Brown, 1993). Dens are usually located in a rocky area of cliffs, ledges or talus slopes with cracks and fissures in the rock where the snakes can retreat below the frost line for the winter (Brown, 1993). In Minnesota, dens are typically located on south and west facing slopes, which allow for warmer surface temperatures and perhaps shallower denning (Martin,

Figure 11: A rocky ledge that serves as a den in SE MN.

Figure 12: Snakes at a den entrance .

1989) (Figures 11 & 12). Eastern snake dens are frequently found in wooded areas and on slopes of varying steepness and aspects. Old snake hunters and landowners in Minnesota mention forested den sites, but little is known about their occurrence in the upper Midwest. Den sites can be shared with other snake species including bullsnakes or gopher snakes (*Pituophis catenifer*), racers (*Coluber constrictor*), and milk snakes (*Lampropeltis triangulum*) (Oldfield and Moriarty, 1994). The southern portion of the timber rattlesnake range has warmer winter temperatures. As a result, these snakes are less dependent on winter hibernacula.

During fall ingress, timber rattlesnakes typically return to the same den from which they dispersed in the spring, and use this den year after year (Ditmars, 1907; Brown, 1989). However, some snakes have been found to use multiple dens within the same area (Adams, 2005). A telemetry study in Wisconsin determined that once in the den, some snakes remained within 7 meters (23 feet) of the den entrance, while others moved 19.44 meters (64 feet) from the entrance. Berg et al. (2005) found evidence of snake movement within the den throughout the winter, with deepest penetration into the den occurring during December and January, and movements toward the den entrance occurring in late March to early April.

Habitat Availability Assessment

A review of GAP level 4 data and Minnesota County Biological Survey (MCBS) natural community mapping was conducted to determine how much habitat is potentially available for timber rattlesnakes in Minnesota. The Blufflands subsection is comprised of 1,287,434 acres (2.4% of the state), and harbors the majority of the present and historic timber rattlesnake range. From the mapping data, slightly over 1 million acres of the Bluffland subsection contains some level of general rattlesnake habitat, which excludes agricultural land, roads, and developed areas. Of these 1 million acres, only 14% (141,524 acres) have been categorized by MCBS Plant Ecologists as native plant communities. Of the categorized sites, 4.4% have been ranked as dry prairie bedrock bluff subtype (i.e. bluff prairie). If this percentage is extrapolated to the entire area of the subsection, an estimated 37,788 acres of dry prairie bedrock bluff subtype exists. The size of bluffs recorded in the Natural Heritage Database range from 0.15 acres to 74.2 acres, with an average bluff size of 4.8 acres. Using this average size, there are an estimated 9,271 bluff prairies in the Blufflands subsection. Since less than 450 bluffs have been surveyed, a large portion of potential habitat for timber rattlesnakes has not been surveyed or otherwise evaluated.

Snake Occupancy Rate of Bluff Prairies

With nearly 450 bluff prairies systematically surveyed in southeastern MN for the presence of timber rattlesnakes, the number of sites with confirmed occupancy is 28%, which would suggest that one out of every four bluff prairies surveyed would have timber rattlesnakes. This is not an accurate reflection of the potential occupancy rate of bluff prairies in MN because the 450 sites surveyed were not randomly selected. Instead, they were largely selected because of their quality, and known or suspected presence of snakes, based on historical data and current reports. The occupancy rate should be recalculated as additional surveys are completed, as more information may give a better reflection of the quantity and location of habitat restoration needs.

Population Status

Determining population numbers for timber rattlesnakes is quite difficult. In fact, no quantitative or mark-recapture studies have been published on timber rattlesnakes. Brown is currently conducting a long-term study that might provide some population estimates for northeastern New York. Otherwise, little quantitative population information is known, and few long-term studies are being done because timber rattlesnakes have a very secretive nature, and small population sizes make statistical analysis challenging. Several states have reported extirpation from all or parts of the timber rattlesnake range, resulting in many disjunct populations (Green and Pauley, 1987; Martin, 2002, 1982; Martin et al., 2000; Reinert 1990). Surveys show the same pattern of extirpated dens and many scattered populations at some sites in Minnesota; (J. Edwards, unpublished data). A coordinated, region-wide survey would help establish a baseline of occupied dens from which general population trends could be inferred.

Past and Current Timber Rattlesnake Conservation Work in Minnesota

The MN DNR and partners have made a concerted effort since the 1990s to learn more about timber rattlesnakes in Minnesota. During 1990 and 1991, the MN DNR funded Dr. Dan Keyler and Dr. Barney Oldfield to evaluate the distribution and population status of timber rattlesnakes on state lands. This survey included six state parks, the Reno state forest unit, and sections of the Root River trail (Keyler and Oldfield, 1992a). Also in the 1990s, the Minnesota County Biological Survey (MCBS) conducted extensive surveys throughout much of southeastern Minnesota to further determine the presence of this species at new localities on public and private lands. This effort was lead by Carol (Dorf) Hall of the MN County Biological Survey Program.

Survey and research activities continued through the 1990s into the mid 2000s.These activities included surveys at sites on the periphery of the range (Keyler and Fuller, 1999), habitat assessments (Fuller, 2000), DNA haplotype and lineage research (Keyler, 2000), and a transient movement study on the Root River Trail, funded by the MN Herpetological Society (Hanson and Keyler, 2003). Timber rattlesnake reproduction was assessed at Great River Bluff State Park from 2000 to 2002 (Keyler and Wilzbacher, 2002) and additional population surveys were conducted in state parks (Keyler and Oldfield 2003; Keyler and LeClere, 2005). Dr. Phil Cochran of St. Mary's University in Winona, MN has been monitoring a local population since the mid 1990s, and is also conducting some temperature analysis of these dens.

Beginning in 2001, Nongame Wildlife Program staff and contractors conducted timber rattlesnakes surveys primarily on private land. In the spring of 2001, previously known timber rattlesnake sites in Wabasha, Goodhue, Winona, and Olmsted counties were surveyed. Data were not encouraging. No snakes were found at any sites in Goodhue, Olmsted, and Wabasha Counties. Snakes were found at only a few of the Winona County sites. However, cold, wet weather during these surveys was not conducive to finding snakes, so they should be surveyed again under more optimal conditions. Annual surveys began in 2002, with efforts concentrating on previously known sites and new public and private areas in the Rushford-Peterson area of northeastern Fillmore County, the Houston-Hokah area of northwestern Houston County, the Winnebago Valley in southeastern Houston County, and a few sites near and in the city of Winona. Since 2003, Nongame Wildlife Program staff has conducted annual surveys on private land in Fillmore and Houston counties as part of the Landowner Incentive Program (LIP), which assists landowners with bluff prairie restoration. Public land surveys were conducted under the State Wildlife Grant program, and in partnership with the National Wild Turkey Federation and the Prairie Smoke Chapter of The Prairie Enthusiasts.

In 2008, the MN DNR conducted a range-wide survey of timber rattlesnakes. A total of 183 bluffs on 136 different landowner properties were survey in Fillmore, Goodhue, Houston, Olmsted, Wabasha and Winona Counties. Timber rattlesnakes were positively identified on 37 of 183 bluffs surveyed, so approximately 20% of surveyed sites had timber rattlesnakes. The spring weather was cool, which is not conducive to detecting timber rattlesnakes, particularly on sites overgrown with vegetation. Thus, it is likely that additional sites have timber rattlesnakes, but they were not detected on the survey. No snakes were observed in Goodhue, Wabasha, and northern Winona counties. It should be noted, however, that sites in these counties were severely overgrown with buckthorn, making snake detection challenging.

Combining all the survey efforts conducted in Minnesota up to 2008, approximately 450 bluffs have been surveyed in southeastern Minnesota. At least 122 dens have been identified; however,

the viability of these dens is not known. This information was derived from survey reports, survey data sheets and the MN Natural Heritage Program's Biotics Database. (Private individuals may have surveyed many sites, but if no data sheet or report was turned in to the MN DNR, those efforts were not included in the summary.) These studies have led to heightened awareness and importance of the timber rattlesnake as a significant ecological component in the biodiversity of the Upper Mississippi Valley.

The Natural Heritage and Nongame Research Program maintains all records of timber rattlesnake observations from the above surveys in the Rare Natural Features Biotics database. This database also includes sightings that pre-date formal surveys, and sightings from credible, casual observations from DNR staff, Rattlesnake Responders, and the general public.

During the 1990s, the MN DNR started implementing management activities to improve rattlesnake habitat on State Park land and along the Root River Trail. This effort picked up significantly in the early 2000s, and expanded to include private land sites. The State Wildlife Grants (SWG) program funded several bluff prairie restoration projects on State Parks and Scientific and Natural Areas (SNA) land, along with some State Forest and private land. SWG and other MN DNR monies funded 240 acres of habitat restoration on 42 sites within State Parks, and over 940 acres of prescribed burns on State Park land that benefited timber rattlesnakes. In 2004, a new federal program began called the Landowner Incentive Program (LIP). LIP provided significant funds for private land management of bluff prairies on or near active timber rattlesnake sites. Up to December 2008, LIP funded restoration of more than 580 acres of bluff prairie on 40 different private land sites in Fillmore, Houston and Winona counties. The National Wild Turkey Federation and the Prairie Smoke Chapter of The Prairie Enthusiasts have also worked on timber rattlesnake conservation, restoring over 160 acres on 18 different public and private land sites. In total, approximately 880 acres of habitat has been restored for timber rattlesnakes on public and private land.

Timber rattlesnake monitoring started in the early 2000s. MN DNR State Parks started monitoring den sites with human patrolling as well as with cameras. Camera monitoring of den entrances and surrounding area continued through 2007. The MN DNR Nongame Program began monitoring bluff prairies with snake populations in 2005 as part of the Landowner Incentive Program. Annual monitoring continues on all private land sites as required by LIP.

In addition to surveys and habitat work, a significant amount of effort has been directed toward public outreach regarding snakes in Minnesota. Several DNR brochures (The Timber Rattlesnake in Minnesota, Snakes and People) were published in 1998 aimed at educating individuals about the natural history, uniqueness, and need for conservation of timber rattlesnakes. Interpretive signs were placed along the Root River Trail and a few State Parks informing users of the potential for snake encounters and what to do if that should occur. Additionally, a Rattlesnake Responder program was developed in several communities as an outlet for landowners who have unwanted rattlesnake encounters on their property. These responders provide technical assistance to landowners on how to decrease the attractiveness of their property to snakes, information about snakes and the risk of encounters, and, if absolutely necessary, move the snake to a designated release area. The overall goals of the responder program are to minimize snake encounters, educate the public about snakes, and reduce the fear associated with living in proximity to rattlesnakes.

A training video was developed in the early 2000s for use by animal control staff, law enforcement personnel, conservation officers and natural resource staff. This video goes through how to identify several snake species native to Minnesota, some basic natural history about each species, and also what to do in the event of encounter. It also shows how to safely move a rattlesnake, should the need arise. Along with the video, fact sheets on how to respond to a snake call, possible snakebites, and a list of rattlesnake responders by county were developed and distributed to law enforcement dispatch offices. Five training workshops were also provided for volunteer fire departments, law enforcement, animal control staff and emergency medical technicians in several communities around southeast MN. Another 17 workshops were provided to landowners and the general public throughout southeastern Minnesota. Each year, Whitewater State Park Naturalist, Dave Palmquist, gives numerous public programs on snakes and the Blufflands. Other people have given programs on snakes of Minnesota as well.

At least a dozen newspaper and magazine articles concerning the research, conservation, and natural history of timber rattlesnakes in Minnesota have been published. In 2005, a seminar on Timber Rattlesnake Biology and Conservation in the Upper Mississippi River Valley was held at St. Mary's University. Presentations on the latest timber rattlesnakes activities in the multi-state region were presented. In 2006, Dr. Rebecca Christoffel conducted her doctoral research on human dimensions related to reptile conservation. As part of this research, she conducted public attitude surveys in southeastern Minnesota regarding people's attitudes toward timber rattlesnakes. Information from this study is currently being used to develop more target appropriate outreach materials on snake conservation.

Threats

Dodd (1987) reported that snake populations were declining worldwide due to habitat degradation, rattlesnake roundups, intentional killing, and collection for the fashion and pet industry. Furthermore, Greene and Campbell (1992) estimated that more than 50% of pit vipers were vulnerable to extinction. In Minnesota, the most significant causes of timber rattlesnakes mortality are anthropogenic, and include: human persecution, road mortality, and habitat degradation. Most known conservation threats to reptile populations are anthropogenic in origin, yet human dimensions are seldom considered in reptile conservation planning (Christoffel, 2007). By understanding the human element of conservation, efforts to protect and restore habitat for species such as reptiles could be more efficient and effective, as well as long lasting.

Human Persecution and Public Attitudes

In Minnesota, human persecution was officially sanctioned from 1909 to 1989, during which time counties paid bounties for killing timber rattlesnakes. This resulted in huge numbers of timber rattlesnakes being killed, particularly gravid females, which were easier to find. Additionally, gravid females were preferred because bounties were paid for the female, as well as for each unborn snake she was carrying. From 1967 to 1982, a total of 28,685 rattlesnakes were bountied in Houston County (Keyler and Oldfield, 1992). Annual bounties for this county fell from more than 2000 snakes in 1939 to less than 200 snakes in 1987 (Keyler and Oldfield, 1992). This massive loss of individuals and its impact on reproduction continues to effect the population today. Adults alive during that period would have continued to mate and give birth. Given the 30-year plus life span of timber rattlesnakes, some of those adults and certainly many of their offspring would still be part of the population today. Minnesota's rattlesnake bounty was repealed in 1989, and the state listed the timber rattlesnake as a threatened species in 1996. Although the bounty was repealed and wanton killing of timber rattlesnakes is outlawed in Minnesota, every year rattlesnakes, as well as other snake species, are killed by fearful humans.

Snakes at den sites are particularly vulnerable to disturbance. Poaching and den site destruction are still threats despite measures to protect the snakes and the dens. Some den sites at MN State Parks have recently shown evidence of tampering and destruction (Figure 13), and surveys have shown the population at one site, where den tampering occurred, significantly decreased over a ten-year period (Keyler and Wilzbacher, 2002).

Figure 13: Den destruction and removal of rock.

Timber rattlesnakes are shy creatures, and can be "spooked" by too much human disturbance, especially at critical times of the year. Also, increased human activity near snake habitat increases the potential number of human-rattlesnake encounters, with some encounters resulting in snake deaths. Landowners who encounter a snake around their home can contact a Rattlesnake Responder to have it relocated rather than killed. Limited studies on the relocation of rattlesnakes report low survival rates. In one study where snakes had been relocated to suitable habitat, only 45% were still alive after a four-year period compared to an 89% survival rate of resident snakes during the same period (Nowak and van Riper, 1999; Reinert and Rupert, 1999).

The Nongame Wildlife Program (NWP), through the Rattlesnake Responder Program, the Landowner Incentive Program, and educational workshops, has attempted to address the cause and minimize the number of negative human-rattlesnake encounters. In 2005, the NWP worked with doctoral student, Rebecca Christoffel, to evaluate stakeholder beliefs, attitudes, and behavioral intentions toward reptiles in Minnesota, with an emphasis on timber rattlesnakes. The study focused on southeastern Minnesota, where the highest percentage of reptiles, including snakes, occurs in the state.

Study respondents ranked snakes as lowest on the affinity scale, with non-venomous snakes averaging a neutral rating compared to other reptiles in the survey. Snakes were feared more often and more strongly than any other reptile. A primary reason noted by respondents' for their fear rating was that they were uncomfortable with the way snakes move (Christoffel, 2005). Despite the lowest affinity rating, respondents mentioned few disadvantages of living with snakes, except they viewed venomous snakes as dangerous. Most respondents indicated they would not kill a snake, even a venomous one, if encountered.

Many people indicate they are afraid of rattlesnakes because they believe snakes will kill or significantly harm them or their children (Edwards, pers. com.) This fear was also documented in Christoffel's public attitude survey (2005). Despite the high concern for human bites, very few timber rattlesnake bites have occurred in Minnesota. Keyler (2005) reported only fifteen human bites from timber rattlesnakes in Minnesota from 1982 through 2002. Of those bites, only five were considered natural events. Most rattlesnake bites (81%) involved amateur herpetologists. Many other bites involved young adult males who were teasing or otherwise harassing snakes. A quarter of these victims were intoxicated at the time of the bite.

To address stakeholder's concerns, including the mistaken belief that rattlesnake bites cause yearly deaths, Christoffel (2007) recommends state agencies develop outreach materials that provide accurate information on rattlesnake bites, actions people can take to reduce snakebite risk, appropriate actions to take should a person be bitten by a rattlesnake, and the elevated risk involved in attempting to kill a rattlesnake. Such information could change perceptions by reducing fear and increasing knowledge. This is especially important since many stakeholders voiced concern regarding small children and pets. Well-written outreach materials could also change behavior by reducing aggression towards rattlesnakes. Christoffel (2007) considers the need for public outreach material a priority, given the percentages of people who indicated they would kill a rattlesnake, even with a very mild encounter, such as seeing one once near their home (10% in Michigan, 17% in Minnesota).

Christoffel (2005) conducted six landowner workshops designed to provide face-to-face encounters with native venomous and nonvenomous snakes found in Minnesota. Results indicate that workshop participants, on average, appeared to slightly or moderately tolerate rattlesnakes before completing the workshop. However, they appeared to like rattlesnakes more after the workshop and continued to feel this way even several months later. Additionally, workshop participants felt rather confident in their ability to identify different snakes immediately after the workshop, and maintained that confidence for several months. Therefore, increased knowledge and exposure to snakes in a positive situation, including venomous snakes, may increase tolerance for living with them, and perhaps, accepting snake conservation.

Knowledge about snakes explained the greatest degree of variation in attitudes towards them,

and was the most important factor influencing affinity scores in Minnesota and Michigan (Christoffel, 2007). Those who had more factual information about snakes tended to be less fearful and more tolerant of their presence. Also, where people get their knowledge of snakes affects their acceptance of the information. Parents, teachers, and friends had the highest influence on the attitudes of children toward rattlesnakes (Christoffel, 2007). Direct and indirect experiences, as well as newspaper and media reports, also play an important role in influencing public attitude. Christoffel found that the Internet was not, at this time, an effective way to distribute information to the public. As the population ages, and computers and the Internet become commonplace in rural areas, it may serve a more valuable role.

Aside from human attitudes, there are other threats to timber rattlesnakes, such as development pressure, and habitat degradation. These threats often exacerbate one another, and can lead to the extirpation of a timber rattlesnake population.

Roads

Road mortality is a significant threat to wildlife. Reptiles, particularly snakes, are especially vulnerable to road mortality due to their propensity to thermoregulate on roads, and from intentional killing by humans when observed on road surfaces (Rudolph et al., undated; Ashley et al., 2007; Langley et al. 1989). Species exhibiting low reproductive rates, such as timber rattlesnakes, and having low adult mortality are particularly vulnerable to population consequences from road mortality (Fowle, 1996; Rosen and Lowe, 1994; Rudolph et al., 1998). In eastern Texas, road mortality was suggested as the primary factor in the local extirpation of the timber rattlesnake (*Crotalus horridus*) populations (Rudolph et al. 1998). Another study conducted by Rudolph et al. (undated) also showed that snake mortality associated with roads reduces the abundance of larger snakes. Similarly, a study of wildlife road mortality in southeast Florida showed that more than 50% of animals killed by vehicles were snakes (Rossmanith and Smith, 2006).

In some areas of Minnesota, road mortality is significant for timber rattlesnakes. The Winnebago Valley in far southeastern Minnesota experiences more than twenty road killed rattlesnakes each year (Shaw, pers. com.). There are many other reports of rattlesnake mortality on roads across the southeastern part of the state (Edwards, pers. com.). Gathering road mortality information from larger communities is often challenging because of lack of reporting and too many vehicles driving the roadways. While reports are low from high human population areas, such as Winona, MN, it is likely that snakes are experiencing some level of road mortality.
Timber rattlesnakes and their habitat should be addressed during road placement and design, to keep snakes away from roads. Additionally, outreach concerning the effects of road mortality should also be conducted.

Habitat Loss and Degradation

Human development (residential, commercial, etc.) can destroy, degrade and fragment timber rattlesnake habitat. For species in greatest conservation need in the Blufflands subsection, 82% experience habitat loss as a significant problem, while 88% experience habitat degradation (MNDNR, 2006). This area is becoming more developed each year, and growth is expected to continue up to 3% on average by 2010 (Minnesota State Demography Center, 2007). These changes affect all aspects of timber rattlesnake habitat, but the summer foraging habitat likely receives the bulk of the impacts. Wooded lots are prime real estate, especially if they have a view and are close, but not directly in a town or city. Many of these lots are 2-5 acres, larger, than a

typical city lot. Thus, residential sprawl is an expanding problem around developing communities such as Winona. Aside from the wooded areas, bluffs receive direct impact as well. Many communities do not have set back ordinances, so houses are built on the crest and sometimes directly into the bluff. In addition, quarrying operations pose a threat as they expand to keep up with local development needs.

In pre-European settlement times, the open character of bluff prairies was maintained primarily by frequent fires. As the area was settled by increasing numbers of people, fire was seldom used as a management tool, and wildfires were suppressed. In the absence of fire, native woody plants as well as invasive species increase, often significantly. Invasive species are also threatening oak savanna and forest habitats. These habitat changes manifest themselves slower than outright habitat loss, but the results of habitat degradation are becoming increasingly apparent (Edwards and Spiering, pers. comm.). Of particular concern is the "shading over" of den sites. Brown (1993) reviewed surveyors' opinions regarding the threat of "shading over" by woody species at den sites, and concluded that little consensus on the subject exists. However, at a recent symposium on timber rattlesnake conservation in the Upper Mississippi River Valley, several presenters, representing three Midwestern states, proposed that woody encroachment into bluff prairie den sites is a significant threat to the species in the region (Keyler and Cochran, 2005). The reason for concern is that shaded sites potentially reduce reproductive success by decreasing the number of heating days for a gravid female, which may result in delayed birth. A delayed birth may not allow the female enough time to eat and digest food before ingress, sending her into hibernation with poor body condition. Additionally, shaded sites may force gravid snakes further from den sites in search of open sunning areas, risking increased predation of the neonates or negative human encounters. Lastly, delayed births may leave minimal time for neonates to feed, shed, and find the hibernaculum for overwintering.

Habitat fragmentation is also a concern. Increased development translates into more people, traffic and roads, which can fragment snake habitat and lead to increased snake mortality.

Increased recreational use of public lands can also cause damage. Rocks, soils, and vegetation at den sites are very fragile and can be destroyed or degraded by ATV use, too much human foot traffic, even by well meaning people wanting to see a rattlesnake. Management practices, on or adjacent to den sites, could negatively impact snakes if activities are poorly timed (i.e. prescribed burning).

Recovery Goals

The overall objective of this recovery plan is to identify the steps needed to recover the timber rattlesnake in Minnesota to a level where placement on the State Threatened and Endangered Species list is no longer necessary.

To meet this recovery objective, goals have been established in three areas: population, habitat, and public outreach. These goals need to be met, as outlined in the following sections, in order for the timber rattlesnake to be delisted from Minnesota's State Threatened and Endangered Species List.

I. Populations Recovery Goals

Population goal: protect, maintain and restore viable timber rattlesnake populations throughout the current range.

Determining population recovery goals for the timber rattlesnake is difficult because little information is known about the overall size of Minnesota's population. Additionally, these snakes are secretive in nature, making it hard to detect consistently and completely the number of snakes at any one site. Nonetheless, the following steps were taken to develop a measure of population viability:
Step 1: Determine what component of the population dynamics will be measured for recovery.
Step 2: Determine the minimum threshold of that component needed to attain recovery status.
Step 3: Determine the geographic unit over which the population component will be measured.

Step 1: Den activity will be used as the component for measuring population viability. This is used because a den is associated with overwintering habitat, which is a critical element to long-term survival of timber rattlesnakes in northern climates.

Step 2: A viable den is one that holds enough snakes to persist over time. Brown estimates 30-40 snakes are needed as a minimum population size per den for viability (Brown, 1993). This is a minimum threshold, and Brown recommends a higher level of 60 to 100 snakes for viability to be reached in 20 to 30 years. With this in mind, we established Minnesota's minimum viability threshold of snakes per den to be 50 snakes. This level also agrees with the conservation biology 50/500 rule-of-thumb (Primack, 1993). The rule is a guideline to be used when limited species-specific information exists, and states that a population size of 50 individuals is the minimum number required to prevent population extirpation in the short-term, and 500 individuals are needed to insure long-term population persistence.

According to Brown (1993), some timber rattlesnake population estimates have been based on the intuition of researchers who have considerable field experience. Using this experience, Brown, Martin, Harwig and Stechert believe that under ideal spring weather conditions, 25% of the snakes occupying a den may be visible at one time on the surface. Martin et al. (1990) used a smaller percentage, estimating that during peak emergence, only 5% to 15% of the population may be seen. As Brown states, "subjectivity and some error are inherent in this approach, but it is better than no estimate." Martin (1990) believes that two to four site visits per year over four to five years may allow for an accurate estimate of the population of a den colony.

Minnesota selected a detection percentage of 20%, which is between Brown's 25% and Martin's 5%, for estimating the number of snakes occurring at one den. There is no current research that supports or refutes the use of 20%, however this level is based on the professional opinion of the biologists involved in developing this plan. Thus, for a den to meet the minimum population threshold for viability, a surveyor must see at least 10 snakes at peak spring emergence to equate to a population of approximately 50 snakes, based on a 20% detection rate.

The presence of snakes does not necessarily indicate a den is viable in the long term. Because of continued habitat loss and fragmentation, road mortality, and other threats, it is possible that in the long term, a population may not be viable. Additionally, it is often hard to find sites with ten visible snakes at one time. The existence of neonates or a varied age class that would infer reproduction can be used as a measure of potential viability for that den. However, for a den to be considered viable in Minnesota, it must meet the minimum population threshold of 10 snakes present during spring emergence. A den may have a high potential for meeting viability if there is evidence of reproduction (neonates or a gravid female), or evidence of a varied age class. Determining the varied age class can occur during spring emergence; however, evidence of reproduction will require either a summer or fall survey. Dens with high viability potential should be a priority for restoration and protection.

Lastly, to confirm viability over the long term, it is important that the viability goals be met on more than one occasion in a given amount of time. This recovery plan spans ten years, and will serve as the timeframe for repeated survey efforts to determine that viability is met. For a den to be viable in Minnesota, it must meet the following criteria: maintain a minimum population threshold, or show evidence of reproduction/age class, and be observed at least twice in a ten-year period, with the survey efforts occurring in a five-year cycle. (In other words, you cannot survey a site in two consecutive years, meet the recovery threshold and call the unit viable. Instead, you have to meet the viability goal twice, in a minimum five-year increment).

In summary: a den is viable if the following conditions are observed at least twice in ten (10) years, at a minimum of five-year increments:

1. Ten (10) snakes are observed at one location during peak spring emergence, following established survey protocol;

For a den to have high viability potential, it must meet the following criteria:

1. Evidence of reproduction is documented at that location by one of the following methods:
    - Presence of one or more gravid females in summer or fall
    - Presence of one or more neonates in late summer or fall
    - Presence of varied age class (in spring, summer, or fall)

Step 3: The geographic area over which viable dens will be measured will be called a recovery unit. These recovery units were delineated using major roads that would be considered movement barriers, and the Bluffland subsection boundaries. These recovery units have some biological basis, but also recognize logistical constraints of trying to divide a fragmented habitat into units within which goals can be established and measured. It is acknowledged that population mixing may occur between recovery units, but the unit will be used administratively to establish population and habitat goals. We have identified nine timber rattlesnake recovery

units for Minnesota (Figure 14). Each recovery unit will have a minimum number of viable dens to be considered as having a viable population. That number will be either the number of known viable dens occurring in that recovery unit, or a minimum number determined by the Timber Rattlesnake Recovery Team, whichever is higher. The goal is to have no net loss of viable dens in any recovery unit, but to raise those below an established threshold to the minimum requirement.

For recovery units north of Interstate 90 (I-90), excluding Great River Bluffs, and west of Hwy 52 (US52), the goal is to have a minimum of two viable dens per unit. For the remaining recovery units, a minimum of five viable dens is required per unit. The Upper Iowa River location is considered an outlying population, not a recovery unit, and will not be given a goal in this recovery plan. If future surveys reveal an active population still occurs in this area, recovery goals may be established at that time.

Recovery units north of I-90 and east of US52, which include Frontenac-Zumbro Bottoms, Rattlesnake Crossing-Forestville, Whitewater Valley, and Winona, have significant threats that make it unlikely that more than two viable dens per recovery unit could be attained. This is based on the opinion of the Recovery Team, and is based on the quality and availability of habitat, and on the current number of known dens. Reciprocally, sites south of I-90 and east of US52, which include Great River Bluffs, Root River East, Root River West, Winnebago Valley and Yucatan Valley, have better timber rattlesnake habitat and populations, thus having a higher potential for attaining viable den status. These numbers may change as we learn more about timber rattlesnakes and their needs for long-term survival. It is not known if meeting these goals will result in a fully recovered population for the long-term. Further studies should be conducted to help refine these goals. However, they will be used as a baseline for establishing a measurement of recovery for timber rattlesnakes in Minnesota.

Table 3: Summary of known dens and the minimum number of viable dens required per recovery unit.

Recovery Unit	# Known Dens	Viable Den Goal*
Frontenac – Zumbro Bottoms	3	2
Great River Bluffs	8	5
Rattlesnake Crossing – Forestville	2	2
Root River East	32	5
Root River West	16	5
Whitewater Valley	4	2
Winnebago Valley	26	5
Winona	2	2
Yucatan Valley	28	5
Upper Iowa River Outlier	1	0
	122	**33**

* The minimum number of viable dens per recovery unit will be two or five, or the highest known number of viable dens for that recovery unit. This translates to a no net loss of viable dens. None of the known dens has been designated as viable as of January 2009, so this table lists the minimum goal until a viability determination of known dens is made.

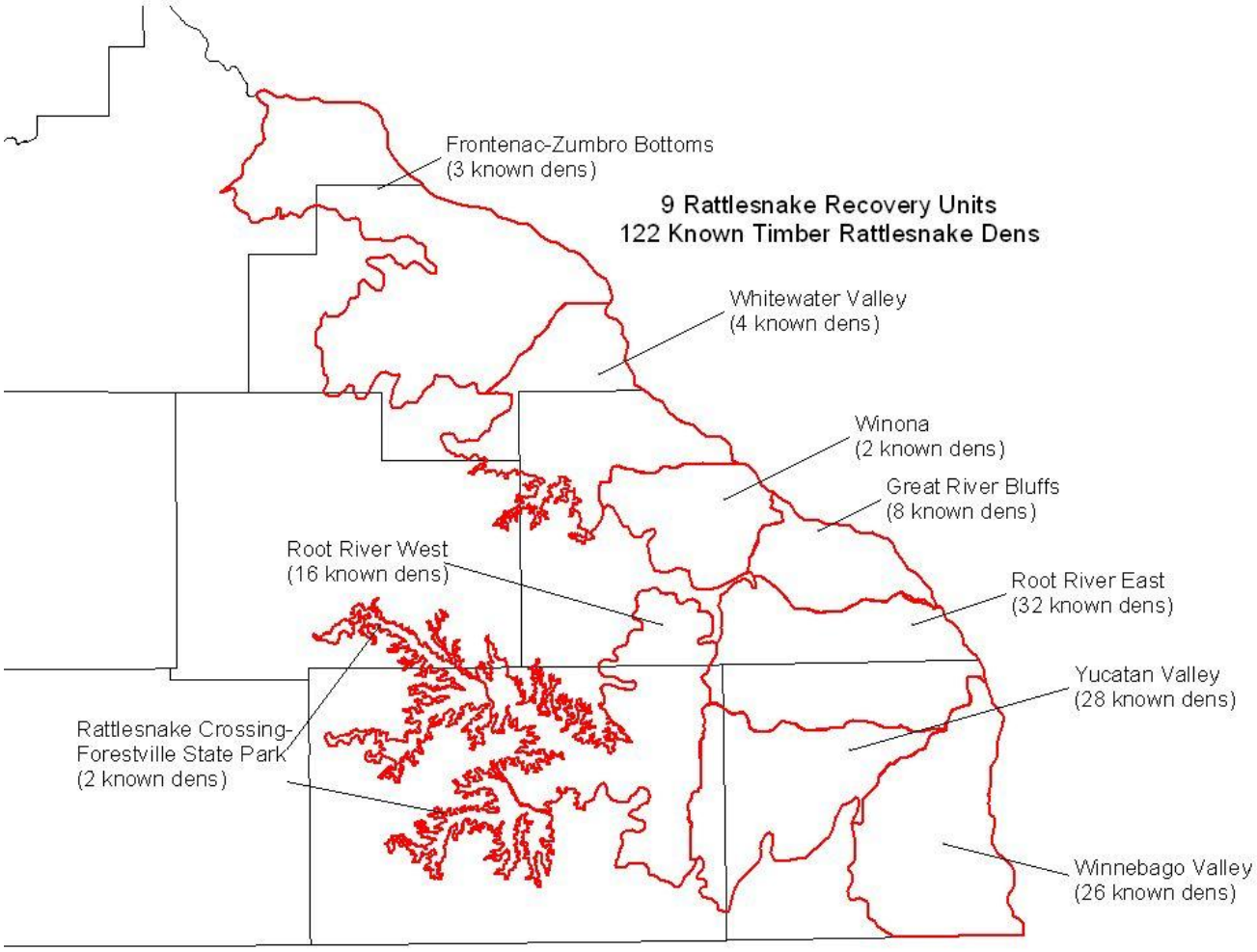

Figure 14: Timber rattlesnake recovery units in Minnesota

Recommended Actions

- Conduct a range-wide survey to update MCBS Biotics data and to evaluate previously un-surveyed sites. This will establish a new baseline for active timber rattlesnake range;
- Determine den viability at sites with timber rattlesnakes;
- Update recovery goals based on data from survey;
- Continue to review research literature regarding measuring and monitoring populations for rare and elusive species. Support such research when possible;
- Protect, restore and manage sites with viable or potentially viable dens.
- Research and implement a population restoration project on State Park lands. This may include population augmentation or reintroduction on sites where the population is no longer considered viable. In addition to preservation of rare species and natural features, MN Statues (MS86A.05 sub. 2C) also directs MN DNR-Parks to reintroduce species to parks where they once occurred but are now extirpated. Reintroduction for any location other than State Parks is not recommended in this plan.

II. Habitat Recovery Goals

Habitat Goals:

1. Restore 2600 acres of bluff prairie habitat that contain active rattlesnake dens;
2. Restore 2600 acres of bluff prairie habitat within a 3.6 km (2.24 mi) area around active den sites;
3. Maintain all dens determined to be viable;
4. Maintain a minimum of one auxiliary den per viable den in the 2600 "buffer" acres to allow for movement and potential colonization of new sites;
5. Address reptile conservation in road enhancement and development;
6. Minimize development in areas with viable timber rattlesnake dens;
7. Address reptile conservation in residential development.

Restoration

In order to protect the long-term viability of snakes in Minnesota, a minimum habitat acreage should be protected and restored to its native condition. This minimum acreage threshold, however, is not presently known, but a baseline can be set using current life history knowledge. Home range sizes and dispersal distances of gravid females and adult male timber rattlesnakes were used to develop habitat goals for this recovery plan. The habitat recovery goals focus on bluff prairies because the Recovery Team believes that the majority of gravid females in Minnesota depend on them for birthing, which is critical to long-term survival of the species.

The smallest gravid female home range size is 8.5 ha (21 acres), which indicates the minimum habitat acreage goal for protecting and restoring dens. Bluff restoration will vary by site, but this lower threshold was used to develop habitat goals for this recovery plan. Current data indicate there are 122-recorded dens in the state; however, some may no longer be active. Restoring 21 acres around and within 1.26 km (.78 mi) of these 122 dens would encompass the minimum home range size and birthing area for gravid females at each site. (Martin (1989) reports that birthing can occur up to .78 miles from the den site). This translates into a habitat goal of restoring at least 2562 acres of bluff prairie that contain active or potentially active rattlesnake dens (Habitat Recovery Goal acres are rounded up to 2600).

In addition to restoring den site areas, surrounding habitat is critical for nongravid and male snakes. These metapopulation dynamics are important for long-term survival of timber rattlesnakes. Additionally, surrounding habitat may be colonized, or in some cases, re-colonized, expanding the population. Each viable den should have at least one auxiliary den that provides compatible habitat and connectivity. Thus, an additional 2562 acres (rounded up to 2600 acres)of rattlesnake habitat should be restored within 3.6 km (2 mi) of a viable den. This distance is based on the longest dispersal range of male timber rattlesnakes.

In terms of habitat management, it is recognized that plant species may not be as critical as vegetative structure. For example, if a site (bluff)is being encroached by vegetation, it doesn't necessarily matter to the snake that buckthorn (non-native) or ninebark (native) is the culprit. However, because the dynamic relationships between wildlife and habitat dominated by native vegetation vs. non-native vegetation is well known, habitat management goals in this recovery plan will focus on restoring bluff prairies to their native vegetative composition and structure.

Road Mortality and Development

Eliminating or significantly reducing road mortality is an ambitious but important goal given how rapidly communities are growing in some areas of southeastern MN. The recovery units south of I-90 and east of US52 have the greatest potential for road development. They include the Yucatan Valley, Winnebago Valley, and the southern half of the Root River East recovery units. These units are currently more rural, but development is increasing and expanding, creating a need for infrastructure such as roads. The other recovery units are fairly developed, so new road construction is less likely, but road enhancement and upgrading could negatively impact snake habitat.

To achieve this goal:
The Minnesota Department of Natural Resources (MNDNR) should work with community planners to avoid or minimize road development in areas with viable timber rattlesnake populations. Environmental review staff should be aware of these areas, and provide appropriate input during the planning and permitting process for development projects.

Additionally, when roads in proximity of a viable timber rattlesnake population are being developed or upgraded, the following recommendations should be considered for minimizing impacts:

1. Reroute the road to avoid or minimize impact to the habitat;
2. Avoid fragmenting bluff prairies and forest habitat immediately surrounding these bluffs by not locating a new road within one mile of a viable den.
3. Avoid cutting into the bedrock of bluff(s) for road placement;
4. Provide a minimum 50' buffer of native vegetation between roads and the base of grassy bluffs;
5. Keep the road footprint as small as possible, optimally a two-lane road with limited shoulders;
6. Use gravel as the first substrate choice, followed by concrete. Use blacktop as the last alternative;
7. Reduce speed limits in areas experiencing high snake road mortality;
8. Consider sign placement, similar to deer warning signs, in areas of high road mortality;
9. Consider placing appropriately designed culverts for safe passage under roads where timber rattlesnakes are known to cross.

To mitigate impacts on snakes and snake habitat resulting from residential or commercial development, county and city planners, and developers should consider the following recommendations:

1. Encourage protection of rare species and their habitat by leaving some areas in their native condition;
2. Pursue land protection options such as: purchase of temporary and perpetual easements, fee-title purchase, or establishing management agreements;
3. Adopt bluff top setback ordinances, with a 200' minimum setback distance;
4. Implement management guidelines in areas where development is near a viable den;
5. Encourage landscaping and nursery companies to not sell species known or highly likely to become invasive;
6. Encourage residential developments to employ cluster housing plans and "snake friendly" landscaping, etc.

Actions Recommended

1. Work with public and private landowners, as well as other agencies, to restore bluff prairie habitat on and around sites with viable timber rattlesnake populations.

2. Work with federal farm program entities to target program implementation in timber rattlesnake recovery units.

3. Work with community planners and developers to avoid or minimize impacts of roads and development on habitat in areas with viable timber rattlesnake populations.

4. Provide a list of priority habitat areas to DNR Environmental Review staff to address road and development projects in areas with viable timber rattlesnake populations.

5. Monitor road kill numbers in areas with high rattlesnake mortality.

6. Develop local weed ordinances to avoid or reduce the presence of invasive species.

7. Develop species lists of plants that landscape centers and nurseries should not sell.

8. Provide invasive species fact sheets for distribution racks at major landscape centers and nurseries.

9. Work with the Department of Agriculture on legislation to ban the sale of all invasives species.

III. Public Outreach Goals

The goal of public outreach is to increase awareness and appreciation of snakes, particularly timber rattlesnakes, in Minnesota. Results of this goal include:

- Reduce human-inflicted mortality of timber rattlesnakes as well as other snake species;
- Engage landowners to participate in protecting and restoring habitat for snakes;
- Increase public support for reptile conservation efforts, particularly snakes.

Based on results of Christoffel's study and knowledge of the stakeholders involved in reptile conservation in Minnesota, a comprehensive outreach program for snake conservation should include the following:

- Accurate and informative outreach materials that address snake bites, snake ecology, snake identification, and risk assessment;
- Opportunities for personal encounters with venomous and nonvenomous snakes in a positive environment;
- Detailed management guidelines for land managers and other outdoor workers, such as utility workers;
- Habitat programs that engage landowners in stewardship of their property.

Recommended target audiences for outreach efforts:

- Law enforcement and conservation officers;
- Land managers (especially state and county, including Department of Transportation);

- Utility right-of-way personnel;
- Front-line interpreters and naturalists;
- Landowners in rattlesnake habitat;
- Volunteer snake responders and rehabilitators;
- Outdoor writers for local newspapers;
- Veterinarians and medical personnel.

The Minnesota Dept. of Natural Resources, particularly through the State Parks Division, currently provides numerous public programs regarding timber rattlesnakes. Additionally, the MNDNR has developed a variety of outreach materials regarding timber rattlesnakes. These programs and materials should be reviewed to determine if current human dimensions data related to improved techniques for public outreach on snake conservation are being used. Outreach materials and programs should be revised or created to meet these standards. Additionally, outreach efforts should be monitored for effectiveness, and adjustments made as needed.

Recommended Actions

1. Provide training workshops and identification guides for local law enforcement and conservation officers.
2. Develop management guidelines for wildlife managers, foresters and private landowners.
3. Develop facility maintenance tip sheets for utility and highway department personnel.
4. Provide educational materials for front-line interpreters, such as teachers, and naturalists.
5. Improve the MN Rattlesnake Responder program by engaging volunteers in more training and communication, and expand the program into additional communities in SE MN.
6. Develop seasonal news releases and video clips for local media.
7. Provide fact sheets and workshops for veterinarians and medical personnel.
8. Develop factual outreach materials regarding snakebites in Minnesota.
9. Provide all target audiences, but particularly landowners and communities with rattlesnakes, the opportunity for hands-on interactions with native nonvenomous and venomous snakes. This should be a periodical effort rather than a one-time event.
10. Monitor human behavior and attitude changes over time by conducting periodic surveys.

Monitoring

Goals:

I. Collect data on timber rattlesnake populations to determine progress toward meeting population recovery goals;

II. Conduct periodic habitat assessments on sites with viable or potentially viable dens to ensure that the vegetative structure and composition is compatible with timber rattlesnake needs;

Population Monitoring

Conduct visual encounter surveys of selected bluff prairies, particularly those with viable or potentially viable rattlesnake dens. The preferred timing for surveys is spring, but fall surveys can be conducted as well. Each den site should be surveyed at least once in five years. If the site meets the viability threshold during the first survey, a second survey to confirm viability should be conducted in five years. Sites should not be surveyed repeatedly each year, as such activity could be detrimental to the snake population of a particular site.

If a den site is surveyed under the conditions recommended below and no snakes are observed, then the site should be surveyed at least two additional times that year to determine occupancy. If no snakes are observed in each subsequent survey, the site may be considered extirpated. Because snake detection at sites, particularly those with extensive vegetative cover, is often challenging, it is suggested that surveys be conducted in another year to verify no occupancy before designating it as extirpated.

Extirpated den sites within two miles of active den sites should be resurveyed periodically to determine if recolonization has occurred.

Recommended Population Monitoring Protocol
(See Appendix B for sample data sheet)

Conditions

1. Dates: Spring - last week of April through first week of June
   Fall – 15 August through 20 September
2. Time: approximately 8:am until visibility becomes problematic
3. Weather: Air Temp >50° F and no precipitation, misting ok (do not survey in heavy rain)

Data Collection

1. Survey date, include the month, day and full year (MMM/DD/YYYY)
2. Site name and location. If the site is new, record a GPS location of the den, if one is present, otherwise GPS the center of the site. If GPS data cannot be collected, the site should be marked on a topographic map or aerial photo.
3. Survey start and end time, which will allow for the survey duration to be calculated for determining encounter rates. Caution: this information may not be useful on sites with extensive vegetation that would decrease snake detection rates or increase search effort.
4. Number and names of observers. This information, when combined with the survey duration,

is used to calculate encounter rates. The number of observers should be kept to a minimum, particularly at sites with large numbers of snakes.
5. Weather conditions including air and ground temperature in °F, wind speed (Kestrel or Beaufort scale), % cloud cover, and precipitation within last 12 hours of survey.

If a snake is encountered, record the following data:
1. Location of snake, GPS the snake location if possible
2. Number and species of snakes observed in each location
3. Estimated snake length, number and condition of rattles (some may be broken)
4. Age of snake: neonate, juvenile, or mature adult
5. Reproductive status if observable
6. Picture – take a picture of each snake if possible
7. Sheds – if sheds are found, the same information listed above should be collected for that shed, especially if it is a fresh shed.

Optional Data/notes:
1. Snake data including posture (coiled, extended, moving), behavior (basking, shedding), color morph, proximity to rocks/ledges or other habitat features.
2. Other wildlife species (and their abundance) observed, particularly those unique to bluff sites such as various lizard species.

Habitat Monitoring
In addition to monitoring timber rattlesnakes, it is often useful to monitor the habitat conditions of a site. While this is secondary to monitoring the actual population, data collected on habitat can help determine management needs to ensure the site remains in optimal condition for snakes and other species using the same habitat.

For habitat monitoring, collect the following information:
1. In spring and fall, record native as well as exotic plant species (keep in mind that many species appear at different times of the year, so this will not give a complete site inventory of plants, particularly herbaceous plants)
2. During the summer (June – August), record percent cover of vegetation groups (native grasses, native forbs, exotic species, woody species, etc) and species richness in plots along randomly placed transects. General vegetation observations can be made rather than conducting transects if the information will only be used to estimate future management needs.
3. The presence of timber rattlesnake habitat components (e.g. rock ledges and outcroppings, rookery rocks)

Photo Monitoring of Bluff Prairie Habitat
Photo monitoring does not provide quantitative data on timber rattlesnakes or their habitat, but is very useful in presentations to people interested in rattlesnakes or prairie restoration, natural resource managers, the public, etc. Post-restoration treatment photos are also useful for evaluating the success of bluff prairie restoration.

1. Take photos from a distance of bluff prairies over several years or pre- and post-restoration treatment at the same location, to show changes in cedar or brush cover and in native prairie vegetation. The photo point should be GPS'ed or recorded and described in a way (e.g. mile marker) so other observers could return to the location.

2. Take close-up photos over several years of vegetation (cedars, prairie grasses, etc.) with a reference object (robel pole, meter stick) in the picture, or photos of pre- and post-restoration treatment at the same location to show changes in woody cover and native prairie vegetation. The photo point should be GPS'ed or marked in a way (e.g. rebar stake) that other observers could return to the location.

Appendix A: Definitions

Den/Hibernaculum – A subterranean overwintering retreat used by one or more snakes. A den may have a single entrance, multiple entrances (den system), or a complex of dens where two or more hibernacula are not connected. The latter may include a large bluff with several discrete dens on it. In areas such as Minnesota, where winter temps are <32º F, dens are usually crevices located in ledges, scree, or talus that extend below the frost line and may or may not be soil-covered.

Active den – a den with a known active snake population.

Extirpated den – a den with a history of snakes, but no longer has an existing population.

Neonate – a newborn snake, with a pre-button.

Juvenile snake – a snake born the previous year. These snakes are no longer gray, have one full segment in the rattle, and are typically still quite small (less than 15").

Mature Adult – Snakes that are known to have bred and those whose age is equal to or greater than the average age of first mating. This includes all pregnant and postpartum females and snakes that have shed >10 times.

Site – site in this recovery plan is defined as a bluff prairie. Size will vary based on the size of the bluff prairie.

Timber Rattlesnake Survey Datasheet

Date:(mm/dd/yy)	Surveyor(s): (max. 4)	Time: Start End	Air Temp. (F) Grnd Temp. (F)

Cloud Cover % ☐ 0-25 ☐ 25-50 ☐ 50-75 ☐ 75-100	Wind (mph) ☐ 0-5 ☐ 5-10 ☐ 10-15 ☐ 15+ Direction:	Precipitation in the Previous 12 hrs:

Location Information

Site name:		County:	
Twshp:	Range:	Section:	Site GPS'd: ☐yes ☐no
Landowner(s):			
Address:	City:	State:	Zip:
Phone:	E-mail:		
Directions to Site/Comments:			

Reptile Species If rattlesnake, Add # of rattles and age class	Length (inches)	Location			Posture			Behavior (basking, shedding, feeding, etc.)
		Hidden	Exposed	Dist. to rock ledge	Coiled	Extended	Crawling	
		☐	☐		☐	☐	☐	
		☐	☐		☐	☐	☐	
		☐	☐		☐	☐	☐	
		☐	☐		☐	☐	☐	
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		☐	☐		☐	☐	☐	
		☐	☐		☐	☐	☐	
		☐	☐		☐	☐	☐	
Comments:								

Habitat Conditions Photos taken: ☐ no ☐ yes, number of photos

Trees and Shrubs	Abundant	Common	Rare
☐ Buckthorn	☐	☐	☐
☐ Honeysuckle	☐	☐	☐
☐ Ninebark	☐	☐	☐
☐ Oak	☐	☐	☐
☐ Poplar/ Aspen	☐	☐	☐
☐ Paper Birch	☐	☐	☐
☐ Prickly Ash	☐	☐	☐
☐ Common Juniper	☐	☐	☐
☐ Red Cedar	☐	☐	☐
☐ Sumac	☐	☐	☐
☐ Dogwood	☐	☐	☐
☐	☐	☐	☐

Rock Outcroppings & Potential Den Sites
Comments:

Non-natives and Weeds	Abundant	Common	Rare
☐ Sweet Clover	☐	☐	☐
☐ Common Mullein	☐	☐	☐
☐ Thistles	☐	☐	☐
☐ Wild Parsnip	☐	☐	☐
☐ Smooth Brome	☐	☐	☐
☐ Crown Vetch	☐	☐	☐
☐	☐	☐	☐

Comments:

Prairie Grasses and Forbs

☐ Shooting Star	☐ Lead Plant	☐ Whorled Milkweed	☐ Wormwood
☐ Hoary Puccoon	☐ Coreopsis	☐ Green Milkweed	☐ P. Prairie Clover
☐ Fringed Puccoon	☐ Cliffbrake	☐ Other	☐ Evening Primrose
☐ Flowering Spurge	☐ Cream Wild Indigo	☐ Prairie Turnip	☐ Yellow Flax
☐ Harebell	☐ White Wild Indigo	☐ Bastard Toadflax	☐ Western Ragweed
☐ Spiderwort	☐ Prairie Violet	☐ Blue-eyed Grass	☐ Hoary Vervain
☐ Prairie Smoke	☐ Bird's Foot Violet	☐ Pale Spiked Lobelia	☐ Porcupine Grass
☐ Columbine	☐ Valerian	☐ Wood Betony	☐ Switch Grass
☐ Pussy Toes	☐ Death/White Camass	☐ Yellow Painted Cup	☐ Mulhy Grass
☐ Pasque Flower	☐ Gray Goldenrod	☐ Bergamot	☐ Side Oats Grama
☐ Compass Plant	☐ Stiff Goldenrod	☐ Mountain Mint	☐ Hairy Grama
☐ Golden Alexander	☐ Other	☐ Spotted Mint	☐ Indian Grass
☐ Small Skullcap	☐ Silky Aster	☐ Wood Sorrel	☐ Big Blue Stem
☐ Prairie Ragwort	☐ Sky-blue Aster	☐ Prairie Phlox	☐ Little Blue Stem
☐ Prairie Rose	☐ Aromatic Aster	☐ Native Hawkweed	☐ Drop Seed
☐ Alum Root	☐ Heath Aster	☐ Naked Sunflower	☐ June Grass
☐ Lyre-leaved Rockcress	☐ Rough Blazing Star	☐ Daisy Fleabane	☐ Panic Grass
☐ Yellow Star Grass	☐ Cyl. Blazing Star	☐ Starry Solomon Seal	☐ Sedges
☐ Canada Anemone	☐ Scaly Blazing Star	☐ Penstemon	☐

Comments and Management Recommendations (cutting, burning, etc.):

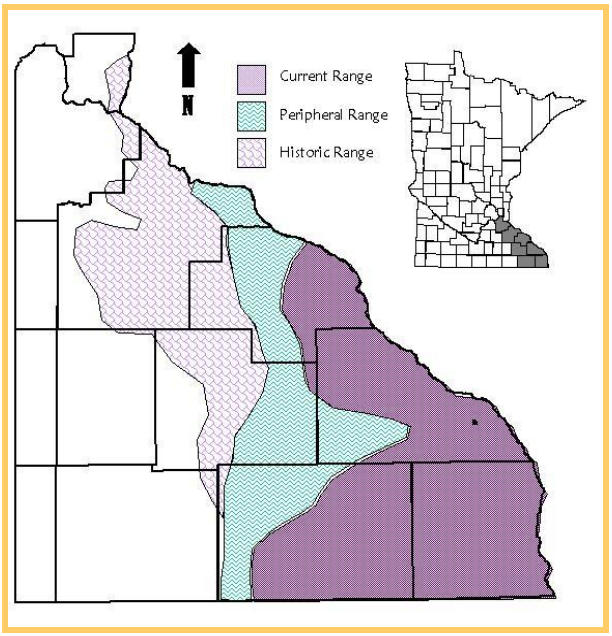
Status: *Threatened*
Type: *Venomous reptile*
Size: *36" – 54"*
Young: *Live young, average 5 per litter*
Nickname: *Velvet Tail*

Brief Description

The timber rattlesnake (*Crotalus horridus*) is a large, heavy-bodied rattlesnake native to the bluffs of southeastern Minnesota. This snake has a wide, triangular-shaped, unmarked tan head and a narrow neck. Its background color can range from yellowish tan to brown to gray, and is marked with dark brown to black crossbands (chevrons). Its tail is black with a tan rattle, which is typically held perpendicular to the ground. In MN, timber rattlesnakes typically have a rust-colored stripe down the center of the back. This color may vary throughout its range and within MN. Neonate (newborn) timber rattlesnakes are grayer in color and are born with a button rattle.

Bullsnakes, fox snakes, milk snakes and hognose snakes are often mistaken as rattlesnakes because they mimic rattlesnakes by shaking their tail against the ground or leaves to create a "rattling" sound. These species don't have a rattle and are not venomous.

Range, Habitat, & Brief Life History



Timber rattlesnakes live among the steep, rugged bluffs of southeastern Minnesota. Historically, timber rattlesnakes occurred in eight counties in SE MN. However, recent surveys indicate many dens in the northern portion of its historic range are extirpated. The population's stronghold in MN has been reduced to the far southeastern counties of the state. Population declines are due to continued persecution, habitat deterioration, road mortality, and predation, particularly by birds of prey.

In Minnesota, timber rattlesnakes typically emerge from hibernation in late April to early May, and disperse by mid June. The average home range size varies, with males traveling about 2 miles, and non-gravid females up to 1.5 miles from the den. Gravid (pregnant) females typically stay within ¼ mile of the den, often staying within a couple hundred yards of the den and rookery rocks, which they use to sun themselves and develop their embryos. Female timber rattlesnakes do not reach reproductive maturity until 6-11 years old, and reproduce every 2-3 years. In Minnesota, females give birth to 5-7 live young in mid to late September. Timber rattlesnakes go into hibernation in early to mid October, depending on fall temperatures.

Timber rattlesnakes require south to southwest facing bluff prairies with rock outcrops for overwintering and gestation. Gravid females use rock outcrops of limestone, sandstone or dolomite, and grassy, open slopes with about 12% canopy closure (Keenlyne, 1972; Sajdak, 1999). Male and nongravid females need forests for foraging. These forests must be adjacent to or near bluffs. Studies have shown that male and

nongravid female timber rattlesnakes prefer mixed deciduous forests with greater than 58% canopy cover, as well as woodland edges around agricultural fields. These habitat components are typically within 1.5 miles of the overwintering den. Young snakes use more open habitat than adult males, but not as open as gravid females (Sajdak, 1999).

Timber rattlesnakes overwinter in ancestral, communal dens in rock fissures and crevices that reach below the frost line. These dens are typically located on south to west facing bluff prairies.

Management Information

Ingress/Egress*:* In the upper Midwest, timber rattlesnakes egress in late spring, hang around the den for several weeks, and then disperse. Emergence has been documented as early as April 6th, but typically does not occur until late April to early May. Researchers have not found a significant relationship between air and ground temperatures and timber rattlesnake emergence (Galligan & Dunson, 1979). Timber rattlesnakes typically disperse by mid-June; however, gravid females will stay near the den throughout the summer. Gestation areas are estimated to be ~50 acres, although half the female's time is spent in an area only about five acres (Reinert & Zappalorti, 1988). Gravid females appear to be especially sensitive to human disturbance, including surveys and management activity. Of interest, Brown (1992) reported that on overcast days, nearly as many snakes are found underground as above ground, which suggests the impacts of management activities conducted during the active season could be reduced if conducted on overcast days. During fall, ingressing snakes will remain on the surface about 32'- 328' from the den for up to 14 days, making them potentially vulnerable to management activities such as fall burning. The latest date documented in the Midwest for ingress is Oct 19th, but snakes are most likely in for the season by early October, depending on fall temperatures. Rattlesnakes typically give birth by mid-September, but have been recorded as late as the end of September, even into early October. Neonate snakes stay with the adult female for 10-14 days, then they shed and move out to feed. This means young rattlesnakes may still be active into mid-October. Additionally, female rattlesnakes that have given birth must also feed prior to ingress. As a result, these females and neonates are probably at greater risk of impact from management activities because they may be actively hunting, or otherwise not ingressed. Since activity by these snakes, as well as returning snakes, will be in proximity to the overwintering den, these areas should be given special consideration for the timing of fall management activities.

Emergence / Ingress Date Comparisons

	WI	MN	NY
Earliest emergence	6 Apr	23 Apr	8 Apr
General Emergence	7 – 21 May	5 – 21 May	7 – 21 May
General Ingress	14 Sep – 1 Oct	14 Sep – 1 Oct	14 Sep – 1 Oct
Latest Ingress	19 Oct	16 Oct	16 Oct

Site Fidelity: Timber rattlesnakes show high fidelity to dens and birthing rookeries (Brown, 1993, Ditmars 1907, Bielema 1998, Ballard, Brandon & Palis, unpublished). Because of this, it is important to protect dens and birthing rookeries for the long-term viability of the population. Additionally, survey data may not be up-to-date, so dens with historical occupancy should be considered as still occupied unless the den has been declared extirpated by the MN DNR Nongame Wildlife Program.

Management Recommendations

***Prescribed Burning*:** Burning should be conducted before April 15th and after October 20th. It is recognized that this is a challenging window in which to conduct prescribed burns in SE Minnesota, but it should be used as a guideline for planning burns. Because bluff prairies are south to west facing, they typically are clear of snow and dry enough to burn by late February to early March. If a burn unit includes a bluff prairie with timber rattlesnakes, pre-burning the bluff prior to April 15th would be a good option for a spring burn of the surrounding area.

While studies do not show a relationship between weather and emergence, we have observed delayed emergence during cool and/or wet springs. Nonetheless, if spring burning of bluff prairies with known timber rattlesnake sightings in Fillmore, Goodhue, Houston, Wabasha and Winona counties must go beyond April 15th, the Nongame Wildlife Specialist out of Rochester must be contacted prior to burning. If you are unsure a site has timber rattlesnakes on it, please contact the Rochester Nongame Wildlife Specialist.

If burning prior to April 15th, using back burning or head firing techniques on the bluff are acceptable. If burning after April 15th, back burning is the preferred technique, as this will allow slow-moving reptiles a chance to retreat from the fire. This technique will also reduce intense radiant heat associated with burning a slope using a head fire.

If areas of the burn unit do not burn, leave them as refugia.

***Creating and Burning Woody Debris*:** Restoration of bluff prairies often involves significant tree and shrub cutting, and piling the material. Piles should be burned in the winter on frozen ground. If it is at all feasible, trees should be pulled off the site for salvage or burning. Since most bluffs are too steep to make this feasible, tree limbs and trunks should be cut up and compactly piled. Directional felling of trees is ok, but leaving whole trees in piles or creating windrows is not acceptable because they do not burn completely. The size and number of piles is not as critical as the compactness. Experience indicates having more small, compact piles leaves fewer burn scars than larger piles, and the burn scars from smaller piles recover faster.

Piles should not be placed on pockets of remnant prairie, or on large rock outcroppings or ledges. Trees should be piled in areas where the cedars have been cut off, or may be piled on pockets of cut invasive brush (buckthorn, honeysuckle, prickly ash). Piles should not be placed on ground juniper, if that is present on the site, as this is an important habitat component for gravid female snakes.

Piles burn up best if they are allowed to dry for a season and burned the following winter.

Forest and Invasive Species Management: Forests adjacent to bluff prairies with timber rattlesnakes should retain a minimum canopy cover of 60%. Significant canopy cutting should occur after Oct 20th and before April 15th. Downed woody debris may be left, and is encouraged, as a means of providing habitat for prey species such as rodents. Timber stand improvement (TSI) should also be conducted during this timeframe. However, if TSI work or invasive species control needs to occur outside of this timeframe, activity on bluffs should be avoided. One or two day entries on the bluff would be ok, but repeated, and extended, management activity should not occur on the bluffs, to avoid disturbing gestating female snakes. Additionally, TSI or invasives control should not use foliar herbicide application during the active growing season. This technique, while not recommended, can be used when native species are dormant, but invasive species are active.

General Management Recommendation

Based on the vulnerability of snakes during egress and ingress, and other life history aspects of timber rattlesnakes, it is recommended that prescribed burning, and frequently repeated (many times during active months) or extended-length management activities on bluffs with timber rattlesnakes be conducted after October 20th and before April 15th. Management activities that must occur during the active season for timber rattlesnakes should stay off the bluff face. Any management activity approaching the bluff face should be limited in duration and frequency. Please consult the Rochester Nongame Wildlife Specialist if conducting management activities on bluffs with timber rattlesnakes from April 15th to October 20th.

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