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Conservation Assessment of the Pale Milk Snake in the Black Hills National Forest, South Dakota and Wyoming

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INTRODUCTION

The milk snake, *Lampropeltis triangulum*, is possibly the widest-ranging species of American snake and is found in North, Central, and South America. It is divided into many subspecies that occur in different climatic regions and consequently have developed very different life history strategies. These subspecies express significant geographic variation in many physical and ecological characteristics including size, color and pattern, prey preferences, and reproduction. The pale milk snake, *Lampropeltis triangulum multistriata*, is a North American subspecies that occurs in the northern Great Plains of the United States. The United States Department of Agriculture (USDA) Forest Service Rocky Mountain Region, which includes the Black Hills National Forest, considers it a sensitive species.

Extremely little is known about the pale milk snake in the Black Hills area. It is a harmless and secretive snake that is rarely encountered. Long-term studies of a milk snake population in Kansas have revealed much that may be relevant to pale milk snakes in the Black Hills. However, even long-term studies of milk snakes have not been successful in compiling significant data due to the rarity and elusiveness of the snake. This assessment is a review of the literature on milk snakes and also includes anecdotal information pertaining to local populations based on observations of pale milk snakes in the Black Hills. Our intent is to review the literature and make suggestions for management of pale milk snakes in the Black Hills.

CURRENT MANAGEMENT SITUATION

Management Status

The milk snake, *Lampropeltis triangulum*, is not considered threatened or endangered by any federal or state agency in the United States, although there are some concerns in some areas. The milk snake is a species of special concern in Arizona, Oklahoma, and Utah. Montana and Wyoming list the pale milk snake, *L. t. multistriata*, as a sensitive species due to its rarity and/or limited range within these states. In South Dakota it is considered to be secure and it is not legally protected. The USDA Forest Service Rocky Mountain Region, which includes the Black Hills National Forest in South Dakota and Wyoming, considers this snake a sensitive species.

Existing Management Plans

We could not find any published management plans for *Lampropeltis triangulum*.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics

The milk snake, Lampropeltis *triangulum*, is a wide-ranging non-venomous colubrid snake of North, Central, and South America (Williams, 1988). This species exhibits great diversity throughout its range, with 25 described subspecies, nine of which occur in North America

(Williams, 1988). North American subspecies are similar in color with varying shades of yellow, black and red appearing in a banded or saddled pattern. Red and yellow are separated by black bands of various shades and widths, which often encircle the body and may obscure the other colors. Milk snakes vary in size from 0.5 – 1.9 m snout-vent length (SVL) (Williams 1988). North American subspecies range from 0.5 – 1.0 m SVL (Williams 1988).

The pale milk snake, *Lampropeltis triangulum multistriata*, is the only milk snake that occurs in the Black Hills and the only snake of its color and pattern in the area. It is a medium sized snake with a total length of 189 – 850 mm (Williams, 1988). This subspecies appears faded or washed out compared to other subspecies of milk snake. Young pale milk snakes are more brightly colored and fade as they mature. Dorsally, the generally saddled pattern appears as red blotches surrounded by a thin but definite margin of black on a yellow-cream background. On the head and tail the black completely obscures the red and appears as black blotches on the yellow-cream background. The ventral coloration is generally yellow-cream, with black speckles. Pale milk snakes are often mistaken by Black Hills residents for the venomous coral snake, *Micrurus* species, but the latter do not occur within 1350 km of the Black Hills. The pale milk snake cannot be mistaken for any other naturally occurring snake in the Black Hills.

Distribution

Milk snakes are among the most widely ranging snake species in the Americas and are divided into several different subspecies (Williams, 1988; Conant and Collins, 1991). They occur in eastern and midwestern North America, throughout Central America, and into northwest South America. In the north, east of the Rocky Mountains, their range extends west through northern Wyoming and southern Montana. Centrally through the United States, their range extends west to the eastern Rocky Mountains in central Colorado and southeast Wyoming. They occur farther west in southern Colorado, New Mexico, and Arizona. A single western subspecies occurs throughout Utah, extreme western Colorado, and southwest Wyoming west of the Rocky Mountains.

The pale milk snake, *Lampropeltis triangulum multistriata*, is the northernmost subspecies of milk snake. It is found in Montana, Wyoming, Colorado, Nebraska, and South Dakota west of the Missouri River to the Rocky Mountains. This subspecies intergrades with *L. t. gentilis* in southwestern Nebraska (Iverson, 1977), northeastern Colorado (Hammerson 1999), and southeastern Wyoming (Tanner and Loomis, 1957), *L. t. taylori* in northwestern Colorado (Roth and Smith, 1990), and *L. t. syspila* in South Dakota and Nebraska (Iverson, 1977). The pale milk snake is found throughout the Black Hills and surrounding plains. Within the Black Hills it is found to an elevation of about 1650 m (Peterson, 1974).

Estimates Of Local Abundance

The pale milk snake is rarely seen in the Black Hills; Peterson (1974) simply notes that it is not often encountered. B. E. Smith (unpublished data) has periodically (from 1997 – 2002) received calls about this species from residents of Lead, Deadwood, and Sturgis, South Dakota. A live specimen was collected at Railroad Buttes ca. 40 km southeast of Rapid City (Smith et al., 1996a). Dead specimens were collected at the Visitor's Center, Wind Cave National Park (Smith et al., 1996b).

Movement Patterns

Studies in Kansas have revealed most of what is known about movement patterns in milk snakes (Fitch and Fleet, 1970; Fitch, 1999). Fitch (1999), using mark-recapture techniques, recorded movements by 41 milk snakes in Kansas over a 50-year period. Data was collected for as long as 10 years for one individual and as short as one year for 10 individuals. These snakes were captured as many as 10 times and as few as two times. Milk snakes moved an average of 118 m between capture points (Fitch, 1999). Males moved an average of 127 m and females 106 m (Fitch, 1999). The longest movement was 504 m (Fitch, 1999). Recaptured milk snakes were often found at new locations, but they returned to specific shelters more consistently than other snakes and seemed to regularly use a series of hiding places (Fitch and Fleet, 1970; Fitch, 1999). No such data exist for pale milk snakes in the Black Hills area. However, Peterson (1974) noted that they were active from late April to mid-September.

Fitch and Fleet (1970) discussed home ranges of milk snakes in Kansas but their conclusions were based on limited data and are incorrectly calculated. They calculated average straight-line movements per snake then estimated home ranges using this measure as the radius of a circle that represented the home range size. Using this method, they estimated a home range of about 20 ha for individual milk snakes. Typically, minimum convex polygon methods would dictate that the average of straight-line movements made by all snakes would estimate the diameter of a circle (instead of its radius) that would approximate an average home range size. If the straight-line movements are used as the diameter of a circle that represents the home range size of a snake, home range size is approximately 5.15 ha from the data of Fitch and Fleet (1970). Fitch (1999) also estimated a home range for the milk snake, but used what he felt were typically the longest straight-line movements made by an average snake as the diameter of a circle that encompassed the home range of a typical milk snake. This estimate was approximately 7.07 ha and presumably included some of the Fitch and Fleet (1970) data from the same site. Average straight-line movements calculated by Fitch and Fleet (1970) were 256.15 m, close to the 300 m long-range movements that "mostly" occurred within the home range of the average snake, according to Fitch (1999). The latter measurement was used by Fitch (1999) to derive the size of a snake's home range, but it is not clear from Fitch (1999) exactly why he used this measurement. Fitch (1999) did not give the original measurements so there is no way to ascertain the veracity of his statements on long-range movements.

Habitat Characteristics

Milk snakes display wide variation in habitat preferences throughout their range. This geographic variation is presumably the result of adaptation to different climates, ecosystems, and communities throughout their wide range (Fitch and Fleet, 1970; Fitch, 1999). Studies on milk snakes in Kansas are probably the most relevant detailed studies for managers of milk snake populations in South Dakota and Wyoming.

Populations of milk snakes seem to have local associations with predators and prey (Fitch and Fleet, 1970), because the availability of prey varies geographically. Use of habitat by milk snakes may be most strongly related to the habitat preferences of the snake's prey items (Fitch and Fleet, 1970). Snakes are found where prey items are abundant and habitat use may change temporally with trends in prey populations (Fitch and Shirer, 1982).

Milk snakes were typically found under cover by Fitch and Fleet (1970), Henderson et al. (1980), and Fitch (1999), although Rush et al. (1982) found them in areas where there were no obvious cover items. Cover items such as tarpaper, sheet metal, boards, rocks, logs, and stumps are used by milk snakes (Fitch and Fleet, 1970; Henderson et al., 1980). Fitch and Fleet (1970) stated that milk snakes thermoregulated under cover through conduction with the shelter object. Fitch (1999) established that milk snakes regularly used specific shelters. This may be because the shelter provided a favorable and stable temperature as well as protection from predators (Henderson et al., 1980).

Ecological succession had notable effects on milk snake populations in Kansas (Fitch, 1999). A typical successional pattern at his study site began with open overgrazed pastureland and continued to a diverse grass-forb mixture. Over time, forb diversity declined and dense grasses became dominant in most localities. The climax community of woody shrubs and trees eventually shaded the grasses out. Milk snake abundance increased as the habitat changed from open pasture to the diverse grass-forb mixture, and then gradually declined as the grasses became dominant and woody plants moved in. This pattern of habitat use coincided with the rise and decline of rodent diversity and was observed at this site in many snake species that used rodent prey (Fitch, 1999). Populations of voles, cotton rats and deer mice declined during the later stages of succession and were replaced by a small population of white-footed mice (Fitch, 1999). Milk snakes characteristically ate voles (Fitch and Fleet, 1970; Fitch, 1999).

There are no studies of habitat use for the pale milk snake in the Black Hills region.

Food Habits

Milk snakes are secretive predators that search for prey in burrows and under cover (Fitch and Fleet, 1970; Fitch, 1999). They feed opportunistically on small vertebrates and eggs and kill prey by constriction (Fitch and Fleet, 1970; Fitch, 1999). Peterson (1974) mentioned that pale milk snakes in the Black Hills may seek subterranean shelters and are nocturnal. This behavior probably allows the snake to find inactive prey that are easier to subdue than active prey (Fitch and Fleet, 1970; Fitch, 1999). Fitch (1999) concluded that some prey items were taken from their nesting burrows. His study associated milk snake abundance with the presence of small burrowing mammals such as voles. In a 30-year study of 88 milk snakes in Kansas, Fitch and Shirer (1982) estimated from limited data that individuals took approximately 2.5 times their body weight in food annually. There are no studies of pale milk snake feeding habits in the Black Hills area.

Prey Items

Milk snakes are slender and do not have the capacity to take bulky prey (Fitch and Fleet, 1970). Fitch (1999) found that young milk snakes ate juvenile and adult skinks, *Eumeces* spp., and a juvenile ringneck snake, *Diadophis punctatus*. Larger adults took small mammals and reptiles, but skinks, *Eumeces* spp., made up most of the diet of milk snakes (Fitch and Fleet, 1970; Fitch, 1999). They also ate nestling voles, gravid skinks, and reptile eggs, which they presumably captured or consumed in burrows (Fitch, 1999). Other reported prey items include birds, eggs, insects, spiders, and earthworms (Smith, 1956). Adults also ate shrews, *Blarina* and *Cryptotis* spp. (Fitch, 1999). Fitch and Fleet (1970) explained the possible presence of invertebrates in milk snake diets as residue from the guts of insectivorous prey items like lizards.

There are no studies of the prey items of pale milk snakes in the Black Hills area. However, lizards are uncommon or unavailable throughout most of the Black Hills (Peterson, 1974; Smith et al., 1996a, b), and pale milk snakes may prey more heavily on snakes or they may prefer to eat smaller mammals in the Black Hills. Baxter and Stone (1980) also pointed out that pale milk snake diet could be different in the Black Hills due to the unavailability of prey items used by milk snakes in other parts of their range.

Breeding Biology

The reproductive habits of milk snakes have been documented in various parts of the range (Fitch and Fleet, 1970; Iverson, 1977; Henderson et al., 1980; Tryon and Murphy, 1982; Fitch, 1999). Comparisons of subspecies revealed that clutch size and frequency for this oviparous snake showed significant geographic variation (Fitch and Fleet, 1970; Tryon and Murphy, 1982). These snakes occur in different climatic regions that probably affect the length of the reproductive season. Long-term studies in Kansas (Fitch and Fleet, 1970; Fitch, 1999) are probably the most relevant to students interested in the reproduction of pale milk snakes in the Black Hills area.

Mating behavior was observed in Kansas milk snakes shortly after they became active in spring following hibernation (Fitch and Fleet, 1970; Fitch, 1999). Snakes were found in male/female pairs under shelters in early April and May. Descriptions of courtship behavior are vague. Fitch and Fleet (1970) mentioned that a male milk snake grasped a female behind the head with its mouth during mating, but this is the extent of the description of mating. Copulation to oviposition time is not known. Snakes captured in April and May by Fitch and Fleet (1970) laid eggs in mid-June and early July. Late season mating and multiple clutches are reported for the Kansas subspecies, *Lampropeltis triangulum syspila*, in captivity under optimal conditions (Tryon and Murphy, 1982; Fitch, 1999). A captive *L. t. syspila* produced a fertile clutch of three and an infertile clutch of six, 39 days apart (Tryon and Murphy, 1982). The infertility of the second clutch may have been a factor in the short clutch interval (Tryon and Murphy, 1982). Due to the short reproductive season, multiple clutches probably do not occur as far north as Kansas (Fitch, 1999) or the Black Hills.

Due to variation in clutch size, egg weight, and length of the incubation period in *Lampropeltis triangulum*, it is difficult to estimate these parameters in the pale milk snake in the Black Hills. In addition, the pale milk snake has not been studied in other parts of its range. Eggs of *L. t. syspila* were laid in clutches of 3 – 7, and incubated for 59 – 63 days at an unreported temperature before they were hatched in captivity (Tryon and Murphy, 1982). In another case, five eggs of *L. t. gentilis* were incubated for 42 days at 27 – 30°C and hatched successfully (Iverson, 1977). Fitch (1999) reported incubation periods of 70, 75, and 89 days for *L. t. syspila*. Dimensions of *L. t. syspila* eggs averaged 31.6 mm in length and 13.9 mm in width (Fitch and Fleet, 1970). Clutches were wet and adhesive upon delivery and dried within minutes (Fitch and Fleet, 1970; Tryon and Murphy, 1982; Fitch, 1999). Dried eggs weighed 3.7 – 5.3 g in three different studies *L. t. syspila* (Fitch and Fleet, 1970; Tryon and Murphy, 1982; Fitch, 1999). Two gravid females weighed 61 and 62 g; after oviposition they weighed 34 and 33 g respectively (Tryon and Murphy, 1982; Fitch, 1999), indicating considerable investment in the eggs. These snakes had similar SVL's and produced five and seven eggs, which made up 44 – 47% of their gravid body weight. Fitch and Fleet (1970) compared clutch size and SVL of *L. t.*

syspila and *L. t. triangulum*, but made no specific comparison of egg dimensions. The larger *L. t. triangulum* produced more eggs than the smaller *L. t. syspila*. Fitch and Fleet (1970) also mentioned that differences in life history as well as size might influence geographic variation in the reproduction of milk snakes.

Snakes generally provide little or no parental care after young have hatched. Iverson (1977), however, found a female *Lampropeltis triangulum gentilis* coiled around a clutch of five eggs. Also, females of some species modify their behavior to insure the production of viable offspring (Henderson et al., 1980). For example, gravid females maintained a higher body temperature for optimal development of eggs (Henderson et al., 1980; Peterson et al., 1993). Studies of reproductive behavior in milk snakes have documented aggregation of gravid females (Henderson et al., 1980) and may indicate exploitation of optimal conditions provided by a shelter (Henderson et al., 1980).

Growth of milk snakes in the wild was documented in Kansas by Fitch (1999). Hatchling *Lampropeltis triangulum syspila* ranged from 195 – 265 mm SVL. Some hatchlings fed after birth in September and before hibernation but some did not (Fitch, 1999), so some were larger than others after their first hibernation period. Presumably, these snakes were at an adaptive advantage and continued to gain weight rapidly during their first full season of growth (Fitch, 1999). Growth rates increased in the second and third years of life, remained high through ages five to six years, and began to decline through older ages. Sexual maturity was achieved in three years by males and four years by females (Fitch and Fleet, 1970; Fitch, 1999). The smallest mature male was 420 mm SVL; the smallest mature female was 514 mm SVL (Fitch, 1999). Milk snakes in Kansas may live as long as 10 – 14 years in the wild (Fitch, 1999).

Demography

Snake demography is not well understood because of the secretive nature of snakes (Fitch and Shirer, 1982; Reinert, 1993). Studies of snake populations derived from recapture data often poorly estimate density and other statistics due to limited recaptures and small sample sizes (Seigel, 1993). This has been the case with studies of milk snakes as well (Fitch and Fleet, 1970; Fitch, 1993; Fitch, 1999; Fitch, 2000). Fitch and Fleet (1970) recaptured only 11 of 58 marked milk snakes in their 22-year study. Fitch (1999) discovered little about milk snakes compared to other snake species at his research site due to limited recapture data. Fitch and Fleet (1970) and Fitch (1999) attributed the small sample sizes in their studies to the rarity of milk snakes on the study site, although it could also be that milk snakes are difficult to capture or are rarely observed because of their fossorial habits.

Few demographic parameters have been derived for pale milk snakes, even in the 50-year study of Fitch (1999). Survival is not known for any age class, population size is uncertain, and sex ratio calculations may be biased. More young than old snakes were captured by Fitch (1999). This could mean that young snakes died before they reached older ages, were more active, were more easily captured, or any combination of these factors. Mark-recapture methods can be used to estimate populations if enough individuals can be captured (Krebs, 1999), but typically only one to three milk snakes were captured by Fitch (1999) during any given season and recaptures were too low to make a reliable estimate of population size. Population size of milk snakes was therefore inferred from mark-recapture data on other species of snakes that were more abundant (Fitch and Shirer, 1982; Fitch, 1999), but this inference is probably unreliable. This technique usually estimated densities of less than one milk snake per hectare. This density makes sense given the size of the home range we calculated and that determined by Fitch (1999). More males than females were collected, indicating a male-biased sex ratio. However, male snakes are often more active than females and are more likely to be collected, so the sex ratio calculation may be misleading.

Because age at sexual maturity is relatively late, from three to four years, and pale milk snakes are relatively long-lived, from 10 – 14 years, with fairly low clutch sizes, from five to seven eggs, pale milk snakes could be thought of as K-selected animals (Stiling, 2002). Various characteristics of K-selected animals may include slow development, low reproductive rate, late reproductive age, relatively large body size, a long reproductive lifespan, relatively long life, good competitive ability, low mortality of young, and a relatively constant population density (Stiling, 2002). Many of these life history characteristics have not been studied in milk snakes.

Community Ecology

Since pale milk snakes are so rarely observed, their community ecology is nearly unknown. However, like all organisms they must have interactions with various organisms including predators and competitors, diseases or parasites, and mutualists.

Predators must exert a powerful effect on most organisms, since species have evolved a suite of characteristics to thwart predation. For example, in much of their range, milk snakes are well known mimics of coral snakes (Brodie, 1993). Presumably they derive an advantage from this mimicry because potential predators may mistake them as the venomous coral snake and avoid attacking the harmless milk snakes (Brodie, 1993). Milk snakes do not co-occur with coral snakes in all parts of their range, but may still gain an advantage through their red, yellow, and black markings. These colors are frequently associated with other venomous animals such as bees, wasps, and spiders. It has also been shown that banded snakes may escape predation through optical confusion of predators, such as deflective illusion and flicker fusion, in which the snake blends into its background while moving (Jackson et al., 1976). Predators of milk snakes have not been recorded.

Specific competitors of pale milk snakes have not been identified, but they probably compete most intensely with other snakes. Snakes exploit the most available food source and could exclude it as prey for other snakes (Fitch and Shirer, 1982). Snakes tend to eat prey based on the size of the prey and the ability of a particular species to handle prey. For example, some large constricting snakes eat very large prey for their size (e.g., pythons and boas), whereas others eat relatively small prey for their size (e.g., bullsnakes). Assemblages of sympatric snake species will partition resources by size (Fitch and Shirer, 1982). Likewise, intraspecific competition may be avoided by the partitioning of resources by size (Fitch and Shirer, 1982). For example, young snakes will often utilize different prey items than adults (Arnold, 1993). In Kansas, small mammals were taken only by large adult milk snakes (Fitch and Fleet, 1970; Fitch, 1999), whereas young milk snakes in the same area fed exclusively on small reptiles (Fitch and Fleet, 1970; Fitch and Shirer, 1982; Fitch, 1999). This leads to interesting questions about pale milk snakes in the Black Hills, especially juveniles. Do they feed primarily on smaller snakes, such as juvenile garter snakes (*Thamnophis* spp.), green snakes (*Liochlorophis vernalis*), or redbelly snakes (*Storeria occipitomaculata pahasapae*) or do they primarily eat very small mammals, such as newborns? Regardless, we think their food preferences in the Black Hills are probably different from those in other parts of their range.

Diseases and parasites of milk snakes have not been systematically studied. Virtually nothing is known about how diseases and parasites may affect populations or if they play a role in controlling population densities. Orós et al. (1996) found *Salmonella arizonae* in the digestive and respiratory tract of a captive two-headed milk snake in Honduras, but this bacterium has been found in various captive snakes. There is no published information on diseases or parasites in wild milk snakes.

Likewise, milk snakes are not known to have mutualistic interactions with other species. Their food habits seem to indicate that they may use the burrows of small mammals to hunt prey and they may retreat to such burrows for other reasons as well.

Risk Factors

Because so little is known about pale milk snake populations in the Black Hills (or in other areas), it is difficult to speculate on the greatest risk factors to the species. However, four factors may place pale milk snakes at risk: Habitat loss, loss of habitat diversity, habitat modification, and pollution from pesticides or other environmental contaminants.

Habitat loss typically has its largest effect on predators that are at the top of a food web such as predators that subsist on vertebrate prey. Baxter and Stone (1980) thought that habitat loss might therefore be the greatest threat to pale milk snakes in Wyoming. We think this could be the case in the Black Hills as well. Anecdotal evidence indicates that these snakes are found in many different habitats in and around the Black Hills area (B. E. Smith, unpublished data).

What may be more important, however, is the mosaic of habitat found in the area. As shown by Fitch (1999), milk snakes seem to use specific types of habitat based on the availability of food in these habitats. Specifically, milk snakes at his study site in Kansas used habitat of intermediate successional stages due to the high diversity of rodents found in this habitat type (Fitch, 1999). Evidence exists that the diversity of habitats found in the Black Hills has declined since European occupation (Parrish et al., 1996). Specifically, the amount of habitat covered by ponderosa pine forest, a late-successional stage in the Black Hills, has increased while other types of habitat have decreased. Overall, this has decreased the biological diversity of the region. It is possible that it has also decreased the amount of habitat used by pale milk snakes, since many of the habitat types that are being lost in the Black Hills are similar to the habitat types described by Fitch (1999) as those most favored by the pale milk snake. Turner (1974) has shown that mammals are most diverse in non-ponderosa pine habitats (i.e., deciduous forests, wetland areas, and riparian zones). The greatest diversity and abundance of small snakes that may be prey of pale milk snakes in the Black Hills (i.e., garter snakes, smooth green snakes, and Black Hills redbelly snakes) also occurs in the same kind of habitat (B. E. Smith, unpublished data). Management activities that increase the diversity of habitat types in the Black Hills and decrease the amount of ponderosa pine forest may increase the numbers of pale milk snakes in the region, but this is somewhat speculative.

Habitat modification is another aspect of habitat change that is probably deleterious to pale milk snakes in the Black Hills. Under "habitat modification", we include any activities that modify (but do not destroy or convert) habitat used by pale milk snakes. The primary habitat modifications we see as problematic are soil compaction and movement of soil and substrate, such as litter, rocks, or logs, by large earth-moving machinery or by the activities of logging. Such modification would probably be problematic for a semi-fossorial animal like the pale milk snake. These activities should be reduced where possible, particularly in areas that we have identified as possibly being critical habitat for pale milk snakes (i.e., non-ponderosa pine habitat).

Private individuals and government agencies control noxious weeds and pest species in the Black Hills using pesticides. In addition, pollutants can be added to the water or soil by various practices, including oil and silt from logging and off-road vehicles, various pollutants from mining, and nitrogenous wastes from extensive cattle grazing. Currently, there is no understanding of how these practices could affect pale milk snakes or any other species of snake. Probably more importantly, these environmental contaminants may have indirect effects on pale milk snakes by reducing the abundance of or by eliminating their prey species, but the extent to which this occurs is unknown. Contaminants can also accumulate in tissues of animals that are at high trophic levels in a food web. However, this has not been studied in pale milk snakes.

RESPONSE TO HABITAT CHANGE

Management Activities

Few or no studies exist on how management activities affect snake populations. Many of our ideas are speculative, but informed by the data we have presented. The activities listed below mostly have impacts on vegetation that should, in turn, affect pale milk snake populations. More importantly, these activities may affect pale milk snake prey and indirectly affect populations of the pale milk snake.

Timber Harvest

The effects of logging have not been studied in pale milk snakes. Direct impacts of logging, such as destruction of shelters, compaction of soil, or larger-scale habitat destruction (especially in mesic areas), could be problematic for pale milk snakes. On the other hand, if timbering is designed to favor the restoration of hardwoods or meadows, it could be beneficial. It could also be beneficial if unspent fuel is removed in the timbering process (see "Prescribed Fire and Fire Suppression"). Timber harvest could also be beneficial if used to mimic natural processes of succession, which favors milk snakes (Fitch, 1999). Timbering may also be beneficial if used to thin stands, such that young trees, especially "doghair" pine, are removed, leaving mature trees. However, in the absence of detailed studies, it is impossible to be certain how timber harvest might affect pale milk snakes.

Recreation

Recreational activities on the Black Hills National Forest with regards to the management of pale milk snakes can be divided into high-impact and low-impact activities. In the former category, we would place snowmobiling, off-road vehicle use, and modification of habitat for campgrounds or parking lots. Habitat alteration caused by these types of impacts is reviewed in Smith and Stephens (2003). All these activities involve the displacement or compaction of soil, removal of ground litter and other debris, and/or removal of forest. Any of these activities might negatively affect populations of pale milk snakes. In one study of the effects of off-road vehicle use, one fossorial snake disappeared over several years (Sullivan, 2000). It might be necessary to eliminate or restrict these types of activities in habitats that are known to be rare or declining in the Black Hills, such as deciduous parkland, meadows, riparian zones, and wetlands.

Low-impact activities, such as hiking, cross-country skiing, or fishing, probably have little effect on pale milk snakes, since trails used for these activities displace relatively little soil or litter. However, people that use the Black Hills National Forest should know that pale milk snakes are present and that they should not be confused with the dangerous coral snakes, which do not exist anywhere near the Black Hills. It is also important that users know that pale milk snakes are rare in the Black Hills region and should not be disturbed.

Livestock Grazing

Large numbers of livestock are grazed on the Black Hills annually and livestock grazing has the potential to make a large impact on the management of all wildlife in the Black Hills. Some of the habitat that we have identified as potentially critical to the pale milk snake is habitat with high quality forage. Fitch (1999) pointed out that removal of cattle from overgrazed pastureland initiated succession that resulted in increased diversity of forbs and grasses. In his study, the intermediate successional stage was the most favored by milk snakes due to increased rodent diversity in these areas (see "Habitat Characteristics"). It is not clear how these data might be applied in the Black Hills. Maintaining the diversity of habitats found in the Black Hills and avoidance of overgrazing is probably important for pale milk snakes.

Mining

Mining often requires habitat modification, including soil compaction and removal of vegetation, litter, rocks, and other cover. It can also result in accidental or intentional spillage of various pollutants including heavy metals and it can acidify the soil. Any of these changes could affect pale milk snakes, but there are no studies of the effects of any of the pollutants on milk snakes. As Campbell and Campbell (2002) pointed out, snake ecotoxicology studies are in their infancy. Mining could also affect the prey of pale milk snakes, leading to indirect effects on the snakes.

Prescribed Fire And Fire Suppression

Mushinsky (1985) found that a regular regime of prescribed fire actually increased the density of reptiles and amphibians at his study site in Florida. The Black Hills historically experienced periodic low-intensity fires (Parrish et al., 1996), and prescribed fires can be used to mimic this natural disturbance. A plan of prescribed fire will eliminate unspent fuel. Fire suppression allows this fuel to accumulate, resulting in devastating, high-intensity, wildfire. Parrish et al. (1996) found that low-intensity fires occurred about once every 10 – 15 years in the Black Hills prior to European colonization. Subjecting management areas to prescribed fires of this periodicity might help to return the Black Hills to their natural habitat diversity and could be beneficial for pale milk snakes.

Non-Native Plant Establishment And Control

Many non-native plants have become established in the Black Hills and have decreased the biodiversity of the area. If the goal of management is to increase biodiversity in the Black Hills to manage for pale milk snakes, then control of these plants is necessary. The Black Hills National Forest has a spraying program in place to control non-native plants, but it is important to realize that any program that involves spraying herbicides is potentially injurious to pale milk snakes living in the soil. Indirect effects on snake prey items could also be important. However, the toxicity of most herbicides (and pesticides) has not been investigated in snakes (Campbell and Campbell, 2002). The spraying program needs to be monitored and studies need to be done on the effects of the chemicals on the pale milk snakes.

Fuelwood Harvest

Fuelwood harvest has effects similar to timber harvest, but is not as invasive a practice. It might be prudent to restrict fuelwood harvest to areas of ponderosa pine, since this habitat is abundant throughout the Black Hills. If fuelwood harvest is restricted to areas of ponderosa pine overgrowth, for example doghair stands, fuelwood harvest could even serve a beneficial function in opening up areas overgrown by vegetation that is not likely critical to pale milk snakes. However, because so little is known of how timber harvest affects pale milk snakes, it is difficult to make any recommendations.

Natural Disturbances

There is basically no information on how natural disturbances may affect pale milk snakes or may indirectly affect them through effects on their prey. Our comments in this section are highly speculative.

Insect Epidemics

In the short-term this would probably have a negative effect on pale milk snakes by drying out areas as trees died from insect infestations. Cover items are obviously of great importance to milk snakes (Fitch, 1999), and increased insolation would probably make various cover items, especially rotting logs and bark, less desirable. In the long-term, it may actually increase habitat for pale milk snakes if it results in natural succession that returns diversity to the Black Hills.

Wildfire

This would probably have similar effects to those caused by prescribed fire. Mushinsky (1985) found that fire had beneficial effects on a herpetofaunal community because vegetation in the area became more diverse after fire. Immediate effects of fire are probably negative due to drying of cover objects. Fire suppression interacts with wildfire, since wildfire following fire suppression is more intense (Parrish et al., 1996). These high intensity wildfires would probably have extremely negative effects on pale milk snakes and would likely kill many individuals outright. Low intensity wildfires would have fewer immediate effects on the snakes, and may lead to successional events that increase habitat diversity in the Black Hills.

Wind Events

Any event that causes the removal of overhead canopy probably has a negative effect on pale milk snakes because the cover objects they favor would dry out after these events. However, wind could lead to a chain of events causing succession that would ultimately be beneficial to pale milk snakes by increasing habitat diversity in the Black Hills.

SUMMARY

Little is known about milk snakes throughout their vast range. They seem to be extremely rare in most parts of their range. As predators, their abundance within and use of habitat is associated with their prey. These snakes seem to require a diversity of prey items and may therefore require diverse habitats. The habitats in which pale milk snakes have been found in the Black Hills are diverse but the prey items they use here have not been recorded. We have suggested that habitat loss or modification is a threat to pale milk snakes and it is known that habitat diversity has declined in the Black Hills since European colonization. However, lack of data on Black Hills populations hampers effective management of the species. Providing habitats that are known to be used by pale milk snakes as well as reporting encounters with the snakes may help to protect the species, but much remains to be learned.

REVIEW OF CONSERVATION PRACTICES

Management Practices And Management Models

At this point, so little is known about pale milk snakes, or about milk snakes in general, that derivation of management practices or models is speculative at best. Increasing the diversity of vegetation in the Black Hills might be helpful. This might increase available cover and the extent of mesic habitats. It could have indirect effects on the snakes through their prey as well. Movement towards a more natural fire regime might be helpful, as might reduction in ponderosa pine throughout the area, if these changes are associated with the increase of mesic habitats and if they help to diversify the vegetation of the Black Hills in general.

Survey, Inventory, And Monitoring Approaches

As Fitch (1999) pointed out, milk snakes can be rare. Our current knowledge in the Black Hills is rudimentary. Although there are various techniques that are successful in monitoring snake populations, such as road cruising (Shaffer and Juterbock, 1994), these techniques are not of use unless we begin to have some idea of where to look for pale milk snakes on the Black Hills National Forest. As a first step we advocate keeping detailed records of sightings of pale milk snakes. They are easily recognizable by virtually any person and they are not dangerous. The USDA Forest Service has a large number of employees out in the field in the Black Hills National Forest throughout the active season. The USDA Forest Service should notify all personnel that it is important to record every sighting of pale milk snakes in the Black Hills. Basic field guides, such as Conant and Collins (1991) or our web page (http://msc.bhsu.edu/biology/bsmith/herpssite/milksnake.htm), show field photographs of the species. Several years of field sightings would be needed to build a survey database that could help to develop management techniques.

Additional Information Needs

At this point basic information is needed on where pale milk snakes occur on the Black Hills National Forest. Compiling a list of sightings is the most important information need at this time, as discussed above (see “Survey, Inventory, and Monitoring Approaches”).

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DEFINITIONS

Biotic: Refers to biological features of the environment.

Climax community: The final stage of floral succession.

Colubrid: Species of snake belonging to the family Colubridae.

Critical habitat: Habitat essential for the maintenance of viable populations of a species.

Deflective illusion: Optical illusion created when a banded snake is fleeing, preventing a potential predator from following its forward motion.

Flicker fusion: Optical illusion created when a banded snake is fleeing, giving the snake the appearance of being stationary because it appears to be solidly colored rather than banded.

Fosssorial: Living in or using burrows.

Gravid: A female carrying eggs or young.

Intergrade: An individual that displays intermediate characteristics of two taxonomic groups.

K-selected: A method of categorizing species according to their life history strategy. K-selection is further explained in the text (see “Demography”).

Mesic: Moist habitats.

Mosaic (habitat mosaic): Refers to the overall pattern of diverse habitats in a landscape.

Multiple clutches: The production of more than one clutch by an individual in a single reproductive season.

Mutualism: An interaction between two or more species in which one or more species may benefit.

Oviparous: A species that lays eggs.

Oviposition: The act of laying eggs by an oviparous species.

Riparian zones: Areas of dense vegetation surrounding flows of water in the Black Hills that often contain considerable growth of willows.

Snout vent length (SVL): A measure of length from the end of the snout to the cloacal opening or vent. Commonly used as a measure of size of reptiles and amphibians.

Thermoregulatory: Regarding the regulation of body temperature by animals.