BIOLOGICAL REPORT 82(10.156)
JULY 1989

HABITAT SUITABILITY INDEX MODELS: BLACK-TAILED PRAIRIE DOG

Fish and Wildlife Service

S. Department of the Interior

Biological Report 82(10.156)
July 1989

HABITAT SUITABILITY INDEX MODELS: BLACK-TAILED PRAIRIE DOG

by

Norman W. Clippinger
Hunter Environmental Services
7332 South Alton Way
Suite H
Englewood, CO 80112

U.S. Department of the Interior
Fish and Wildlife Service
Research and Development
Washington, DC 20240

Suggested citation:

Clippinger, N.W. 1989. Habitat suitability index models: black-tailed prairie dog. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.156). 21 pp.

PREFACE

This document is part of the Habitat Suitability Index (HSI) model series [Biological Report 82(10)], which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. This information provides the foundation for the HSI model and may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model section documents the habitat model and incudes information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The HSI Model section includes information about the geographic range and seasonal application of the model, its current verification status, and a list of the model variables with recommended measurement techniques for each variable.

The model is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts. Habitat information about wildlife species frequently is represented by scattered data sets collected during different seasons and years and from different sites throughout the range of a species. The model presents this broad data base in a formal, logical, and simplified manner. The assumptions necessary for organizing and synthesizing the species-habitat information into the model are discussed. The model should be regarded as a hypothesis of species-habitat relationships and not as a statement of proven cause and effect relationships. The model may have merit in planning wildlife habitat research studies about a species, as well as in providing an estimate of the relative suitability of habitat for that species. User feedback concerning model improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning are encouraged. Please send suggestions to:

Resource Evaluation and Modeling Section
U.S. Fish and Wildlife Service
National Ecology Research Center
2627 Redwing Road
Ft. Collins, CO 80526-2899

CONTENTS

ACKNOWLEDGMENTS

This model would not have been completed except for the contributions of many talented individuals. R.C. Solomon, J. Terrell, M. Banowetz, and A. Allen of the National Ecology Research Center (USFWS), and Dr. D.P. Reagan of Hunter/Environmental Science and Engineering (Hunter/ESE), repeatedly reviewed drafts of the model and offered guidance on the field testing. Field assistance was provided by R. Beane, C. Fordham, L. Pye, and L. Bexley of Hunter/ESE, Dr. K.A. Cushmann, and S. Sund of the University of Colorado. The species authorities who reviewed this model were Dr. J.L. Hoogland of the University of Maryland, K. Fagerstone of the Denver Wildlife Research Center, and D.C. Crocker-Bedford of the U.S. Forest Service.

Financial support, equipment, and office support were provided by Hunter/ESE. Hunter/ESE and the U.S. Army provided access and field assistance at Rocky Mountain Arsenal. The U.S. Fish and Wildlife Service provided a literature search and technical advice for the modeling process.

BLACK-TAILED PRAIRIE DOG (*Cynomys ludovicianus*)

HABITAT USE INFORMATION

General

The black-tailed prairie dog is a large, social, ground-dwelling squirrel inhabiting short- and mixed-grass prairie in the semiarid plains of western North America. These diurnal rodents weigh 700-1500 g (Hoogland 1981) and are active above ground year round (Lechleitner 1969). Black-tailed prairie dogs prefer flat or gently sloped terrain for their burrows, and thrive on a variable mixture of short grasses, forbs, and other low lying vegetation (Koford 1958). Historically, bison (*Bison bison*) and prairie dogs interacted to maintain the short-grass vegetation, which is ideal for both species (Coppock et al. 1983a). As man replaced migratory bison with nonmigratory cattle, prairie dogs expanded their range on overgrazed rangeland (Jones et al. 1985). Black-tailed prairie dogs will also invade suitable habitat within urban and suburban areas. These urban locations are often vacant or neglected parcels of land that appear much like short-grass prairie habitat.

Food

Analyzing the food habits of black-tailed prairie dogs is difficult, despite the great number of studies completed on the subject in the past two decades. Because of their burrowing and grazing habits, prairie dogs may change the vegetation structure of a community by their very presence. Prairie dogs will alter their use of prairie habitat in response to a complex set of pressures, both from the productivity of areas they inhabit and by feeding by other herbivores (Whicker and Detling 1988). The ecological history of a prairie dog colony has great influence on what foods are found to be most often eaten in any given study.

Perhaps the most accurate description of prairie dog food selection is that they are "selective opportunists." They prefer certain phenological stages or types of vegetation according to their immediate or eventual needs, and will exploit such vegetation as it occurs in their environment. Prairie dog diets may be best understood by examining the literature for known preferences and examples of opportunistic feeding.

Grass and sedge species are important in the diet of black-tailed prairie dogs as year round staples and preferred foods in most prairie locations (Tileston and Lechleitner 1966; Costello 1970; Summers and Linder 1978; Fagerstone 1979; Uresk 1984). Western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), and buffalo grass (*Buchloe dactyloides*) are reported as among the most common grasses in prairie dog stomachs (Koford 1958; Tileston and

Lechleitner 1966; Bonham and Lerwick 1976; Summers and Linder 1978; Fagerstone 1979). Sand dropseed (Sporobolus cryptandrus) was also reported as a major food item (Hansen and Gold 1977; Uresk 1984), accounting for up to 60% of the prairie dog diet in September (Bonham and Lerwick 1976). Sedges (Carex spp.) may be important on some prairie dog colonies, composing 55%-64% of their diet in May (Bonham and Lerwick 1976; Hansen and Gold 1977; Summers and Linder 1978; Uresk 1984). Other grasses included in prairie dog diets are sixweeks fescue (Festuca spp.) (Kelso 1939; Bonham and Lerwick 1976; Fagerstone 1979), cheatgrass (Bromus spp.) (Costello 1970; Fagerstone 1979), and ring muhly (Muhlenbergia torreii) (Smith 1967; Uresk 1984).

Forbs are a common and occasionally dominant portion of prairie dog diets. Scarlet globemallow (Sphaeralcea coccinea) may form 20%-24% of black-tailed prairie dog diets (Bonham and Lerwick 1976; Fagerstone 1979). Plains prickly pear (Opuntia polyacantha) is an important seasonal food, composing up to 58% of the diet in the winter (Fagerstone 1979). Peppergrass (Lepidium densiflorum) composes 50% of the June diet in some areas (Costello 1970; Fagerstone et al. 1977). Wooly plantain (Plantago purshii) is eaten upon occasion (Bonham and Lerwick 1976; Fagerstone et al. 1977; Summers and Linder 1978), as is prickly lettuce (Lactuca spp.), goosefoot (Chenopodium spp.), and Kochia (Koford 1958; Fagerstone et al. 1977). Plants other than those mentioned above may be locally important food sources for prairie dogs. The plants mentioned above are generally the most commonly available on short- or mixed-grass prairies.

Black-tailed prairie dogs will avoid consuming certain plant species common on their range. Threeawn (Aristida fendleriana), horseweed (Conzya ramossissima), buffalo bur (Solanum rostaratum), and, despite its common name, prairie dog weed (Dyssodia papposa) are all avoided by prairie dogs (Summers and Linder 1978; Fagerstone 1979). King (1955), Tileston and Lechleitner (1966), and Costello (1970) reported that prairie dogs clipped-down and left laying all inedible plants and tall edible plants not needed for food. Koford (1958) found much the same behavior, but noted that they would neither clip nor consume snow on the mountain (Euphorbia marginata), tansy mustard (Sisymbrium altissimum), beeplant (Cleome serrulata), or plains milkweed (Asclepias pumila).

Food choices of prairie dogs are greatly influenced by plant phenology. Prairie dogs prefer grasses and sedges in the spring and summer, but the percentage of forbs in the diet increases by late summer and fall (Koford 1958; Bonham and Lerwick 1976; Hansen and Gold 1977; Fagerstone 1979; Uresk 1984). Black-tailed prairie dogs show a marked preference for growing plants and meristematic tissue (Fagerstone et al. 1981). The prairie dogs' habit of clipping vegetation short leads to higher nitrogen concentration and higher proportions of succulent forage (Coppock 1981; Coppock et al. 1983b). Beckstead (cited in Fagerstone and Williams 1982) proposed that prairie dogs select growing plants because they contain more protein and less fiber than mature plants. Grasses are particularly less digestible when mature in the fall (Bonham and Lerwick 1976). Thus grasses and sedges are preferred in the spring while their young shoots are still succulent and prevalent (Koford 1958; Costello 1970; Fagerstone et al. 1981). Although grasses dominate prairie dog diets in most seasons, forbs are sought out in every season (Fagerstone et al. 1977). Forbs generally grow more slowly and thus remain more palatable than grasses through more of the year. Assimilation efficiencies of prairie dogs are up to twice as high on diets that include forbs than on diets of grass only (Fagerstone et al. 1981). Forbs appear to be sought out by prairie dogs on nutritional grounds.

Flowers and seeds may be required for their fats, protein, and other nutrients, and seem to be taken as they become available from both grasses and forbs (an example of dietary opportunism; Koford 1958; Smith 1967; Fagerstone 1979). Normally, black-tailed prairie dogs prefer different parts of plants depending on the time of year (Fagerstone et al. 1981). Spring and summer plant parts eaten include the early leaves of grasses, early forb shoots, and the seed heads of grasses as they are developed. In the fall, the leaves of forbs and seeds of almost any plant in abundance are eaten (Koford 1958; Smith 1967; Uresk 1984). In the winter, the remaining leaves on plants, seeds, basal parts of grasses, dry grasses, twigs of shrubs, and prickly pear stems are consumed (Koford 1958; Smith 1967). Roots are occasionally taken from within prairie dog burrows and small circular pits dug among the plains grasses (Tileston and Lechleitner 1966; Smith 1967). The only plant parts available in the winter are the few standing stems, seeds of any plants, and plains prickly pear. High proportions of succulent vegetation in most seasons and of prickly pear in winter diets of prairie dogs suggest that they are in need of water as much as forage (Fagerstone et al. 1981).

Black-tailed prairie dogs exhibit food preferences, but they are also highly adaptable. Food availability plays the most important role in determining the overall opportunity of prairie dogs to make a food choice (Fagerstone 1979). Fagerstone et al. (1977) studied black-tailed prairie dog food habits in an area where forbs were reduced in abundance by 2,4-D herbicide. They found that forbs were reduced from 50% in the prairie dog diet to 9% of the prairie dog diet, without any apparent effect on the weight, health, or activities of the prairie dogs. But the prairie dogs must have searched out the very small coverage of forbs (about 1%) reported in the study in order to include them as 10% of their diet (illustrative of 'selective opportunism'). Food choices of prairie dogs exhibited in the studies above suggest that a more diverse plant community (grasses vis-a-vis forbs) would result in higher quality habitat.

Water

The black-tailed prairie dog does not require a standing water source (Young 1944; Tileston and Lechleitner 1966). But black-tailed prairie dogs, in contrast to white-tailed prairie dogs (*Cynomys leucurus*), do not hibernate, and rarely are torporous (Tileston and Lechleitner 1966; Harlow and Menkins 1986). Water is not generally available on short-grass prairie; therefore prairie dogs must obtain it from vegetation. In the winter diet, this must be particularly difficult, given the dry state of winter forage on short grass prairie. Prickly pear retains a high amount of water in the photosynthetic stems. Unlike most other animals (including white-tailed prairie dogs), black-tails tolerate the oxalic acid present in prickly pear and consume this species freely (Fagerstone et al. 1981). Water may be the major dietary attraction of prickly pear to wintering black-tailed prairie dogs (Fagerstone 1979).

Cover

Black-tailed prairie dogs have long been known to occur in areas where there has been very low and sparse vegetation (see Merriam 1902). They will clip down most plants which grow higher than they can see over or more dense than they can see through. Black-tails will seldom enter tall and thick vegetation, particularly if they cannot walk without being constantly brushed by the vegetation (Koford 1958). In contrast to more loosely colonial white-tailed prairie dogs, black-tailed prairie dogs will remove transplants of 0.5 m vegetation that are placed in their colonies (Hoogland 1981). Apparently, black-tailed prairie dogs prefer sites with high visibility afforded by low vegetation for protection from predation (King 1955; Hoogland 1981). They may have evolved their social grouping and extensive warning calls in order to detect possible predators near their towns. Overgrazed rangeland has been known to encourage the growth of prairie dog colonies because of its low vegetation, among other factors (Bond 1945; Osborn and Allen 1949; King 1955; Koford 1958; Smith 1967; Costello 1970). The choice of new territories by dispersing individuals is controlled by the visibility of the site and its proximity to existing colonies (Cincotta 1985; Knowles 1985). In a study of black-tailed prairie dog towns surrounded by tall grass prairie, Osborn and Allen (1949) discovered that prairie dogs will abandon a site or gradually be eliminated if they and other herbivores cannot keep the vegetation clipped down.

The maximum height of vegetation (in summer) on prairie dog colonies can average anywhere from 13 cm on short-grass sites (Koford 1958; Agnew et al. 1986) to 64 cm in grasslands of eastern New Mexico (Clark et al. 1982). Overall cover of vegetation on black-tailed prairie dog colonies is quite variable, ranging from 25%-49% in Montana (Fagerstone et al. 1977), to a maximum range of 73%-91% canopy cover in western South Dakota (Uresk 1984). In other vegetation studies on prairie dog colonies, total canopy cover ranged from 41%-60% in western South Dakota (Agnew et al. 1986), from 32%-58% in Wind Cave National Park, South Dakota (Krueger 1986), and from 58%-70% in northern Colorado (Klatt and Hein 1978).

The burrows of prairie dogs are one of the most conspicuous indicators of their presence. Burrows are refuges from the external environment, a location for breeding and rearing young, and a center for the social structure of prairie dogs (King 1955). The black-tailed prairie dog depends on its burrow for protection from predation, and often will pass its burrow on to its descendants. All of the above factors lead to substantial advantages for the cost in time and effort of building and defending a burrow system (King 1984). Their burrows are one of the most important features in the life of prairie dogs (King 1955).

There are three categories of prairie dog burrow entrances. The characteristic domed entrance is formed by subsoil brought to the surface and deposited evenly around the entrance (King 1955; Smith 1967); the dome may reach 1.8 m in diameter and 0.9 m in height (King 1984). A rimmed crater hole is opened from underground and is constructed by the prairie dog scraping topsoil together at the entrance and pressing moist soil up into a rim, sometimes with its nose (King 1955; Smith 1967). Burrow entrances without structures about them are often located on slopes of more than 10%, or the structures may have eroded away (King 1955; Smith 1967).

Burrows lead downward at an incline of 15°-20° from domed craters into complex passages containing waiting chambers just under the surface, several blind chambers (often containing feces), and nest chambers lined with dry grass (Sheets et al. 1971). Burrows then make an abrupt vertical ascent to a rimmed crater entrance, with the maximum depth ranging from 1-4 m. The burrow is about 2 m deep on average, and extends 13 m in length (Sheets et al. 1971). Most burrow systems have only one or two entrances, with a few long occupied burrows having three entrances (Stromberg 1978). Complicated and extensive prairie dog burrows are preferred for habitation by black-footed ferrets (Houston et al. 1986).

The number and depth of burrows depend greatly on the substrate and length of occupation of an area. Black-tailed prairie dogs will usually build on slopes of less than 10% (Koford 1958; Tileston and Lechleitner 1966; Dalsted et al. 1981). Almost any well-drained soil type other than sandy soils is acceptable for burrows, with silty loam clay soils the best for tunnel construction (Koford 1958; Sheets et al. 1971; Lewis et al. 1979; Dalsted et al. 1981).

The density of prairie dog burrow openings varies substantially. King (1955) found a density of 143 burrow openings per ha in South Dakota, Smith (1967) found 50 per ha in Kansas, and Clark et al. (1982) found 33 per ha in New Mexico. No index can be used to estimate the number of prairie dogs from the number of burrows, since the burrows are often more permanent or constant in number than the prairie dogs (King 1955). Burrow density is not a good index of the suitability of range for prairie dogs either, because it can reflect past as well as present conditions (Koford 1958).

Reproduction and Social Structure

Black-tailed prairie dogs are social rodents that live in colonies or "towns", with as few as five to thousands of individuals. Their colonies are divided by topographic features, such as a hill or stream, into "wards" (King 1955). Communication or interaction between wards is rare, except through emigration/immigration of individuals (Hoogland 1981). Wards are subdivided by the basic polygynous social groups called coteries (King 1955; Hoogland 1979a). A coterie usually contains one adult male, three to four genetically related adult females, and several yearlings and juveniles of both sexes. Coterie members defend a territory of about 0.26 ha (Hoogland 1981) against encroachment by prairie dogs of other coteries. Coterie members gain fitness through the common defence from predators; the variety of sharp alarm calls, "all clear" signals, and other "barks" of prairie dogs are an important aspect of the social structure of this colonial species.

The coterie social structure corresponds to a reproductive function, since females normally mate with the resident male (Foltz and Hoogland 1981). Adult males will chase off any other adult males within the coterie territory. Normal minimum breeding age for both females and males is 2 years, but yearling females may breed if food and space are abundant (Koford 1958; Smith 1967; Garrett et al. 1982). Breeding times vary with site location, latitude, and specific geography of the colony. In the northern extent of the prairie dogs' range, breeding occurs from early March to April (King 1955; Koford 1958), whereas in Kansas breeding occurs from early February to the middle of March (Wade 1928; Smith

1967). Gestation lasts from 34-37 days, and the pups are nursed for about 7 weeks (Hoogland 1985). The number of litters raised per adult female is less than one per year, and there is high juvenile mortality. Infant and juvenile mortality is as high as 50% among the 3-5 pups born (Garrett et al. 1982). Infanticide by resident lactating females accounts for up to 51% of juvenile mortality (Hoogland 1985), but in this curious social system, these same females will sometimes nurse the pups of their kin as part of a limited communal breeding strategy (Hoogland 1983b).

Females will often remain in their natal coterie for their entire lifetimes with their siblings and other female relatives, while males of breeding age will emigrate to the ward boundaries or beyond to start new coteries, or will try to usurp the males on existing territories (Hoogland 1983a). Adult females may emigrate to unoccupied areas if they did not reproduce in the preceding breeding season (Cincotta et al. 1987), as will yearling females in crowded coteries. Adult males leave their breeding coteries before their daughters mature; they may attempt to invade another coterie, disperse, or simply perish in an outlying area (Hoogland 1982). There is high mortality among the emigres, since isolated prairie dogs fall more easily to predation on the borders of coteries and wards, or on rare occasions when they leave their wards (Hoogland 1981). Male dispersal is evidently a mechanism to avoid inbreeding; females are reluctant to mate with close male relatives (Hoogland 1982).

Population Density

Population density is dependent on the availability of food and opportunities for ward or colony expansion. Most plains habitat with colonies support at least 13 prairie dogs per hectare (Koford 1958), with the minimum density for a sustained population at about 10/ha (Lewis et al. 1979). Other densities reported include 32/ha in Colorado (Tileston and Lechleitner 1966) and 22/ha in South Dakota (King 1955). Food availability is often described as a major control on population (Koford 1958; Smith 1967), while the availability of suitable habitat for expansion may be the major limit to prairie dog population densities. Newly established and expanding towns have a greater proportion of successful pregnancies, larger and faster growing litters, higher adult survivorship, and twice the population density than old colonies with stable populations of black-tails (40/ha vs. 18/ha; Garrett et al. 1982).

Special Considerations

The black-tailed prairie dog was the most numerous and widespread herbivore in the American Western grasslands (Koford 1958). Up to the latter part of the 1800's, this species had an estimated population of 5 billion (Costello 1970), and a single colony in Texas spanned 64,750 square kilometers with over 400 million prairie dogs (Merriam 1902). The expeditions of Lewis and Clark and of Zebulon Pike gave the first written accounts of the species and reported a name given the prairie dog by Native Americans, "wishtonwish" (apparently from a territorial call of the prairie dogs; Coues 1895). Since the turn of the century, however, they have been labeled as destructive and dangerous pests. Early studies of the diet and habits of prairie dogs concluded that they competed directly with livestock for forage, and advised that they be eliminated from any "usable" range (Merriam 1902; Bell 1921; Kelso 1939). Both the Federal

Government and cattle ranchers followed that advice, as towns were destroyed by the plowing, shooting, and poisoning of millions of prairie dogs in the first half of this century. The mass extermination continued until the banning from public lands of secondary poisons, such as compound 1080, in 1972. From 1972 to the late 1970's, it is believed that prairie dog populations grew on Federal lands; this has lead to considerable agitation by ranchers to resume "management" of prairie dog towns on public lands (see USDA Forest Service 1977). Yet prairie dog populations are probably only 2% or less of their level a century ago (Coppock et al. 1983b).

The future treatment and proper management of the black-tailed prairie dog should be tempered by discoveries relating to the diet and ecology of the species. Competition between prairie dogs and cattle for forage on rangeland and the rodents' alleged destructive influence on range values were (and are) the main reasons given for eliminating prairie dogs. But when prairie dogs are poisoned out of overgrazed cattle range, plant productivity on that range does not improve (Uresk 1985). On range where both cattle and black-tails forage, cattle do not show any significant weight losses when compared to cattle foraging on range without prairie dogs (O'Meilia et al. 1982). Cattle, in fact, seem to prefer prairie dog towns for grazing locations (Knowles 1986), which may exacerbate already bad range conditions. The black-tailed prairie dog habit of invading overgrazed grasslands and other areas of little vegetative cover has implicated them as the cause of poor range conditions. But the presence of prairie dogs is an accurate indication that the range was already damaged and vegetation reduced by cattle or other human disturbance (see Knowles 1986). Prairie dogs unquestionably modify the development of grassland they occupy from the area that surrounds them, but their modification of environment may actually result in gains in productivity or diversity (Koford 1958; Bonham and Lerwick 1976; Coppock et al. 1983a; Agnew et al. 1986), and does not always damage rangeland. Grass is the main component of prairie dog diets in most areas, but they will consume vegetation which cattle will not (Bond 1945; Koford 1958; Smith 1967; Fagerstone 1979). Prairie dogs tend to maintain short-grass communities over time rather than cause devegetation and erosion (Koford 1958; Smith 1967; Costello 1970). If the prairie dog were overwhelmingly destructive to the short grass communities they maintain, it is not likely they would have flourished for the million or so years in which they shared the prairie with millions of bison and antelope (Clark 1968).

Prairie dog poisoning efforts by either the Government or private ranchers have been shown to be grossly uneconomical (Collins et al. 1984). In ecological terms, the costs of eliminating prairie dog colonies include the elimination of the prairie dog ecosystems. Prairie dogs are a regulator and representative of their own ecosystem, unique and set apart from the surrounding grassland ecosystems by the alteration of soil and vegetation. Prairie dog colonies are an important reservoir of diversity for plants, birds, and many carnivores (Clark et al. 1982; Coppock et al. 1983a; Agnew et al. 1986). Bison preferentially graze on prairie dog colonies (Coppock et al. 1983a). Rattlesnakes, desert cottontails (*Sylvilagus audubonii*), and burrowing owls (*Athene cunicularia*) use prairie dog burrows for cover and nesting (Butts and Lewis 1982; Clark et al. 1982), while other birds, such as mountain plovers (Charadrius montanus) and McCown's longspur (Calcarius mccownii), utilize prairie dog town habitat for feeding and cover locations (Clark et al. 1982; Knowles et al. 1982).

Poisoning of prairie dogs has adversely affected the predators that feed upon them, including the endangered black-footed ferret (Clark 1986). Badgers (Taxidea taxus), foxes (Vulpes spp.), coyotes (Canis latrans), bobcats (Lynx rufus), weasels (Mustela spp.), rattlesnakes, eagles, and hawks are also potential indirect targets of poisoning programs, through the consumption of poisoned animals and loss of prey (Koford 1958; Clark 1968; Clark et al. 1982).

Management of range with prairie dog colonies calls for logical decisions based on the best information available. Often, poisoning programs are started based on outdated management policies, uneducated opinion, and prejudicial evidence, or they may be halted by emotional pleas for the "cute" prairie dogs. For complete recovery of some grasslands and selected range, some sites may require the elimination of prairie dogs with simultaneous elimination of cattle grazing for years, possibly decades. But poisoning should be an option of last resort rather than the preferred method for prairie dog control. By encouraging predators, reducing grazing when possible, and by promoting the growth of higher and more dense cover surrounding prairie dog colonies, black-tailed prairie dog populations might be controlled in an ecologically sound manner (Osborn and Allen 1949; Koford 1958; Cincotta 1985).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model has been developed for application throughout the range of the black-tailed prairie dog (Figure 1).

Season. The model will produce HSI values for year-round habitat needs of the species.

Cover types. The model was developed to evaluate black-tailed prairie dog habitat in short-grass prairie and mixed-grass prairie cover types.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. A home range for a social animal such as the black-tailed prairie dog is hard to delineate, since coterie boundaries depend much on habitat quality, prairie dog density/social factors, and the age of a colony. Coterie sizes averaged 0.26 ha $\pm$ .12 in South Dakota (Hoogland 1981), and Lewis et al. (1979) suggested that a fenced area of 0.25 ha is large enough to encourage the establishment of a small transplanted colony of 3-10 black-tailed prairie dogs. Two individuals at an isolated site rarely survive or establish a new colony (Hoogland 1981; Knowles 1985). Therefore, in this model, any area smaller than 0.25 ha will be considered as unsuitable habitat.

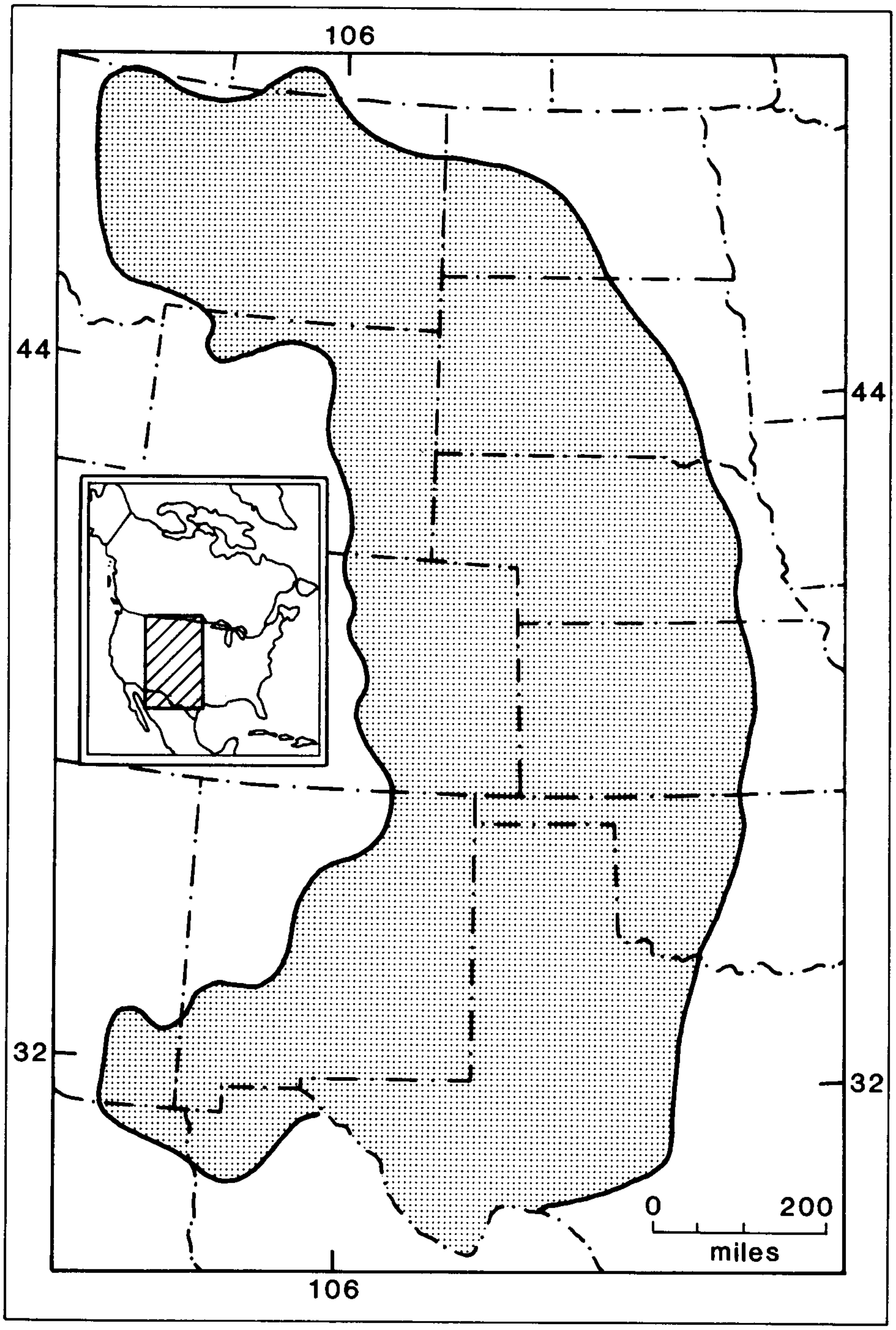

Figure 1. Range of the black-tailed prairie dog (Cynomys ludovicianus). From Hall (1981).

Verification level. This model has been reviewed by species authorities. The conclusions of a field test of this model have been incorporated into this version, with the modifications discussed below. A summary of the field test and suggested means of improvement of this model are included in a discussion following the model description.

Model Description

Overview. All habitat requirements of black-tailed prairie dogs are met by short-grass and mixed-grass prairie habitats. These two habitat types may be considered as one for the purposes of habitat evaluations, since the same variables in this model will apply to both short- and mixed-grass habitat types. It is assumed the life requisite for water is satisfied from the vegetation prairie dogs consume, and if the life requisite requirements for food and cover are satisfied, the reproductive habitat requirements for this species are also satisfied.

Relationships between habitat variables and life requisites of food and cover are presented in Figure 2. Note that the percentage of herbaceous cover is assumed to influence both food and cover values of the habitat.

The following sections identify the variables, define and justify the suitability levels of each variable, and describe the assumptions shaping the calculation of a HSI value for the black-tailed prairie dog.

Food component. The percentage of herbaceous cover (variable V_1) should be at least 15% for continuous habitation of an area by prairie dogs. The shape of the SI graph (Figure 3) was determined by observing the minimum cover of 25% reported on active prairie dog colonies (Fagerstone et al. 1977) and the maximum cover of 91% (Uresk 1984). The minimum cover is assumed to meet the year-round food requirements of black-tailed prairie dogs, while the maximum cover is limited by the visibility requirements for the species.

Cover component. Black-tailed prairie dogs avoid building burrows on slopes of more than 10%, and they do not build at all on slopes over 20%. Thus, variable V_2 (in Figure 3) shows a linear decline in SI values from 1 to 0 as slope increases from 10% to 20%. Koford (1958) mentioned that flat areas might be avoided by prairie dogs, but their occurrence in such flat terrain indicates that his observations may have been limited to areas where there is a history of flooding.

The average height of vegetative cover (variable V_3; Figure 3) and the slope of an area have the narrowest range of optimum habitat values of all the variables in this model. The SI graph for the height variable has been modified based on the field test data. The modified graph should be used in this version of the model.

Contrary to early descriptions of habitat preferences, prairie dogs will not likely occur in areas devoid of vegetation. There is a height below which grasses and forbs will not grow and will expire, ceasing to be a food source for prairie dogs. The minimum height for viable vegetative cover is near 5 cm for most plains locations. In most prairie dog towns, the height of vegetative cover

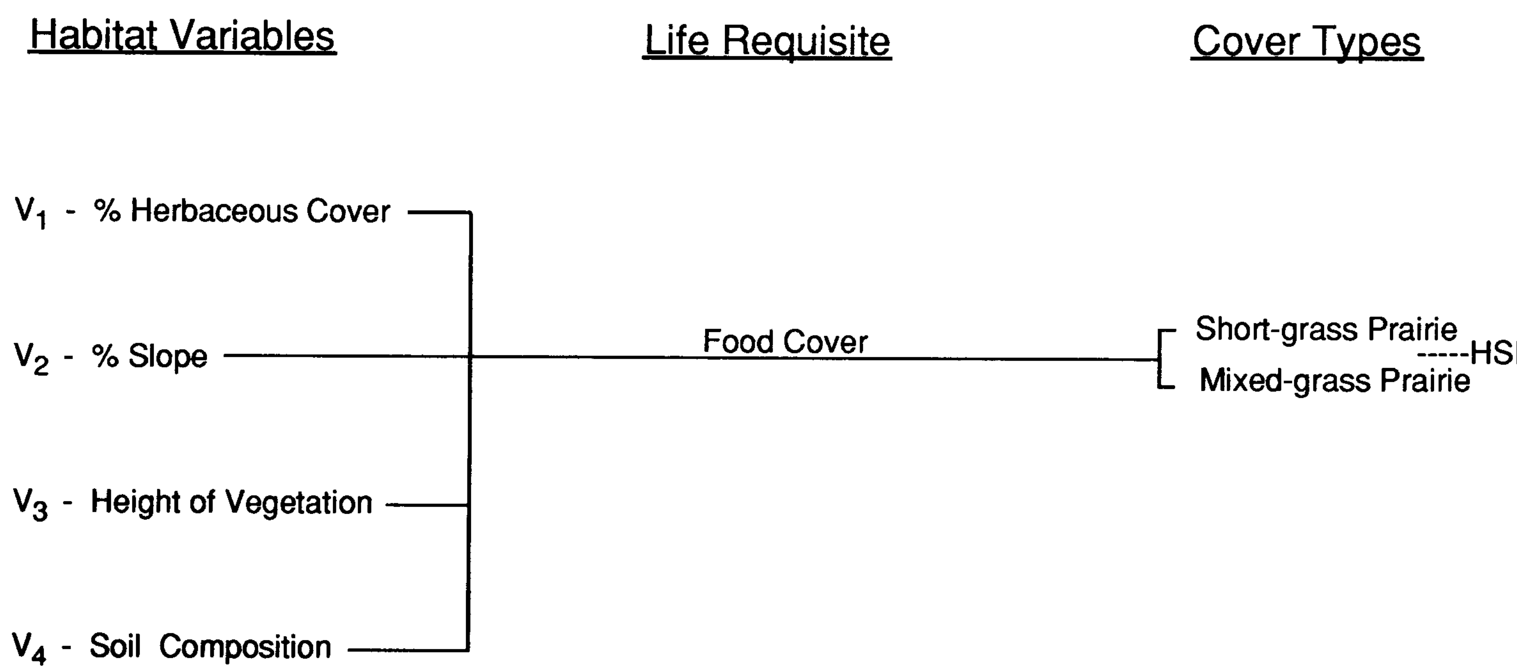

Figure 2. The relationship of habitat variables, life requisites, cover types, and the HSI for the black-tailed prairie dog model.

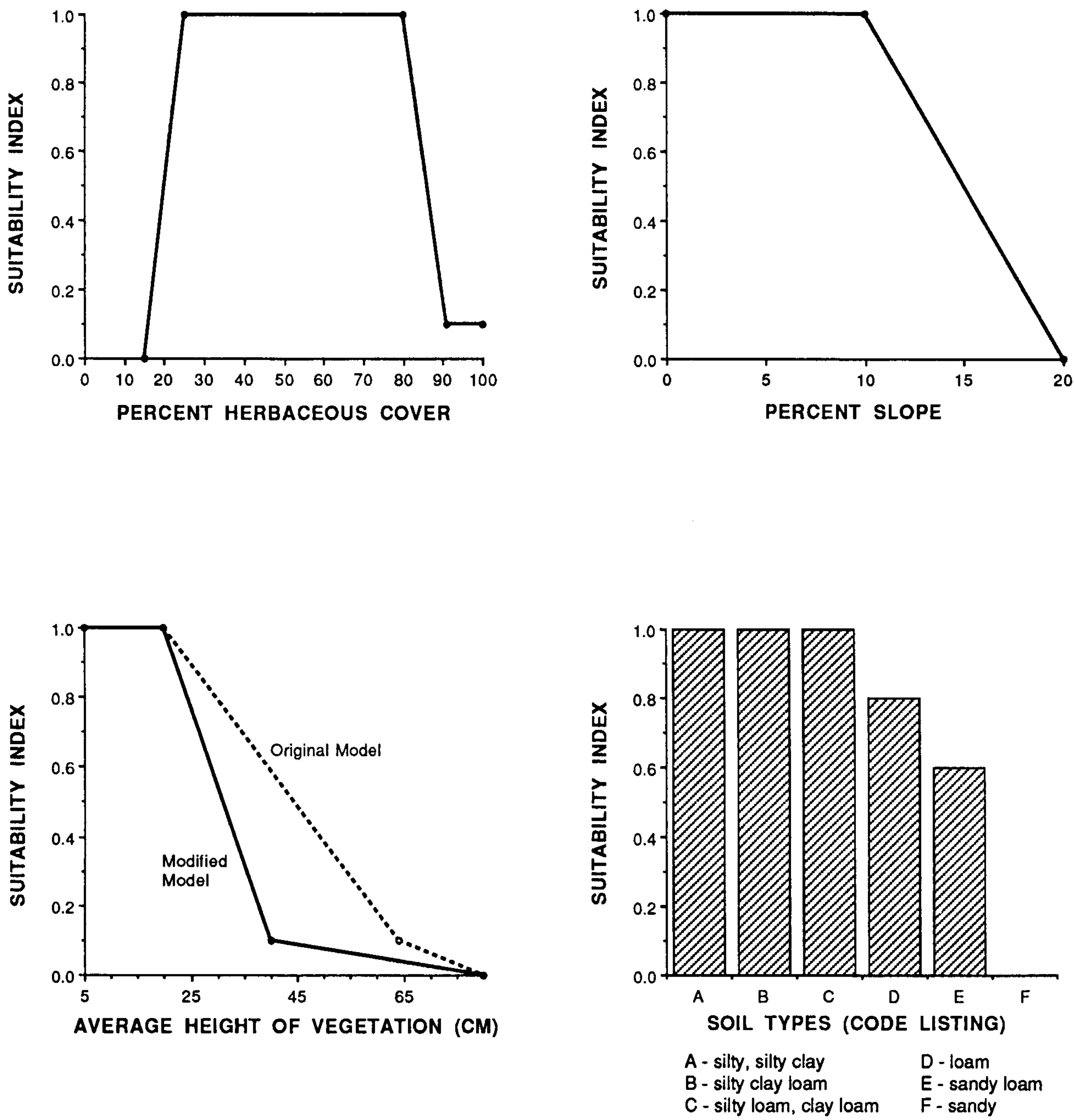

Figure 3. Suitability Index (SI) graphs for the four variables in the black-tailed prairie dog model.

averages from 7 cm and 13 cm up to 64 cm. Vegetation heights from 5 to 20 cm are considered optimal in this model, with a steep decline in habitat suitability for higher vegetation. Greater heights of vegetation might be tolerated on some locations if the overall cover is low; this would allow for high visibility for prairie dogs.

The soil type in an area (variable V_4; Figure 3) has perhaps the widest range of optimum values of all the variables. Prairie dogs are known to avoid excessively sandy areas for their burrows. They are most often found in silty loam clay soils, but will use other substrates which will support a burrow system.

Model Relationships

Suitability index (SI) graphs for habitat variables. The SI graphs are presented in Figure 3. All variables are numeric, except for Soil Composition (V_4), which displays SI values based on a category.

Equation for HSI determination. The variables from life requisites for food and cover are included in the equation below:

$$(V_1 \times V_2 \times V_3 \times V_4)^{1/4} = HSI$$

Field Testing and Modification of this HSI Model

A field test of the black-tailed prairie dog model was completed in the summer of 1987 at Rocky Mountain Arsenal (RMA) near Denver, Colorado. RMA was a chemical weapons production facility for the U.S. Army and was partially leased to Shell Chemical Company. These two tenants contributed to toxic waste contamination at various locations across the site. However, due to its isolation from surrounding land use options (mostly agricultural and residential), lack of grazing, and the restriction of hunting, RMA contains a diverse collection of vertebrate plains species, including 5,000 acres (1,961 ha) of prairie dog colonies (Clippinger 1987).

Data were collected on five habitat variables on twenty-one 1-ha plots randomly distributed over the RMA colonies, including a variable which was eventually eliminated from the model, relative herbaceous cover of forbs. Forb cover, overall cover, and average height of species were determined on two 50-m transects within the plot boundaries. Slope was determined by taking the maximum slope found on each plot, while soil types were deduced from Soil Conservation Service maps of RMA in comparison with plot locations. Prairie dog densities on the plots were then determined by a visual count of all prairie dogs above ground in the morning activity period. The population estimates were then compared to an HSI value calculated for each plot from the habitat data (a geometric mean of the five SI's). A simple Pearson's correlation coefficient was calculated from this data.

The HSI model values as originally formulated correlated significantly ($r = 0.45$, $p = 0.05$; see Figure 4) with prairie dog densities on the RMA plots. By examining the relationship of vegetation height to the HSI values calculated, it was hypothesized that lower SI values for this variable at heights greater than 20 cm would create a better fit to population densities (see Figure 3). Forb SI's varied from 0 to 1.0, but did not seem to correlate at all to the populations found on the plots. The forb cover variable was eliminated from the model based on author review and the above field test results. The modified HSI model values did indeed correlate closer with population densities found on RMA ($r = 0.49$, $p = 0.02$; Figure 5).

There was very little variability in the soil and slope SI's over RMA plots. Only 2 of 21 slope SI's were below 1.0, which was also the case with the cover variable. Twelve of the 21 plots had a sandy loam soil type, lending little variability in soil SI values. This made it difficult to make a judgement on the validity of the soil type variable. The slope and herbaceous cover variables were only expected to influence habitat quality at extreme percentages.

Prairie dogs require at least 5% of their diet in forbs for nutritional purposes. Thus, the original form of the HSI model held that habitat with at least 10% relative cover of forbs was preferred habitat. The forbs cover variable was eventually eliminated by the model verification procedure. The studies reviewed for this model and the results the field test of this HSI model indicated that increases in plant species diversity (including forbs) may lead to more favorable habitat for prairie dogs. High plant species diversity is generally encouraged by the grazing and burrowing habits of this species. Areas which are inhabited by prairie dogs for 3 or more years may naturally develop the diversity in vegetation on which prairie dogs seem to thrive (Whicker and Detling 1988). A variable which could measure diversity of grasses and forbs on prairie dog colonies and assign a SI value may be developed in the future, but was not included in the validation study for this model.

Long-term testing of prairie dog habitat preferences is suggested by the RMA studies, and should involve introduction of prairie dogs to uncolonized sites with carefully selected variable values (e.g., high slope with low vegetation, high species diversity; low slope with medium height vegetation, low diversity) and observation of densities and variable value changes over time.

Colonial Species, Carrying Capacity, and HSI

If we examine the graphs of the original and modified HSI values versus population (Figures 4 and 5), there is a paucity of HSI values from 0 to about 0.5. This may be due to the lack of sampling in the extreme ranges of variables such as cover. But since I sampled randomly, and only within the boundaries of prairie dog towns, the absence of HSI values in this low range may be due to the colonial nature of black-tailed prairie dogs and the need for a threshold of habitat value for prairie dogs to inhabit an area. As previously stated, prairie dogs will not continue to survive in isolation or thrive in small groups (less than 10 per ha). Thus, an area's vegetation, soil, and slope characteristics (its habitat value) must be sufficient to support a minimum of about two coteries or 15 prairie dogs per hectare, not just one or a few prairie dogs. It then follows logically that there should be a minimum or threshold value for the HSI

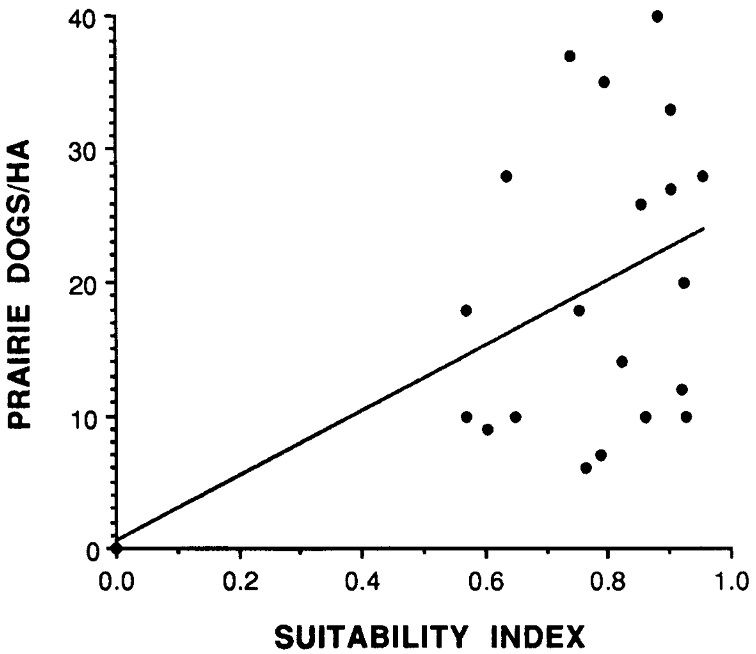

Figure 4. Prairie dog populations on RMA and corresponding HSI values for the original HSI model (includes a best fit regression line).

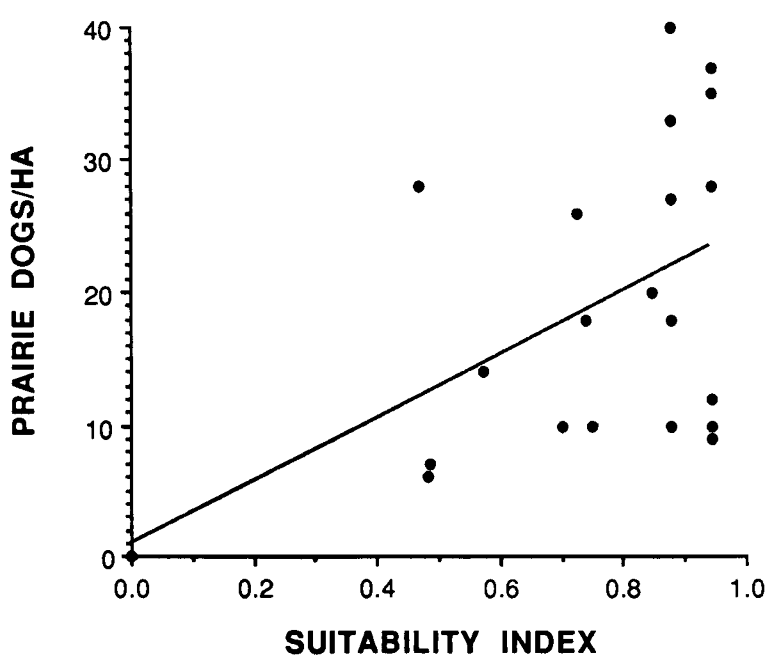

Figure 5. Prairie dog populations on RMA plots and corresponding HSI values for the modified HSI model (includes a best fit regression line).

on any site to allow successful colonization or continuation of prairie dogs in a given area. The data from RMA suggest that this is indeed the relationship between HSI and populations of prairie dogs. Certainly, the line describing this relationship in Figures 4 and 5 lacks validity under scrutiny; the relationship between HSI and population density would appear to be either linear from a threshold HSI value, or a nonlinear function from the origin. Although the data from the RMA plots would be inadequate to test these hypotheses directly, the conclusions seem logical, based on available evidence.

A threshold or minimum HSI may hold for other species as well as for prairie dogs. Other colonial species, or species which depend on a minimum density of individuals for reproduction, also would require a minimum habitat value for survival in an area. The consideration of colonial species' requirements appears to be an aspect of HSI modeling which requires further investigation.

A more detailed treatment of the model test at RMA may be found in a thesis on the subject (Clippinger 1987).

<u>Application of the Model</u>

This model may be applied by making a number of simple observations on the vegetation and soil of an area. The variable definitions and suggested field techniques are presented in Table 1. The model was calibrated to generate an HSI for a 1-ha plot. Any study area larger than 2-3 ha should contain multiple 1-ha samples.

Table 1. Suggested techniques for gathering information on habitat variables.

Variable	(definition)	Cover type	Suggested technique
V_1	Percent canopy cover of herbaceous vegetation.	SgP, MxgP	As above for forb cover.
V_2	Slope (%).	SgP, MxgP	Clinometer, topographic maps.
V_3	Mean height of herbaceous canopy (mean distance from the ground surface to the dominant height stratum of the herbaceous canopy).	SgP, MxgP	Graduated rod (along transects).
V_4	Soil texture.	SgP, MxgP	Soil texture by feel (Hays et al. 1981); deduction from soil maps.

This model should only be applied to the black-tailed prairie dog, and not to any of the other four species of _Cynomys_ (white-tailed prairie dogs; the threatened Utah prairie dog, _C. parvidens_; Gunnison's prairie dog, _C. gunnisoni_; and the Mexican prairie dog, _C. mexicanus_). White-tailed, Utah, and Gunnison's prairie dogs have loosely social towns of lower density and lesser impact on vegetation, which is ecologically quite different from the black-tails' dense, highly social colonies with short vegetation.

The black-tailed prairie dog model could be used in making management decisions on prairie dogs and the species that depend on prairie dogs as prey. Possible uses of this model include the evaluation of current colony sites for habitat suitability, the evaluation of possibilities for colony expansion, and the suitability of sites for transplantation or rehabilitation by prairie dogs.

REFERENCES

Agnew, W., D.W. Uresk, and R.M. Hansen. 1986. Flora and fauna associated with prairie dog colonies and adjacent ungrazed mixed grass prairie in western South Dakota. J. Range Manage. 39:135-139.

Bell, W.B. 1921. Death to the rodents. Pages 421-428 _in_ USDA Yearbook 1920.

Bond, R.M. 1945. Range rodents and plant succession. Trans. of the North American Wildlife and Natural Resource Conference 10:229-234.

Bonham, C.D., and A. Lerwick. 1976. Vegetation changes induced by prairie dogs on shortgrass range. J. Range Manage. 29:221-225.

Butts, K.O., and J.C. Lewis. 1982. The importance of prairie dog towns to burrowing owls in Oklahoma. Proc. Okla. Acad. Sci. 62:46-52.

Cincotta, R.P. 1985. Habitat and dispersal of black-tailed prairie dogs in Badlands National Park. Ph.D. dissertation. Colorado State University, Fort Collins. 52 pp.

Cincotta, R.P., D.W. Uresk, and R.M. Hansen. 1987. Demography of black-tailed prairie dog populations reoccupying sites treated with rodenticide. Great Basin Nat. 47:339-343.

Clark, T.W. 1968. Ecological roles of prairie dogs. Wyoming Range Manage. 261:102-104.

Clark, T.W. 1971. Bibliography: Literature concerning prairie dogs. Wyoming Range Manage. 286:29-44.

Clark, T.W. 1986. Black-footed ferret technical introduction. Great Basin Nat. Mem. 8:8-10.

Clark, T.W., T.M. Campbell, III, D.G. Socha, and D.E. Casey. 1982. Prairie dog colony attributes and associated vertebrate species. Great Basin Nat. 42:572-582.

Clippinger, N.W. 1987. Habitat suitability for the black-tailed prairie dog at Rocky Mountain Arsenal. M.S. Thesis. University of Colorado, Boulder.

Collins, A.R., J.P. Workman, and D.W. Uresk. 1984. An economic analysis of black-tailed prairie dog control. J. Range Manage. 37:358-361.

Cook, J.G., and L.L. Irwin. 1985. Validation and modification of a habitat suitability model for pronghorns. Wildl. Soc. Bull. 13:440-448.

Coppock, D.L. 1981. Impacts of black-tailed prairie dogs on vegetation in Wind Cave National Park. M.S. Thesis. Colorado State University, Fort Collins.

Coppock, D.L., J.E. Ellis, J.K. Detling, and M.I. Dyer. 1983a. Plant-herbivore interactions in a North American mixed-grass prairie. 2: responses of Bison bison to modification of vegetation by prairie dogs. Oecologia 56:10-15.

Coppock, D.L., J.K. Detling, J.E. Ellis, and M.I. Dyer. 1983b. Plant herbivore interactions in a North American mixed-grass prairie. 1: effects of black-tailed prairie dogs on intra-seasonal aboveground biomass, nutrient dynamics, and plant species diversity. Oecologia 56:1-9.

Costello, D.F. 1970. The world of the prairie dog. J.B. Lippincott Co., New York. 160 pp.

Coues, E. 1895. The expeditions of Zebulon Montgomery Pike, vol. 2: Arkansaw journey to Mexican tour. Francis P. Harper, New York. 855 pp.

Dalsted, K.J., S. Sather-Blair, B.K. Worcester, and R. Klukas. 1981. Application of remote sensing to prairie dog management. J. Range Manage. 34:218-223.

Environmental Science and Engineering, Inc. (ESE). 1989. Remedial investigation for biota. Draft final report. Rocky Mountain Arsenal. Prepared for the Office of the Program Manager, RMA.

Fagerstone, K.A. 1979. Food habits of the black-tailed prairie dog. M.S. Thesis. University of Colorado, Boulder. 161 pp.

Fagerstone, K.A., and O. Williams. 1982. Use of C3 and C4 plants by black-tailed prairie dogs. J. Mammal. 63:328-331.

Fagerstone, K.A., H.P. Tietjen, and G.R. LaVoie. 1977. Effect of range treatment with 2,4-D on prairie dog diet. J. Range. Manage. 30:57-60.

Fagerstone, K.A., H.P. Tietjen, and O. Williams. 1981. Seasonal variation in the diet of black-tailed prairie dogs. J. Mammal. 62:820-824.

Foltz, D.W., and J.L. Hoogland. 1981. Analysis of the mating system in the black-tailed prairie dog by likelihood of paternity. J. Mammal. 62:706-712.

Garrett, M.G., J.L. Hoogland, and W.L. Franklin. 1982. Demographic differences between an old and a new colony of black-tailed prairie dogs. Am. Mid. Nat. 108:51-59.

Hall, E.R. 1981. Mammals of North America, 2nd ed. Wiley and Sons, New York. 1181 pp.

Hansen, R.M., and I.K. Gold. 1977. Black-tail prairie dogs, desert cottontails and cattle trophic relations on shortgrass range. J. Range Manage. 30:210-214.

Harlow, H.J., and G.E. Menkins. 1986. A comparison of hibernation in black-tailed prairie dogs, white-tailed prairie dogs, and Wyoming ground squirrels. Can. J. Zool. 64:793-796.

Hassien, F. 1976. Prairie dog bibliography. Technical Note No. 279. Department of the Interior, Bureau of Land Management. 28 pp.

Hays, R.L., and J.E. Heasley. 1985. Users manual for MICRO-HSI. U.S. Fish Wildl. Serv., HEP Software Support. Fort Collins, CO.

Hays, R.L., C. Summers, and W. Seitz. 1981. Estimating habitat variables. U.S. Fish Wildl. Serv., OBS Publ. 81/47. Fort Collins, CO. 111 pp.

Hoogland, J.L. 1979a. The effect of colony size on individual alertness of prairie dogs. Anim. Behav. 27:394-407.

Hoogland, J.L. 1979b. Aggression, ectoparasitism, and other possible costs of prairie dog coloniality. Behaviour 69:1-35.

Hoogland, J.L. 1981. The evolution of coloniality in white-tailed and black-tailed prairie dogs. Ecology 62:252-272.

Hoogland, J.L. 1982. Prairie dogs avoid extreme inbreeding. Science 215:1639-1641.

Hoogland, J.L. 1983a. Nepotism and alarm calling in the black-tailed prairie dog. Anim. Behav. 31:472-479.

Hoogland, J.L. 1983b. Black-tailed prairie dog coteries are cooperatively breeding units. Am. Nat. 121:275-280.

Hoogland, J.L. 1985. Infanticide in prairie dogs: lactating females kill offspring of close kin. Science 230:1037-1040.

Houston, B.R., T.W. Clark, and S.C. Minta. 1986. Habitat suitability index model for the black-footed ferret: a method to locate transplant sites. Great Basin Nat. Mem. 8:99-114.

Jones, J.K., D.M. Armstrong, and J.R. Choate. 1985. Guide to mammals of the plains states. University of Nebraska Press, Lincoln. 371 pp.

Kelso, L.H. 1939. Food habits of prairie dogs. U.S. Dept. Agric. Circ. No. 529. 15 pp.

King, J.A. 1955. Social behavior. social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Univ. Michigan Cont. Lab. Vert. Zool. 67:1-123.

King, J.A. 1984. Historical ventilations on a prairie dog town. Pages 447-556 in the biology of ground dwelling squirrels. J.O Murie, and G.R. Michener, eds. Univ. of Nebraska Press, Lincoln.

Klatt, L.E., and D. Hein. 1978. Vegetative differences among active and abandoned towns of black-tailed prairie dogs. J. Range Manage. 31:315-317.

Knowles, C.J. 1985. Observations on prairie dog dispersal in Montana. Prairie Nat. 17:33-40.

Knowles, C.J. 1986. Some relationships of black-tailed prairie dogs to livestock grazing. Great Basin Nat. 46:198-203.

Knowles, C.J. 1987. Reproductive ecology of prairie dogs in Montana. Great Basin Nat. 47:202-206.

Knowles, C.J., C.J. Stoner, and S.P. Gieb. 1982. Selective use of black-tailed prairie dog towns by mountain plovers. Condor 84:71-74.

Koford, C.B. 1958. Prairie dogs, whitefaces, and blue grama. Wildl. Monographs No. 3. 78 pp.

Krueger, K. 1986. Feeding relationships among bison, pronghorn, and prairie dogs: an experimental analysis. Ecology 67:760-770.

Layher, W.G., O.E. Maughan, and W.D. Warde. 1987. Spotted bass habitat suitability related to fish occurrence and biomass and measurements of physicochemical variables. N. Am. J. Fish Manage. 7:238-251.

Lechleitner, R.R. 1969. Wild mammals of Colorado. Pruett Publishing Co., Boulder, Colorado.

Lerwick, A.C. 1974. The effects of the black-tailed prairie dog on vegetative composition and their diet in relation to cattle. M.S. Thesis. Colorado State University, Fort Collins.

Lewis, J.C., E.H. McIlvain, R. McVickers, and B. Peterson. 1979. Techniques used to establish and limit prairie dog towns. Proc. Okla. Acad. Sci. 59:27-30.

Merriam, C.H. 1902. The prairie dog of the great plains. Pages 257-270 in U.S. Dept. Agric. Yearbook, 1901.

O'Meilia, M.E., F.L. Knopf, and J.C. Lewis. 1982. Some consequences of competition between prairie dogs and beef cattle. J. Range Manage. 35:580-585.

Osborn, B., and P.F. Allan. 1949. Vegetation of an abandoned prairie dog town in tall grass prairie. Ecology 30:322-332.

Sheets, R.G., R.L. Linder, and R.B. Dahlgran. 1971. Burrow systems of prairie dogs in South Dakota. J. Mamm. 52:451-453.

Smith, R.E. 1967. Natural history of the prairie dog in Kansas. Univ. Kansas Mus. Nat. Hist. and State Biol. Surv. Kansas Misc. Publ. No. 49. 39 pp.

Stromberg, M.R. 1978. Subsurface burrow connections and entrance spatial pattern of prairie dogs. Southwest Nat. 23:173-180.

Summers, C.A., and R.L. Linder. 1978. Food habits of the black-tailed prairie dog in western South Dakota. J. Range Manage. 31:134-136.

Tileston, J.V., and R.R. Lechleitner. 1966. Some comparisons of the black-tailed and white-tailed prairie dogs in north-central Colorado. Am. Midl. Nat. 75:292-316.

U.S. Department of Agriculture, Forest Service. 1977. Forest Service environmental statement: management of prairie dogs on land administered by the supervisor of the Nebraska National Forest. USDA-F2-R2-FES (ADM).

U.S. Fish and Wildlife Service. 1981a. Standards for the development of habitat suitability index models. 103 ESM. U.S. Fish Wildl. Serv., Div. Ecol. Serv. n.p.

U.S. Fish and Wildlife Service. 1981b. Habitat Evaluation Procedures. 102 ESM. U.S. Fish Wildl. Serv., Div. Ecol. Serv. n.p.

Uresk, D.W. 1984. Black-tailed prairie dog food habits and forage relationships in western South Dakota, USA. J. Range Manage. 37:325-329.

Uresk, D.W. 1985. Effects of controlling black-tailed prairie dogs on plant production. J. Range Manage. 38:466-468.

Wade, O. 1928. Notes on the time of breeding and number of young of Cynomys ludovicianus. J. Mamm. 9:149-151.

Whicker, A.D., and J.K. Detling. 1988. Ecological consequences of prairie dog disturbances. Bioscience 38(11):778-785.

Young, S.P. 1944. Longevity and other data on a male and female prairie dog kept as pets. J. Mamm. 25:317-319.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. Biological Report 82(10.156)	2.	3. Recipient's Accession No.

4. Title and Subtitle
Habitat Suitability Index Models: Black-Tailed Prairie Dog

5. Report Date
July 1989

6.

7. Author(s)
Norman W. Clippinger

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Hunter Environmental Associates
7332 South Alton Way
Suite H
Englewood, CO 80112

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Department of the Interior
Fish and Wildlife Service
Research and Development
Washington, DC 20240

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the black-tailed prairie dog (Cynomys ludovicianus). The model consolidates habitat use information into a framework appropriate for field application, and is scaled to produce an index between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). HSI models are designed to be used with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

17. Document Analysis a. Descriptors

Mammals
Wildlife
Habitability
Mathematical models

b. Identifiers/Open-Ended Terms

Black-tailed prairie dog
Cynomys ludovicianus
Habitat suitability

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release unlimited	Unclassified	21
	20. Security Class (This Page)	22. Price
	Unclassified	

(See ANSI-Z39.18) See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

☆ U.S. GOVERNMENT PRINTING OFFICE: 1989 - 676-651/5124