

**American Hog-nosed Skunk
(*Conepatus leuconotus*):
A Technical Conservation Assessment**



**Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project**

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COVER PHOTO CREDIT

Photograph of an American hog-nosed skunk (*Conepatus leuconotus*) taken by Loyd Hampton using a Penn's Woods Digital-Scout Model DS-03 camera on the NLH Ranch located 5.5 miles east of Lometa in Lampasas County, Texas, May 2004. Animal is possibly a juvenile or subadult. Used with permission.

LIST OF ERRATA

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF AMERICAN HOG-NOSED SKUNK

The USDA Forest Service (USFS) Rocky Mountain Region (Region 2) has designated the American hog-nosed skunk (*Conepatus leuconotus*) as a sensitive species. Within Region 2, this species occurs only in Colorado, where it reaches its northernmost distributional limit. Recent morphological and genetic work suggests that it and the western hog-nosed skunk (*C. mesoleucus*) should be recognized as one species, *C. leuconotus*. This taxonomy is widely accepted and is followed in this assessment.

Little is known about the natural history, distribution, and density of the American hog-nosed skunk anywhere in its range; most research on its biology and ecology has occurred in Texas. The species appears to be associated with riparian areas, rocky canyonlands, piñon-juniper woodlands, shrublands, and grasslands that contain brushy and rocky habitat.

The current status and viability of hog-nosed skunk populations in Colorado are unknown. Until the collection of a footprint in 1996 and two skulls in 1997 and 2000, from animals estimated to have died from 2 to 15 years earlier, there had been no new evidence of this species in Colorado since 1932. There are only 14 records or specimens of the species in the state, and most of these are from early decades of the last century. Extant populations in Colorado, along with those from western Oklahoma and northeastern New Mexico, may represent a population or metapopulation. A roadkill specimen documented in 2003 in New Mexico at the Colorado state line raises the possibility of connectivity between populations in the Colorado foothills and those in New Mexico.

Biologists who have worked with this species, especially in Texas, believe that it is experiencing rangewide decline. While the causes of this apparent decline are unknown, suggested reasons include habitat loss; conversion of brushy habitat to agriculture, and the attendant use of insecticides; grazing, and the attendant loss of grassland and forb understory; fire suppression, and the resulting changes in plant communities; and in Texas and elsewhere, potential competition with introduced feral hogs (*Sus scrofa*). Past predator control efforts, disease, and roadkill may also be factors. However, the apparent decline in numbers is exacerbated by the extreme difficulty in detecting the animals, which has been attempted by live capture, baited track plates, and baited remote cameras. One of the most successful means of detecting American hog-nosed skunks is roadkill surveys. Recent survey efforts in Texas are promising and will likely provide much-needed information on the species that can be applied rangewide.

The first step in developing management plans that address the needs of the American hog-nosed skunk in Region 2 is an active assessment of the species' current presence in Colorado. Because limited resources make surveying the complete range of a widely distributed, low-density, nocturnal species difficult, assessments of potential habitat and a team approach will be key to management and conservation of the species. An initial assessment might involve a coordinated approach, beginning with the establishment of an inter-agency team of biologists and managers, with subsequent inclusion of interested landowners and other stakeholders. Our predicted range model can be used to define potential suitable habitat and prime locations for subsequent efforts that would include a public education effort, development of a protocol for roadkill surveys, and general queries to agency staff and landowners. In terms of habitat management, conservation likely requires retention of and management for good foraging habitat that supports abundant insect populations, such as areas with well-developed leaf litter and herbaceous understory, and brush-dominated habitat. At this point, research needs are great due to the dearth of existing information. Coordination with researchers in other states where studies are being conducted will be of value.

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INTRODUCTION

This conservation assessment is one of many being produced for the Species Conservation Project being conducted by the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS) (Figure 1). The American hog-nosed skunk (*Conepatus leuconotus*) is the focus of an assessment because it is listed as a sensitive species by Region 2. Within the National Forest System, a sensitive species is a plant or animal whose population viability is identified as a concern by a regional forester because of significant current or predicted downward trends in abundance or significant current or predicted downward trends in habitat capability that would reduce its distribution (FSM 2670.5 (19)). A sensitive species may require special management, so knowledge of its biology and ecology is critical. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

This assessment addresses the biology of American hog-nosed skunks throughout their range, but primarily in Texas since this is where most research on the biology and ecology of this species has been completed. Thus, there may be some constraints in extrapolating information in this assessment to other locales, including Colorado. This is a necessary shortcoming, however, due to the dearth of existing information. There are no published studies of the species in Colorado, although there are published anecdotal accounts. Nomenclature, including the common name, follows Wozencraft (2005).

Goal

Species conservation assessments produced for the Species Conservation Project are designed to provide land managers, biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species

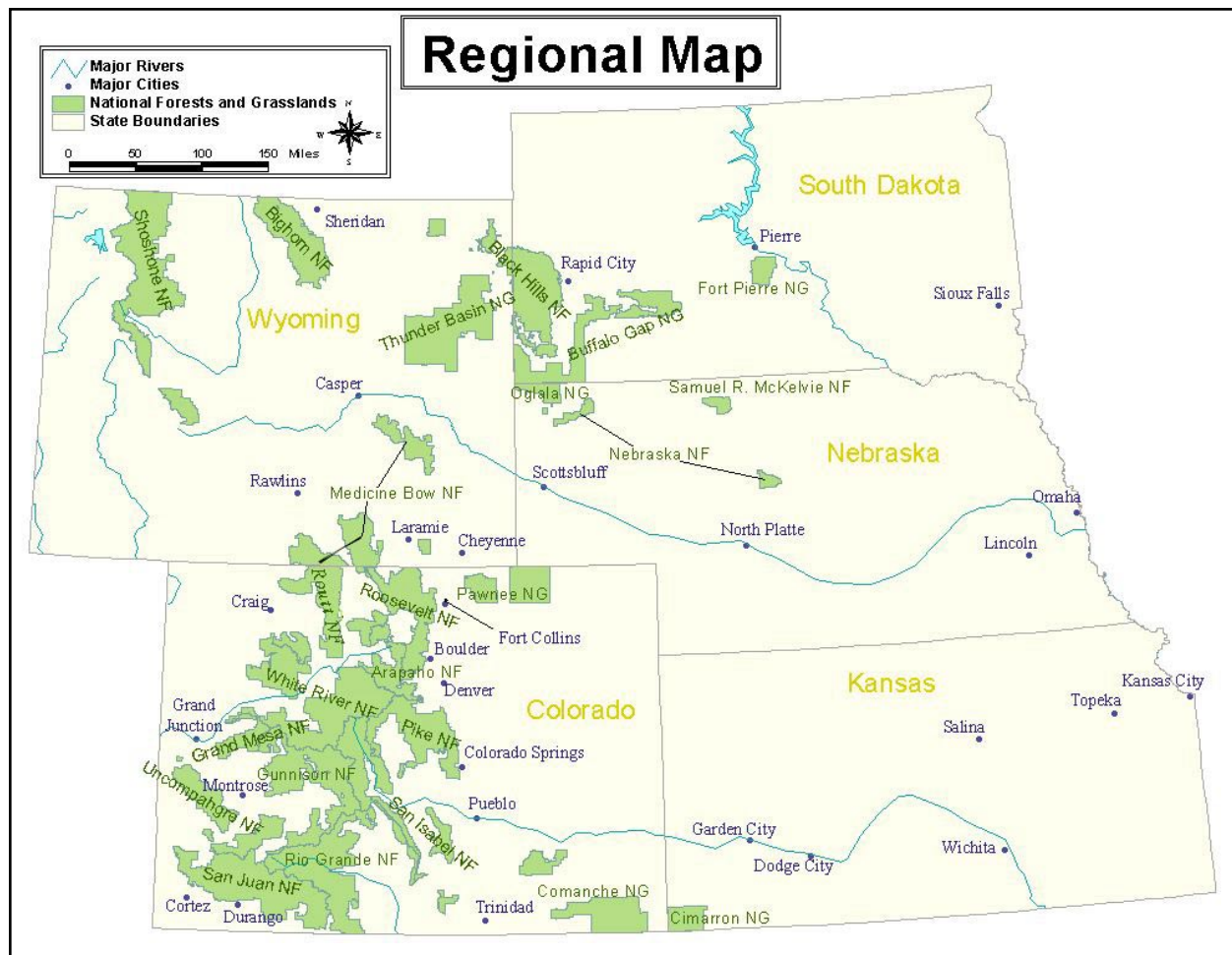


Figure 1. National forests and grasslands within USDA Forest Service Region 2.

based on current scientific knowledge. Assessment goals limit the scope of the work to critical summaries and syntheses of scientific knowledge, discussion of implications of that knowledge, and outlines of information needs. While the assessment is not intended to prescribe management for the USFS, it does provide the ecological background upon which management must be based and offers insight into the conservation needs of the species in this region. The assessment focuses on the consequences of changes in the environment that result from management (i.e., management implications) that managers will use to guide land management decisions. Furthermore, we discuss management proposed or implemented elsewhere.

Scope

This American hog-nosed skunk conservation assessment examines the biology, ecology, conservation status, and management of this species with specific reference to the geographic and ecological characteristics of Region 2. Although a majority of the literature on the species originates from field investigations in Texas, this document places that literature in the ecological and social contexts of its range in Region 2, in this case, southeastern Colorado. Similarly, this assessment is concerned with characteristics of American hog-nosed skunks in the context of the current environment. The evolutionary environment of the species is considered in conducting the synthesis, but it is placed in a current context. In producing the assessment, we reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. Not all publications on American hog-nosed skunks are referenced in the assessment, nor were all published materials considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. Non-refereed publications or reports were regarded with greater skepticism and used when refereed information was unavailable or when it contributed important insights to our understanding of American hog-nosed skunks in this region. However, the lack of published journal articles created a need to rely on all existing sources to the fullest extent possible. We also made use of the knowledge of agency staff and faculty at academic institutions. Unpublished data (e.g., specimens from the Denver Museum of Nature and Science and University of Colorado Museum, and records from the Colorado Natural Heritage Program) were important in estimating the current and historic geographic distribution of the American hog-nosed skunk in Colorado.

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clear results in the ecological sciences, and often observations, inference, good thinking, and models must be relied upon to guide the understanding of ecological relationships (Chamberlain 1897, Hilborn and Mangel 1997).

In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described where appropriate. Because there is so little information – published work, unpublished reports, observations – available for American hog-nosed skunks, alternative approaches such as critical assessment of and inference from observations, in addition to the published literature and unpublished reports, were accepted as sound approaches to understanding the species. When dealing with uncertainty in this assessment, we always noted when inferences were made, and we used phrases such as ‘is likely to,’ ‘is probable that,’ and ‘might be’ when the strength of evidence for particular ideas was not certain. Much of the uncertainty in this assessment is related to the lack of available information.

Publication of Assessment on the World Wide Web

To facilitate their use, species conservation assessments are being published on the USFS Region 2 World Wide Web site (<http://www.fs.fed.us/r2/projects/scp>). Placing the documents on the Web makes them available to agency biologists, managers, and the public more rapidly than publishing them as reports. More important, it facilitates revision of the assessments, which will be accomplished following protocols established by Region 2.

Peer Review

In keeping with the standards of scientific publication, assessments developed for the Species Conservation Project have been externally peer reviewed prior to their release on the Web. This assessment was reviewed through a process administered by the Society

for Conservation Biology, which chose two recognized experts (on this or related taxa) to provide critical input on the manuscript.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Federal Endangered Species Act

The American hog-nosed skunk currently has no federal status under the Endangered Species Act, but it has been given an International Union for the Conservation of Nature Red List Category of LC - Least Concern. A subspecies, *Conepatus leuconotus texensis*, was a candidate for federal listing until 1997 (62 FR 49191).

USDA Forest Service

The range of the American hog-nosed skunk encompasses portions of three USFS regions: the Rocky Mountain Region (Region 2), Southwestern Region (Region 3), and the Southern Region (Region 8). Only Region 2 formally designates the American hog-nosed skunk as a sensitive species (USDA Forest Service 2005; <http://www.fs.fed.us/r2/projects/scp/sensitivespecies/index.shtml>). USFS sensitive species are designated “as appropriate in order to focus conservation management strategies and to avert the need for Federal or State listing

as a result of National Forest management activities.” (Forest Service Manual 2670.5; <http://www.fs.fed.us/biology/tes/index.html>). Sensitive species designation by USFS requires the development and implementation of conservation strategies, including coordinated management objectives with state and federal agencies and other cooperators as appropriate. Approaches may include collaboratively developing individual species or multi-species conservation strategies, formalizing interagency conservation agreements, and incorporating recommendations into management direction set forth in Land and Resource Management Plans (Pivorunas 2005 cited in USDA Forest Service 2005).

Bureau of Land Management

The Bureau of Land Management assigns the American hog-nosed skunk no protective designations or measures.

State wildlife agencies

The primary regulatory and management authority for the hog-nosed skunk rests with the states where it occurs. State status designations range from “predator” to “species of concern” (**Table 1**).

Within Region 2, the American hog-nosed skunk is found only in Colorado, where the Colorado Division of Wildlife (CDOW) classifies it as a nongame species. The CDOW describes its distribution and density in

Table 1. Status of the American hog-nosed skunk (*Conepatus leuconotus*) in states throughout its range. USDA Forest Service (USFS) Region 2 states are in bold.

State	Natural Heritage Program rank ^a	State wildlife management agency classification	Bureau of Land Management designation	USFS designation
Arizona	G4/S4	Predator – Legally harvested with year-long season	None	None
Colorado	G4/S1	Nongame	None	Sensitive
New Mexico	G4/S2	Unprotected Furbearer - Legally harvested with year-long season	None	Sensitive
Oklahoma	G4/S2	Category II Species of Concern	None	Sensitive
Texas	G4/S4	Furbearer - Legally harvested	None	Sensitive

^a – G = global rank, S = state rank.

1 – Critically imperiled because of extreme rarity (5 or fewer records of occurrence in the state or less than 1,000 individuals) or because of extreme vulnerability to extinction within the state due to some natural or man-made factor.

2 – Imperiled because of rarity (6 to 20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction within the state due to some natural or man-made factor.

3 – Vulnerable throughout its range within the state or found locally in a restricted range (known from 21 to 100 occurrences or less than 10,000 individuals).

4 – Apparently secure within the state though it may be quite rare in parts of its range, especially at the periphery (usually more than 100 occurrences and 10,000 animals).

Colorado by the statement “no specimens have been reported in the past half-century, and the species may not live in Colorado now” (<http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/Skunk.htm>). In 1995, the Colorado Wildlife Commission took the affirmative step of closing all trapping harvest of American hog-nosed skunks. Due to the passage of Amendment 14 (CRS 33-6-203) to the Colorado Constitution, there has been no recreational trapping for any species in Colorado since 1997. A request was made in 2001 to reinstate trapping using live or box traps for several species, including the American hog-nosed skunk. CDOW recommended against subjecting the species to harvest due to its rarity in the state (<http://wildlife.state.co.us/NR/rdonlyres/31FE339B-9BCA-492D-AD3486F2A428CC3B/0/ch3part3.pdf>). The striped skunk (*Mephitis mephitis*), a similar-looking species, is classified as a furbearer in Colorado and is subject to a four-month winter hunting season or taken year-round as necessary to protect private property (<http://wildlife.state.co.us/Hunting/SmallGame/Statistics/>). Given the similar appearance of the two species and their sympatric occurrence in some areas, it is possible that American hog-nosed skunks could be taken where striped skunks are the target.

In New Mexico, skunks are classified as a “furbearer,” and some (fewer than 50 individuals) animals identified as American hog-nosed skunks have been taken each season between 1994-1995 and 2004-2005 (**Table 2**; Stuart personal communication 2006). The Biota Information System of New Mexico (BISON) (http://fwie.fw.vt.edu/states/nmex_main/species/050735.htm; developed for biologists by The New Mexico Department of Game & Fish Department, and The Fish & Wildlife Information Exchange,

Conservation Management Institute) classifies the American hog-nosed skunk as sensitive, an informal designation that carries no legal status. This designation is made when, in the opinion of a qualified New Mexico Department of Game and Fish biologist, “a species deserves special consideration in management and planning, and is not listed as Threatened or Endangered by the state of New Mexico.” The intent of this category is to alert land managers to the need for caution in management where these taxa may be affected (New Mexico Department of Game and Fish 2004).

Oklahoma classifies hog-nosed skunks as a Category II Species of Concern and does not have any harvest season that includes them. Species of Concern are native species identified by technical experts as possibly threatened or vulnerable to extirpation but for which little, if any, evidence exists to document the population level, range, or other factors pertinent to its status (Oklahoma Department of Wildlife Conservation 2006).

In Texas, this species is classified as a furbearer, for which there is a year-round recreational harvest season and a commercial harvest season that is two months shorter. Declining numbers in annual harvest reports and very low captures by researchers targeting the species have led to an assessment by biologists that the species has declined in Texas over the past several decades (Davis and Schmidly 1994, Dragoo et al. 2003).

Arizona lists the American hog-nosed skunk as a “predator” and maintains a year-round season for recreational hunting.

Table 2. American hog-nosed skunk (*Conepatus leuconotus*) harvest data for New Mexico. Data taken from annual harvest reports, provided by Jim Stuart, New Mexico Department of Game and Fish.

Year	Number of trappers	Number of skunks harvested
1994-1995	4	33
1995-1996	4	9
1996-1997	1	1
1997-1998	0	0
1998-1999	NA	12
1999-2000	NA	13
2000-2001	1	10
2001-2002	1	10
2002-2003	3	33
2003-2004	6	46
2004-2005	4	27

Natural Heritage ranks

The Natural Heritage Network assigns rangewide and state-level ranks to species based on established evaluation criteria. The American hog-nosed skunk has been assigned a global rank of G4, indicating that the rangewide population is considered apparently secure (NatureServe Explorer 2005). Species with this rank are uncommon but not rare, and there is some cause for long-term concern due to declines or other factors. The global rank is based on a synthesis of state ranks and biological evidence.

Although apparently secure at the global level, at the regional level American hog-nosed skunks are rare and have been assigned some state rankings reflective of this rarity. State ranks range from S1 to S4 (**Table 1**). In general, state ranks are assigned based on the assessed risk of extinction within a state, where S1 species are considered “critically imperiled” and S5 are considered “demonstrably secure.” These assessments are based on population status, distribution, natural history, and threats within the state.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Management authority for the American hog-nosed skunk throughout its range in the United States rests with each state’s wildlife management agency. Despite special status listings in Colorado, New Mexico, and Oklahoma, no management plans or conservation strategies that explicitly address this species have been prepared by any state or federal agency. In addition, populations in Arizona, Colorado, and Oklahoma are not monitored. The New Mexico Department of Game and Fish collects information on incidental roadkill and voluntary harvest data provided by trappers in New Mexico. Starting in 2007-2008, trapper reports will be mandatory (Stuart personal communication 2006). Attempts are underway to survey hog-nosed skunk populations in Texas (Dowler personal communication 2006, Tewes personal communication 2006).

American hog-nosed skunk occupancy of National Forest System lands in Region 2 has not been verified. However, evidence indicates that populations may exist on portions of the San Isabel National Forest, including the San Carlos Ranger District near Cañon City (Mellaci 2000; see Distribution, abundance, and population trend section), as well as on the Comanche National Grassland in far southeastern Colorado.

Current laws and regulations are likely adequate to conserve hog-nosed skunks given the presumed very low trapping and hunting pressure on the species where it exists in Region 2. However, few data are available on the status of populations throughout its range or on its habitat requirements in Colorado. Thus, specific land management practices in Colorado, including hunting or predator control, may have an effect on the species of which we are unaware.

Biology and Ecology

Systematics and description

Taxonomy

The American hog-nosed skunk is a member of the monophyletic family Mephitidae that was recently split from the family Mustelidae based on molecular systematic studies (Dragoo and Honeycutt 1997). This distinction is recognized by Baker et al. (2003), Feldhamer et al. (2003), and Wozencraft (2005). Mephitidae contains thirteen species in two subfamilies and four genera. The subfamily Mephitidae contains the genera *Conepatus* (hog-nosed skunks), *Mephitis* (striped skunks), and *Spilogale* (spotted skunks), and the subfamily Melinae contains the stink badgers *Mydaus*. Some authorities cite fewer species, combining all the spotted skunks except the pygmy spotted skunk (*S. pygmaea*) under a single species, and combining some of the hog-nosed skunk species as well. Recent molecular evidence provided by research at the Dragoo Institute has confirmed that the skunks and stink badgers are sufficiently different from the Mustelidae to place them in their own family.

Of the three genera of skunks, *Conepatus* is the least predacious, with the most poorly developed carnassials, largest molars, and an elongate snout and long foreclaws, all suggesting that it is well-adapted to rooting in the ground for and consuming insects (Ewer 1973). Five species of hog-nosed skunks, genus *Conepatus*, were recognized in the past: two species, *C. chinga* and *C. humboldtii*, occur only in South America; *C. semistriatus* occurs in Central and South America; and in North America *C. mesoleucus* was described as ranging from the southwestern United States, through most of Mexico and into Central America, while *C. leuconotus* was described as occurring along the coastal plain of the Gulf of Mexico from Vera Cruz to the southern tip of Texas (Jones et al. 1992, Wozencraft 1993).

The recognition of two species of *Conepatus* in North America has long been questioned (Coues 1877, Hall and Kelson 1959, Raun and Wilks 1961, Dragoo et al. 1993). Recent morphologic (external and cranial) and genetic (mtDNA sequence) comparisons of the five species of *Conepatus* led Dragoo et al. (2003) to recommend that the three taxa from Central and South America, *C. chinga*, *C. humboltii*, and *C. semistriatus*, be recognized as distinct species, and that only one species of hog-nosed skunk be recognized in North America, *C. leuconotus*, which has page priority over *C. mesoleucus* (Lichtenstein 1832). This proposed revision was accepted by Baker et al. (2003) in the Revised Checklist of North American Mammals North of Mexico and by Wozencraft (2005).

Within the species *Conepatus leuconotus*, Dragoo et al. (2003) recognize three management units or subspecies: *C. l. leuconotus*, which includes the central portion of the range of the species and most of the subspecies; *C. l. figginsii*, the taxon of southeastern Colorado and northeastern New Mexico, and hence Region 2; and *C. l. telmalestes*. They suggest that the latter two taxa (*C. l. figginsii* and *C. l. telmalestes*) may represent unique North American subspecies. However, morphological and genetic comparisons of the members of the genus *Conepatus* in the United States and Mexico revealed a lack of morphological distinction between the named subspecies. *Conepatus leuconotus telmalestes*, from eastern Texas, is geographically separated from all other subspecies, and is likely extinct.

The pattern of variation in mtDNA across all these subspecies was similar with the exception of *Conepatus mesoleucus figginsii*, which grouped separately and differed from the other major clade by 2.5 percent. Since there was only one specimen of *C. m. fremonti*, it could not be included in the analysis, but this may be possible if mtDNA fragments can be successfully amplified from the one museum skin available. Additionally, no new specimens of either taxa were available for the genetic analysis; all material came from museum specimens from the 1920's and 1930's. The authors contend that these two Colorado and New Mexico subspecies, *C. leuconotus figginsii* and *C. l. fremonti*, are likely to be genetically similar and that further genetic research may indicate that *C. l. figginsii* (and *C. l. telmalestes*) are not valid taxa but that the populations they represent – if not already extinct – will require different management strategies from the wider-ranging *C. l. leuconotus*. However, geographic variation in Colorado had been recognized for the two previously-named subspecies, one of which, *C. l. fremonti*, is known only from Colorado. Systematic treatment of this subspecies has

not been evaluated by either cranial morphology or genetics. Additionally, a detailed analysis of adjacent populations in Oklahoma and New Mexico has not been completed, and these subspecies boundaries require further investigation.

Identification

The American hog-nosed skunk is comparatively large and is distinguished from the other skunks by a single, broad white stripe of varying width (**Figure 2**) typically running from the top of its head to the base of its tail (striped skunks can also occasionally have a single white stripe) (Davis 1966, Davis and Schmidly 1994, Dragoo and Sheffield in press), and by its elongated, protruding, bare, and broad snout (Bailey 1905, Davis 1951, Rosatte 1987). Variations in the stripe, including double stripes, no stripes, and short stripes have been reported on occasion (Davis 1945). Its bushy tail is white on the dorsum with some black on the ventral side; the remainder of its body is black to blackish-brown (Bailey 1905, Davis 1951, Rosatte 1987). The tail is shorter in proportion to the body than in other skunks (Dragoo et al. 1988). Size is variable and sexually dimorphic. Males are generally about 10 percent larger than females; total length ranges between 450 and 900 mm and weight ranges between 1.5 and 4.5 kg (Davis 1951, Hall and Kelson 1959, Walker 1964, Patton 1974, Hall 1981). The dental formula is I 3/3, C 1/1, Pm 2/3, M ½, with a total of 32, and the palate extends beyond the posterior plane of the molars (**Figure 3**; Davis 1945). Females have six mammae, one pair inguinal and two pair pectoral (Bailey 1931). In contrast, striped skunks have Pm 3/3, the posterior border of the palate ending at the plane of the molars, and 10 to 14 mammae (Fitzgerald et al. 2004).

These animals are well-adapted to a life of digging. The nose pad is large (20 mm broad and 25 mm long), bare, and approximately three times wider than that of the striped skunk, resembling the nose of a small hog (Davis and Schmidly 1994, Rosatte and Larivière 2003). The nostrils are located ventrally and open downward; the ears and eyes are small (Davis 1945, 1951). The nose is used in locating and capturing prey that is buried in the ground or under debris; the sense of smell is acute (Rosatte and Larivière 2003). There are five toes on each foot with the claws of the forefeet long, much longer than those of the hind feet (20 mm versus 7 mm) (Howard and Marsh 1982, Rosatte and Larivière 2003). The forelegs are adapted for digging, and the pelage is long and coarse with thin underfur (Bailey 1905, Davis 1966).



Figure 2. American hog-nosed skunk (*Conepatus leuconotus*) specimen from Denver Museum of Nature and Science collection (catalog number 2372). Photograph by C. Meaney.



Figure 3. Skulls of American hog-nosed skunk (*Conepatus leuconotus*) (left) showing palate extending posteriorly to the plane of the molars, and striped skunk (*Mephitis mephitis*) (right) showing palate terminating close to the posterior border of the upper molars. Note also that third premolar on the striped skunk skull has fallen out, as is often the case. The small empty socket for the peg-like tooth is only barely visible. Photographs by C. Meaney of specimens from Denver Museum of Nature and Science, not to scale.

Its many common names, hog-nosed skunk, white-backed hog-nosed skunk, white-backed skunk, rooster skunk, and badger skunk are all suggestive of the American hog-nosed skunk's habits and appearance.

Distribution, abundance, and population trend

Distribution

The genus *Conepatus* occupies a geographic range that extends from the southwestern United States to the Strait of Magellan and is the only skunk genus to occur in South America (Walker 1964, Honacki et al. 1982). The American hog-nosed skunk ranges

through parts of Arizona, New Mexico, Colorado, the Oklahoma panhandle, Texas, south through Mexico and the highlands of Guatemala, Honduras and El Salvador, into Nicaragua (**Figure 4**; Fitzgerald et al. 1994, Wozencraft 2005).

The potential distribution for the American hog-nosed skunk in Region 2 was modeled as an extrapolation of the physical environment at the locations of all documented observations of the species in the region, totaling only six locations in Colorado (**Table 3, Figure 5**). Two of the six records are from the Colorado Natural Heritage Program, and the remaining four are from Hall (1981). The model was produced

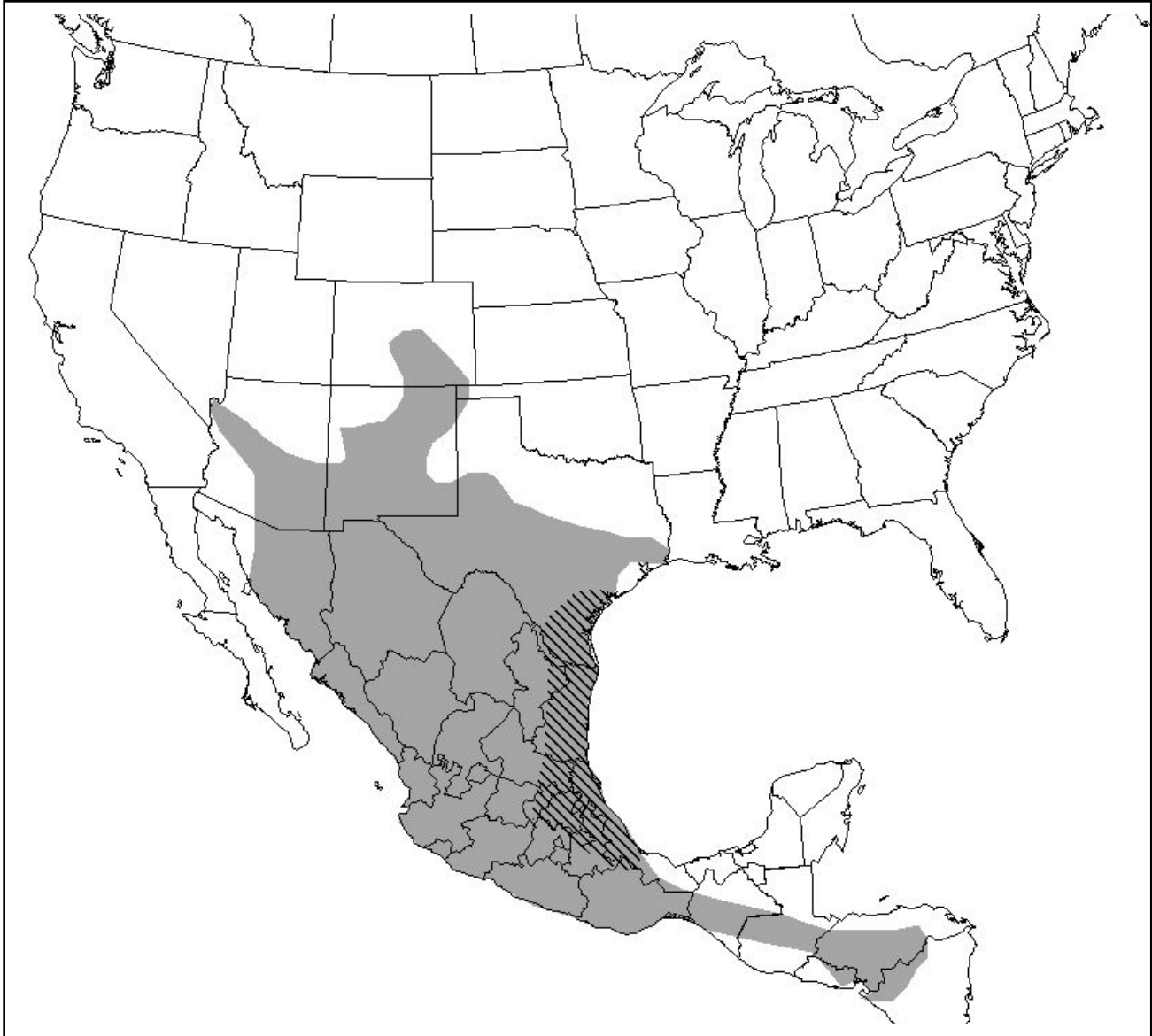


Figure 4. Geographic range of the hog-nosed skunk (*Conepatus leuconotus*) in North America, as currently understood (solid gray). The formerly understood distribution of *C. leuconotus* was only on the Gulf Coast (cross-hatched area) and of *C. mesoleucus* was the unhatched area. The two have since been synonymized as *C. leuconotus*. Redrawn from Fitzgerald et al. (1994), with permission.

with the methods of Beauvais and Smith (2005) and can be seen as a correction of their original *Conepatus leuconotus* model which was based on nine observation records, three of which were inadvertent duplicates. The suitable environment mapped in **Figure 5** encompasses five of the six American hog-nosed skunk localities, thus is best interpreted as a core distribution envelope. Note that due to a paucity of information on habitat use by this skunk in this region, no landcover information was used in the modeling exercise. Because of this, and because of the exceedingly few locations, the model output is best thought of as an “untested hypothesis”

and should be seen as only suggestive of potential distribution of the species in Region 2. Future modeling efforts should be expanded to include known locations of the species in Oklahoma and New Mexico.

In Region 2, the American hog-nosed skunk occurs at the northern margin of the species’ range, where it is apparently found in rocky canyonlands and mesa country, montane shrublands, piñon-juniper woodlands, and grassland areas of southeastern Colorado and adjacent states (Findley et al. 1975, Jones et al. 1983, Caire et al. 1989, Fitzgerald et al.

Table 3. All known specimens and records of American hog-nosed skunks (*Conepatus leuconotus*) in Colorado. Note that nine specimens from Furnace Canyon comprise a single locality. Furnace Canyon is likely a misspelling of Furnish Canyon, as it is known now.

Date	County	Locality	Catalog number ^a	Collector	Comments ^b
20-Nov-1922	Baca	Furnace Canyon	DMNS 1961	S.O. Singer	Holotype specimen for <i>C. mesoleucus figginsi</i>
02-Dec-1922	Baca	Furnace Canyon	DMNS 1964	S.O. Singer	Paratype specimen
1924	Baca	Furnace Canyon	DMNS 2246	S.O. Singer	--
Dec-1926	Baca	Furnace Canyon	DMNS 2332	S.O. Singer	Adult male
1925	El Paso	Keaton Ranch, Little Fountain Creek, 12 miles southwest of Colorado Springs (in 1925)	UCM 10727	S. Keaton	From E.R. Warren collection (4252) Skin only, missing skull. Cited as Miller (1933)
19-Jan-1927	Baca	Furnace Canyon	DMNS 2337	S.O. Singer	Adult male
19-Jan-1927	Baca	Furnace Canyon	DMNS 2338	S.O. Singer	Immature male
15-Dec-1927	Baca	Furnace Canyon	DMNS 2373	S.O. Singer	Adult female
10-Jan-1928	Baca	Furnace Canyon	DMNS 2372	S.O. Singer	Adult male
23-Mar-1928	Baca	Furnace Canyon	DMNS 2376	S.O. Singer	Adult male
01-Feb-1932	Fremont	Garden Park near Canyon City	DMNS 2506	C.J. Williams	Holotype specimen for <i>C. mesoleucus fremonti</i> , skin only
21-Sep-1996	Fremont	Badger Creek, Arkansas headwaters, Jack Hall Mountain Quadrangle	Track No specimen or photograph	K. West and J. Coles	Clear footprint in mud, one animal, from Colorado Natural Heritage Program database
Sep-1997	Baca (listed as Bent) on museum tag	Carrizo Canyon	DMNS 9930	J.P. Fitzgerald	Skull found on ground
4-Jun-2000	Custer	San Isabel National Forest, near Wetmore (T21S, R69W, S25)	DMNS 9989	R. Watts	Skull found on ground

^aDMNS = Denver Museum of Nature and Science

UCM = University of Colorado Museum

^bHolotype = the single designated type specimen, used to describe and publish a new species

Paratype = any specimens from the same series as the holotype

1994), where it is known mostly from historical records (Fitzgerald et al. 1994). In New Mexico in 1931, its northernmost limit (as *Conepatus mesoleucus mearnsi*) was described as 18 miles east of Albuquerque (Bailey 1931). Its occurrence in Colorado is known from 13 museum specimens (skin, skull, or both), many of which were collected in the 1920's, and one track, for a total of 14 records. These 14 records comprise six localities because of the multiple specimens from Furnace Canyon, Baca County. This locality is likely a misspelling of Furnish Canyon, as it is known now. All records are from Baca, El Paso, Fremont, and Custer

counties (Armstrong 1972). Three of the records are recent, including a clear track from Fremont County in 1996, and two apparently recent skulls found on the ground, one collected in Baca County in 1997 and another in Custer County in 2000 (**Table 3**). In adjacent New Mexico, a specimen is known from north of Roy, Harding County, about 90 km south of the Colorado border (Geluso 2002), and a roadkilled animal was found in March 2003, 1.3 km south of the Colorado border, at the base of Raton Pass on I-25 (**Figure 6**). Much of the country in northeastern New Mexico is shrub-free grassland, and only the broken country

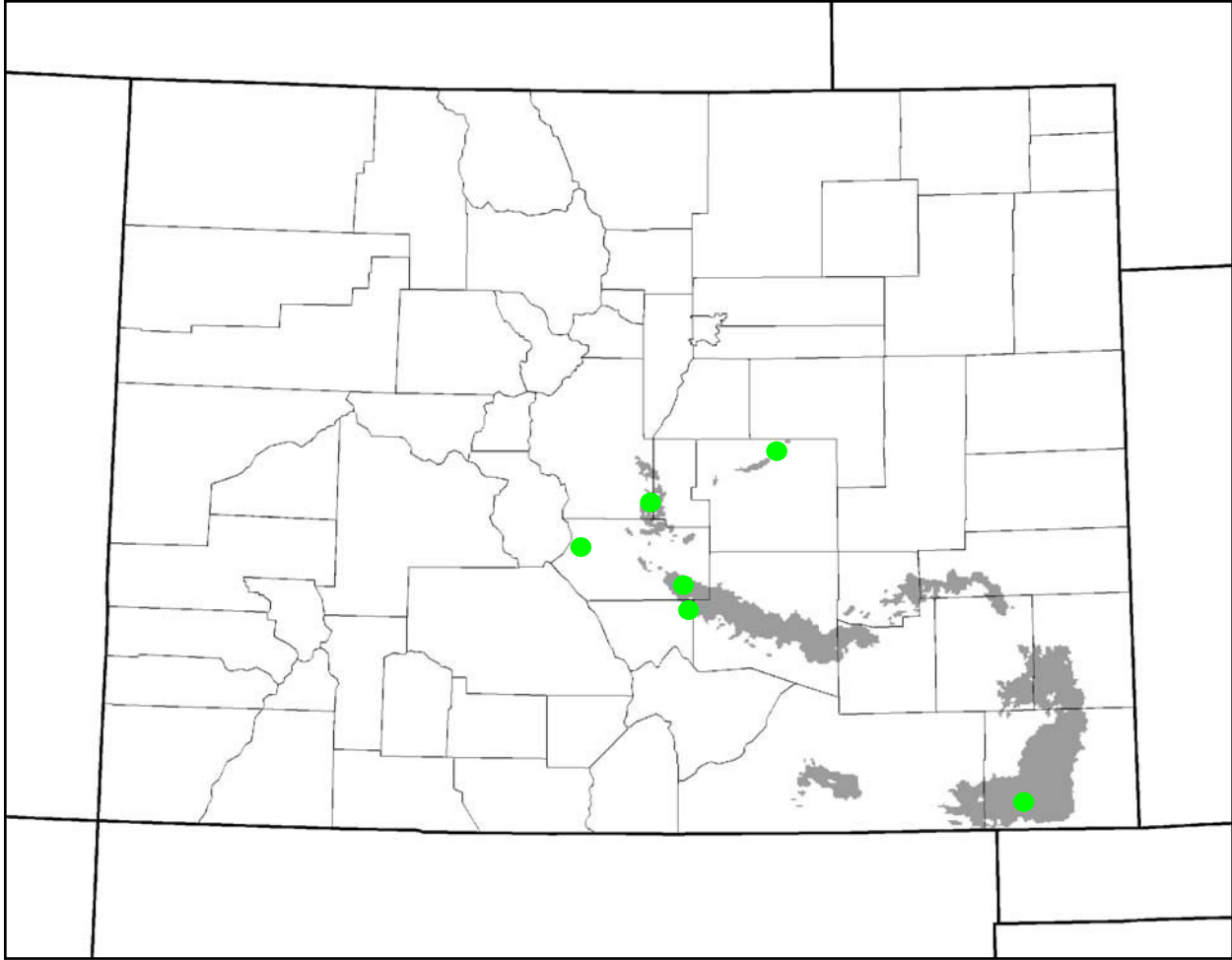


Figure 5. Predicted distribution of the hog-nosed skunk (*Conepatus leuconotus*) in Colorado (solid gray). Documented observations ($n = 6$), shown as green dots, are from Hall (1981) and the Colorado Natural Heritage Program. These locations were used to model the species' potential distribution (solid gray) following the methods of Beauvais and Smith (2005). Climatic and other physical variables were used as predictors; no landcover variables were included.

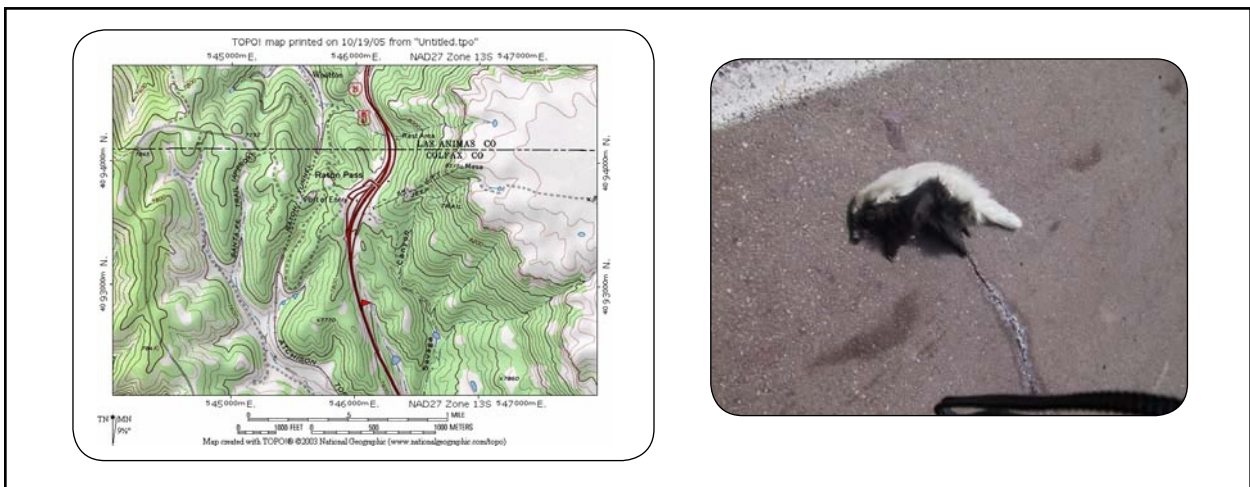


Figure 6. Location (red flag) and photograph of roadkilled American hog-nosed skunk (*Conepatus leuconotus*) found in New Mexico just south of the Colorado state line by Chris Pague, Senior Conservation Ecologist with The Nature Conservancy.

near mesas and stream valleys appear suitable for the species. Two specimens are known from Oklahoma, at the western end of the panhandle in Cimarron County, and a report is known from just north of Black Mesa from the 1940's (Glass 1949 cited in Caire et al. 1989 as [Glass 1951]). Specimens from southern Baca County, Colorado, near the Oklahoma border include the skull found in 1997 from Carrizo Canyon, and the specimens from the 1920's from Furnace Canyon. These scarce records from Colorado, New Mexico, and Oklahoma could suggest a continuity of hog-nosed skunk populations in this region. Caire et al. (1989) note that the species has moved northwards "through the ages," from South America through Central America to its current occurrence in the southwestern United States.

Abundance and population trend

There are few published data documenting abundance, or changes in abundance at any scale. That being said, researchers have derived information from trapping records, efforts to detect the species, and collection of road mortalities. Most of these observations are from Texas, but there are some roadkill records from southern New Mexico as well (Stuart personal communication 2006). Few recent specimens have been obtained from throughout the species' range. Collectively, the available evidence indicates extreme rarity of the species today, at least in Texas (Davis and Schmidly 1994) and Colorado.

In the early 20th century, the hog-nosed skunk was considered the most common species of skunk in east Texas (Bailey 1905). Dragoo et al. (1988) found that 80 percent of all collected specimens of *Conepatus leuconotus* (then known as the Gulf Coast hog-nosed skunk) were collected between the mid-1800's and 1900, 13 percent were collected between 1901 and 1950, and only 7 percent were collected after 1950. Davis (1966) reported that hog-nosed skunks were seldom as abundant in any part of their range as were striped skunks.

Only two hog-nosed skunks – and many striped skunks – were taken in 12,833 M-44 days (number of M-44 traps deployed multiplied by the number of days deployed), 4,000 strychnine egg baits, 8,000 strychnine meat baits, and 24,446 steel-trap days in a study of predator control in Kleberg County, Texas (Beasom 1974). Trapping and spotlighting for skunks in south Texas during 1985 and 1986 yielded no hog-nosed skunks in 1,424 trap-nights and 175 nights of spotlighting (Dragoo et al. 1988).

By the early 1980's, Schmidly (1983) had found that the species was declining in south Texas and that the east Texas subspecies (*Conepatus mesoleucus telmalestes*) was extinct. After seven years of intensive research in the Big Thicket National Preserve, Schmidly et al. (1980) failed to find any evidence of their presence, and despite thousands of miles of spotlighting and extensive trapper interviews, Dragoo et al. (1988) similarly found scant direct evidence of hog-nosed skunks in south Texas. During a project to survey the Gulf Coast and south Texas for populations of the hog-nosed skunk, they queried trappers, obtained sight records, and employed spot-lighting and road survey techniques. Trapper reports indicated that hog-nosed skunks accounted for about 20 percent of the take of skunks in the past, but most respondents believed the species had declined during their years of trapping. Spot-light surveys from March through July over approximately 5,940 miles yielded striped and spotted skunks but no hog-nosed skunks. Road surveys conducted over approximately 2,000 miles yielded no hog-nosed skunks, nor were there any sightings reported by predator control agents. Davis and Schmidly (1994) and Schmidly (2004) reported that there was a growing consensus among professional mammalogists that hog-nosed skunks in Texas had declined drastically during the previous several decades. The species, once thought common, is now rarely encountered.

Dowler et al. (2005) undertook a project to describe the ecology of striped, western spotted (*Spilogale gracilis*), and American hog-nosed skunks in west-central Texas. They used track plates, cameras (12 arrays each including two open track plates, two closed track plates, and a camera – set to take pictures 24 hours per day – for 14 days four times during the year), and live-trapping (6,732 trap nights) to successfully capture enough striped and western spotted skunks to meet the study objectives. Track plates have been shown to be useful in determining furbearer distribution and relative abundance in California (Barrett 1983). However, only one American hog-nosed skunk was captured, and it was captured by hand. Cameras made the only other detection of an American hog-nosed skunk (Ebeling 2006).

A review of new specimen records for Oklahoma postdating Caire et al. (1989) shows no new records of hog-nosed skunks (Braun 2005). Information on abundance in Oklahoma is lacking.

There is little information on abundance of American hog-nosed skunks in Arizona. They may be

expanding their range to the northwest and may be increasing in abundance in the Graham and Huachuca mountains (Hoffmeister 1986). Striped skunks were once a major furbearer species in the state, but their proportion in the legal furbearer harvest has declined over recent years to the point that fewer than 100 “skunks” per year have been taken since 1995 (Arizona Game and Fish 2006). The take is not differentiated by species and may reflect demand rather than trend.

The status of the species in New Mexico is unknown (Findley et al. 1975). The animals are relatively scarce in terms of detection; however, there is no information suggesting a population decline or reduction of range in the state (Montoya 1994). They are occasionally found as roadkill in southern portions of the state and are described as uncommon but not rare (Stuart personal communication 2006). No population density studies or trend analyses for American hog-nosed skunks in New Mexico have been conducted. When mentioned, the species is merely listed in occurrence checklists for specific land management units (New Mexico Department of Game and Fish 2004). New Mexico trapping records from 1982 through 1994 indicate that the mean annual harvest of American hog-nosed skunks for the period 1982-1994 was 122 animals and ranged from 246 in 1985-1986 to five in 1990-1991 (Stuart personal communication 2006). Records from 1994-95 to 2004-05 are shown in **Table 2**. These harvest records are difficult to interpret because there is no information on the harvest effort or about the ability to differentiate species of skunk. However, these data do indicate that the animals are consistently present.

Fur harvest records can provide an index of population trends for regulated species (Erickson 1982). However, trapper effort, which is influenced by pelt price and fashion preferences, influences the number of animals harvested. With this species, correct identification is also problematic because the pelage patterns of striped and American hog-nosed skunks are similar and easily confused (Rosatte 1987). Furthermore, hog-nosed skunks have not been an important furbearer species because their fur is short and coarse (Bailey 1931, Davis 1945, 1966), reducing demand and, consequently, pelt prices are below those for striped skunks (Bailey 1931, Howard and Marsh 1982, Schmidly 1984). As a result, most captures of this species result from incidental take associated with trapping for other species (Rosatte and Larivière 2003).

Because only 14 records exist from Colorado, little can be concluded about the abundance of the

American hog-nosed skunk in the state, other than that they are apparently rare (**Table 3**). However, there is no evidence to suggest that they have increased in abundance. Whether American hog-nosed skunks have declined in numbers in Colorado as elsewhere since the early 1900’s is not known. Consider that S.O. Singer collected nine specimens in the 1920’s in one canyon in Baca County (**Table 3**) and that they were well known in the first half of that century, albeit not as abundant as other skunks (Warren 1942). However, no similar effort has been made in more recent times to search for the species in Colorado, and the authors are not aware of any searches in Furnace Canyon. The hog-nosed skunk was classified as a predator in Colorado in 1969 (Lechleitner 1969), suggesting perhaps a greater abundance than is currently the case. Since 1970, there has been an increasing emphasis on nongame species, and the term predator is no longer used (Barrows and Holmes 1990, Fitzgerald et al. 1994). No sightings of hog-nosed skunks emerged in conversations in 2006 with CDOW biologists, some of whom have worked the southeastern portion of the state for many years.

Colorado harvest records (<http://wildlife.state.co.us/Hunting/SmallGame/Statistics/>) were accessed, but hog-nosed skunks are not identified separately from other skunk species, and it is not known how many, if any, are included in these estimates (Gorman personal communication 2006). Consequently, these records could not be used to evaluate historical abundance or trend in Colorado.

The American hog-nosed skunk is solitary, secretive, and difficult to census; a variety of techniques have been applied with little success (Ebeling 2006). For these reasons, the species could be more numerous in some locations than available evidence indicates. Still, collectively there is substantial evidence to indicate a strong decline in the species’ abundance in at least portions of its range, if not rangewide.

Activity pattern and movements

Behavior of this species has been rarely studied (Rosatte 1987). Its solitary nature, sparse distribution, and the difficulty in detecting it have made research into habitat use, behavior, and ecology difficult. What is known has been largely collected from anecdotal observations or from information associated with collected specimens largely before 1950 (Rosatte and Larivière 2003). The most recent attempt to elucidate home range, seasonal activity pattern, den site locations, habitat preferences, foraging patterns, and relative abundance of the American hog-nosed skunk resulted in

minimal data – one captured animal and one photograph – and little new information (Dowler et al. 2005, Ebeling 2006). Radio-telemetry has not been successfully used with the American hog-nosed skunk; one animal was collared, but its signal was lost within a few days (Dowler et al. 2005). Thus, data on movements, home ranges, and patterns of habitat selection are sparse, and no information is available regarding dispersal movements (Rosatte and Larivière 2003).

Daily and seasonal activity patterns

The American hog-nosed skunk is typically solitary (Bailey 1905, Dragoo et al. 1988, Davis and Schmidly 1994, Rosatte and Larivière 2003), but females and young will be found together until the young disperse in late summer (Allen 1906, Davis and Schmidly 1994). This species is generally nocturnal and crepuscular (Bailey 1905, Davis 1951, Taylor 1953, Schmidly 1994, Rosatte and Larivière 2003) but may forage during the warm part of the day in winter (Taylor 1953, Davis and Schmidly 1994). During the day, animals typically retreat to underground burrows, brush piles, or rock crevices (Davis 1945, Leopold 1965, Dragoo et al. 1988). These skunks can become moderately fat, suggesting to one author that they may be inactive or torpid for short periods during winter in the northern reaches of their range (Bailey 1931).

Habitat

Little is known about the ecology of this species. What is known is derived from capture records obtained largely during the 19th century and first half of the 20th century. American hog-nosed skunks occur in riparian areas, canyons, and rocky mountain slopes (Nelson 1918). Across the range of the species, habitat is described as grassland, open woodland, and open forest. However, given the paucity of records and data, generalizations may be problematic, and habitat use is likely variable across the species' range.

In Texas, the American hog-nosed skunk has been reported to prefer rocky areas, where they will use the cracks and hollows for dens, and shrub-dominated communities (Rosatte 1987, Davis and Schmidly 1994). They have also been reported from canyons, open plains, and savannahs (Cook 1986, Dragoo et al. 1988, Rosatte and Larivière 2003). Bailey (1905) described their habitat in Texas as comprising brush patches and gulch bottoms for foraging, and rock piles and hollow logs for dens. Davis (1966, 1974) found the species most often associated with canyons, streambeds, and rocky terrain. Patton (1974) collected them in rough,

rocky areas along streambeds, canyons, in oak brush habitat, mesquite brushland, and areas of semi-open grasslands where cactus dominated. In a status survey of this species, Dragoo et al. (1988) reviewed existing capture records and found that most of the capture sites were associated with brush or cactus from the coastal plains to the mountains. Recent work at San Angelo State Park in west-central Texas had one detection of this species in a brushy area dominated by mesquite (*Prosopis glandulosa*) and prickly pear (*Opuntia* spp.) (Dowler et al. 2005, Brant et al. 2006, Ebeling 2006).

In Arizona, almost 50 percent of all records are from woodlands, with the remaining records from grassland, chaparral, and conifer forest (Hoffmeister 1986). In the Huachuca Mountains in southern Arizona, hog-nosed skunks occurred in woodland and chaparral (Hoffmeister and Goodpaster 1954).

In Colorado, New Mexico, and Oklahoma, hog-nosed skunks associate with canyons, mesas, and riparian valleys, with additional observations from grasslands. In Oklahoma, piñon pines (*Pinus edulis*) provide favored foraging areas (Caire et al. 1989), and in New Mexico, hog-nosed skunks are found in oak-pine forests. In New Mexico, the American hog-nosed skunk has been reported from the hot canyons and foothills of the desert mountains (Bailey 1931) and from creosote desert to pine-oak forest (Findley et al. 1975). More recently, they have been reported from coniferous and mixed woodlands, juniper (*Juniperus* spp.) savanna, montane scrub, Chihuahuan desert scrub, closed basin scrub, desert grassland, and lava beds (Cook 1986, Thompson et al. 1992, Frey and Yates 1996). Secondary habitat types include coniferous forest, deciduous forest, sagebrush (*Artemisia* spp.), riparian, grassland, and desert (Cook 1986, Spowart and Samson 1986, Thompson et al. 1992).

In Colorado, the few records of this species are associated with scrub oak (*Quercus* spp.), piñon scrub, and piñon-juniper woodlands in the southeastern part of the state (Warren 1942, Fitzgerald et al. 1994). Brushy areas with sandy soils and rocks are also used (Lechleitner 1969). A skull found in 2000 on the east side of the Wet Mountains in the San Isabel National Forest was located in scrub oak and ponderosa pine (*Pinus ponderosa*) (Mellaci 2000). Furnace Canyon contains patches of shrubs including mountain-mahogany (*Cercocarpus montanus*), squaw currant (*Rhus trilobata*), and Gambel oak (*Q. gambelii*), in areas where moisture accumulates. These areas contain leaf litter and an herbaceous/grassy understory, which provide abundant insects for foraging and likely are

important habitat components. Grassy understories are present in many of the record localities and likely provide important habitat for this species, which roots for insects.

Conepatus mesoleucus was collected from desert-scrub and mesquite-grassland habitats in northern and eastern Zacatecas, Mexico (Matson and Baker 1986). It has also been associated with grasslands and prairie dog towns in the Chihuahuan Desert during fall (List and MacDonald 1998). In work completed on the Tehuantepec Peninsula, pooled data from wet and dry season spot-lighting counts showed *C. mesoleucus* to be sighted in grassland 52 percent of the time, in marsh 29 percent of the time, and in scrub 19 percent of the time (Cervantes et al. 2002).

Elevation range is variable and can reach up to higher elevations in mountainous areas. In Arizona, hog-nosed skunks are known up to 9,000 ft. in pine-fir forests in the Graham Mountains (Hoffmeister 1986), and in Mexico they range up to 10,000 ft. (Cahalane 1961). They are rarely associated with either open desert or heavily timbered habitats (Davis 1945, Rosatte 1987). Where their range overlaps with *Mephitis*, they appear to make use of similar habitats (Cahalane 1961).

Dens

Similar to other small and medium-sized mammals that occur in areas with high daytime temperatures, dens are likely essential for protection from the elements, as well as for rearing of young. The American hog-nosed skunk uses rocky areas, brush, and ground burrows for dens and nurseries in Texas (Davis 1951, Patton 1974, Davis and Schmidly 1994, Rosatte and Larivière 2003). Dens have also been reported in caves, woodrat (*Neotoma* spp.) nests, and even an old mine shaft, where a large grass nest was constructed (Hoffmeister 1986). American hog-nosed skunks will use deserted burrows from other animals or dig their own (Warren 1942). Unlike other skunk species, they are not typically reported to den in buildings or other sites with human activity (Patton 1974). Dens located on the Edwards Plateau of Texas were occasionally lined with grass or leaves, and were found in stony bluffs, cedar (*Juniperus* spp.) breaks, shinoak (*Quercus* spp.) draws, and blackjack oak (*Q. nigra*) ridges (Taylor 1953). Recent work in Texas located den sites for the species in rocky sites and in mature mesquite brushland (Dowler et al. 2005). In areas of range overlap with *Mephitis*, hog-nosed skunks use similar den sites (Cahalane 1961).

In a study investigating the denning behavior of striped and spotted skunks in Tom Green County, Texas, it was found that these species changed dens almost every day throughout the year (Doty and Dowler 2006). Females of both species were also found to den communally on occasion, and most den sites were associated with prickly pear cactus (*Opuntia* spp.) (Doty and Dowler 2006). Although American hog-nosed skunks were not reported to den communally (Davis 1945), Davis and Schmidly (1994) recount the report of a trapper in central Texas who found two individuals occupying a winter den. American hog-nosed skunks were present at the study site of Doty and Dowler, but the researchers were unable to capture and collar any, and so were unable to obtain information about their use of dens.

Food habits

The elongated nose of American hog-nosed skunks facilitates rooting and houses a well-developed sense of smell (Bailey 1905, 1931, Rosatte 1987). The forelimbs are strong and have long claws that facilitate digging in rough ground (Patton 1974). These skunks will root up large areas in search of food, sometimes as much as 12 m in diameter for a depth of several cm (Miller 1925 in Warren 1942). These areas of disturbed litter and topsoil have been used as a clue to their presence (Bailey 1905, Taylor 1953, Davis 1966, Dragoo et al. 1988).

American hog-nosed skunks feed primarily on terrestrial insects and are more insectivorous than other skunks (Bailey 1905, Seton 1929, Rosatte and Larivière 2003). They may take other foods when insects are less available, and they are known to consume carrion, small reptiles and mammals, gastropods, ripe fruit of prickly pear cactus, berries, and nuts (Bailey 1905, Taylor 1953, Fitzgerald et al. 1994). In an analysis of the viscera from 118 hog-nosed skunks taken in central Texas from February 1942 through January 1943, Taylor (1953) found that animal material comprised 96.2 percent of the diet by volume, of which insects, primarily larvae, comprised 66 percent. The only other food item for which the species showed a preference was black persimmon (*Diospyros texana*) fruits taken in July and August, 42.3 percent of the diet. Mammals comprised 2.8 percent, birds 0.8 percent, and reptiles 2.9 percent of the annual diet. Traces of bat, woodrat, cottontail (*Sylvilagus* spp.), white-tailed deer (*Odocoileus virginianus*), lizard egg, and snail were also found (Taylor 1953). Bailey (1931) reported signs of an individual having taken chickens from a farmyard in New Mexico.

In New Mexico (Bailey 1931) and Mexico (Leopold 1965), beetle (Coleoptera) larvae were a significant component of the diet. In Texas, insects represented 50 to 90 percent of the diet regardless of season (Davis 1945, Patton 1974), also consisting largely of beetles. Vertebrates accounted for only 7.5 percent of food, and plant material (fleshy fruits) 4 percent (Taylor 1953).

Researchers have found that this species seldom comes to baits used for trapping other skunk species (Bailey 1905, 1931, Davis 1951, Dragoo et al. 1988, Dowler et al. 2005, Ebeling 2006). This may reflect their preference for an insectivorous diet and the difficulty in providing insect bait (Bailey 1931). Still, Bailey (1931) reported two individuals found dead in New Mexico because they fed on poison put out for wolves, indicating at least some willingness to consume carrion.

Energy requirements

There is no information addressing the American hog-nosed skunk's energy requirements. Nor is there any information about winter dormancy. Striped skunks that experience winter dormancy lose significant body weight – 40 to 58 percent – and can starve (Sunquist 1974, Bjorge et al. 1981). American hog-nosed skunks have been reported to sometimes become “moderately fat,” and it is not improbable that they may hibernate for brief periods, especially in the northern portions of their range (Bailey 1931). In the southern portion of their range, where insects are likely to be available year-round, “there is little excuse for their taking a winter vacation except for short periods of unusual cold” (Bailey 1931). In Colorado and New Mexico, at the northern edge of their range, periods of torpor could occur (Bailey 1931, Rosatte and Larivière 2003), especially at higher elevations, but there are no data available.

Food availability and population dynamics

The only research successfully addressing hog-nosed skunk population dynamics comes from the southern portion of the Isthmus of Tehuantepec, coastal Oaxaca, Mexico (Cervantes et al. 2002). Wet season population density in 1996 (derived from spotlighting surveys) of *Conepatus mesoleucus* was 0.6 ± 0.17 individuals per km^2 ; in contrast, dry season (1997) density was 1.3 ± 0.26 individuals per km^2 (Cervantes et al. 2002). Wet season transects were run in August and September, and the dry season transects were run in February and March. The authors do not discuss

possible reasons for this difference in density, but it may reflect food availability during wet and dry seasons, sightability differences during periods of lush (wet season) and sparse (dry season) vegetation, or it may have been simply a one-year phenomenon. However, since this species appears to rely almost exclusively on insects for its food, availability of insects should affect survival, especially juvenile survival.

Water resources

There is no information with respect to whether this species requires free water or whether it can obtain what it needs from its diet. In Mexico, it was found that the American hog-nosed skunk was more abundant in riparian vegetation and near water in forested or shrubby uplands than in arid areas (Cervantes et al. 2002). However, the authors did not make any inferences about access to water but rather to the food found in such sites. The hog-nosed skunk occurs in many arid areas and can probably get water from its food. However, it is not known whether this species requires free water.

Breeding biology

There is little information on the natural history and reproduction of the American hog-nosed skunk (Rosatte 1987, Davis and Schmidly 1994, Rosatte and Larivière 2003). The species is polygynous with males mating with multiple females, and males provide no paternal care (Rosatte 1987, Rosatte and Larivière 2003). Delayed implantation, as in the western spotted skunk, has not been reported for this species or for hooded skunks (*Mephitis macroura*) and is unlikely to occur for either species because they live in low-seasonality environments (Ferguson et al. 1996).

The breeding season for North American hog-nosed skunks begins in late February. A female collected in southeastern New Mexico in mid-February had neither embryos nor placental scars, indicating that breeding had not yet occurred (Dragoo et al. 1988). A female collected in west Texas in late March contained a single embryo, and two females collected in April were nursing (Bailey 1905). Most sexually mature females are pregnant in March (Davis and Schmidly 1994). Gestation is 42 to 60 days with litters of two to four young born during April and May (Davis 1951, Walker 1964, Davis 1966, Patton 1974, Howard and Marsh 1982, Rosatte 1987, Dragoo and Honeycutt 1999, Rosatte and Larivière 2003).

The small number of mammae (6) suggests that litter size should be smaller than in striped skunks,

which have 10 to 14 mammae (Bailey 1931). Litter size for hog-nosed skunks has been reported to range from one to five (Allen 1906, Davis 1945, Rosatte 1987, Rosatte and Larivière 2003). Embryonic litter sizes for six females in Texas were reported as three embryos in three females and two embryos in three females (Davis 1966). A female captured in Texas on 4 July was accompanied by two young (Patton 1974). South American species of the hog-nosed skunk average two to five young per litter (Walker 1964).

The young are born blind and begin moving in the nest before their eyes open (Davis and Schmidly 1994, Rosatte and Larivière 2003). Musk is present at birth. By mid-June, kits weigh 450 g (Taylor 1953, Davis 1966, Davis and Schmidly 1994), and adult size is reached in August, signaling independence (Davis and Schmidly 1994, Rosatte and Larivière 2003). Sexual maturity is attained by 10 to 11 months (Hayssen et al. 1993). In captivity, males show breeding behavior as early as November while females do so as early as January (Dragoo and Honeycutt 1999). Most females probably experience their first pregnancy in their first year; 95 percent of 178 female striped skunks collected in the upper Midwest were pregnant or parous (Greenwood and Sargeant 1994).

Demography

American hog-nosed skunks reach sexual maturity in their first year and produce one litter a year of one to five kits (Rosatte 1987, Davis and Schmidly 1994, Rosatte and Larivière 2003). There is no information on longevity of this species in the wild, but a captive individual lived 8 years, 8 months (Nowak 1999). Longevity in the wild, however, is probably less than 3 to 4 years (Patton 1974), and turnover within a population is probably high. In a striped skunk (a species with a higher rate of fecundity) sample of 178 females, 74 percent were only 1-year-old (Greenwood and Sargeant 1994).

American hog-nosed skunk populations are probably regulated by a combination of habitat and demographic factors including litter size, adult and juvenile survival, and social spacing patterns. Habitat factors influencing American hog-nosed skunk demographics probably include prey abundance and den site availability.

In striped skunks, disease and poor physical condition, especially during winter, are the major causes of mortality in both urban and rural populations in Illinois where rabies is absent (Gehrt 2002). Prolonged

winter dormancy results in a substantial reduction in body weight and is the ultimate cause of mortality, with added stress of parasite loads and disease. Road kill accounts for the majority of mortality events in the rural population in summer and fall.

There is very little known about the causes of mortality for American hog-nosed skunks. Because hog-nosed skunks are occasionally detected as roadkill, there is potential for significant negative impacts from road-related mortality (Howard and Marsh 1982). Trapping and predator control activities may also have an effect where they occur due to the unintended take of American hog-nosed skunks while targeting striped or spotted skunks.

Community ecology

Symbiotic and mutualistic interactions

There are no known mutualistic relationships reported for any of the skunk species except for the use of dens. American hog-nosed skunks use dens excavated by other species, such as badgers (*Taxidea taxus*) or foxes (*Vulpes* spp., *Urocyon cinereoargenteus*) (Warren 1942). Conversely, other den-using species may use abandoned skunk dens. The rooting activity of hog-nosed skunks may create desirable microhabitats for certain invertebrates, and likely disturbs habitat for others.

Parasites and disease

A variety of diseases and parasites may infect American hog-nosed skunks (Rosatte 1987, Davis and Schmidly 1994, Rosatte and Larivière 2003). Two roundworms, *Filaria mastis* and *Physaloptera maxillaris*, a tick species (*Ixodes texanus*), and fleas (*Pulex* spp.) have been reported as parasites of this species (Erickson 1946, Tiner 1946, Patton 1974). Presence of the nematode *Skrjabingylus chitwoodorum* was also detected in hog-nosed skunks from Texas (Patton 1974).

Western spotted skunks are infested by a variety of parasites including bots, fleas, ticks, mites, and tapeworms (Mead 1963, Patton 1974, Whitaker and Maser 1985). Significant proportions of western spotted skunk populations also host the nematode *Skrjabingylus chitwoodorum*. *Skrjabingylus* spp. is a metastrongyloid nematode that is found living in slugs and snails. Skunks (Mephitids) consume the parasite while eating infected gastropods. The adult nematode inhabits the frontal sinuses of its host and causes an infection that leads to

deformation and disintegration of the bone surrounding this region. *Skrjabinylus* nematodes continue their life cycle by passing their eggs through their host's feces, and the cycle is completed when another gastropod eats the feces. In California, 42.9 percent of western spotted skunks exhibited the eroded sinuses characteristic of this nematode (Mead 1963), and in the United States and Canada, 85 percent of western spotted skunks exhibited the characteristic sinusoidal erosion (Kirkland and Kirkland 1983). The extent of this parasite in hog-nosed skunk populations and the importance of these parasites as a cause of direct or indirect mortality have not been established (Rosatte 1987).

Disease, including leptospirosis, tularemia, rabies, and distemper, plays an important role in regulating striped skunk numbers (Houseknecht 1969, Davidson and Nettles 1997, Schubert et al. 1998). Of these, rabies probably has the greatest impact. Parkham (1983) reported that between 1961 and 1982, the striped skunk was the species most frequently diagnosed with rabies. In 1981, 62 percent of all reported rabies cases were found in skunks. The number of reported instances of rabid skunks between 1960 and 1995 ranged from 500 to 4,500 annually (Krebs et al. 1997). A recent assessment found that skunks account for approximately 27 percent of animals that tested positive in the United States (Krebs et al. 2005). While these figures may be skewed upward by the fact that skunks tend to be tested at a high rate, a high rate of positive tests for rabies has not been found to be true for hog-nosed or hooded skunks (Parker 1975). This may be because they have a more limited distribution, occur more sparsely, and are not as social as the other two species. Of 24 skunk specimens submitted for rabies testing from Arizona, New Mexico, and Texas from 2001 through 2002, only one was positively identified as a hog-nosed skunk, and it tested negative (Dragoo et al. 2004). Rabies has been documented in the hooded and hog-nosed skunks in Arizona (Hass and Dragoo accepted). The impact of infectious diseases such as rabies on the regulation of populations of this species is unknown.

Pneumonia and severe parasite infections affected a high proportion of striped skunks in Illinois, and high seropositive rates for canine distemper and parvovirus (more than 80 percent infection rate) were also found. All 73 skunks studied (in both rural and urban populations) had one to six parasite species, and 50 percent had a parasite load sufficient to contribute to or cause their death (Gerht 2005).

Predators

Humans appear to be an important mortality factor for hog-nosed skunks, largely through roadkills (Howard and Marsh 1982). No references have been found that note mortality resulting from predation (Rosatte 1987, Rosatte and Larivière 2003). A variety of predators of other species of skunk have been noted, including badgers, coyotes (*Canis latrans*), golden eagles (*Aquila chrysaetos*), great horned owls (*Bubo virginianus*), red foxes (*Vulpes vulpes*), cougars (*Felis concolor*), and bobcats (*Lynx rufus*) (Bailey 1931, Godin 1982, Rosatte 1987). These species likely also prey on American hog-nosed skunks. In South America, cougars are reported killing *Conepatus humboldtii* (Donadio and Buskirk 2006), and Hass (submitted) has found hog-nosed skunk remains in puma (*Puma concolor*) scat in North America.

Interspecific competition

There is very little in the literature about interspecific competition and American hog-nosed skunks. There are, however, a variety of anecdotal accounts that describe interactions between this and other species. Potential competitors include other skunk species, armadillos (*Dasypus novemcinctus*), Virginia opossums (*Didelphis virginiana*), and feral pigs. A non-native species found through much of Texas, New Mexico and, more recently, parts of southeastern Colorado, the feral pig roots for invertebrates, fruits, and roots (Davis and Schmidly 1994, Dragoo et al. 2003) in habitats occupied by the American hog-nosed skunk, and so the two may compete.

Throughout their range in Texas, American hog-nosed skunks are sympatric with western spotted skunks, striped skunks, and hooded skunks. Patton (1974) reported that despite the overlap in habitat preference and the presence of the more numerous striped skunk at his study site near Balmorhea, Pecos County, Texas, the species avoided one another. When he observed confrontations between the two species in the Trans-Pecos, the striped skunk prevailed, probably due to its larger size although he reported very few such interactions, citing the solitary nature of the hog-nosed skunk. Because the striped skunk is more of a generalist carnivore and appears to be more commensal with humans than is the American hog-nosed skunk, the former may out-compete the latter in situations where insect food is scarce and/or humans are abundant (Dragoo et al. 1988).

In Mexico, no physical interactions among three species of skunk (*Mephitis macroura*, *Conepatus mesoleucus*, and *Spilogale putorius*) were observed during one year of field work (Cervantes et al. 2002). However, the authors did observe the skunks walking or feeding near one another in the same type of habitat. They concluded that the three species coexist sympatrically in tropical habitats of coastal Oaxaca and displayed similar levels of abundance (Cervantes et al. 2002).

This species, like the other skunks, is equipped to ward off potential predators or competitors. They possess muscle-encapsulated musk glands that can forcefully eject yellowish musk through two papillae located immediately inside the anal sphincter (Walker 1964, Rosatte 1987, Rosatte and Larivière 2003).

CONSERVATION

Threats to American Hog-nosed Skunk Viability in Region 2

Primary threats to the continued persistence of American hog-nosed skunks throughout their range include degradation, fragmentation, and loss of habitat, interspecific interactions with feral hogs (*Sus scrofa*) and striped skunks, roadkill, control of predators and insect pests, and grazing (Honeycutt and Dragoo 1995, Schmidly 2002).

Habitat degradation, fragmentation, and loss due to agricultural and urban development have been cited as a potential cause of perceived declines of American hog-nosed skunks in Texas (Davis and Schmidly 1994, Dragoo et al. 2003). The species is now largely absent from the Rio Grande Valley where it was once relatively common (Dragoo et al. 1988, Schmidly 2002). Since the mid-1900's, there has been extensive conversion of the natural scrub habitat to row crops and citrus orchards (Tewes and Schmidly 1987), and this may have eliminated large areas of skunk habitat (Dragoo et al. 1988, Davis and Schmidly 1994). Conversion to agriculture and residential development are very likely factors in Colorado as well. Coincident with conversion of habitat, especially to agriculture, is the increased use of insecticides that may limit insect food available to this species (Davis and Schmidly 1994, Dragoo et al. 2003). In addition to direct effects of spraying in agricultural areas, aerial spraying results in drift of the insecticidal chemicals to adjacent areas, and could result in body burdens of pesticides resulting from the species rooting behavior and heavy intake of invertebrate prey.

Much available specific habitat information suggests that herbaceous ground cover is associated with hog-nosed skunk occurrence. Such habitats would be compatible with rooting behavior and a need for high ground dwelling insect abundance. Loss of grassy herbaceous habitats, or the herbaceous component of habitats, may be of primary importance to the decline of the species. Consequently, grazing practices that alter the herbaceous components of habitats should be considered a threat to species persistence.

Eastern spotted skunks (*Spilogale putorius*) increased in western Kansas with the agricultural practices of early settlers, and then declined after the 1933 - 1940 drought when many farms were abandoned (Choate et al. 1974). Prior to the 1940's, eastern spotted skunks were common throughout the Great Plains but have suffered serious rangewide declines since then (Gomper and Hackett 2005). There is some evidence that subsequent further declines in eastern spotted skunks are correlated with conversion of habitat to intensively managed row crops and the application of insecticides (Gomper and Hackett 2005), both presumably resulting in declines in insect density.

This tandem decline in both eastern spotted and American hog-nosed skunks is interesting, as is the fact that records of the latter in Colorado appeared to decline after 1932, at the beginning of a severe multi-year drought. Unfortunately, there is no information to indicate whether or not there are connections between population declines of American hog-nosed skunks in Colorado and eastern spotted skunks on the Great Plains, or the effects of a major drought on American hog-nosed skunks.

Although probably not a factor in Colorado at this time, competition with feral hogs may limit insect food available to American hog-nosed skunks and has been cited as a potential explanation of declines observed in Texas (Davis and Schmidly 1994). Free-ranging feral hogs have been present for decades in Arizona, Texas, Oklahoma, and New Mexico (Nowak 1999). In New Mexico, feral hogs are known from the southwestern corner and more recently from the northeastern plains in Union and Mora counties (Frey 2004), and from Quay and Chaves counties (Stuart personal communication 2006). Feral hogs appear to be expanding into Colorado (Nowak 1999), where they now occur in low numbers south of Pagosa Springs, south of Stonewall in Las Animas County (Skiba personal communication 2006), and in southeastern Colorado near Eads in Kiowa County (Hartman 2006). Our habitat modeling effort, however,

did not portray suitable hog-nosed skunk habitat in Kiowa County (**Figure 5**). Feral hogs are omnivores; their diet includes grasses, forbs, roots, tubers, hard and soft mast (acorns, pecans [*Carya illinoensis*], persimmons, cactus fruit), and invertebrates (Tolleson et al. 1995). Whether invertebrates are taken purposely or incidental to rooting and feeding activities, impacts are apparent on invertebrate populations through reduced ground vegetative cover and leaf litter, accelerated decomposition of organic matter, accelerated leaching of some minerals and altered ecosystem nitrogen transformation processes (Synatzske 2006).

Roadkill appears to be the way in which American hog-nosed skunks are most consistently detected (Dragoo et al. 1988, Schmidly 2002, Dowler et al. 2005, Ebeling 2006). This skunk is largely crepuscular and nocturnal, and it moves deliberately rather than quickly (Bailey 1905, Davis 1951, Rosatte 1987, Rosatte and Larivière 2003), causing it to be susceptible to roadkill mortality. Striped skunks have been reported to normally flee from vehicles, but they apparently assume a defensive posture when they realize they cannot escape. This results in them frequently being struck and killed on roads and in fields by farm machinery (Verts and Storm 1967, Case 1978). In Colorado, an occasional hog-nosed skunk roadkill could easily be overlooked and assumed to be a common striped skunk.

Roads are known to contribute to vehicle-caused mortality and reduced habitat connectivity for many species of wildlife. The negative impact of roadways is proportional to road density, road width, traffic volume, and traffic speed. The barrier effect of roadways on American hog-nosed skunks has not been examined; consequently, the threshold at which highways may become a substantial barrier to their movement is unknown. In Illinois, striped skunks in urban areas avoided highways (with four to ten lanes), using them instead as home range boundaries (Gehrt 2002). Rural skunks from the same study also appeared to avoid roads, causing the author to suggest an avoidance response by skunks to roads.

Past predator and nuisance animal control and commercial harvest for the fur trade may have impacted some populations of this species; striped skunks have been a specific target of both activities (Schmidly 2002, Rosatte and Larivière 2003). In the past, hog-nosed skunks were listed as predators in Colorado; however, we have not found evidence of any nuisance animal control efforts that specifically targeted American hog-nosed skunks. Nonetheless, where this species is sympatric with striped skunks and control programs

target striped skunks, take of American hog-nosed skunks is possible and perhaps likely. However, it is not anticipated that take of this species will be great, as it is reported to be difficult to capture with baited traps (see Abundance and population trend section). Hog-nosed skunks have been reported in fur harvest records in Texas, New Mexico, and Arizona (see Distribution, abundance, and population trend section), and they have been reported as unintended take from past predator control efforts (Bailey 1905). However, their reported number has always been small. There is some suggestion that hog-nosed skunk pelts may have been an exchange item among some Native American groups of the southwest (Bailey 1905).

Heavy grazing reduces understory grass and forb communities. This in turn reduces habitat available for the insects and other ground-dwelling invertebrates that are the main food resource for hog-nosed skunks. Many of the localities for the species are in habitats that support herbaceous understory and leaf litter, such as plains grassland, mesquite and other shrublands, ponderosa pine forest, piñon-juniper woodland, and pin-oak forest. Although not detailed in ecological studies of the species, these specimen and record localities, combined with the insect rooting behavior of this skunk, suggest that the loss of this rich understory may be detrimental to the species.

Although not addressed in the literature as a particular threat, disease and parasites are a factor in skunk biology. Two of note are the nematode *Skryabingylus*, for which information on its occurrence in the hog-nosed skunk is scarce, and rabies (see Parasites and disease section).

Conservation Status of the American Hog-nosed Skunk in Region 2

Within Region 2, American hog-nosed skunks occur only in Colorado, where the current status and viability of populations are unknown. Until the collection of a footprint in 1996 from Fremont County, and two skulls in 1997 (Baca County) and 2000 (Fremont County) (**Table 3**), both from individuals which were estimated to have died 2 to 15 years earlier, there had been no confirmed evidence of this species in Colorado since the 1920's (as *Conepatus mesoleucus figginsii*) and 1933 (as *C. m. fremonti*) (Armstrong 1972). These findings, along with the roadkill record from the New Mexico border, are indicative of the fact that American hog-nosed skunks have maintained a presence in Colorado over the past 75 years. Because they are known to be nowhere abundant, and the fact

that no active efforts have been made to survey for them in Colorado, the paucity of records is not surprising. In summary, the evidence suggests that the species currently occurs in Colorado.

Given the paucity of information, it is not known if American hog-nosed skunks have declined in Colorado as elsewhere. Nonetheless, it is reasonable to suppose that factors in Colorado may be similar to those that have caused a decline of populations elsewhere in the species' range. However, little is known about causes of declines in Texas, the area having the greatest amount of information for the species. The biogeography of American hog-nosed skunks provides a backdrop of potential vulnerability of populations in Colorado, where they are at the northernmost distribution of their range. Thus, the introduction of agriculture, grazing of domestic livestock, and energy development and residential development may result in the loss and degradation of suitable habitat with well-developed forb and grass understory, reduction in prey, and the potential reduction in continuity of existing peripheral populations in Colorado, New Mexico, and Oklahoma. The high annual turnover, as occurs in other species of skunks (see Breeding biology section), and the species' low fecundity are additional potential vulnerability factors.

If a Colorado/New Mexico/Oklahoma meta-population has persisted, it might suggest that it could self-sustaining. However, if Colorado populations are disconnected from adjacent populations, are very small, have a high turn-over rate, and occupy habitat that is being lost and fragmented, then existing populations may be at or below the threshold of sustainability. Because these skunks always seem to occur at low density and are difficult to detect, it is possible that these skunks may have survived undetected or unrecognized for almost 70 years. In small populations, stochasticity of demographic (finding a mate, birth rate, death rate) and environmental (drought, alterations in habitat) events can have a large effect on population persistence (Primack 2002).

We can hypothesize that American hog-nosed skunk populations in Colorado are part of a larger metapopulation that includes Oklahoma and northeastern New Mexico, at a minimum, and is sustained by immigration of individuals from adjacent subpopulations. The addition of even an occasional reproductive animal from another population can make a relatively large difference in population persistence (Stacey and Taper 1992, 1997). If habitat continuity is not maintained, then the potential for such immigration

events is reduced. The difficulty is in not knowing much about the location of populations in northeastern New Mexico, western Oklahoma, and Colorado. The roadkill record of a hog-nosed skunk 1.3 km south of the Colorado border suggests the possibility of population connectivity. If metapopulation dynamics apply to American hog-nosed skunk populations, then it would appear, due to the recent records of two skulls, one track, and a roadkill, that connectivity to other populations may exist, at least to some degree. However, due to the lack of information on population sizes, dynamics, and connectivity with other populations (location, condition, and use of dispersal corridors), it is not possible to reach conclusions about the likelihood of connectivity between subpopulations, the potential for metapopulation dynamics to occur in this three-state area, or the viability of populations in Colorado.

Generally, habitat conversion and degradation have been the causes most frequently associated with the loss of biodiversity (Noss et al. 1995). Half of the species listed under the Endangered Species Act have at least 80 percent of their habitat on private lands (Nagle and Ruhl 2002). In Colorado, 91 percent of the land east of Interstate 25 is privately-owned (The Nature Conservancy 1998), and for most of the last 100 years has been used for agriculture, approximately 40 percent row-crop and 60 percent rangeland (Grunau et al. 2003). For those hog-nosed skunks that potentially occur east of I-25, this nexus between habitat conversion and the dependence of sensitive species on private lands can make conservation of declining species difficult. The magnitude of pesticide use, degree of habitat conversion, extent and intensity of grazing, and human attitudes towards skunks in general and hog-nosed skunks in particular are factors that likely affect the extent to which American hog-nosed skunks can survive on private lands.

Two elements of habitat conversion relate to fire suppression and grazing. Currently, southeastern Colorado has areas with dense stands of scrub oak and piñon-juniper. In contrast, early settlers described this part of Colorado as mostly grasslands with patchy shrubs of varied species composition, and very few trees (Davies personal communication 2006). Intensive grazing reduces herbaceous vegetation. These alterations in vegetative communities, where understory plants are greatly reduced, have likely caused changes in insect communities. Whether this change has affected American hog-nosed skunks in Colorado is not known.

As urban and exurban growth continues in Colorado, road density and traffic volume continue

to increase, compounding problems for wildlife (Ruediger 1996). The direct result is loss of habitat and increased road-associated mortality. Perhaps more insidious, however, are the indirect effects on habitat: fragmentation of habitat, the creation of barriers to movement, changes in topography, introduction or increase of predator corridors, and the introduction of weeds (Grunau et al. 2003).

Because of their limited distribution, feral hogs are probably not at this time as significant a competition factor for hog-nosed skunks in Colorado as they may be elsewhere. However, there is the potential for additional unsanctioned introductions of feral hogs in hog-nosed skunk habitat.

At the periphery of their range, the distribution of the species may be dynamic with some degree of ebb and flow. Environmental factors such as global warming may have effects that are more noticeable at the periphery of a species' range. Increasing temperatures could expand suitable habitat northward, resulting in a corresponding northward range expansion by these skunks, as has occurred with armadillos (Meaney et al. 1987), and as has already been mentioned for hog-nosed skunks (Cahalane 1961, Hoffmeister 1986).

Potential Management of the American Hog-nosed Skunk in Region 2

Implications and potential conservation elements

Little is known about the distribution, habitat requirements, or population density of American hog-nosed skunks in Colorado. However, critical elements for a sustained population of this species in Colorado likely includes forb and grassy understories with leaf litter, ample insect populations and den sites, and corridors of continuous habitat that connect with adjacent populations in New Mexico and Oklahoma. Efforts to mitigate threats have not been undertaken but could include measures such as reduction in mortality from hunting and trapping of similar species, predator control, and roadkill, and the habitat-altering effects of livestock grazing. Impacts to the species from habitat degradation and conversion may be lessened by protecting areas that appear to be suitable habitat. This raises two issues that require further work: delineation of suitable habitat (see Management approaches section) and protective measures. Protective measures may include a comparative assessment of insect densities and pesticide use in order to determine optimal approaches to habitat protection and enhancement.

Of particular significance is the taxonomy of the species. The subspecies of southeastern Colorado, western Oklahoma, and northeastern New Mexico, *Conepatus leuconotus figginsii*, is at the northeastern edge of the species' range, and may possibly represent two subspecies. The lack of understanding of the subspecies *C. l. fremonti* due to lack of specimens is problematic. It is presently assigned to *C. l. figginsii*, but no genetic analyses have been conducted. The subspecies *C. l. figginsii* should be considered a focal point for conservation.

Hog-nosed skunks are generally benign and can be considered useful to agricultural interests because of their insect-eating behavior. There is no evidence of control efforts targeting this species. Grazing, however, is a very common land use in Colorado, including the southeastern portion of the state. There are great differences in how grazing is implemented. A regime with heavy grazing of short duration may result in increased understory and insect density (especially dung beetles). Long-term heavy grazing without rotation may harm development of forb and grass understory, and hence robust insect populations.

The significant strategic challenge is to develop data on the occurrence and habitat associations of the species in the region by initiating a survey program for the species. This will require coordination between agencies, and with private landowners. Where grazing practices present a problem, as has been suggested here, it will be very challenging to make changes because this grazing occurs on private lands. Education may be useful.

Five of the nine record localities (**Table 3, Figure 5**) in Colorado are on or near National Forest System lands. Consequently, these national forests and grasslands may take on a role of particular importance for American hog-nosed skunks. The two Baca County localities, from Furnace Canyon and Carrizo Canyon, are both near the Comanche National Grassland, and the single specimen from Custer County was found on the San Isabel National Forest. The two specimens from Fremont County were also located very near the San Isabel National Forest boundary.

Tools and practices

Inventory and monitoring

Due to the apparent extreme rarity of American hog-nosed skunks in Region 2, determining their presence and distribution is a critical first step in developing

management strategies that address their conservation. Such an effort may best involve a coordinated approach, perhaps beginning with the establishment of an inter-agency team of species experts, area biologists, and USFS biologists. Eventually, interested landowners can be included. A public education effort, with an active query to trappers, agency personnel, and landowners in southeastern Colorado, to obtain possible sightings (including tracks, roadkilled individuals, harvest) might be a first step in collecting distribution information for Colorado. These data might be stored on a common database such as NatureServe.

The first step in developing the needed information is an active assessment of the species' current presence in Colorado. Because limited resources make surveying the complete range of a widely distributed, low-density, nocturnal species difficult, assessments of potential habitat will be key to management and conservation of the species (Gerrard et al. 2001). Rangewide inventory of potential habitat may be accomplished with Geographic Information Systems (GIS)-based predictive models resulting in spatially explicit analyses of habitat value. The Wyoming Natural Diversity Database has developed such a model for American hog-nosed skunks, using specimen locations from the Colorado Natural Heritage Program and Hall (1981), and data layers for climate, soils, and vegetation (**Figure 5**; Beauvais and Smith 2005). There may need to be recognition that habitat association information in Colorado is so limited that such a model may have limitations and could overpredict or underpredict habitat. Therefore, a somewhat more robust approach may be needed initially until those associations are better understood. This model can be used to refine potential suitable habitat and prime locations for roadkill surveys and/or general queries to agency staff and landowners.

A next step would be to attempt to develop a population model with presence-absence information. Museum specimens, trapping records, and other historical records can be used to begin establishing a pattern of distribution, to infer relative density, and to extrapolate habitat selection patterns (Gu and Swihart 2004). A standardized query to trappers, landowners, land management agency personnel, and state department of transportation personnel in southeastern Colorado could be employed.

Where there is regulated harvest of skunks, harvest records may be a useful way to track presence, and may yield an index of population trend (Raphael 1994). Yet, because harvest levels often depend on pelt

prices and other economic factors, and thus variable trapper effort, these statistics may not correlate well with true population size or trend of the furbearer in question (Strickland 1994). Overall, participation in trapping has declined in the United States for many reasons, including low pelt prices, posting of private land, and the increasing political influence of the animal rights movement (Novak et al. 1987, Daigle et al. 1998). Recreational trapping using leg-hold traps is no longer legal in Colorado (since 1997), but striped skunks remain open to harvest as a furbearer species (see Management Status section). Nevertheless, harvest figures have been very useful for monitoring broad regional trends in mesocarnivore populations over time (Raphael 1994). In Colorado, there has been no attempt to identify skunk species in trapper reports. Such a query could add some information derived from harvest data.

Because these American hog-nosed skunks are primarily nocturnal, typically exist at low densities elsewhere in their range, and are difficult to attract to traps (see Abundance and population trend section), they may often go undetected (Dragoo et al. 1988, Schmidly 2002, Rosatte and Larivière 2003). This species has proven difficult to study using standard mammal survey techniques, rarely being encountered alive but often seen as roadkills in areas of its range where it is more common (Raun and Wilks 1961, Brant et al. in press).

A traditional method used to detect carnivores is capture – lethal and non-lethal. However, this species is difficult to trap, even when numerous (Bailey 1905, 1931). During 27,466 steel-trap days over 2 years during a study of predator control, only two American hog-nosed skunks were taken (Beasom 1974); and in 1,424 trap nights, targeting skunks, during 1985-1986, no American hog-nosed skunks were taken (Dragoo et al. 1988). In 2001-2003, 1,977 trap nights targeting American hog-nosed skunks and using Tomahawk live-traps baited with raw chicken eggs, chicken livers, chicken meat, canned cat food, or fruit yielded striped skunks but no American hog-nosed skunks (Dowler et al. 2005); the one American hog-nosed skunk captured was captured by hand while spotlighting (Dowler and Brant 2002). Researchers speculate that the problem may be that because this species is heavily insectivorous, it is difficult to bait it into traps (Bailey 1905, Davis 1951, Rosatte and Larivière 2003).

However, there are a number of indirect methods for detecting presence of carnivores. These include camera traps, scent stations, spot-lighting, scat deposition, DNA analysis of scat, hair snares,

track surveys, snow tracking, and track plates (Barrett 1983, Zielinski and Kucera 1995, Harrison et al. 2002, Moruzzi et al. 2002, Schauster et al. 2002, Swann et al. 2004, Manley et al. 2005). A study in Argentina that compared the effectiveness of sooted track plates and scent stations in detecting Molina's hog-nosed skunk (*Conepatus chinga*) found that the species was detected more often at scent stations (17 detections) than at track plates (two detections) (Bilenca et al. 1999).

In a comparison of detection methods for skunks in west-central Texas, three methods (open track plates, closed track plates, and automatic camera systems) were used to survey three sympatric species of skunk (striped skunks, western spotted skunks, and American hog-nosed skunks) (Ebeling 2006). Twelve sample units were established that consisted of one TrailMaster™ camera system, two open track plates, and two covered track plates. Sample periods were 14 days per season (winter, spring, summer, fall) in 2005, and all stations were baited with chicken parts and a commercially available scent lure (Liquid Grub). The camera system was set up with the infrared beam positioned approximately 7 to 10 cm above the ground and the camera attached approximately 1.5 m above the ground. Open track plates were pieces of plywood with thin aluminum plates attached to the plywood and sooted using an acetylene torch. A small hole in the center of each plate held an applicator stick impaling a marshmallow scented with Liquid Grub; a chicken wing was put in the center of the plate. Covered track plates consisted of an aluminum plate sooted in the same manner as the open plates and covered by a corrugated plastic box open on one end. Cameras in brushy habitats during a 6 to 8 day sampling period in winter proved to be the most effective method for surveying all three species, and hog-nosed skunks were *only* detected by TrailMaster™ cameras.

Given their low density and the difficulty in attracting this species to traps, development of a roadkill survey protocol across their predicted range may be one of the more fruitful approaches to assist in establishing presence-absence and distribution of this species in Colorado. Dowler et al. (2005) found that American hog-nosed skunks were more often detected as roadkill than by any other method (open and closed track plates, photo traps, and live-traps) that they employed in a study designed to detect the species. Over the past several years, one scientist in Texas has picked up over 50 road-killed hog-nosed skunks (Dowler personal communication 2006). The New Mexico Department of Game and Fish is also keeping informal records of

roadkills, which have only been found in the southern half of the state.

However, it may well be that the American hog-nosed skunk goes undetected because roadkilled skunks are typically assumed to be the common striped skunk. Consequently, to generate the desired information, development of a protocol for collecting roadkill data from individuals and various agencies (including state transportation and wildlife agencies, federal land management agencies, and others) could be implemented in coordinated manner across the predicted range of the species in Colorado. Dowler et al. (2005) suggest that surveying for and monitoring roadkilled American hog-nosed skunks might not only be a useful detection method but may also yield information about habitat associations, another critical piece of information if meaningful conservation strategies are to be developed and implemented.

Management approaches

A number of aspects and factors are appropriate for investigation of management approaches. In order to develop these effectively and appropriately, the first step should be to convene a panel of experts to develop a plan and protocols for roadkill surveys, habitat assessment, refinement of threats, and conservation management; each of these is described below. Because of the potential continuity of hog-nosed skunk populations in southeastern Colorado, western Oklahoma, and northeastern New Mexico (*Conepatus leuconotus figginsi* as currently understood), it is recommended that the political boundaries be put aside in favor of biological continuity. Thus, we recommend the following approaches to address the subspecies *C. l. figginsi*.

Roadkill surveys

The panel can develop protocols for roadkill surveys in the three states, with clear direction for specimens to be deposited with natural history museums such as the Denver Museum of Nature and Science, University of Colorado Museum, Museum of Southwestern Biology (affiliated with the University of New Mexico), and New Mexico Museum of Natural History and Science. Availability of staff at these museums to prepare and curate specimens should be important determinants in which museums are selected for depositing specimens. The panel can also provide valuable networking with institutions and organizations, and agency involvement.

Habitat associations

The panel can develop an approach for a better understanding of habitat associations for *Conepatus leuconotus figginsi*. It may be valuable to visit sites associated with specimen records, and to assess habitat and landscape associations, and the potential impact of grazing on forb and grass understories. Insect monitoring may provide added information from these sites.

Threats refinement

Because much of the information on American hog-nosed skunks comes from Texas, it is possible that threats to *Conepatus leuconotus figginsi* are different. The panel can develop a plan for refinement of the threats analysis presented in this document. For example, it has been proposed that livestock grazing may present a significant problem for the species because of the impacts to understory vegetation and the associated insect communities. This can be assessed to confirm whether or not this is a serious problem for *C. l. figginsi*.

Conservation planning and management

Once the expert panel has addressed the factors described above, a conservation plan can be developed. Development of a strategic conservation plan should probably include species experts, land managers, and non-technical stakeholders. There may be a need to address land use and land use planning, necessitating involvement of private landowners.

Information Needs

The American hog-nosed skunk has received little attention from managers, probably because it is not an economically important species; however, researchers have expressed concerns about perceived population declines and distribution constrictions since the 1980's (Dragoo et al. 1988, Davis and Schmidly 1994). This species is not a furbearer of economic importance (Davis 1945), but it is still taken occasionally in traps set for other species (see Abundance and population trend section). This species does not thrive in urban environments (Rosatte 1987, Rosatte and Larivière 2003) and thus is seldom in conflict with humans. It occurs at low densities in most localities where it is found (Ceballos and Leal 1984, Ceballos and Miranda 1986, Davis and Schmidly 1994, Rosatte and Larivière 2003), so little information has been gleaned from projects that either focused on this species or congeners

(Dowler et al. 2005, Ebeling 2006). For all these reasons, there has been very little research targeted toward this species directly, and as a result, the information needs are basic and extensive.

However, knowledge of the distribution and abundance of carnivores is important because they are often indicators of habitat and ecosystem health (Moruzzi et al. 2002, Stanley and Royle 2005). A report addressing the conservation and research priorities of western forest carnivores stressed the importance of knowledge of habitat requirements at various scales, community interactions, and responses of carnivores to human-altered landscapes for providing a scientific basis for conservation of these animals (Lyon et al. 1994, Ruggiero et al. 1994).

Below is a list of information needs required to enhance management of American hog-nosed skunk populations. Some of these studies need to be conducted in areas of greater hog-nosed skunk abundance than Colorado, and inferences then made for Region 2.

1. Create a multi-agency team, including species experts, to develop and implement an assessment of the presence of the American hog-nosed skunk in Colorado.
2. Develop a plan to conduct and coordinate roadkill surveys, combined with public education and public involvement. Roadkill surveys appear to be one of the most effective tools for detecting the presence of American hog-nosed skunks (Dragoo et al. 1988, Dowler et al. 2005). Data from all sources should be collected in a common database such as NatureServe.
3. Develop detection and capture methods that are successful for this species.
4. Coordinate among researchers conducting ecological and life history studies on known populations of the species in central and southwestern Texas, and encourage studies in Arizona and southern New Mexico. These are localities where the species is numerous enough that radio telemetry can be used to investigate daily and seasonal movement patterns, food habits, causes of mortality, demography, and interspecific interactions, especially indirect competition with other skunks and with other medium-sized rooting insectivorous mammals.

5. Determine population densities in areas where there are known populations. There is some evidence that abundances are seldom very high (Dowler et al. 2005).
6. Evaluate the interaction between prey abundance and land use practices and other factors, especially the effects of insecticide use, grazing, and fire suppression on prey availability.
7. Investigate the relationship between prey populations and American hog-nosed skunk population dynamics.
8. Develop demographic data for American hog-nosed skunks in natural and anthropogenically-modified landscapes for use in population viability analyses.
9. Conduct studies of population dynamics and movement in adjacent populations in Oklahoma and New Mexico. Presence/absence surveys targeted to suitable habitat; perhaps beginning with a focus on monitoring roadkilled wildlife since this has been found to be when most sightings of the species have occurred in Texas (Dragoo et al. 1988, Dowler et al. 2005).
10. Conduct an assessment of habitat health for the species within its likely range in Colorado. Delineate suitable habitat in Colorado, especially in areas where dispersal to and from New Mexico and Cimarron County, Oklahoma is likely.
11. Develop public awareness of this species, separate from other skunks.
12. Determine and monitor dispersal and movement patterns.
13. Develop and distribute an information packet and query to hunters and private landowners in southeastern Colorado.
14. Once preliminary survey data (roadkills, mailed queries, habitat evaluations) are in hand, select locations for more in-depth occurrence assessments and surveys with remote cameras, scent stations, and track plates.

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LIST OF ERRATA

1/3/07 Page 15: Changed “**These 14 records com**These 14 records comprise six localities because of the multiple specimens from Furnace Canyon, Baca County” to “These 14 records comprise six localities because of the multiple specimens from Furnace Canyon, Baca County”.

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