ESTIMATING IMPACTS OF HIGHWAY PROJECTS ON SELECT RARE, SENSITIVE, OR DECLINING SPECIES ON COLORADO'S CENTRAL SHORTGRASS PRAIRIE

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For amphibians and reptiles – Lauren Livo (independent researcher), Chuck Loeffler (Colorado Division of Wildlife), and Dr. Stephen Mackessy (University of Northern Colorado);

For birds – Jerry Craig (Colorado Division of Wildlife), Beth Dillon (Colorado Division of Wildlife), Scott Hutchings (Colorado Bird Observatory), Dr. Fritz Knopf (USGS-Biological Resources Division), Janet Ruth (USGS-BRD), Susan Skagen (USGS-BRD), and Tom Stanley (USGS-BRD;

For fish – Tom Nesler (Colorado Division of Wildlife);

For mammals – Dr. Carron Meaney (University of Colorado) and Dr. Jerry Choate (Hays University, Kansas);

For invertebrates – Dr. Boris Kondratieff (Colorado State University), Phyllis Pineda (Colorado State University), and Chuck Loeffler (Colorado Division of Wildlife);

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EXECUTIVE SUMMARY

Purpose of the Project

This project was undertaken by the Colorado Department of Transportation (CDOT) for the purpose of achieving three goals: 1) proactive conservation of declining species in the Central Shortgrass Prairie (CSP) ecoregion of Colorado; 2) compensation for potential impacts to these species from transportation improvements on the existing highway network; and 3) improved efficiency and effectiveness of environmental assessments associated with CDOT projects. A key means to achieve this interagency vision was advance compensation for potential impacts from transportation improvement projects through proactive multi-species habitat protection and adaptive management in perpetuity.

This project focuses on the Colorado portion of the Central Shortgrass Prairie ecoregion as modified by TNC (1998) from Bailey et al. (1994). For the purposes of this project, TNC's CSP boundary was further modified to include all segments of I-25 within Colorado. The total project area includes the entire eastern prairie in Colorado (~27,520,863 acres) and has a western boundary roughly coincident with Interstate 25 (Figure 1). It is dominated by shortgrass, mixed-grass, and sandsage prairie spread across rolling plains, tablelands, canyons, badlands, and buttes (TNC 1998).

This analysis was designed to address routine maintenance and construction activity on existing state and federal highways in the CSP. For the purposes of this analysis, "impact" refers to adverse effects to species that may result from maintenance and construction actions undertaken by CDOT over the next 20 years. **This analysis does not address construction of new roads.**

Methods

There were three components to this analysis: 1) selection of target species, 2) expert review of species range/distribution, discussion of possible impacts from CDOT activities, and definition of potential impact zones, and 3) GIS calculations of potentially impacted acres based on defined impact zones. The impact analysis was conducted using a geographic information system and the best available scientific data, in conjunction with expert review. The core project team consulted with experts in each taxonomic group (amphibians and reptiles, birds, fish, mammals, invertebrates, and plants) to help select target species, to refine existing range/distribution data, and to guide development of impact zones.

After consultation with experts on species' distribution and potential impacts, the core project team distinguished between species that would be targeted for conservation through off-site habitat protection, and species that would benefit most from on-site conservation measures. The GIS-based impact analysis focused only on the species targeted for off-site habitat protection. The purpose of this analysis was to calculate the maximum acreage of permanent habitat loss for

each species that could potentially result from highway improvement projects. Impact zones were used to spatially represent areas of potential habitat loss for each species. Results were edited to represent only suitable habitat for each species. Results for each species were then combined to eliminate redundancy.

Results

The potential impact that was most widely recognized by experts across most taxonomic groups was permanent habitat loss. There was general consensus among the experts consulted that potential impacts from most routine maintenance activities would probably temporary, and could be minimized through the use of best management practices. However, construction projects that result in permanent habitat loss should be mitigated. The final list of species included in the GIS analysis was:

BIRDS

Bald Eagle (*Haliaeetus leucocephalus*)
Burrowing Owl (*Athene cunicularia*)
Cassin's Sparrow (*Aimophila cassinii*)
Ferruginous Hawk (*Buteo regalis*)
Lark Bunting (*Calamospiza melanocorys*)
Lesser Prairie-chicken (*Tympanuchus pallidicinctus*)
Loggerhead Shrike (*Lanius ludovicianus*)
Long-billed Curlew (*Numenius americanus*)
McCown's Longspur (*Calcarius mccownii*)
Mountain Plover (*Charadrius montanus*)

MAMMALS

Black-tailed Prairie Dog (*Cynomys ludovicianus*)

REPTILES

Massasauga Rattlesnake (*Sistrurus catenatus*)
Texas Horned Lizard (*Phrynosoma cornutum*)
Western Box Turtle (*Terrapene ornata*)

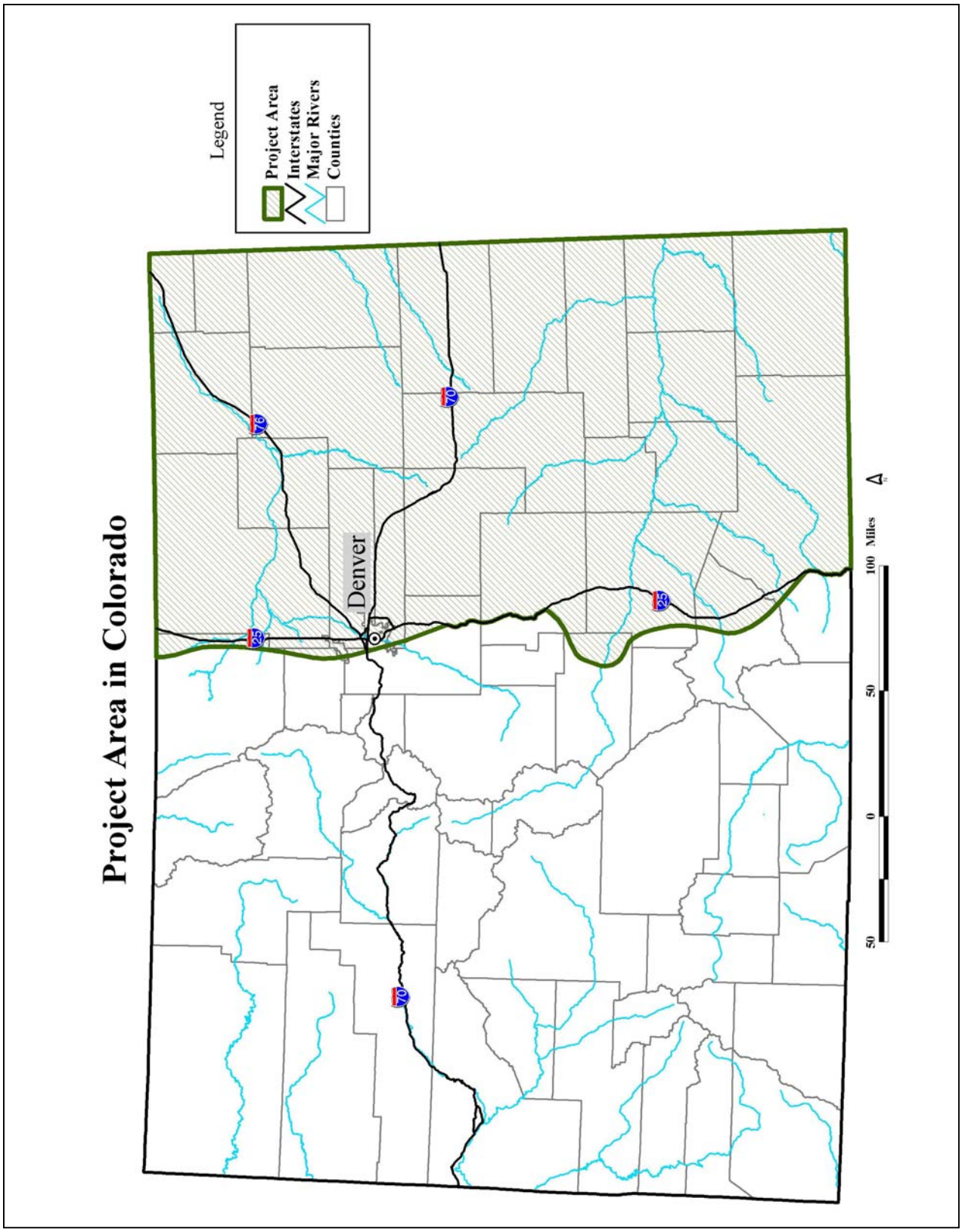
PLANTS

Arkansas River Feverfew (*Bolophyta tetraneuris*)
Pueblo Goldenweed (*Oonopsis puebloensis*)
Round-leaf Four-O'clock (*Oxybaphus rotundifolius*)

Maximum Impacted Acres

During a 20-year time period (i.e., the amount of time covered by this project), the maximum number of road miles within the CSP that can feasibly undergo construction leading to permanent habitat loss is estimated by CDOT at 22%. This estimate is based on typical funding levels and the amount of time required to complete construction projects. Therefore, "maximum potential impact" was defined as 22% of the number of acres of presumed presence within the impact zone for each species. Once the maximum potential impact was calculated for each species, all impact zones were overlaid to subtract overlap among species (i.e., to account for the same areas of potentially impacted habitat being reported for multiple species). **When redundancy in reporting is eliminated, the total amount of CSP habitat for targeted species that is potentially impacted by CDOT improvement projects within existing transportation corridors is 15,160 acres**.

FIGURE 1. Project area



PART 1: INTRODUCTION

This project was undertaken by the Colorado Department of Transportation (CDOT) for the purpose of achieving three goals: 1) proactive conservation of declining species in the Central Shortgrass Prairie (CSP) ecoregion of Colorado; 2) compensation for potential impacts to these species from transportation improvements on the existing highway network; and 3) improved efficiency and effectiveness of environmental assessments associated with CDOT projects. A key means to achieve this interagency vision was advanced compensation for potential impacts from transportation improvement projects through proactive multi-species habitat protection and adaptive management in perpetuity.

CDOT worked jointly with the U.S. Fish and Wildlife Service (USFWS), the Colorado Division of Wildlife (CDOW), The Nature Conservancy (TNC), and the Colorado Natural Heritage Program (CNHP) to develop a process that would not only identify declining prairie species most likely to be adversely impacted by CDOT activities, but would also provide a meaningful contribution to the protection of those species through establishment of one or more protected areas. The first step in this process was to conduct an analysis of potential impacts to targeted prairie species that may result from CDOT projects. That impact analysis is the subject of the following report.

This project focuses on the Colorado portion of the Central Shortgrass Prairie ecoregion as modified by TNC (1998) from Bailey et al. (1994). For the purposes of this project, TNC's CSP boundary was further modified to include all segments of I-25 within Colorado. The total project area includes the entire eastern prairie in Colorado (~27,520,863 acres) and has a western boundary roughly coincident with Interstate 25 (Figure 1). It is dominated by shortgrass, mixed-grass, and sandsage prairie spread across rolling plains, tablelands, canyons, badlands, and buttes (TNC 1998).

This analysis was designed to address routine maintenance and construction activity on existing state and federal highways in the CSP. For the purposes of this analysis, "impact" refers to adverse effects to species that may result from maintenance and construction actions undertaken by CDOT over the next 20 years. **This analysis does not address construction of new roads.**

PART 2: TARGET SPECIES, EXPERT REVIEW, AND GIS IMPACT ANALYSIS

There were three components to this analysis: 1) selection of target species, 2) expert review, including refinement of species' range/distribution, discussion of possible impacts from CDOT activities, and definition of potential impact zones, and 3) calculations of impacted acres based on defined impact zones. Because of the programmatic nature of the project, the regional scale of the project area, and the multi-species focus, the core project team (consisting of representatives from CDOT, USFWS, Federal Highways Administration (FHWA), CDOW,

TNC, and CNHP) decided to base the impact analysis on a geographic information system (GIS) using the best available scientific data, in conjunction with expert review.

Preliminary Evaluation of Target Species

The process for selecting the species to be targeted in this analysis was primarily driven by the ultimate goal of the project - large scale, off-site mitigation for those prairie species most likely to be 1) adversely impacted by CDOT activities, and 2) federally-listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, as amended, in the next 20 years. The project team began with the species list compiled in 1998 by The Nature Conservancy for their Central Shortgrass Prairie conservation plan (TNC 1998)[1]. TNC's list included all imperiled, declining, and endemic species for the Central Shortgrass Prairie (portions of Colorado, Nebraska, Kansas, Oklahoma, Texas, Wyoming, and New Mexico). Scientists from CDOT, USFWS, CDOW and CNHP updated and refined the TNC list, and added professional insight into the vulnerability of species in question. Species that do not occur in Colorado were deleted, and some species of state concern were added. The resulting list of 96 species (Appendix A) was then ranked according to two criteria: 1) likelihood of impact from CDOT activities within 20 years, and 2) likelihood of federal listing under the ESA within 20 years.

Likelihood of impact was scored "yes" or "no" for each species, based on proximity to any state or federal highway within the Colorado CSP. Proximity was defined as any known occurrence within a 0.5mile distance from any state or federal highway. Identification of "known occurrence" was based on existing information in CNHP and CDOW databases, and then refined by expert review.

Likelihood of federal listing within 20 years was scored "high," "medium," or "low" for each species. These scores reflect existing information on species status, trends and threats. Chris Pague, Director of Conservation Science for The Nature Conservancy of Colorado, performed the preliminary evaluation, which was further refined by other biologists on the core project team and species experts that were consulted during the impact analysis process (as described in the following section).

Species that met the "likelihood of impact" and "likelihood of listing" criteria were further evaluated for extent of their range and distribution within the CSP. It became clear during the ranking process that some declining prairie species were very restricted in their range and distribution in Colorado, and that a multi-species habitat protection effort was not likely to be an effective alternative for offsetting impacts to range-restricted species. Also, for some species, expert opinion suggested that potential threats may be better ameliorated on-site. Therefore, the core project team developed two species lists – a primary list of species that would be targeted for off-site habitat protection, and an "on-site mitigation" list for species that would be targeted for *in situ* conservation measures. The target species lists were finalized by the core project team

[1] TNC's plan was developed over a one and a half-year period by a multi-disciplinary team of biologists and conservation practitioners. The stated goal of the plan is "the long-term survival of all viable native species and natural plant community types occurring within the ecoregion." The planning process included consultation with experts on the status of all native species within the ecoregion, threats, and landscapes where conservation success might be achieved.

after consultation with the experts (as described in the following section) on species distribution and potential impacts.

Expert Review

The core project team consulted with experts in each taxonomic group (amphibians and reptiles, birds, fish, mammals, invertebrates, and plants) to help select target species, to refine existing range/distribution data, and to guide analysis of potential impacts. These experts were identified by TNC, CNHP, CDOW, and USFWS based upon their widely recognized statewide expertise on Colorado flora or fauna. In addition to their evaluations of best available data, these experts contributed their field knowledge and, in some cases, their colleagues' insights. The experts reviewed and commented on the species list, and provided, through one-on-one or group meetings, refined information on range and distribution for each species. Current understanding of range and distribution was mapped as "presumed presence" for each species. Experts also provided guidance and direction on the types of impacts that might be expected from routine highway maintenance and reconstruction on the existing road network. This guidance was used to develop "impact zones," or spatial representations of potential impact. Impact zones were then used to estimate of total acres of habitat that may be adversely impacted for each species, as described in Parts 2 and 3 of this document.

This section summarizes the results of discussions the core project team held with the experts. **Unless noted otherwise, all comments in this section were provided to the project team by one or more of the experts consulted**.

AMPHIBIANS AND REPTILES

Representatives from CDOT, USFWS, and/or CNHP met individually with the following experts: Dr. Stephen Mackessy (Univ. Northern Colorado), Chuck Loeffler (Colorado Division of Wildlife), and Lauren Livo (independent researcher).

Species Status and Presumed Presence

Experts refined presumed presence maps and discussed species status and potential impacts for the following species: northern cricket frog (*Acris crepitans*), northern leopard frog (*Rana pipiens*), roundtail horned lizard (*Phrynosoma modestum*), Texas horned lizard (*Phrynosoma cornutum*), western box turtle (*Terrapene ornata*), and the massasauga rattlesnake (*Sistrurus catenatus*). Based on expert opinion, the roundtail horned lizard was dropped from the project species list. This species is only known from two locations in Colorado. Although any other occurrence would likely be restricted and may be easily overlooked, there has been a fair amount of inventory effort for the round-tailed horned lizard with only one new occurrence located.[2] The only known occurrences are along dirt roads on private land. No foreseeable action from CDOT would affect these localities.

[2] Subsequent to these discussions, CNHP discovered a new occurrence of the roundtail horned lizard in a relatively remote area in Las Animas County. However, the decision to not include this species on the project species list was not changed, because this occurrence was not located near any state or federal highways, and would not be impacted by any project covered under this programmatic agreement.

Potential Impacts

According to the experts, potential impacts to the northern leopard frog and northern cricket frog from CDOT activities would be largely related to changes in local hydrology. Primary concerns would be habitat loss through temporary or permanent de-watering, and indirect effects from aquatic alteration, pollution (e.g., salts, de-icing compounds) and siltation. If aquatic alteration resulted in habitat favoring the exotic bullfrog, additional impacts may include increased predation on adult leopard and cricket frogs, loss of tadpoles due to increased competition, and an increase in pathogens. In terms of favoring the exotic bullfrog, the most important habitat alteration would be the new establishment of permanent water, particularly if this were to occur in areas near any potential corridor (e.g., an irrigation ditch that is connected to habitat occupied by bullfrogs) (pers. comm., L. Livo).

Northern leopard frogs and northern cricket frogs breed in ponds and slow-moving pools. They are most likely to be found within approximately 0.25 – 0.5 miles from water in rainy weather, and in the immediate vicinity of water in dry weather. Experts suggested that impacts to these species from construction projects would most likely be manifested within approximately 0.3 miles of the road where suitable habitat exists (i.e., along drainages). Seasonal restrictions for construction projects would be helpful if these restrictions included avoiding impacts during the breeding season when adults are searching for mates and when the young of the year are dispersing.

In general, the primary concern for impacts to the Texas horned lizard, massasauga rattlesnake, and western box turtle was roadkill. This includes construction activities by CDOT that lead to increased roadkill. Roads may attract reptiles such as horned lizards for basking or hunting prey. According to Dr. Mackessy, "Massasaugas do…cross roads regularly when moving from hibernation to foraging areas in Lincoln County (and likely elsewhere); in addition, they frequently cross roads during the active season (April to October) anywhere that roads bisect habitat, and as such, they are subject to significant risk. From 1995-1998, we collected over 200 road-killed massasaugas in se [southeastern] Colorado, virtually all killed by vehicles. If a reserve was set up in an area where massasaugas would likely cross roads, even dirt county roads (highly likely since these animals may make linear movements of up to 2-4 km in a season), then snakes would likely be killed regularly by vehicles. If a particular directionality of movement was determined, most road mortality could be minimized/avoided with underpasses and drift fencing. Although at first glance this may seem very expensive, from our experience there are apparently 'migration corridors' where larger numbers of snakes tend to cross, and so fencing could be minimized (similar to elk fencing, though a bit shorter and cheaper)."

Box turtles are common victims of roadkill on some roads (e.g., Dr. Mackessy's crew once counted 75 roadkilled box turtles on a single pass of US287 – approximately 21 miles - between Kit Carson and Eads). Because box turtles are long-lived, populations may not be able to sustain current levels of highway mortality. Also, turtles use road banks for breeding sites (egg deposition), and are potentially susceptible to impacts from ground disturbance. Unfortunately, there is no information on where such breeding sites may be, so scope or severity of this impact cannot be estimated.

Other comments: Roads are among the most significant threats to amphibian and reptile populations locally. The primary highway impacts are those that cause direct mortality such as mowing and roadkill. Increases in traffic levels and speed increase potential for roadkill. Measures to avoid roadkill such as underpasses accompanied by barriers would be helpful, as would minimizing highway construction in the most valuable habitats and directing roads away from riparian areas (including small drainages). Roads may also pose barriers to movement between wetlands.

BIRDS

Representatives from CDOT and CNHP met with the following experts as a group to review presumed presence and potential impacts for bird species: Jennie Slater (Colorado Division of Wildlife), Chris Pague (TNC), Dr. Fritz Knopf (USGS Biological Resources Division), Scott Hutchings (Colorado Bird Observatory), Susan Skagen (USGS BRD), Janet Ruth (USGS BRD), Beth Dillon (currently with Colorado Division of Wildlife), and Tom Stanley (USGS BRD). Consultations on presumed presence and potential impacts to federally-listed birds were conducted over the telephone with Jennie Slater (CDOW), Gerald Craig (CDOW), and Chris Pague (TNC).

Species Status and Presumed Presence

Experts refined presumed presence maps, and discussed species status and potential impacts for the following species: bald eagle (*Haliaeetus leucocephalus*), plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*), greater prairie-chicken (*Tympanuchus cupido pinnatus*), lesser prairie-chicken (*Tympanuchus pallidicinctus*), western snowy plover (*Charadrius alexandrinus nivosus*), piping plover (*Charadrius melodus*), mountain plover (*Charadrius montanus*), long-billed curlew (*Numenius americanus*), interior least tern (*Sterna antillarum athalassos*), burrowing owl (*Athene cunicularia*), Cassin's sparrow (*Aimophila cassinii*), and McCown's longspur (*Calcarius mccownii*).

Based on expert review, the greater prairie-chicken and the plains sharp-tailed grouse were dropped from the project species list. Greater prairie-chicken was previously listed by CDOW as threatened in Colorado, but has since been down-listed and became a game bird open to limited harvest in the fall of 2000. Although the plains sharp-tailed grouse has a limited distribution in Colorado, and is listed as endangered in the state by CDOW, the species is hunted in other parts of its range. Therefore, it is highly unlikely that the species will be federally-listed in the foreseeable future.

Two additional species were added to the list: lark bunting (*Calamospiza melanocorys*) and loggerhead shrike (*Lanius ludovicianus*). The lark bunting is on the Partners in Flight national watchlist, and the loggerhead shrike is listed as a species of common conservation concern under the North American Free Trade Agreement. The core project team decided that the presence of these species on other "radar screens" may indicate a higher potential for future federal listing.

In team meetings subsequent to the meeting with bird experts, the ferruginous hawk (*Buteo regalis*) was also added to the primary species list. There was lack of clear consensus as to the status of this species among the bird experts. Also, this bird frequently appears on various lists

of species of conservation concern. In addition, the shortgrass prairie (especially prairie dog colonies) represents the primary habitat for the ferruginous hawk. Therefore, the core project team decided to give the benefit of doubt to the species and add it as a target species for this project.

Potential Impacts

There was strong consensus among the experts that the primary concern for most of these species over the long term is loss of habitat. In some cases, highway ROWs may be attracting nesting or foraging birds (i.e., creating habitat), but this was generally not considered a desirable situation by the experts (note that field data are not available to either support or reject this theory). Most commonly, nesting birds appear to avoid ROWs, and the experts considered these areas permanently lost as breeding habitat.

CDOT activities that were considered likely to result in permanent habitat loss were road widening, maintenance yards and stockpiling, and bridgework. CDOT activities that were considered to have potential for temporary impacts were mowing, re-surfacing and shoulder improvements, winter maintenance (e.g., sanding, de-icing), and weed management. There was consensus among experts that these temporary impacts would be localized and unlikely to result in long-term adverse impacts to populations. Use of best management practices and seasonal restrictions during construction projects should be sufficient to offset temporary impacts. Otherwise, experts agreed that ROWs should be managed such that they do not attract birds.

For off-site mitigation purposes, experts suggested the following major habitat types for protection: shortgrass prairie, playas, and mixed-grass shrub interface. Protection of shortgrass prairie habitat targeting the burrowing owl would also contribute to the conservation of mountain plover, long-billed curlew, and McCown's longspur. Protection of playa habitat would contribute to the conservation of western snowy plover. Protection of mixed-grass/shrub habitat targeting lesser prairie chicken would also contribute to the conservation of Cassin's sparrow and loggerhead shrike.

Exceptions to the above comments on potential impacts to birds are the bald eagle, interior least tern, piping plover, and western snowy plover. According to Gerald Craig (CDOW raptor expert), eagles tend not to frequent areas where traffic is high, and adaptations to existing roads have already occurred. Where bald eagles occur near existing roads, they have habituated to roadway activities, and CDOT projects would not be expected to affect them. However, bald eagles rely heavily upon prairie dogs in the winter, and any impact to prairie dogs would translate into impacts to eagles through lost food resources. Therefore, any spatial measure of potential impact to prairie dogs would also measure potential impact to the bald eagle (in effect, doubling the importance of the potential impact).

The experts consulted agreed that there would not be any foreseeable impact from transportation improvement projects on nesting habitat for interior least tern, piping plover, and western snowy plover. According to the best available data, these birds are restricted in occurrence within Colorado to the a few specific reservoirs in the southeastern corner of the state. The only potential for impact to these species that was identified by the experts and the core project team

was the potential for disruption of surface flows or groundwater movement in feeding habitat if any roads were to be widened in the vicinity of nesting habitat.

FISH

Representatives from CNHP met with the state's primary expert on native fish, Tom Nesler (CDOW).

Species Status and Presumed Presence

Mr. Nesler assisted in the refinement of presumed presence maps and discussion of status and impacts for all species that are still known to exist in the state, and are either ranked "high" or "medium" for potential federal listing (see Appendix A), or are listed by CDOW as endangered or threatened in the state. These species are: southern redbelly dace (*Phoxinus erythorgaster*), Arkansas darter (*Etheostoma cragini*), plains minnow (*Hybognathus placitus*), suckermouth minnow (*Phenacobius mirabilis*), brassy minnow (*Hybognathus hankinsoni*), common shiner (*Notropis cornutus*), flathead chub (*Hybopsis gracilis*), and plains topminnow (*Fundulus sciadicus*).

Known distribution and recovery streams identified by CDOW for each species were mapped. Known distribution and potential recovery streams for most of these species are restricted to either the mainstem of the Arkansas and/or South Platte Rivers, and/or to relatively small, isolated segments of tributaries.

The southern redbelly dace, plains topminnow, and common shiner occur in relatively isolated populations. The southern redbelly dace is a pond/pool species that currently exists in a very disjunct distribution, with two occurrences in Pueblo County and one in Fremont County. Recovery efforts for this species will probably be limited to the Cañon City – Pueblo area. The Arkansas darter and the brassy minnow are primarily tributary species, but they need connection to the mainstem for colonization and dispersal. The plains minnow and the suckermouth minnow are both mainstem species. The plains minnow is virtually extirpated from the state. The only known occurrence consists of a few individuals in the South Platte River near Balzac, Colorado. Additional populations will likely be introduced; recovery efforts will focus on the Arkansas River from Pueblo to the Kansas state line. The suckermouth minnow currently occurs in the Arkansas River downstream of John Martin Reservoir, near Lake Meredith, and in one location on the South Platte River near Ovid. The brassy minnow currently occurs in scattered tributaries of the South Platte drainage. The flathead chub occurs throughout the Arkansas River basin above John Martin Reservoir.

Potential Impacts

The primary concern for these species was the construction of permanent barriers to upstream/downstream movement (e.g., conduit pipes). The critical threshold for gradients that prohibit fish movement is unknown. Other impacts commonly associated with roadwork, such as siltation and turbidity, are not thought to negatively affect these species unless such impacts continue for longer than one year. If these impacts are of short duration, they are not substantially different from the types of storm and flood events that these species are adapted to.

Continuance of these types of impacts for longer than a year may affect life cycles; continuance for longer than two years could extirpate local populations. Overall, CDOW considered use of best management practices during CDOT actions a more appropriate conservation approach than off-site mitigation.

MAMMALS

Representatives from CDOT, USFWS, and/or CNHP conferred individually with the following experts: Dr. Carron Meaney (University of Colorado) and Dr. Jerry Choate (Hays University, Kansas).

Species Status and Presumed Presence

Presumed presence maps were refined, and species status and potential impacts was discussed for the following species: Botta's pocket gopher *rubidus* subspecies (*Thomomys bottae rubidus*), northern pocket gopher *macrotis* subspecies (*Thomomys talpoides macrotis*), swift fox (*Vulpes velox*), and black-tailed prairie dog (*Cynomys ludovicianus*). There was some discussion with Dr. Meaney about future concern over white-tailed jackrabbits. They are broadly distributed, but she suspects there have been some declines. Because documentation of potential declines is not available, the project team decided not to add this species to the project list. Heavily cultivated areas were removed from the swift fox presumed presence map.

Potential Impacts

The greatest concern for both pocket gopher subspecies was the potential for roads to form barriers to underground movement between burrows. Sufficient fragmentation could lead to genetic barriers as well. Compaction of the soil underneath roadways would probably be a limiting factor. Lane widening could contribute to the barrier effect of roads. Regular maintenance such as mowing would not be expected to adversely impact these subspecies because the vibrations would likely cause animals to go underground. Roadkill was not considered a significant threat to these subspecies.

The greatest impact to swift foxes from roads is roadkill. Otherwise, this species is hardly affected at all by the presence of humans. The swift fox is a generalist species that does well in highly altered habitats. Roadside ditches that lead to the growth of tall vegetation may result in some potential denning habitat being eliminated, but this was not considered significant. Experts did not consider fragmentation of habitat to be a threat. This species is still widely distributed throughout the prairie between Kansas and the Front Range of Colorado.

The project team was unable to confer with any experts on potential impacts to the black-tailed prairie dog. However, the USFWS included a discussion of factors affecting this species in their 12-month administrative finding for the petition to list the black-tailed prairie dog. There was no mention of roads as a primary threat to prairie dogs in this discussion. Habitat loss due to urban development was believed to be a low threat. Habitat fragmentation was considered a moderate threat, but there was no mention of roads as a source of fragmentation. Although there have been significant declines in range and population numbers, this species is still widely distributed

throughout the eastern plains of Colorado. Gary Skiba of the CDOW estimated that there are not more than 100,000 acres of occupied habitat in Colorado.

INVERTEBRATES

Representatives of CDOT, CNHP, USFWS, and CDOW met individually with Dr. Boris Kondratieff (Colorado State University) and Phyllis Pineda (Colorado State University) on butterflies, and with Chuck Loeffler (CDOW) on mollusks.

Species Status and Presumed Presence

Experts discussed species status, presumed presence, and potential impacts for the following species: Ottoe skipper (*Hesperia ottoe*), hops feeding azure (*Celastrina humulus*), regal fritillary (*Speyeria idalia*), arogos skipper (*Atrytone arogos*), cylindrical papershell (*Anodontoides ferussacianus*), and giant floater (*Anodonta grandis*). There were no revisions made to the presumed presence maps for the mollusks (*A. ferussacianus* and *A. grandis*).

Draft presumed presence maps showed that the current distributions of the butterflies are largely concentrated in the foothills of the Front Range area west of Interstate 25. There are a few outlying occurrences documented for regal fritillary, Ottoe skipper, and hops feeding azure. Ms. Pineda suspects that some of these butterflies may also occur in the Big Sandy drainage area of Elbert County, but there are no data to confirm this. Of the butterfly occurrences documented on the eastern plains, the most significant is probably the regal fritillary occurrence near Flagler. According to current information, this is the only known breeding site for this species in Colorado. This breeding site is a wetland on private land. The proximity of this wetland to the highway, and therefore the potential for adverse impact, is unknown. Dr. Kondratieff and Ms. Pineda agreed that the apparently restricted distribution of these butterflies may indicate some lack of sampling, but indicated that, in general, many people have been collecting butterflies throughout the plains for a long time. They felt that if these are the distributions that existing data show, then they are probably accurate.

Dr. Kondratieff suggested that the project species list be expanded to include several species of robber flies and cicadas that are very rare and potentially impacted by roads: *Mydas luteipennis*, *Phyllomydas phyllocerus*, *Nemomydas venosus*, *Tibicen bifidus*, *Pacarwa puella*, *Okanagona synodica*, *Microstylum morosum*, *Microstylum galactodes* and *Amblycheila cylindriformis*. *A. cylindriformis,* a keystone species found only in eastern Colorado, is imperiled by road-building. Dr. Kondratieff was able to provide distribution information for *M. luteipennis, P. phyllocerus,* and *N. venosus.* County level distribution is available for the other species, but Dr. Kondratieff agreed that the likelihood of any of these species becoming federally-listed in the next 20 years was low. Therefore, they were not added to the species list for this project.

Potential Impacts

The greatest concern for potential impacts to butterflies was any adverse effect on host plants and nectar sources from mowing, spraying, and construction activities. Many invertebrates are host-plant specific species. ROWs on the prairie may contain more host plant and nectar source plants than surrounding landscapes that are heavily grazed. However, mowing, spraying, or re-

seeding after construction with non-native plants may result in reduced availability of host plant and nectar sources, thereby reducing reproductive success of the butterflies. Ground disturbance that accompanies highway construction, presence of heavy equipment, and maintenance activities are usually vectors for introduction and spread of noxious weeds. Seasonal mowing (mid-spring) may be beneficial because reduction in the growth of weedy cool season grasses will benefit the native, warm-season grasses that are used as host plants by butterflies.

Also, siltation from bridgework can be problematic for a whole suite of aquatic insects as well as mollusks if best management practices are not employed. The only potential impacts to mollusks would be related to altered quantity or quality of permanent water sources. Impacts from future CDOT activities will likely be temporary since the disturbance mechanism (the road) is already present.

PLANTS

Representatives from CDOT, USFWS, and CNHP met individually with the following experts: Susan Spackman (CNHP botanist), Janet Coles (Colorado Natural Areas Program), Kathy Carsey (Colorado Natural Areas Program), and Dr. Tass Kelso (Colorado College).

Species Status and Presumed Presence

Experts discussed species status, presumed presence, and potential impacts for the following species: dwarf milkweed (*Asclepias uncialis*), Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*), Arkansas River feverfew (*Bolophyta tetraneuris*), Pueblo goldenweed (*Oonopsis puebloensis*), golden blazing star (*Nuttallia chrysantha*), round-leaf four-o'clock (*Oxybaphus rotundifolius*), and Arkansas Valley evening primrose (*Oenothera harringtonii*).

The experts agreed that the dwarf milkweed (*A. uncialis*) could be removed from the project species list because CDOT activities would not be expected to impact this plant. It is not currently known from any populations that occur close to state or federal highways, and does not typically occur in ROWs. Furthermore, the habitat requirements for this plant are hard to identify, and plants are not predictably found in habitat that appears suitable.

The Colorado butterfly plant is currently known from only one location in Colorado, adjacent to Interstate 25 north of Ft. Collins. All other occurrences were deleted from the presumed presence map for this species. Minor revisions were made to the presumed presence maps for some plants, but the overall range and distribution for these species did not change.

Other plants that some experts considered appropriate for potential inclusion on a secondary list were: plains ragweed (*Ambrosia linearis*), single-head goldenweed (*Oonopsis foliosa*), Colorado green gentian (*Frasera coloradensis*), and Bell's twinpod (*Physaria bellii*).

Potential Impacts

The Colorado butterfly plant is a wetland species, and as such, is vulnerable to negative impacts from alteration to local hydrology. It is unclear whether current impacts from I-25 are positive or negative. The construction of I-25 created additional habitat for this plant. This occurrence is

now fairly large, and represents the only known site for this plant in Colorado. Future impacts on local hydrology from CDOT actions could have a negative influence.

The Arkansas Valley evening primrose, Pueblo goldenweed, round-leaf four-o'clock, golden blazing star, and Arkansas River feverfew (collectively referred to herein as the "Arkansas Valley plants") grow either in shortgrass prairie or on rock outcrops (including both vertical outcrops and outcrops on flat ground), but they also occur on roadcuts. The primary concerns for potential impacts to these species are road widening, mowing, and herbicide application. Experts noted that the pollinators for these plants are unknown. Habitats adjacent to roadways may be important for pollinators as well as for the plants themselves.

The Arkansas River feverfew is the most common of the Arkansas Valley plants, and is known from a greater number of occurrences in natural habitat away from roads. However, it is also the hardest to mitigate for because it is long-lived and slow-growing. This species does not tolerate disturbance well, and will not re-colonize. Road clearing, habitat destruction from widening, and herbicide application could eliminate local populations.

The Pueblo goldenweed is known from roadside habitats. Utilities maintenance in CDOT ROWs is currently having adverse impacts on the population at the intersection of Highways 50 and 115. There is significant risk of further negative impacts from CDOT activities.

The golden blazing star and the round-leaf four-o'clock are both found on roadsides. Road widening could have major negative impacts to these populations. A moratorium on late season mowing (late August – September) would protect the golden blazing star during its reproductive stage. Mowing after July 31 would be best for the round-leaf four-o'clock. The golden blazing star does not transplant well. Re-seeding this species in disturbed areas may be a viable mitigation alternative, but it is very important not to decimate the original seed source population. This species is not abundant, and seed availability is limited. Seed harvest would need to be restrained so as not to deplete the soil seed bank in remaining populations (pers. comm., T. Kelso; pers. comm., J. Coles).

The Arkansas Valley evening primrose is no longer known from high quality natural habitats; almost all known occurrences are along roadways. This plant is potentially affected by road widening, mowing, and herbicide application. Spraying of herbicides would be particularly harmful to populations of this plant.

Final Target Species Lists

Further Considerations in Selection of Target Species

Based on available data and consultation with experts, the project team concluded that, for some species, on-site conservation measures might be more effective in offsetting potential impacts from transportation improvement projects than off-site habitat protection. According to information provided by CDOW, most of the targeted fish species are restricted to stretches of the mainstems of the Arkansas River or the South Platte River, and/or to relatively isolated and

disjunct reaches of tributaries. The core team decided that it would not be feasible to develop a large-scale habitat protection project that would adequately offset impacts to all these species, and that land protection per se would not be an adequate tool to conserve fish species. Because of the complexities inherent in Colorado water rights laws and practices, control over the management of surrounding lands would not necessarily include control over water in the stream. Furthermore, the primary concern regarding potential impacts to fish species from transportation improvements was creation of permanent barriers in the streams and reduction in water quality, not habitat loss. Similarly, the primary concerns expressed by the experts regarding potential impacts to amphibian species from transportation improvement projects were alteration to local hydrology and increased direct mortality (e.g., from mowing, roadkill, etc.). The primary concern regarding potential impacts to mollusk species was possible reduction in water quality (especially related to bridgework) and loss of permanent water sources. Therefore, the project team concluded that the most appropriate conservation strategy for fish, amphibian, and mollusk species would be use of best management practices (BMPs) and other on-site conservation measures to avoid, minimize and mitigate impacts to aquatic habitats.

According to the best available data, the interior least tern, piping plover, and western snowy plover are restricted in occurrence within Colorado to a few specific reservoirs in the southeastern corner of the state. Additional consultation with experts and field refinement of presumed presence for these species revealed there is little likelihood that transportation improvements would directly impact existing nesting habitat for these species. The only potential for impact to these species was identified as the potential for disruption of surface flows or groundwater movement in feeding habitat if any roads were to be widened in the vicinity of nesting habitat. The extremely limited distribution of these species within the project area, the lack of available habitat for off-site mitigation, and the fact that experts considered likelihood of impact to be very low suggest that on-site conservation measures would be more appropriate than off-site habitat protection for these birds.

The greatest concern for potential impacts to butterflies from transportation improvements was any adverse effect on host plants and nectar sources in the ROW from mowing, spraying, and construction activities. Comments from experts suggested that these potential impacts could be readily avoided or minimized through seasonal restrictions on mowing and spraying and using native plants during post-construction re-seeding.

The only feasible approach for three of the targeted plant species is use of on-site conservation measures. There is only one documented extant occurrence of the Colorado Butterfly Plant in Colorado. This occurrence is located in a wetland area downstream from I-25. There is potential for transportation improvement projects to adversely affect this site, and there are no other known sites that could be protected to offset potential impacts. The Arkansas Valley evening primrose is no longer known from high quality natural habitats. Almost all of the known occurrences are along roadways. Similarly, the majority of known occurrences of the golden blazing star are found within existing ROWs. Therefore, the most appropriate conservation strategy for these plants is avoidance to the maximum extent practicable, and the application of BMPs and other *in situ* conservation measures where necessary.

Further discussion by the core project team resulted in both pocket gopher subspecies and the swift fox being removed from the target species list. Because of the very limited range of both pocket gopher subspecies, the core project team felt that these animals would best benefit from a site-specific, project-based approach to mitigation rather than a programmatic approach. According to expert comments, there would be no discernable impacts to swift fox expected to occur as a result of transportation improvement projects on existing roads.

PRIMARY SPECIES LIST

Species in Table 1 are targeted for off-site mitigation to offset potential habitat loss. The keys to this conservation strategy are acquisition of high quality habitat and adaptive management of that habitat in perpetuity. Results of GIS analyses to calculate potential habitat loss are presented in Part 3 of this document.

Table 1: Primary Species List

Common name	Scientific Name	ESA Status/State Status
BIRDS		
Bald Eagle	*Haliaeetus leucocephalus*	Federal threatened
Burrowing Owl	*Athene cunicularia*	Colorado threatened
Cassin's Sparrow	*Aimophila cassinii*	
Ferruginous Hawk	*Buteo regalis*	Colorado special concern
Lark Bunting	*Calamospiza melanocorys*	
Lesser Prairie-chicken	*Tympanuchus pallidicinctus*	Federal candidate
Loggerhead Shrike	*Lanius ludovicianus*	Colorado special concern
Long-billed Curlew	*Numenius americanus*	Colorado special concern
McCown's Longspur	*Calcarius mccownii*	
Mountain Plover	*Charadrius montanus*	Federal proposed
MAMMALS		
Black-tailed Prairie Dog	*Cynomys ludovicianus*	Federal candidate
REPTILES		
Massasauga Rattlesnake	*Sistrurus catenatus*	Colorado special concern
Texas Horned Lizard	*Phrynosoma cornutum*	Colorado special concern
Western Box Turtle	*Terrapene ornata*	
PLANTS		
Arkansas River Feverfew	*Bolophyta tetraneuris*	
Pueblo Goldenweed	*Oonopsis puebloensis*	
Round-leaf Four-O'clock	*Oxybaphus rotundifolius*	

ON-SITE MITIGATION SPECIES LIST

Species in Table 2 are targeted for on-site conservation measures. This strategy will focus primarily on the use of Best Management Practices to offset potential impacts. These species were not considered in the GIS analysis, and are not considered further in this document.

Additional information on these species is presented in the biological assessment and conservation strategy document (Grunau et al. 2002) that accompanies this report.

GIS Analyses Using Impact Zones

As noted previously, after consultation with experts on species' distribution and potential impacts, the core project team distinguished between species that would be targeted for

Table 2: Off-site Mitigation Species List

Common name	Scientific Name	ESA Status/State Status
AMPHIBIANS		
Northern Cricket Frog	*Acris crepitans*	Colorado special concern
Northern Leopard Frog	*Rana pipiens*	
FISH		
Arkansas Darter	*Etheostoma cragini*	Federal candidate
Brassy Minnow	*Hybognathus hankinsoni*	Colorado threatened
Common Shiner	*Notropis cornutus*	Colorado threatened
Flathead Chub	*Hybopsis gracilis*	Colorado special concern
Plains Minnow	*Hybognathus placitus*	Colorado endangered
Plains Topminnow	*Fundulus sciadicus*	Colorado special concern
Southern Redbelly Dace	*Phoxinus erythrogaster*	Colorado endangered
Suckermouth Minnow	*Phenacobius mirabilis*	Colorado endangered
MOLLUSKS		
Cylindrical Papershell	*Anodontoides ferussacianus*	
Giant Floater	*Pyganodon = [Anodonta] grandis*	
INSECTS—BUTTERFLIES		
Arogos Skipper	*Atrytone arogos*	
Hops Feeding Azure	*Celastrina humulus*	
Ottoe Skipper	*Hesperia ottoe*	
Regal Fritillary	*Speyeria idalia*	
PLANTS		
Arkansas Valley Evening Primrose	*Oenothera harringtonii*	
Colorado Butterfly Plant	*Gaura neomexicana* ssp. *coloradensis*	Federal Threatened
Golden Blazing Star	*Nuttallia chrysantha*	

conservation through off-site habitat protection, and species that would be targeted for on-site conservation measures. The GIS-based impact analysis focused only on the species targeted for off-site habitat protection. The purpose of this analysis was to calculate the maximum acreage of permanent habitat loss for each species that could potentially result from highway improvement projects.

DEFINING IMPACT ZONES FOR SPECIES

The potential impact that was most widely recognized by experts across most taxonomic groups was permanent habitat loss. There was general consensus among the experts consulted that potential impacts to target species from most routine maintenance activities would probably be temporary (with the exception of the plants), and could be avoided or minimized through the use of best management practices. However, construction projects that resulted in permanent habitat loss should be mitigated.

According to the best estimates and the professional opinions of the experts, as well as the experience of CDOT biologists, the direct habitat loss from construction projects is expected to be limited to ROWs. Therefore, the average ROW distance for state/federal highways and interstate highways was used in the GIS analysis as the basic "impact zone." Based on information provided by CDOT, the average ROW width was estimated at 150 feet total for state and federal highways (i.e., 75 ft. on either side of the road), 300 feet total for Interstate 25 and Interstate 70, and 400 feet total for Interstate 76. The botany experts agreed that 50 meters on either side of the roadways was an appropriate estimate of impact zone for plants. In the analyses of impacts to targeted plant species, all highways were buffered by 50 meters on each side. This distance is a measure of the assumed potential for loss of habitat and roadside populations.

GIS INFORMATION USED IN THE ANALYSIS

This section briefly describes the GIS datasets used in the analysis. Additional details on these datasets are presented in Appendix B.

Habitat Data

The project team held extensive discussions about the best available datasets and the appropriateness of their use. Because of the programmatic nature of the project, the regional scale of the study area, and the multi-species focus, the core project team agreed that the most effective approach to the impact analysis and the conservation strategy would be habitat-based. The best scientific data available for a regional habitat-based analysis was CDOW's GAP vegetation data. Colorado GAP vegetation is a habitat/vegetation map of Colorado with 52 habitat types photo-interpreted from Landsat imagery.

Species Distribution Data

The best sources of biological data in a readily available GIS format were CNHP's element occurrence (EO) and Potential Conservation Area (PCA) data; CDOW's Wildlife Resource Information System (WRIS) and potentially suitable habitat data, and Colorado Breeding Bird Atlas data. CNHP occurrence data are point locations ("occurrences") documented for species that are considered by CNHP to be rare or imperiled rangewide or in Colorado. CNHP PCA data are polygons that include an occurrence plus the area of surrounding landscape that theoretically encompasses the ecological processes considered important for continued viability of the occurrence. Both occurrence data and PCA data from CNHP are based on field observations. CDOW's WRIS data represent known species distribution based on field observations by

CDOW personnel. CDOW's potentially suitable habitat data are computer models of habitat that may be suitable for a species based on vegetation, elevation, and other parameters. Colorado Breeding Bird Atlas data represent field observations of potential, probable, and confirmed breeding sites for birds.

Prairie dog data developed by EDAW (2000) during the course of this project were not used. This GIS dataset was compiled primarily from existing datasets documenting prairie dog towns, although some field verification of historic data and incidental new mapping were included. However, a comprehensive survey was not undertaken, and the resulting dataset presented only a snapshot of known prairie dog towns (both active and historic) at one point in time. Because this project covers a 20-year timeframe, the project team felt strongly that the estimate of potential impacts would need to consider all potentially suitable habitat that may become occupied during that time. Therefore, for the prairie dog, presumed presence was based on a more comprehensive estimate of potentially suitable habitat defined by vegetation affinities, as described in following section of this report. The EDAW dataset represents approximately 269,077 acres of prairie dog town occurrence (including active, inactive, and unknown status), whereas the presumed presence mapped in this project represents 19,687,641 acres of habitat, both occupied and potential, in the same area (Colorado's eastern plains). The core project team considered basing the impact analysis on the larger area the most appropriate approach to give the benefit of doubt to the species – a concern for all species throughout the process.

IMPACT ANALYSIS PROCESS

In general, the impact analysis process was a simple intersection between presumed presence and impact zone. For each species, all roadways within the presumed presence were buffered by the impact zone defined for that species to calculate acres of maximum potential impact. For vertebrate species, results were then edited to reflect only suitable habitat. "Suitable habitat" was defined as vegetation types identified as "affinities." Habitat affinities were originally defined by CDOW for most vertebrate species to reflect all habitat types used by a species. These habitat affinity lists were then edited by Chris Pague (Director of Conservation Science for TNC) and Jennie Slater (Grassland Species Coordinator for CDOW) to highlight only habitat types that were considered critical for completion of the species' life cycle[3].

For plant species, the impact analyses were occurrence-based rather than habitat-based, so vegetation affinities were not defined for plants. The Arkansas Valley plants are very edaphic (i.e., tightly correlated with a specific geological substrate), and are narrow endemics.

Once the acreage representing maximum potential impact was calculated for each species, all impact zones were overlaid to subtract overlap among species (i.e., to account for the same areas being reported for multiple species). Because these analyses were conducted using different data for different species, the precise process was somewhat variable among species. Details on the process for each species are presented in Appendix C.

[3] In other words, vegetation types where species may periodically be seen, but that are not considered habitats critical to the completion of any stage of the species' life cycle, were deleted from the presumed presence. This process primarily deleted human-altered landscapes (e.g., urban areas, feed lots, etc.) that would not be considered high-quality natural habitats for conservation purposes.

FRAGMENTATION

Because fragmentation is such a difficult concept to define and evaluate, but is nonetheless usually at the forefront of any discussion on impacts to habitat, a more in-depth examination of this potential impact is included here. The following comments were taken from personal communications with Chris Pague, a conservation scientist with The Nature Conservancy of Colorado.

The term "fragmentation" does not refer to a single effect, but rather to a group of collective effects. The concept of fragmentation deals with decreasing patch size of the matrix community – i.e., increasing fragmentation results in more numerous patches of smaller size. If the matrix contains both habitat and non-habitat, then as patches become smaller, the percentage of the matrix that is habitat is reduced. The impact of fragmentation on a species may vary depending on the distribution of population(s) relative to percent of total population.

Both direct and indirect effects may result from creation of non-habitat within the matrix. In the case of roads, primary direct effects would be habitat loss and increased mortality through roadkill. Indirect effects could include altered hydrology, introduction or spread of weeds, changes in topography and microclimate, and introduction of, or increase in, predator corridors. There is a third possible effect from fragmentation related to roads that is known as the barrier effect. The barrier effect is related to the species' vagility (ability to move) and willingness to get across the road, and to the chance that an individual will be successful. From a species conservation standpoint, the issue is not whether an individual succeeds in crossing the road, but whether populations on either side of the road are viable. There is a viability threshold for species (within the landscape context that exists), but in most cases, what those thresholds are remains unknown. The presence of roads has some effect. The question is – is the effect significant relative to conservation goals? Fragmentation is not considered a potential impact for any of the targeted bird species. Fragmentation could be an impact to targeted turtles, lizards, and snakes.

For the purposes of this project, the issue is not that the road is present. Issues would be road-widening (resulting in wider separation between patches), or any improvement (e.g., realignment) that significantly increased speed and or traffic volume (leading to increased roadkill). Because this project is focused only on transportation improvement to existing roads, any fragmentation that may occur would be expected to be limited to local effects. Population level effects would be minimal due to road widening. Greater impacts would be habitat loss and local degradation of habitat.

For turtles, the fragmentation issue is road density relative to the population distribution. On the eastern plains of Colorado, high quality areas that support turtles are all in the sandhills, where road density is quite low because these areas do not support agriculture. The key conservation strategy in this project is protection of high quality habitat in a good landscape context, thereby minimizing fragmentation and compensating for roadkill elsewhere.

For snakes the issues are somewhat different. If there are migratory paths from summer to winter grounds, a road through a migratory path may have disproportionately large impacts to a local population (though not everywhere the snakes occur).

Some species appear to be attracted to roads or roadsides, including all of the targeted herpetofauna, prairie dogs (because of higher moisture levels and more grass), longspurs and buntings (because they use gravel to crush seeds), and shrikes and hawks (because they use associated poles and fences). Regardless of how roadside habitat is managed, it will always be less than optimal.

PART 3: RESULTS

The following section summarizes the results of the presumed presence mapping and GIS analyses. Tables 3 and 4 present cumulative results. Figures 2-18 and tables 5-21 present presumed presence maps and GIS impact analysis results for each species. Appendix B contains detailed metadata for each base data layer used in the analyses. Descriptions of the detailed steps taken in the analysis for each species are presented in Appendix C. Vegetation affinities for vertebrate species are presented in Appendix D.

Maximum Potential Impact

During a 20-year time period (i.e., the amount of time covered by this project), the maximum number of road miles within the CSP that can feasibly undergo construction leading to permanent habitat loss is estimated by CDOT at 22%. This estimate is based on typical funding levels and the amount of time required to complete construction projects. Therefore, "maximum potential impact" was defined as 22% of the number of acres of presumed presence within the impact zone for each species. Once the maximum potential impact was calculated for each species, all impact zones were overlaid to subtract overlap among species (i.e., to account for the same areas of potentially impacted habitat being reported for multiple species). **When redundancy in reporting is eliminated, the total amount of potential habitat loss for targeted species in the CSP is 15,160 acres.**

Table 3: Maximum Estimated Impact by Vegetation Type

Acres of Maximum Potential Impact: 15,160
Total acres in the Presumed Presence: 25,188,497
Highway Miles within Presumed Presence: 3,217
Total Highway Miles in the Project Area: 4,307

Vegetation Types within Presumed Presence	Acres of Vegetation Type within Presumed Presence	Acres of Maximum Potential Impact	Percent of Presumed Presence Subject to Potential Impact
Dryland Agriculture	8,479,627	5,221	0.06%
Shortgrass Prairie	9,912,523	4,901	0.04%
Sand Dune Shrub Complex	2,634,015	1,888	0.07%
Irrigated Agriculture	804,586	1,396	0.17%
Midgrass Prairie	953,633	468	0.04%
Forest Dominated Wetland/Riparian	170,044	263	0.15%
Tallgrass Prairie	492,327	257	0.05%
Pinyon-Juniper	427,610	252	0.05%
Foothills/Mountain Grassland	205,710	223	0.10%
Desert Shrub	165,823	128	0.07%
Graminoid/Forb Dominated Wetland/Riparian	77,256	68	0.08%
Juniper Woodland	576,739	34	0.01%
Barren Land	37,502	29	0.07%
Shrub Dominated Wetland/Riparian	27,235	17	0.06%
Open Water	68,290	13	0.01%
Bare Soil	3,386	2	0.05%
Sand Dune Grassland Complex	132,762	0	0
Exposed Rock	11,133	0	0
Sandy Areas	5,250	0	0
Greasewood Fans/Flats	2,191	0	0
Big Sagebrush	855	0	0

Table 4: Maximum Estimated Impact by Species

Species Name	Acres of Presumed Presence	Acres of Maximum Potential Impact	Percent of Presumed Presence Subject to Potential Impact
BIRDS			
Bald Eagle	5,779,669	3,688	0.064%
Burrowing Owl	21,915,906	11,246	0.051%
Cassin's Sparrow	4,128,397	2,284	0.055%
Ferruginous Hawk	19,736,274	10,773	0.055%
Lark Bunting	22,550,620	12,124	0.054%
Lesser Prairie-chicken	486,299	78	0.016%
Loggerhead Shrike	14,331,360	8,780	0.061%
Long-billed Curlew	10,247,358	5,058	0.049%
McCown's Longspur	3,487,710	1,888	0.054%
Mountain Plover	19,184,617	9,936	0.052%
MAMMALS			
Black-tailed Prairie Dog	19,687,641	10,744	0.055%
REPTILES			
Massasauga Rattlesnake	5,194,767	1,891	0.036%
Texas Horned Lizard	4,723,929	1,568	0.033%
Western Box Turtle	3,118,218	1,910	0.061%
PLANTS			
Arkansas River Feverfew	52,960	141	0.266%
Pueblo Goldenweed	44,703	82	0.183%
Round-leaf Four-O'clock	49,349	117	0.237%

FIGURE 2: Bald Eagle

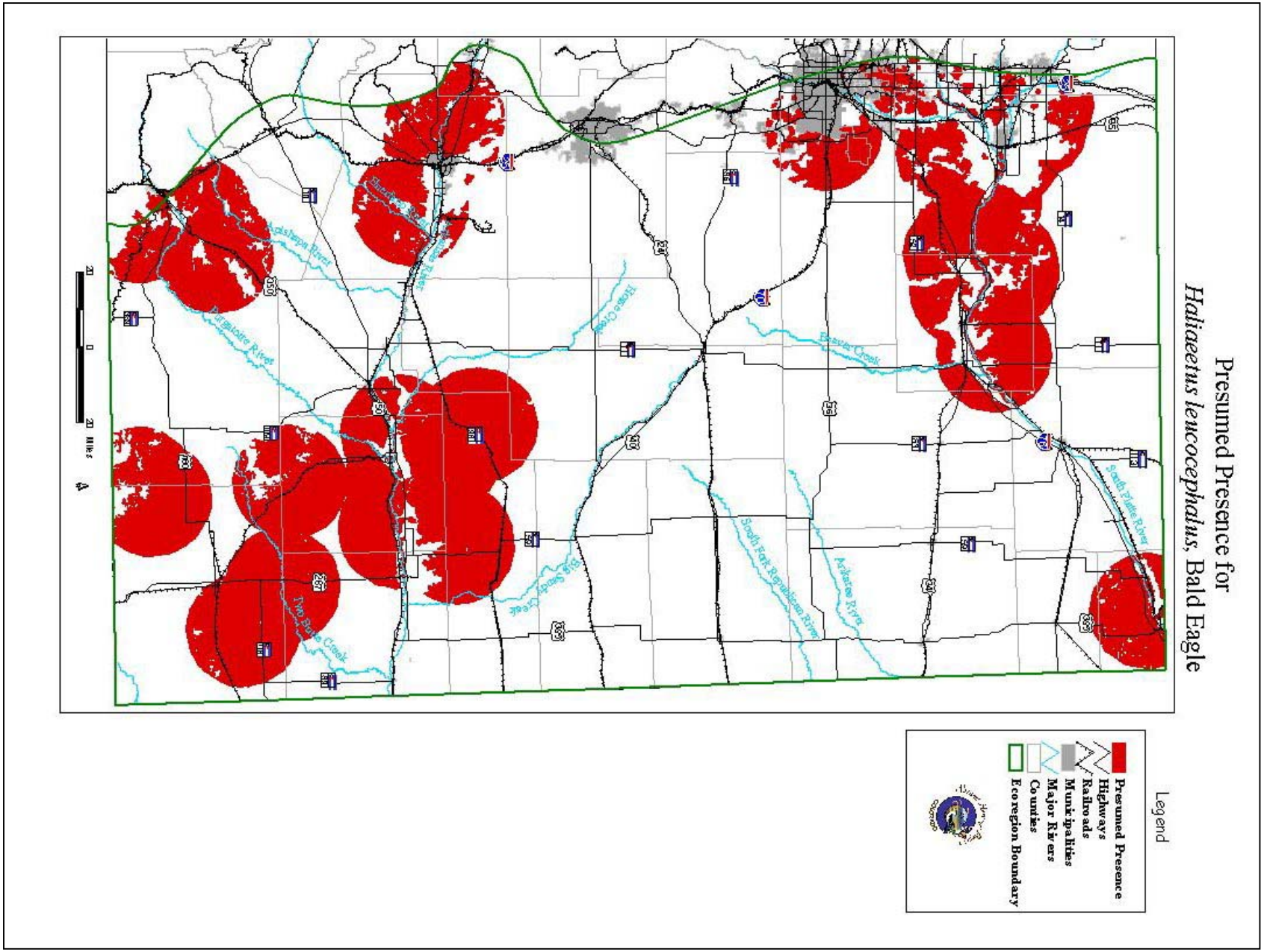


TABLE 5: Bald Eagle (*Haliaeetus leucocephalus*)

Acres of Maximum Impact: 3,688
Highway Miles: 742
Acres of Presumed Presence: 5,779,669

Vegetation Types	Acres in Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	1,773,520	1,423
Shortgrass Prairie	3,120,065	1,305
Sand Dune Shrub Complex	665,715	738
Forest Dominated Wetland/Riparian	86,909	153
Graminoid/Forb Dominated Wetland/Riparian	24,555	23
Barren Land	17,750	18
Tallgrass Prairie	25,002	15
Open Water	56,154	13
Sand Dune Grassland Complex	4,747	0
Sandy Areas	5,250	0

FIGURE 3: Burrowing Owl

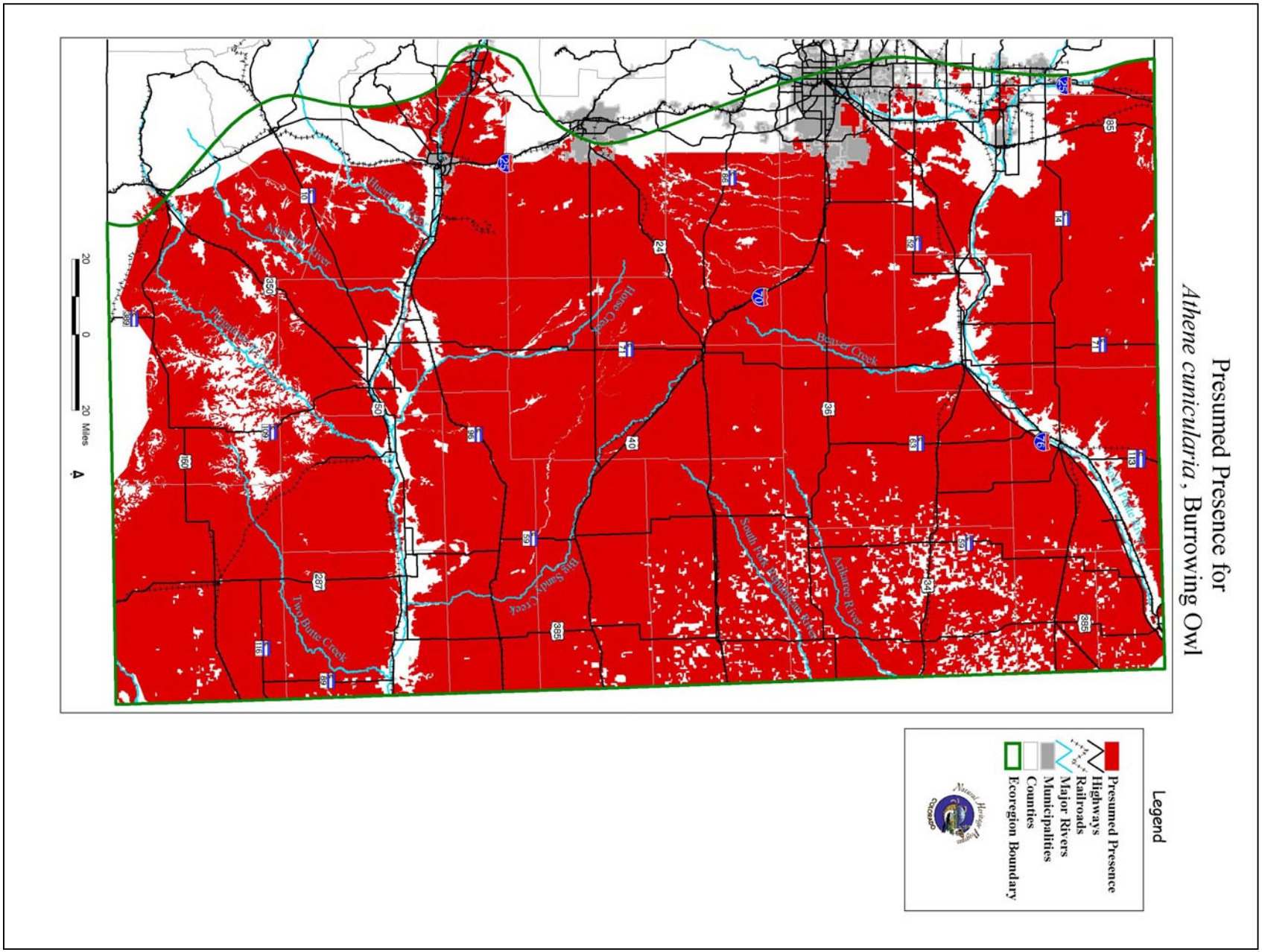


TABLE 6: Burrowing Owl (*Athene cunicularia*)

Acres of Maximum Impact: 11,246
Highway Miles: 2,437
Acres of Presumed Presence: 21,915,906

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,283,148	4,734
Shortgrass Prairie	9,395,285	4,029
Sand Dune Shrub Complex	2,634,015	1,888
Midgrass Prairie	729,890	229
Tallgrass Prairie	444,298	197
Desert Shrub	156,728	113
Foothills/Mountain Grassland	112,246	30
Barren Land	25,344	26
Sand Dune Grassland Complex	132,762	0
Greasewood Fans/Flats	2,191	0

FIGURE 4: Cassin's Sparrow

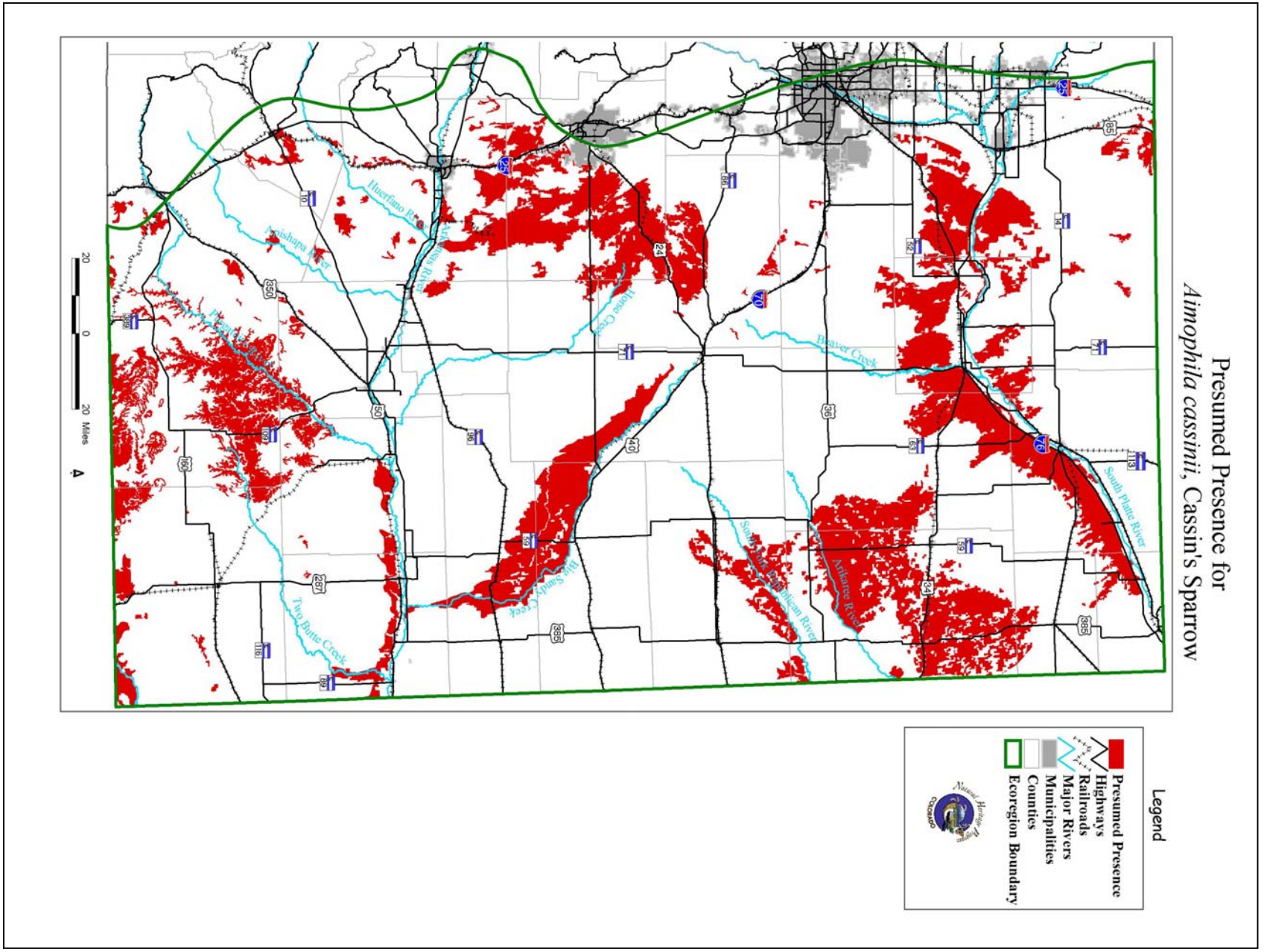


TABLE 7: Cassin's Sparrow (*Aimophila cassinii*)

Acres of Maximum Impact: 2,284
Highway Miles: 395
Acres of Presumed Presence: 4,128,397

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Sand Dune Shrub Complex	2,604,236	1,861
Midgrass Prairie	564,408	270
Tallgrass Prairie	260,434	123
Juniper Woodland	564,365	30
Sand Dune Grassland Complex	132,762	0
Greasewood Fans/Flats	2,191	0

FIGURE 5: Ferruginous Hawk

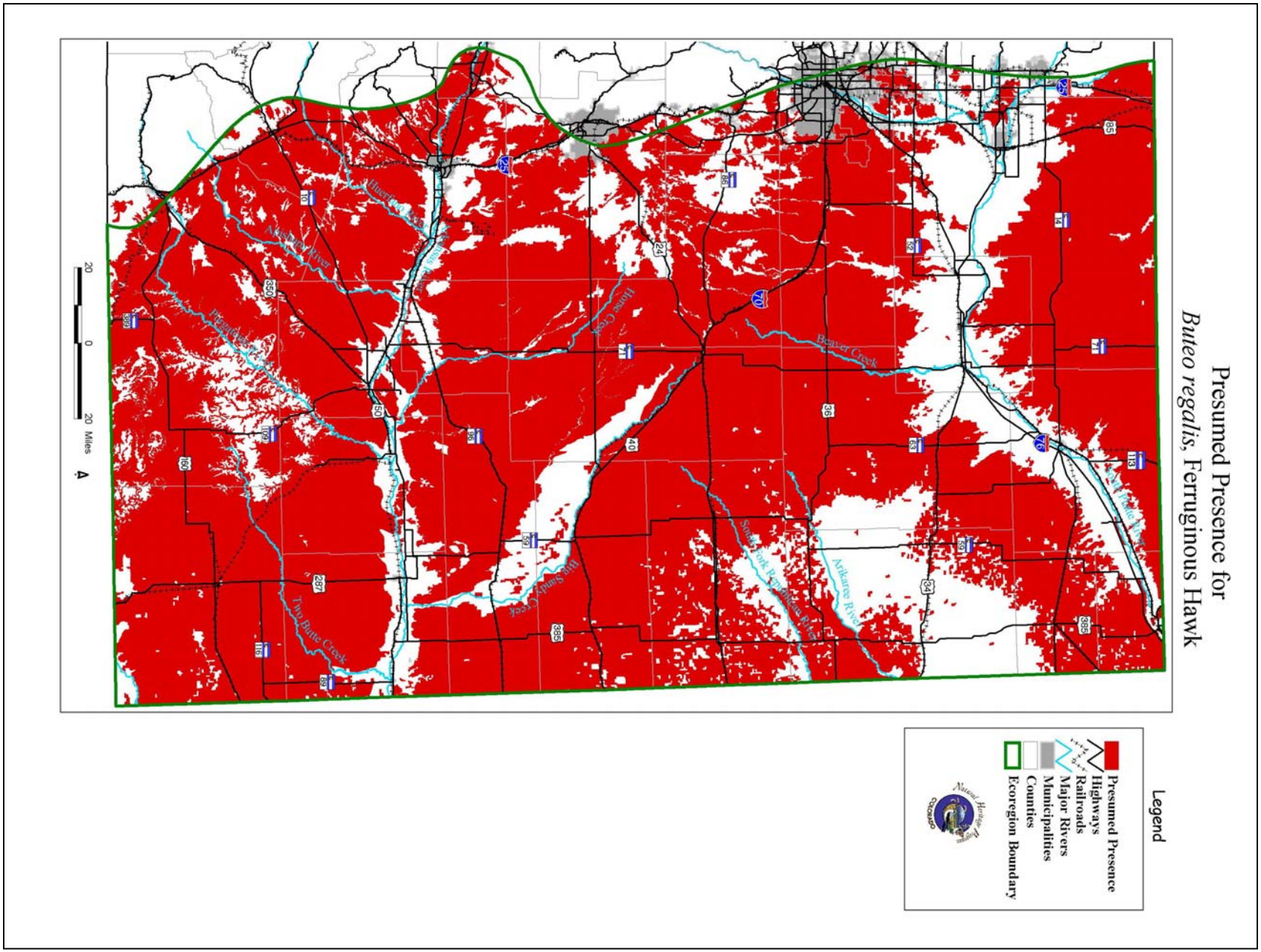


TABLE 8: Ferruginous Hawk (*Buteo regalis*)

Acres of Maximum Impact: 10,773
Highway Miles: 2,352
Acres of Presumed Presence: 19,736,274

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,479,627	5,221
Shortgrass Prairie	9,912,523	4,830
Midgrass Prairie	953,633	468
Foothills/Mountain Grassland	205,710	223
Barren Land	37,502	29
Bare Soil	3,386	2
Sand Dune Grassland Complex	132,762	0
Exposed Rock	11,131	0

FIGURE 6: Lark Bunting

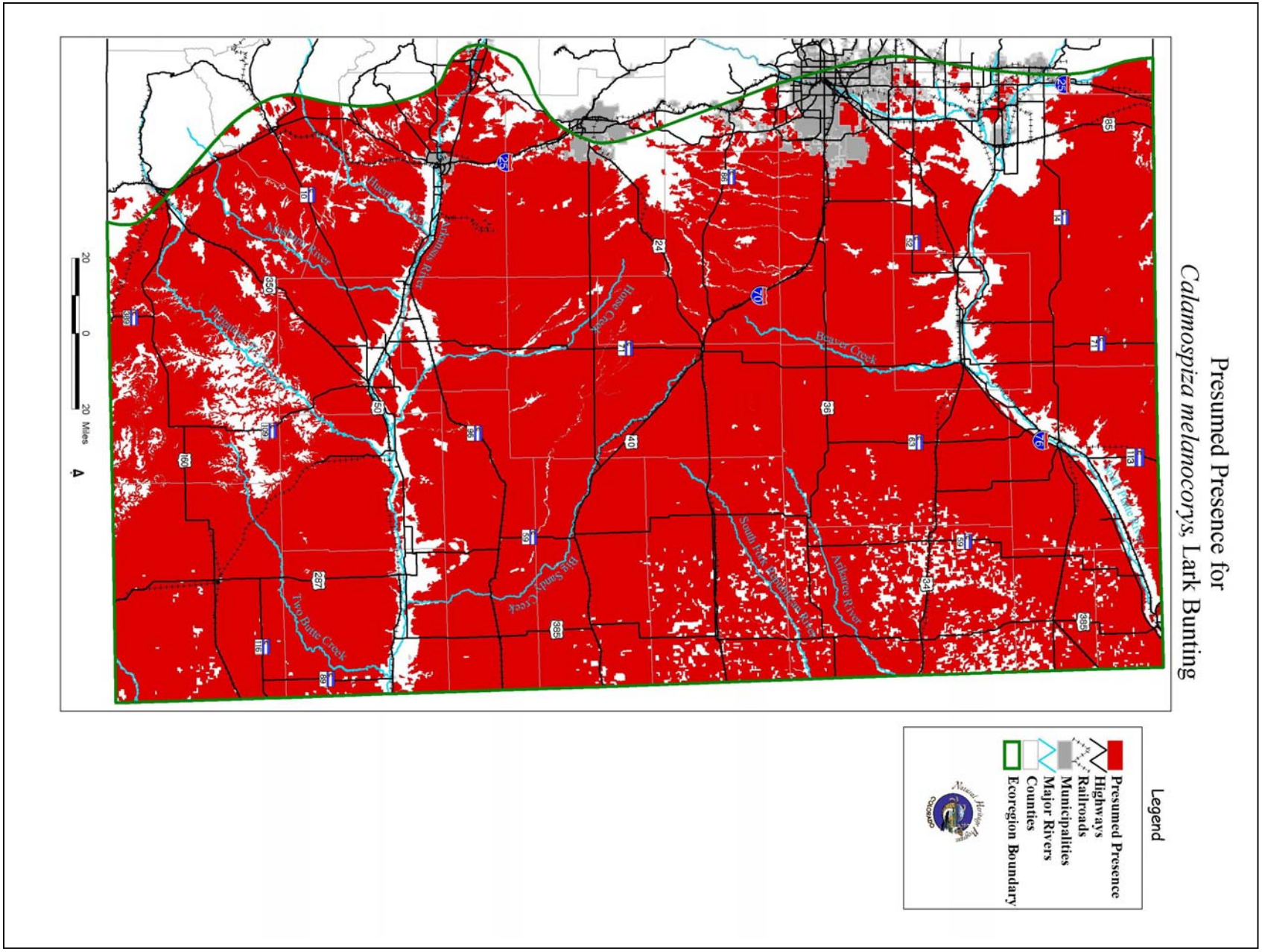


TABLE 9: Lark Bunting (*Calamospiza melanocorys*)

Acres of Maximum Impact: 12,124
Highway Miles: 2,570
Acres of Presumed Presence: 22,550,620

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,338,162	4,789
Shortgrass Prairie	9,892,246	4,717
Sand Dune Shrub Complex	2,631,179	1,862
Midgrass Prairie	920,057	404
Tallgrass Prairie	470,637	227
Desert Shrub	165,577	125
Sand Dune Grassland Complex	132,762	0

FIGURE 7: Lesser Prairie-chicken

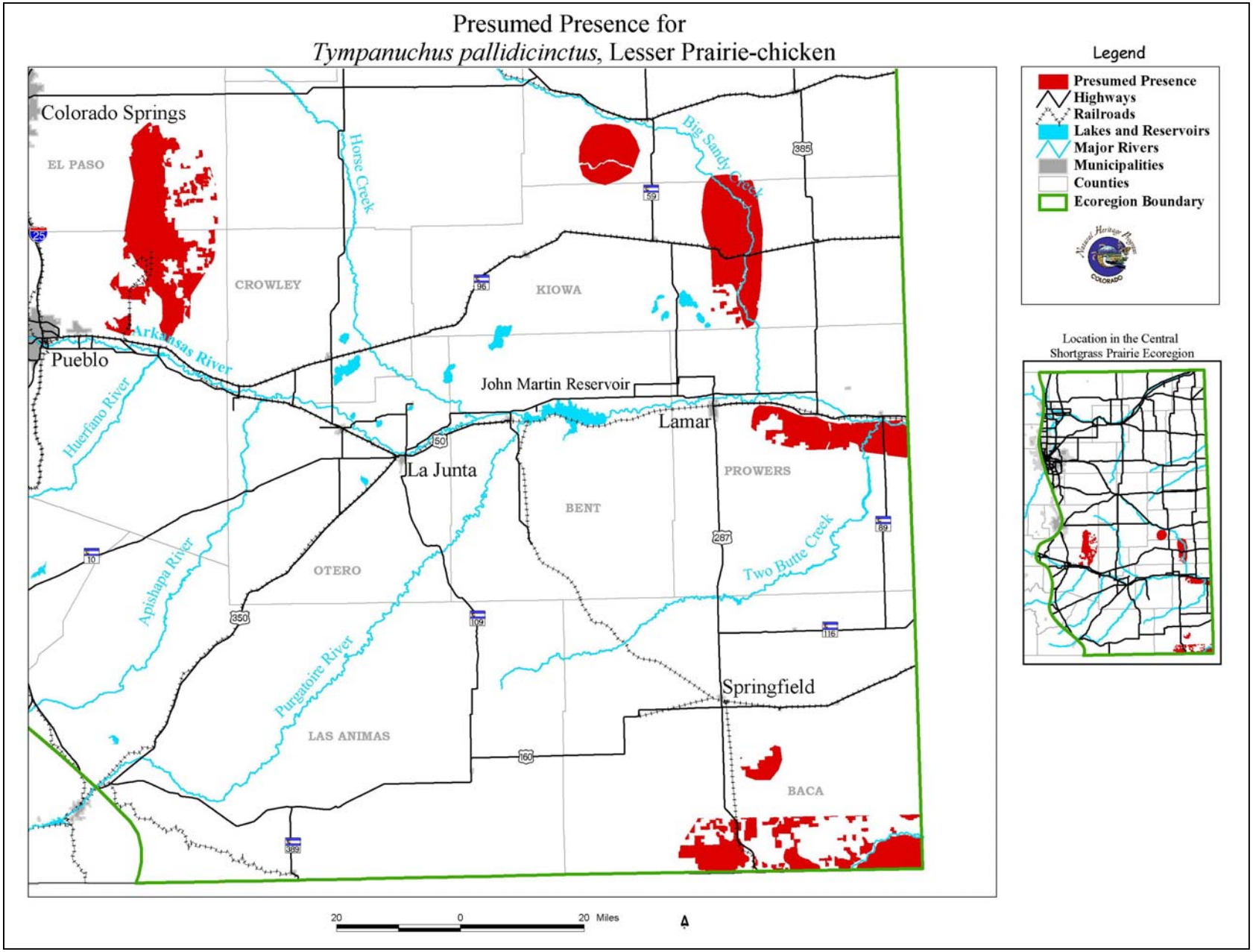


TABLE 10: Lesser Prairie-chicken (*Tympanuchus pallidicinctus*)

Acres of Maximum Impact: 78
Highway Miles: 20
Acres of Presumed Presence: 486,299

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Sand Dune Shrub Complex	272,142	47
Irrigated Agriculture	20,782	17
Dryland Agriculture	123,798	14
Sand Dune Grassland Complex	63,831	0
Midgrass Prairie	5,747	0

FIGURE 8: Loggerhead Shrike

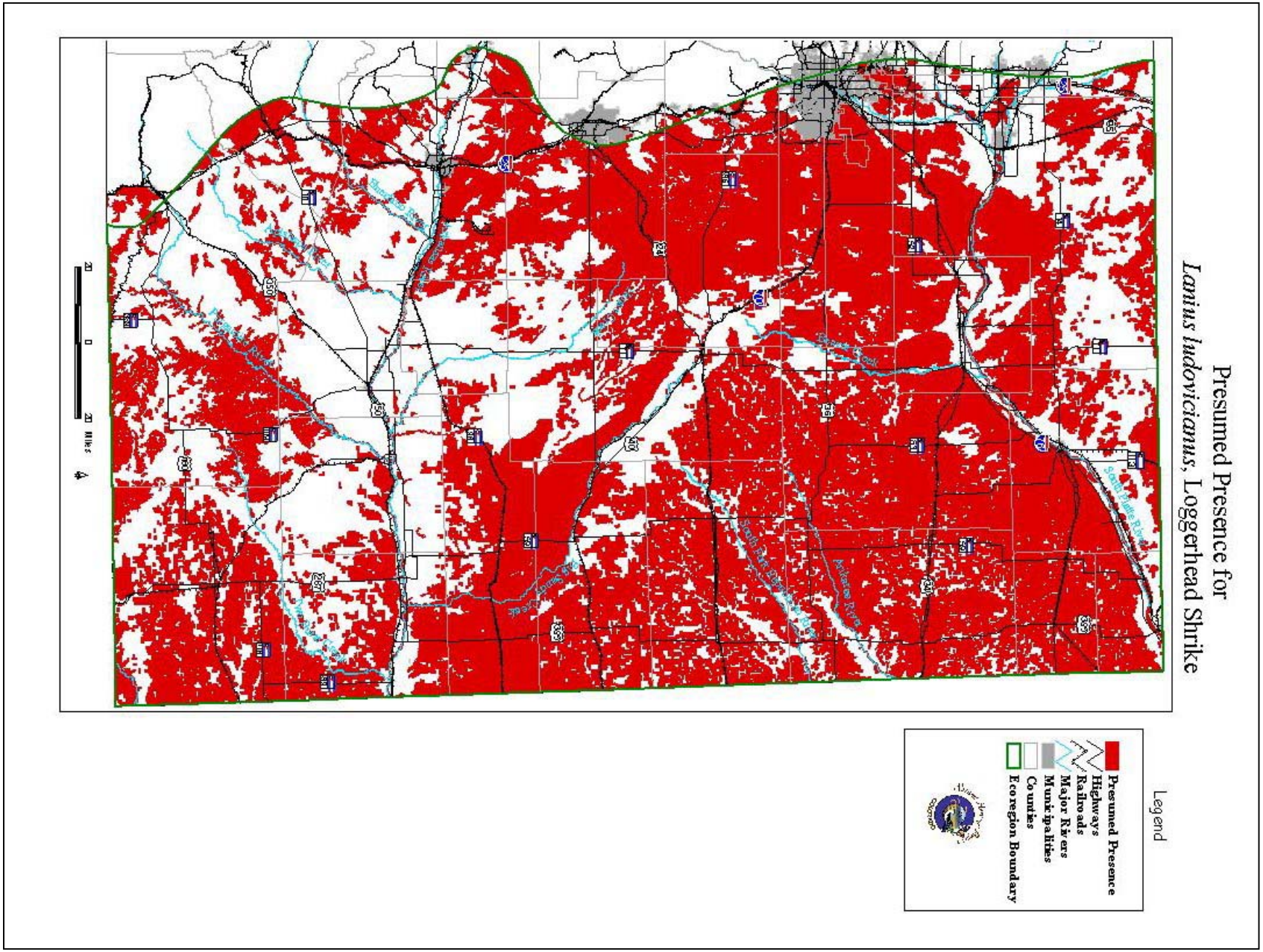


TABLE 11: Loggerhead Shrike (*Lanius ludovicianus*)

Acres of Maximum Impact: 8,780
Highway Miles: 1,813
Acres of Presumed Presence: 14,331,360

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,479,627	5,221
Sand Dune Shrub Complex	2,631,179	1,862
Midgrass Prairie	953,633	468
Tallgrass Prairie	492,327	257
Forest Dominated Wetland/Riparian	168,880	254
Pinyon-Juniper	427,489	252
Foothills/Mountain Grassland	198,653	222
Desert Shrub	165,577	125
Graminoid/Forb Dominated Wetland Riparian	77,256	68
Juniper Woodland	576,741	34
Shrub Dominated Wetland/Riparian	27,235	17
Sand Dune Grassland Complex	132,762	0

FIGURE 9: Long-billed Curlew

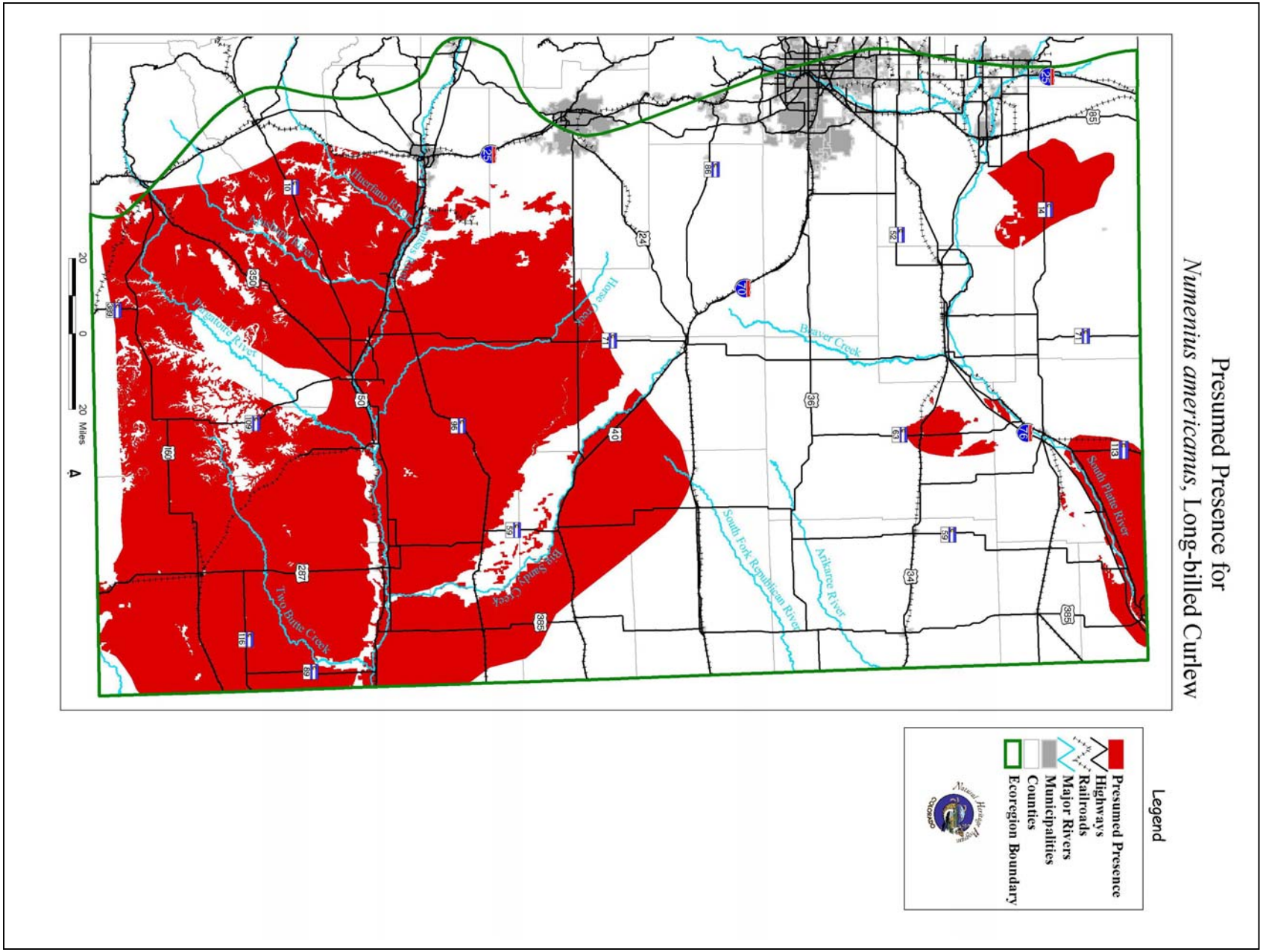


TABLE 12: Long-billed Curlew (*Numenius americanus*)

Acres of Maximum Impact: 5,058
Highway Miles: 1,235
Acres of Presumed Presence: 10,247,358

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	6,390,016	2,352
Irrigated Agriculture	799,999	1,383
Dryland Agriculture	2,969,360	1,268
Graminoid/Forb Dominated Wetland/Riparian	46,676	53
Open Water	41,307	2

FIGURE 10: McCown's Longspur

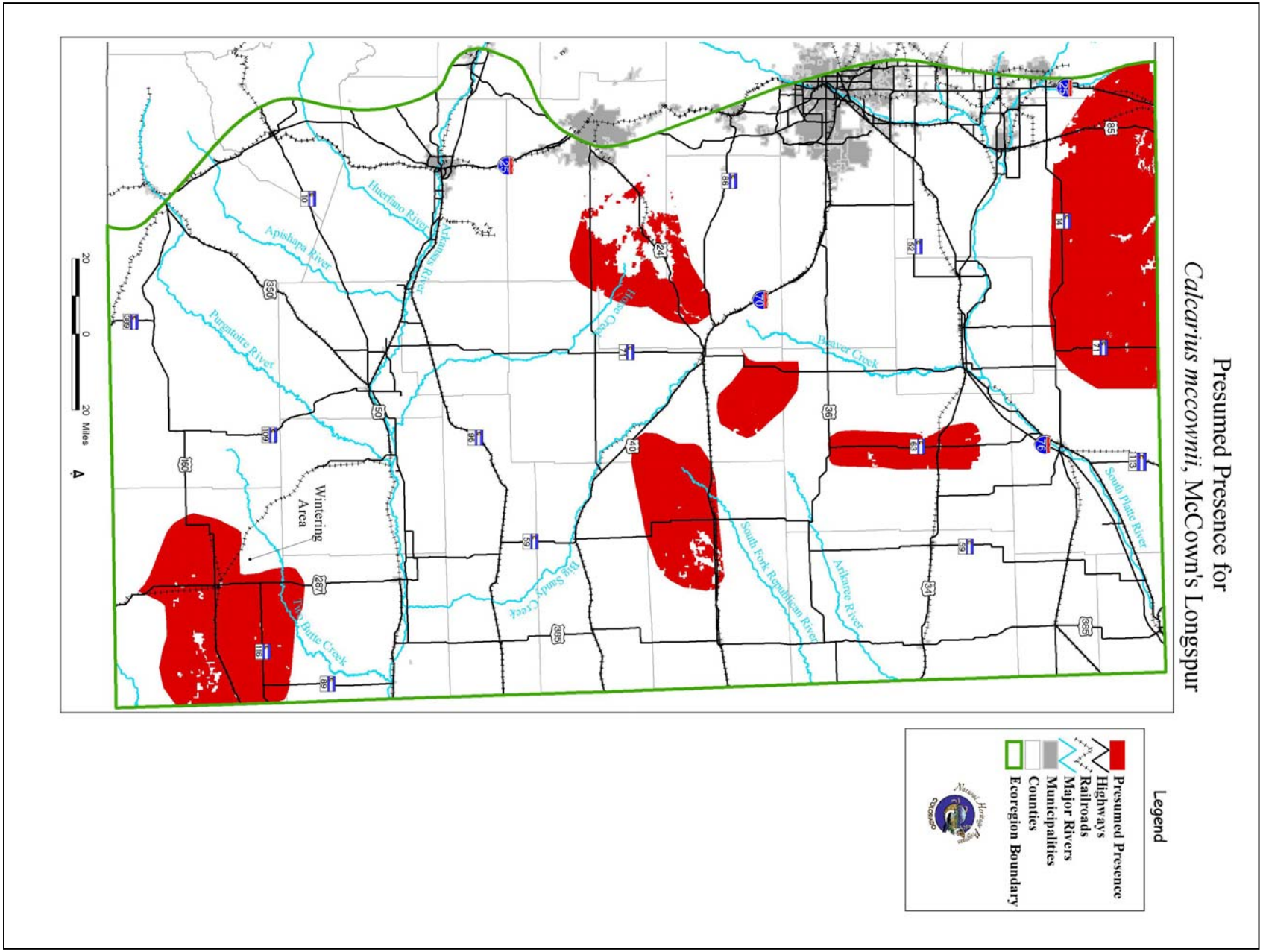


TABLE 13: McCown's Longspur (*Calcarius mccownii*)

Acres of Maximum Impact: 1,888
Highway Miles: 430
Acres of Presumed Presence: 3,487,710

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	1,679,355	1,067
Shortgrass Prairie	1,621,135	745
Midgrass Prairie	185,163	76
Sand Dune Grassland Complex	1,956	0
Barren Land	101	0

FIGURE 11: Mountain Plover

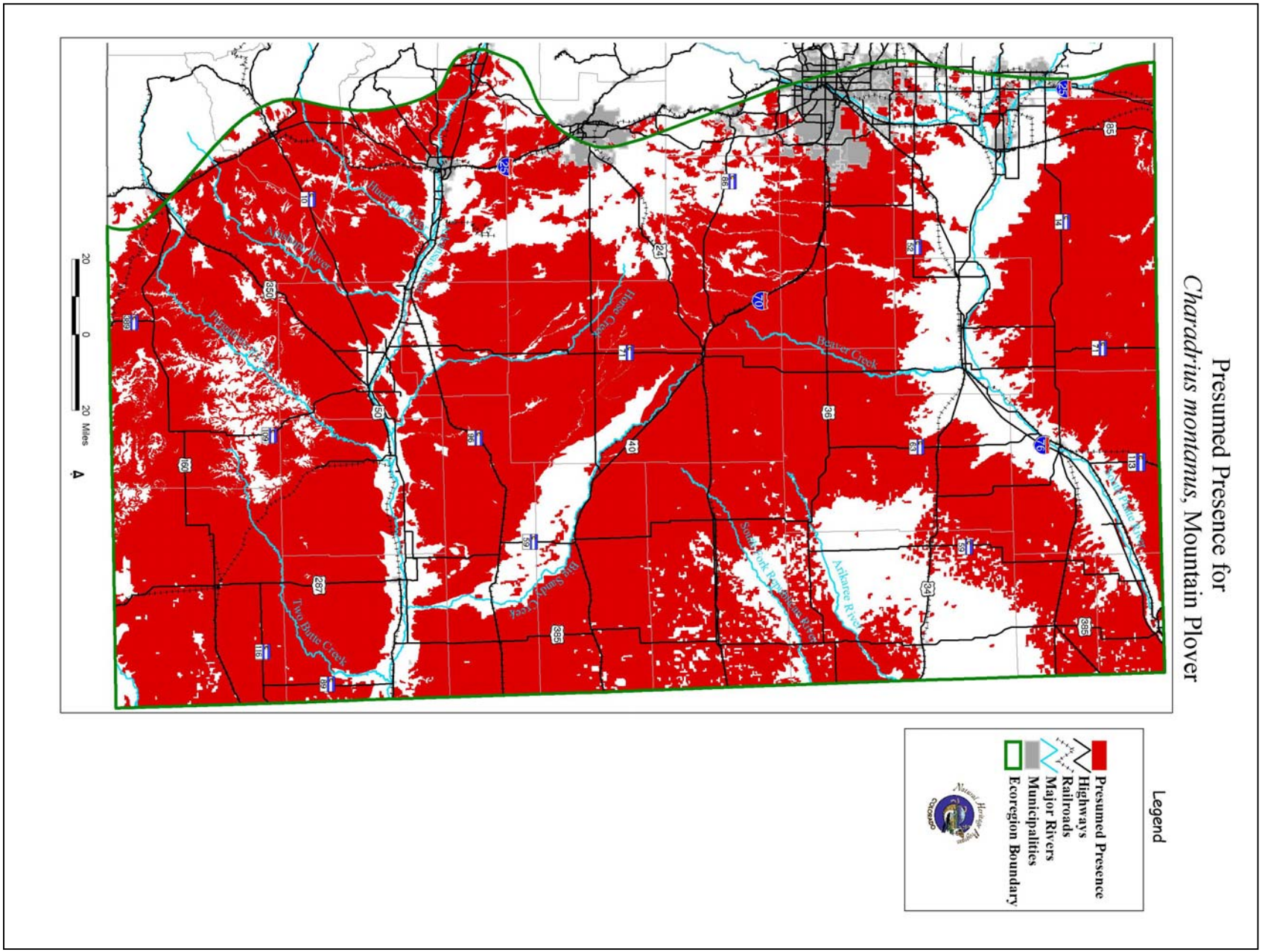


TABLE 14: Mountain Plover (*Charadrius montanus*)

Acres of Maximum Impact: 9,936
Highway Miles: 2,196
Acres of Presumed Presence: 19,184,617

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,338,162	4,789
Shortgrass Prairie	9,892,336	4,717
Midgrass Prairie	920,057	404
Barren Land	34,062	26

FIGURE 12: Black-tailed Prairie Dog

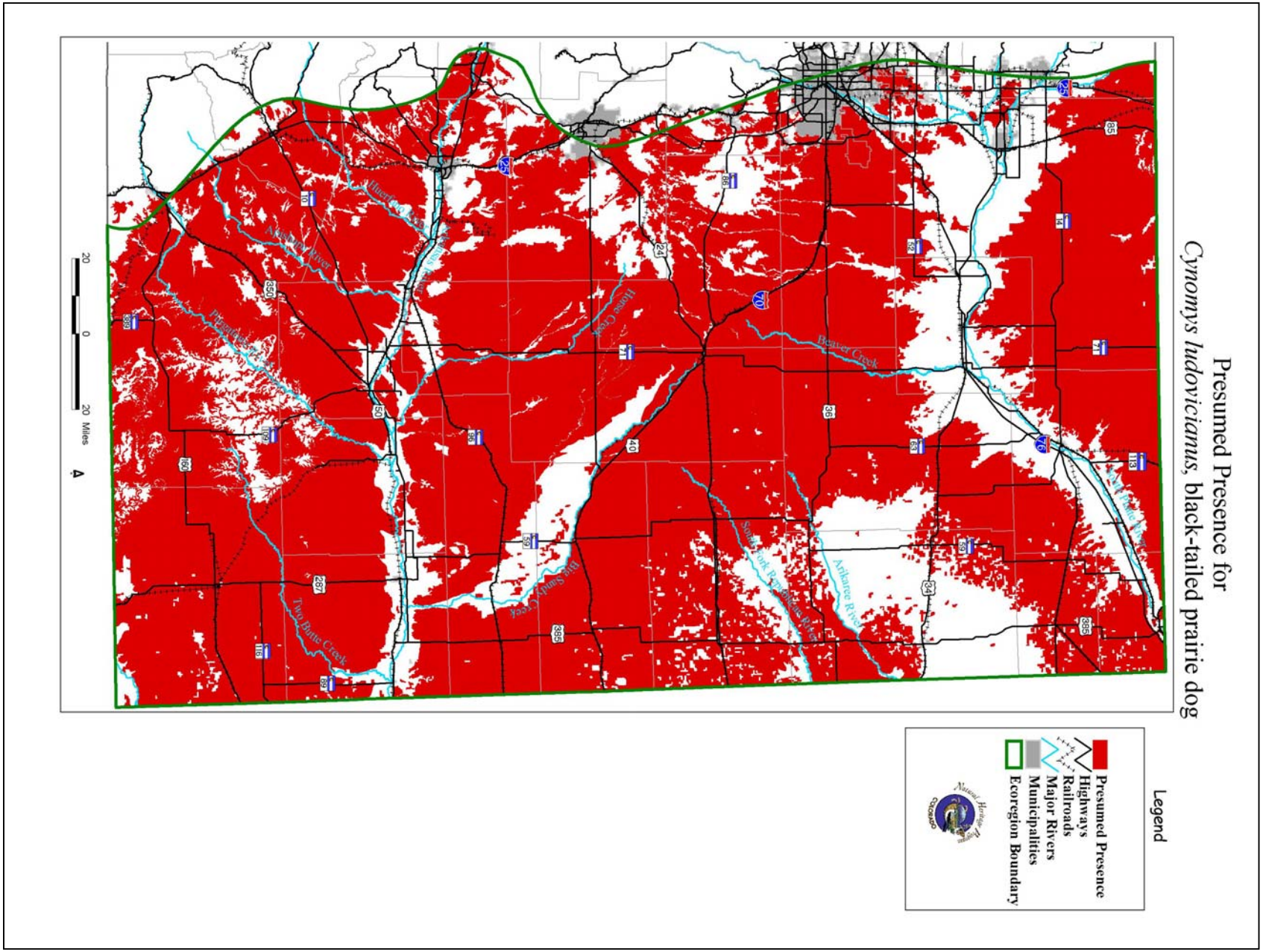


TABLE 15: Black-tailed Prairie Dog (*Cynomys ludovicianus*)

Acres of Maximum Impact: 10,744

Highway Miles: 2,344
Acres of Presumed Presence: 19,687,641

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Dryland Agriculture	8,479,627	5,221
Shortgrass Prairie	9,912,523	4,830
Midgrass Prairie	953,633	468
Foothills/Mountain Grassland	205,710	223
Bare Soil	3,386	2
Sand Dune Grassland Complex	132,762	0

FIGURE 13: Massasauga Rattlesnake

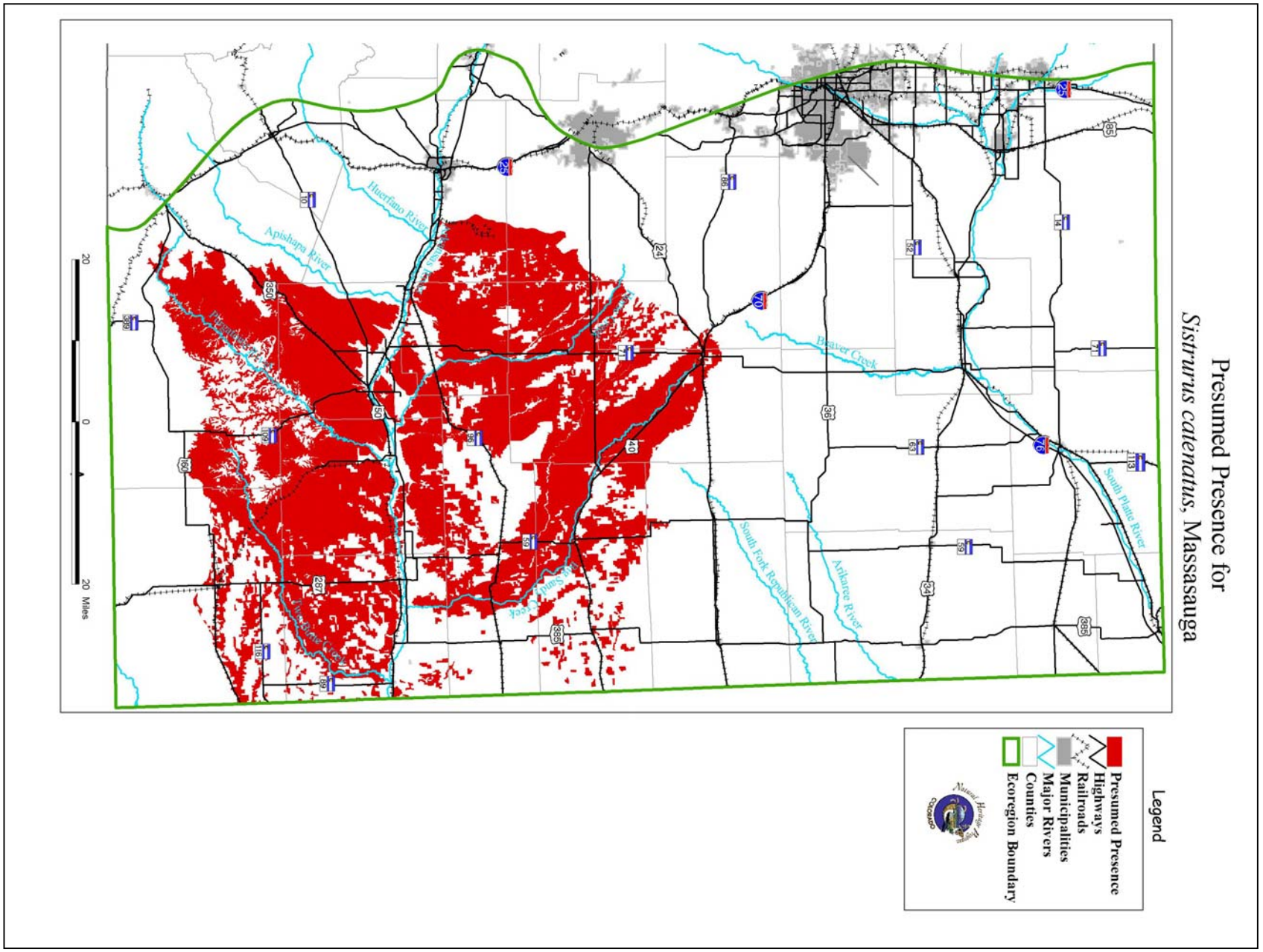


TABLE 16: Massasauga Rattlesnake (*Sistrurus catenatus*)

Acres of Maximum Impact: 1,891
Highway Miles: 460
Acres of Presumed Presence: 5,194,767

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	4,507,097	1,693
Sand Dune Shrub Complex	608,418	170
Midgrass Prairie	29,805	28
Sand Dune Grassland Complex	49,447	0

FIGURE 14: Texas Horned Lizard

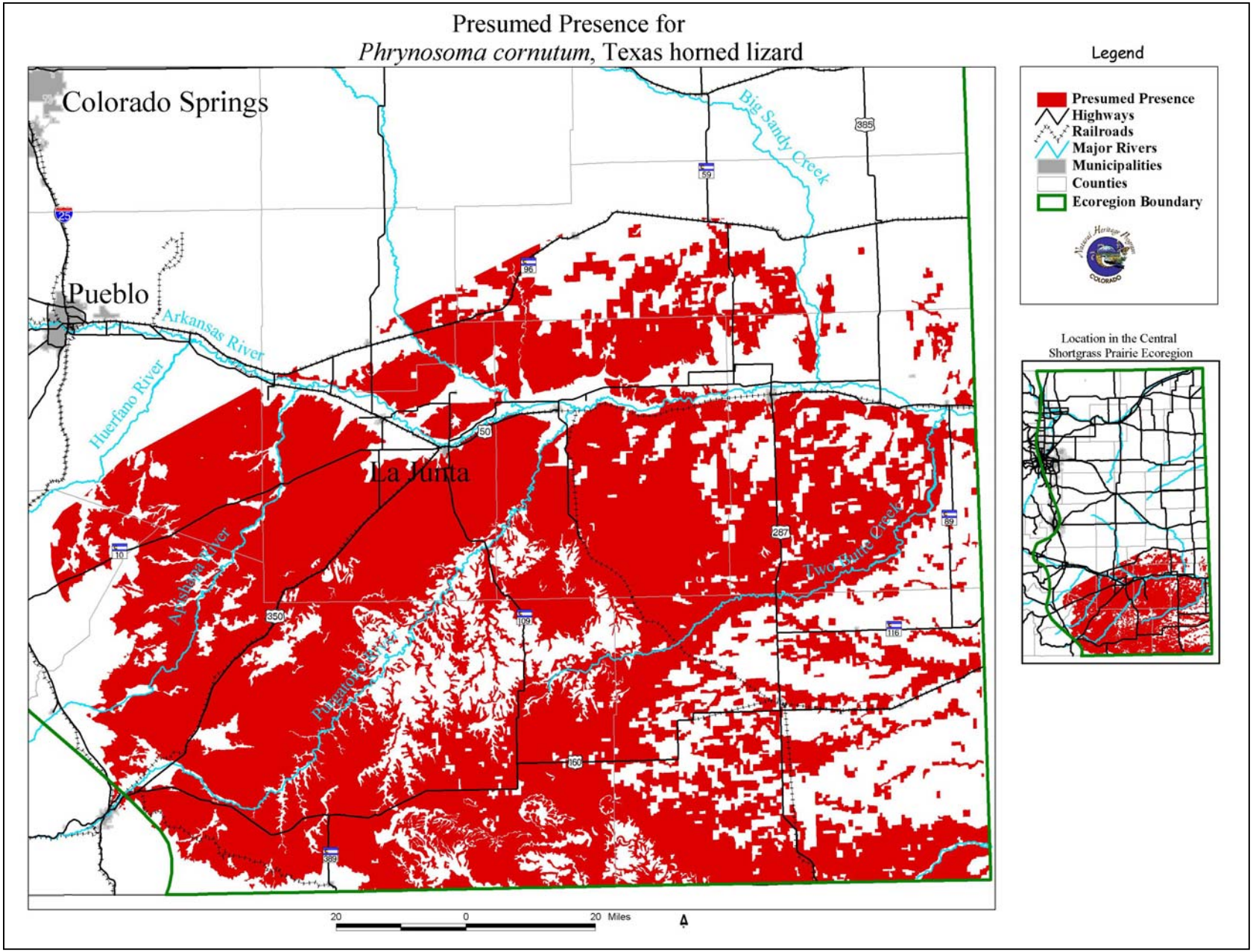


TABLE 17: Texas Horned Lizard (*Phrynosoma cornutum*)

Acres of Maximum Impact: 1,568
Highway Miles: 393
Acres of Presumed Presence: 4,723,929

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	4,468,799	1,535
Sand Dune Shrub Complex	170,859	27
Midgrass Prairie	84,271	6

FIGURE 15: Western Box Turtle

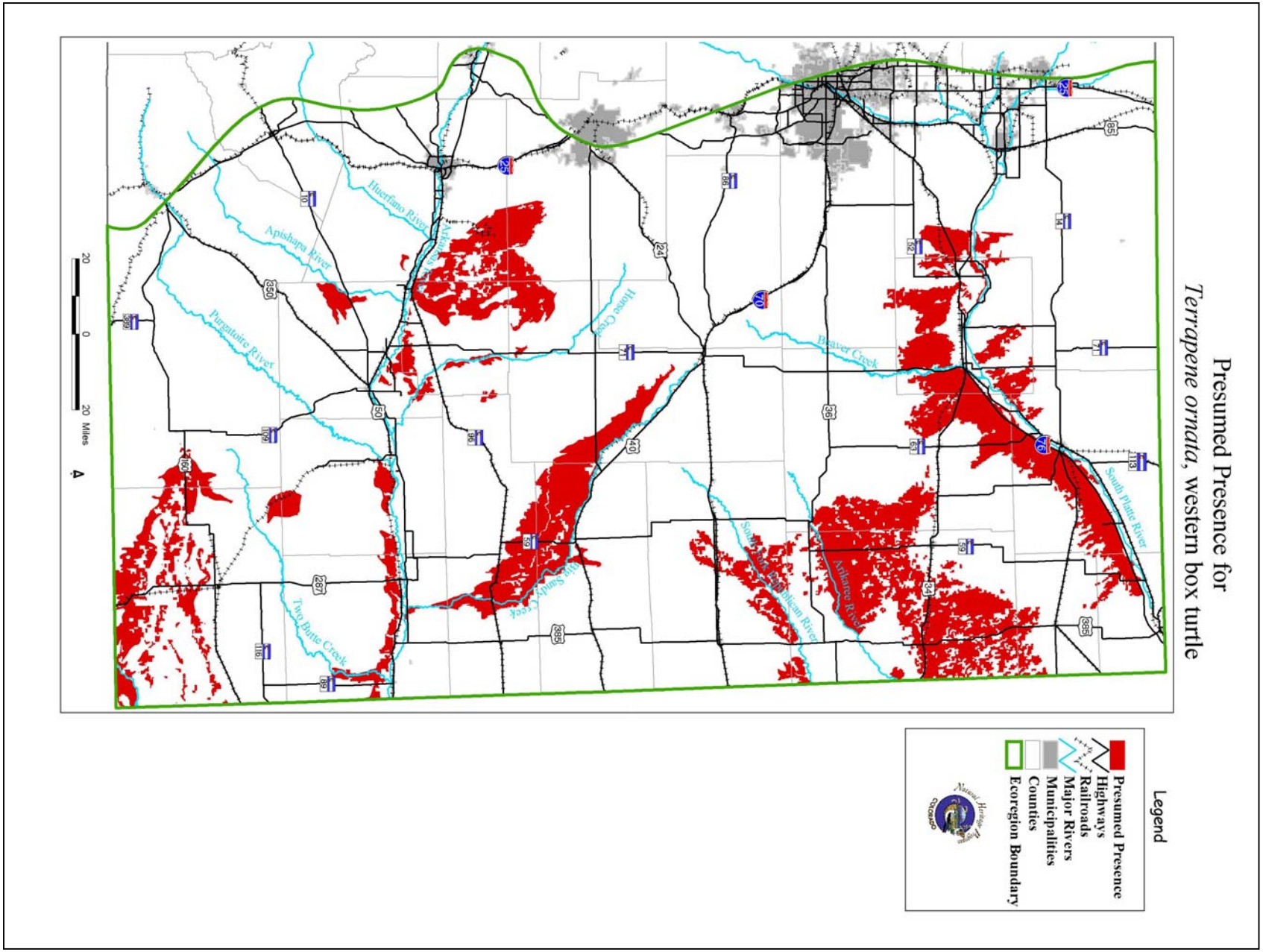


TABLE 18: Western Box Turtle (*Terrapene ornata*)

Acres of Maximum Impact: 1,910
Highway Miles: 328
Acres of Presumed Presence: 3,118,218

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Sand Dune Shrub Complex	2,391,228	1,746
Shortgrass Prairie	643,794	148
Desert Shrub	9,471	11
Midgrass Prairie	1,551	5
Sand Dune Grassland Complex	72,173	0

FIGURE 16: Arkansas River Feverfew

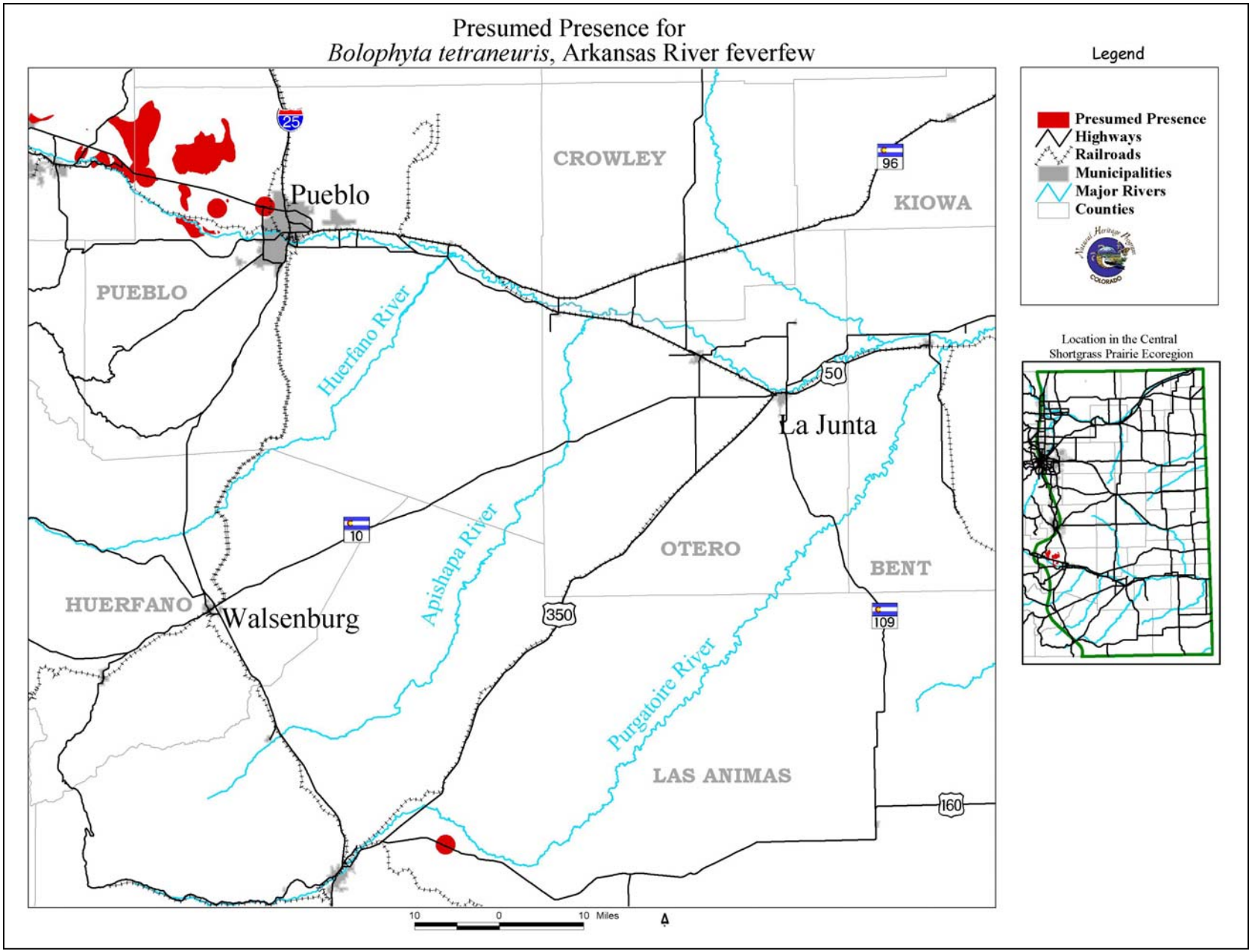


TABLE 19: Arkansas River Feverfew (*Bolophyta tetraneuris*)

Acres of Maximum Impact: 141
Highway Miles: 17
Total Acres of Presumed Presence: 52,960

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	32,171	132
Desert Shrub	1,003	4
Forest Dominated Wetland/Riparian	3,655	4
Pinyon-Juniper	5,130	1
Barren Land	3,847	0
Juniper Woodland	3,070	0
Midgrass Prairie	2,788	0
Big Sagebrush	855	0
Tallgrass Prairie	441	0

FIGURE 17: Pueblo Goldenweed

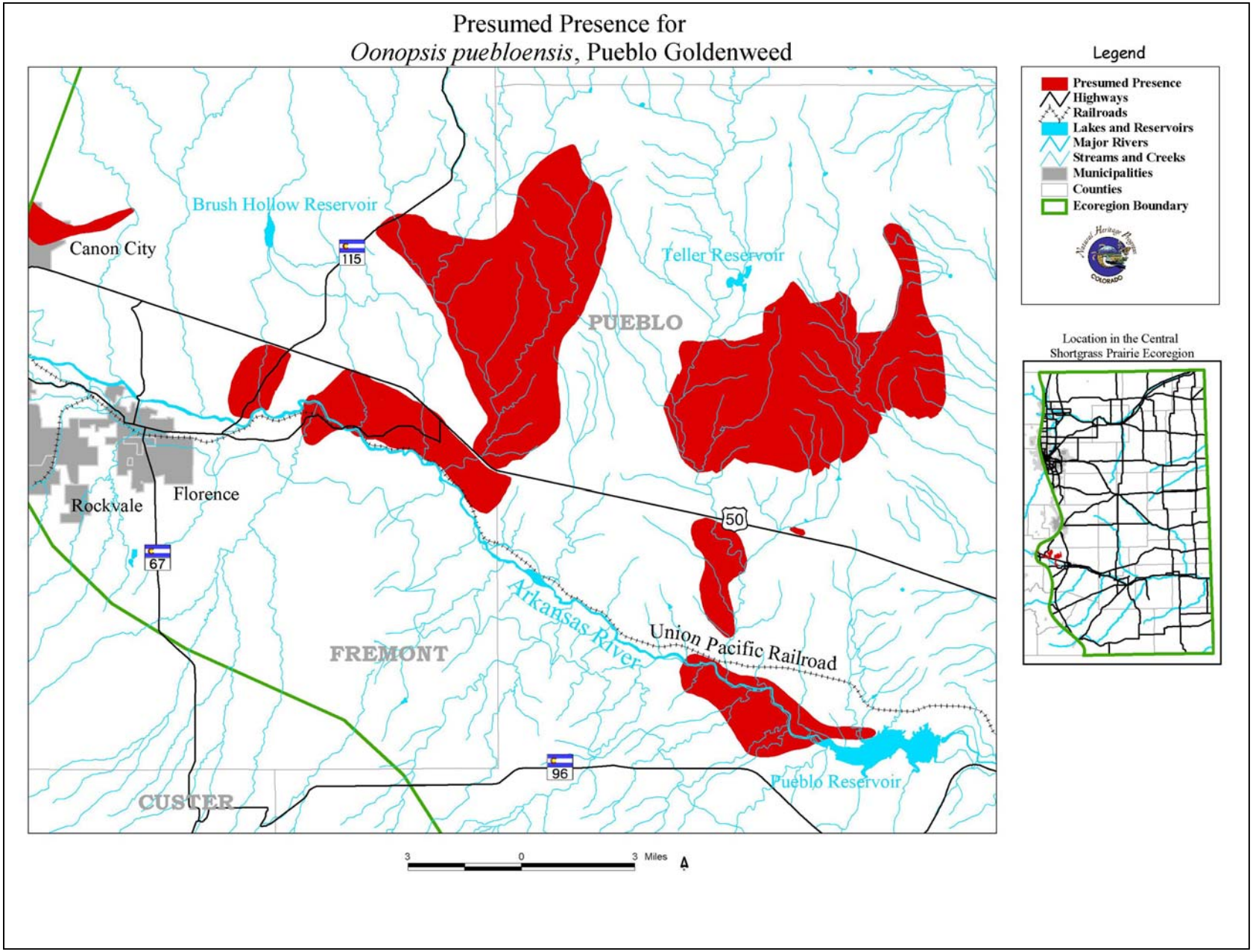


TABLE 20: Pueblo Goldenweed (*Oonopsis puebloensis*)

Acres of Maximum Impact: 82
Highway Miles: 9
Acres of Presumed Presence: 44,703

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	24,970	62
Irrigated Agriculture	1,068	14
Forest Dominated Wetland/Riparian	3,661	5
Pinyon-Juniper	5,121	1
Barren Land	1,593	0
Juniper Woodland	3,070	0
Midgrass Prairie	2,788	0
Open Water	1,136	0
Big Sagebrush	855	0
Tallgrass Prairie	441	0

FIGURE 18: Round-leaf Four-O'clock

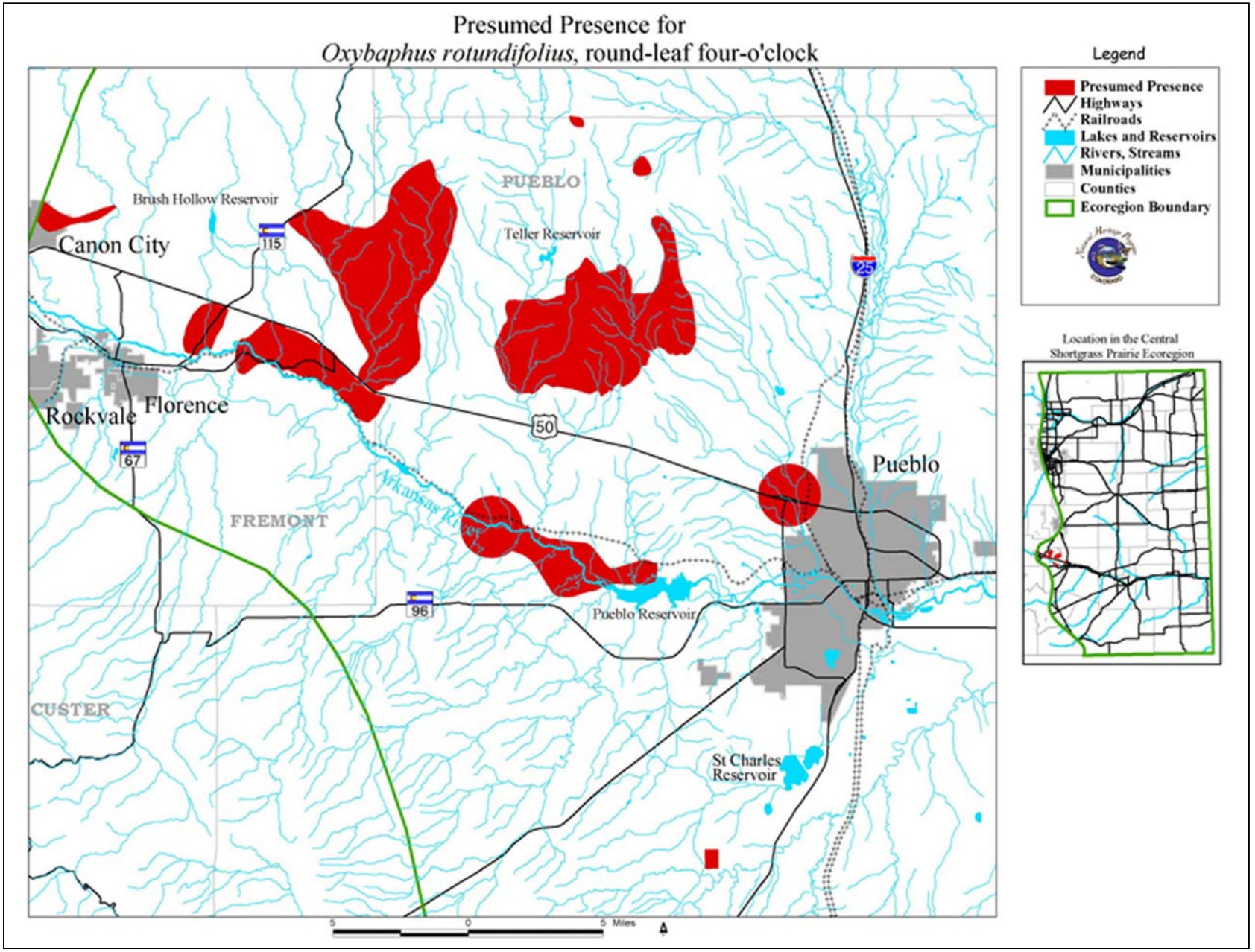


TABLE 21: Round-leaf Four-O'clock (*Oxybaphus rotundifolius*)

Acres of Maximum Impact: 117
Highway Miles: 14
Acres of Presumed Presence: 49,349

Vegetation Types	Acres of Presumed Presence	Acres of Maximum Impact
Shortgrass Prairie	27,875	92
Irrigated Agriculture	1,068	14
Desert Shrub	1,001	4
Forest Dominated Wetland/Riparian	3,655	4
Urban/Built-up	76	2
Pinyon-Juniper	5,121	1
Juniper Woodland	4,265	0
Midgrass Prairie	2,796	0
Open Water	1,681	0
Big Sagebrush	855	0
Barren Land	677	0
Tallgrass Prairie	279	0

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APPENDICES

Appendix A: Potential Target Species Ranking Table
Appendix B: Data Layers
- Base Data
- Biological Data

Appendix C: GIS Impact Analysis Process by Species
- Birds
- Mammals
- Reptiles
- Plants

Appendix D: Vegetation Affinities for Vertebrate Species
Appendix E: Highway Miles in the CSP (by highway)

APPENDIX A: POTENTIAL TARGET SPECIES RANKING TABLE

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
AMPHIBIANS					
BUFO DEBILIS	GREEN TOAD	Y	G5S2	LOW	Poorly known species that is relatively common south of its Colorado range. Population is not taxonomically or ecologically unique.
ACRIS CREPITANS	NORTHERN CRICKET FROG	Y	G5SH; STATE SPECIAL CONCERN	MED	Remains common throughout most of its very large range in North America; however, is declining in many areas at the periphery of its range.
SCAPHIOPUS COUCHII	COUCH'S SPADEFOOT	Y	G5S1; STATE SPECIAL CONCERN	LOW	Common throughout most of its range. While there is some evidence that the Colorado population(s) are isolated, there are no known threats as long as ranching is the primary land use in the southern CSP.
RANA PIPIENS	NORTHERN LEOPARD FROG	Y	G5S3;STATE SPECIAL CONCERN	MED	One of the most widespread species in N. A. Many populations are in decline for an as yet undetermined suite of reasons. Some populations are coming back, others seem to continue in decline. Southern Rocky Mountain populations seem to be in decline, at least those above 8,000’

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
BIRDS[4]					
BUTEO REGALIS	FERRUGINOUS HAWK	Y	G4S3B; STATE SPECIAL CONCERN	LOW	Although low in density, they are widespread. Populations have been increasing for the past 30+ years. They seem to be stable to increasing. Wintering populations, in Colorado, appear to be associated with prairie dog colonies; however, the relationship with prairie dogs and survivorship is unknown
TYMPANUCHUS CUPIDO PINNATUS	GREATER PRAIRIE CHICKEN	Y	G4T4S3	MED	Population trends are positive throughout most of its range; however, the genus is noted for its quickly reversing trends. Needs more rigorous surveys. Recently delisted by CDOW.
TYMPANUCHUS PALLIDICINCTUS	LESSER PRAIRIE CHICKEN	Y	G3S2; STATE LISTED THREATENED	HIGH	Already a federal candidate, FS Sensitive species. Genus is well known for dramatic declines in short periods.
TYMPANUCHUS PHASIANELLUS JAMESI	PLAINS SHARP-TAILED GROUSE	Y	G4T4S1; STATE LISTED ENDANGERED	MED	The subspecies is state listed as endangered in Colorado; although there are recent invasions from Wyoming. The subspecies is relatively common farther north, but the genus is always somewhat unpredictable.
CHARADRIUS ALEXANDRINUS NIVOSUS	WESTERN SNOWY PLOVER	Y	G4T3S1B; STATE SPECIAL CONCERN	MED	Small populations in the Great Plains are not well known. Fewer than 100 pairs in Colorado. Believed to be stable in their small area.

[4] Some birds on the final target species list were not included in this part of the species list evaluation. The interior least tern and the piping plover were not ranked because they were already federally-listed. The loggerhead shrike was not originally considered for inclusion because of BBS data indicating increasing populations on the Colorado plains. It was subsequently added due to its presence on the NAFTA conservation species list (assuming that its presence on other radar screens may indicate a higher potential for future federal listing).

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
CHARADRIUS MONTANUS	MOUNTAIN PLOVER	Y	G2S2B; FEDERALLY PROPOSED THREATENED; STATE SPECIAL CONCERN	HIGH	Already proposed for listing – possibly in the next 6-12 months (?)
HIMANTOPUS MEXICANUS	BLACK-NECKED STILT	Y	G5S3B	LOW	Populations in the Great Plains are relatively small, but widely distributed. Populations in other parts of the west are much larger, and probably stable.
NUMENIUS AMERICANUS	LONG-BILLED CURLEW	Y	G5S2B; STATE SPECIAL CONCERN	HIGH	Declining throughout its range; however, remains widespread. COPIF Bird Plan notes its significance and says it "is arguably the highest conservation priority in this physiographic area".
VIREO VICINIOR	GRAY VIREO	Y	G4S2B	LOW	Widespread species that occurs in the CSP sparsely. Poorly known, but with few threats to its habitat. BBS trends do not show significant trends.
DENDROICA GRACIAE	GRACE'S WARBLER	Y	G5S3B	LOW	Only a few isolated pairs occur at the western edge of the CSP. National level trends are not different from stable.
SEIURUS AUROCAPILLUS	OVENBIRD	Y	G5S2B	LOW	This species occurs in small populations in the foothills at the western edge of the CSP. Population status is unknown, but the species is widespread in North America and remains abundant in much of its range. Any local threats are due to expanding residential development in the Front Range.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
CALCARIUS MCCOWNII	MCCOWN'S LONGSPUR	Y	G5S2B	MED	The species is on the national watchlist. Not adequately sampled by BBS. There is likely a considerable loss of habitat from changing grazing strategies.
CALCARIUS ORNATUS	CHESTNUT-COLLARED LONGSPUR	Y	G5S1B	LOW	Marginally occurs in Colorado and prefers taller grasses, a habitat that is more favored by current grazing management. Rangewide status is unknown.
AIMOPHILA CASSINII	CASSIN'S SPARROW	Y	G5S4B	MED	This species is on the national watchlist. Colorado BBS does not show a significant decline, but rangewide, the species has declined ~2.5% annually.
ATHENE CUNICULARIA	BURROWING OWL	Y	G4S4B; STATE LISTED THREATENED	MED	Conservation status is tied to the fate of prairie dog colonies. No apparent declines in Colorado, except locally, associated with urban expansion. However, the species has gained the attention of the environmental community. A petition for listing in the foreseeable future is a real possibility. For additional information, see JWM 64(4):1067-1075.
BUTEO SWAINSONI	SWAINSON'S HAWK	Y		LOW	Populations are indicated as stable by the BBS. There is some local concern about the loss of nesting trees in the CSP.
FALCO MEXICANUS	PRAIRIE FALCON	Y	G5S4B	LOW	There is no evidence of decline.
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER	Y		LOW	There is no evidence of declines in the west. The species has a restricted distribution in Colorado and the CSP.
CALAMOSPIZA MELANOCORYS	LARK BUNTING	Y		LOW	The species is widespread and remains common in the CSP. However, the long-term trends indicate declines of almost 2% annually.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW	Y		LOW	The species remains common in the western prairie, although BBS indicates long term trends of -2.6%. This species has strong population fluctuations based on climatic trends.
FISH					
NOCOMIS BIGUTTATUS	HORNYHEAD CHUB	Y	G5SX?	LOW	Species is a wide-ranging species in the central and eastern U. S. Declines in Colorado populations are evident, but because the population is not isolated, it seems unlikely that a federal listing would occur.
PHOXINUS EOS	NORTHERN REDBELLY DACE	Y	STATE LISTED ENDANGERED	LOW	Colorado populations are disjunct, rare, and isolated. There is some potential for listing as a unique population. CDOW is watching this species closely. There is no supporting genetic or demographic data.
PHOXINUS ERYTHROGASTER	SOUTHERN REDBELLY DACE	Y	STATE LISTED ENDANGERED	LOW	Colorado populations are disjunct, rare, and isolated. There is some potential for listing as a unique population. CDOW is watching this species closely. There is no supporting genetic or demographic data.
ETHEOSTOMA CRAGINI	ARKANSAS DARTER	Y	G3S2; FEDERAL CANDIDATE; STATE LISTED THREATENED	HIGH	Already a candidate for listing. Listed by CDOW. Considered globally vulnerable by CNHP. The species is highly restricted to prairie springs populations, although it was once more common in mainstems. There is no supporting demographic data.
HYBOGNATHUS PLACITUS	PLAINS MINNOW	Y	STATE LISTED ENDANGERED	MED	state-listed; extremely rare

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
HYBOGNATHUS HANKINSONI	BRASSY MINNOW	Y	STATE LISTED THREATENED	LOW	state-listed
PHENACOBIUS MIRABILIS	SUCKERMOUTH MINNOW	Y	STATE LISTED ENDANGERED	MED	state-listed; extremely rare
NOTROPIS CORNUTUS	COMMON SHINER	Y	STATE LISTED THREATENED	LOW	state-listed
NOTROPIS BLENNIUS	RIVER SHINER	Y	STATE SPECIAL CONCERN	?	Unknown; likely extirpated in CO.
NOTURUS FLAVUS	STONECAT	Y	STATE SPECIAL CONCERN	LOW	Special concern in CO; always rare due to limited distribution.
HYBOPSIS GRACILIS	FLATHEAD CHUB	Y	STATE SPECIAL CONCERN	MED	Relatively abundant in CO; declining elsewhere in Midwest.
MACROHYBOPSIS AESTIVALIS TETRANEMUS	SPECKLED CHUB	N	STATE SPECIAL CONCERN	MED	Unknown; likely extirpated in CO.
ETHEOSTOMA SPECTABILE	PLAINS ORANGETHROAT DARTER	Y	STATE SPECIAL CONCERN	LOW	Abundant in CO in Republican; special concern due to limited distribution.
FUNDULUS SCIADICUS	PLAINS TOPMINNOW	Y	STATE SPECIAL CONCERN	MED	Special concern in CO due to limited, vulnerable distribution on Front Range; declining elsewhere.
ETHEOSTOMA EXILE	IOWA DARTER	Y	STATE SPECIAL CONCERN	LOW	Special concern in CO due to limited, vulnerable distribution on Front Range.
NOTROPIS TOPEKA	TOPEKA SHINER	N		?	Not considered native.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
MAMMALS					
BLARINA HYLOPHAGA	SHORT-TAILED SHREW	Y	G5SH	LOW	This shrew is at the western periphery of its range in eastern Colorado. The species remains abundant throughout most of its range.
THOMOMYS BOTTAE RUBIDUS	BOTTA'S POCKET GOPHER SUBSP.	Y	G5T1S1	HIGH	This subspecies of Botta's pocket gopher is highly restricted in its range. Although there are no recent taxonomic revisions, the subspecies is recognized by experts. The uniqueness of gopher populations is well established. This subspecies occurs in the vicinity of Canon City.
THOMOMYS TALPOIDES MACROTIS	NORTHERN POCKET GOPHER SUBSP.	Y	G5T1S1	HIGH	This subspecies of northern pocket gopher is highly restricted in its range to northern Douglas County and southern Arapaho County. Much of its habitat is developed and there are plans to develop most of the remainder. While there are taxonomic questions, this may be the most endangered mammal in Colorado.
NEOTOMA MICROPUS	SOUTHERN PLAINS WOODRAT	Y	G5S3	LOW	This woodrat species occurs in a limited range in Colorado; however, it is common throughout its Colorado range as well as outside of the state.
VULPES VELOX	SWIFT FOX	Y	G3S2; FEDERAL CANDIDATE; STATE SPECIAL CONCERN	LOW	While doing well in Colorado, there is some concern in the northern part of its range. A recent proposed listing did not qualify under existing laws.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
SPILOGALE PUTORIUS	EASTERN SPOTTED SKUNK	Y	G5S2	LOW	Although declining in the central shortgrass prairie, there is considerable evidence that the species was not historically common or perhaps present. The species followed the homesteaders into much of the prairie, declining with the advent of modern agriculture.
CYNOMYS LUDOVICIANUS	BLACK-TAILED PRAIRIE DOG	Y	G4S4; STATE SPECIAL CONCERN	MED	A recent listing proposal was determined to be warranted but precluded. There will be an annual review of the status of the species. It is a sensitive species of the USFS. There are many efforts to develop a strategy for this species' conservation.
PEROGNATHUS FASCIATUS INFRALUTEUS	OLIVE-BACKED POCKET MOUSE	Y	G5T?S2?	LOW	The range of this subspecies of pocket mouse co-occurs with front range development patterns; however, at this time, it appears to remain "catchable." Because it also occurs south of Pueblo, it is likely not to be listed in the foreseeable future.
REPTILES					
KINOSTERNON FLAVESCENS	YELLOW MUD TURTLE	Y	G5S1; STATE SPECIAL CONCERN	LOW	The species remains common throughout much of its range. Knowledge of its distribution in Colorado shows that it is more common than once believed. Several new populations were discovered in the past few years.
PHRYNOSOMA CORNUTUM	TEXAS HORNED LIZARD	Y	G4G5S3; STATE SPECIAL CONCERN	MED	While common in New Mexico, Oklahoma and Colorado, more southern populations have declined sharply. The reason is not clear, but strongly suspected to be from fire ants.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
CNEMIDOPHORUS NEOTESSELATUS	TRIPLOID COLORADO CHECKERED WHIPTAIL	Y	G2QS2	LOW	The species is widespread and can tolerate some disturbance. Many populations are remote. As long as ranching is a primary use of the prairie, the status should be stable. Note that a few populations near Pueblo were extirpated, including the type locality.
LAMPROPELTIS GETULA	COMMON KINGSNAKE	Y	G5S1; STATE SPECIAL CONCERN	LOW	The species is widespread and common in most of its very large range in the U. S. The species is poorly documented in Colorado and probably rare. However, other populations are likely to be found.
RHINOCHEILUS LECONTEI	LONGNOSE SNAKE	Y	G5S1?	LOW	This species is widespread in the SW U. S. It is also secretive. There is no indication of significant declines.
SONORA SEMIANNULATA	GROUND SNAKE	Y	G5S3	LOW	This secretive snake is range-restricted in Colorado, but widespread in the arid SW U. S. It appears to be common where found and does not have documented threats of consequence.
THAMNOPHIS CYRTOPSIS	BLACKNECK GARTER SNAKE	Y	G5S2?	LOW	This is another fairly common species that occurs at the northern edge of its range in the CSP. There are no identified threats to its population or habitat in Colorado.
LEPTOTYPHLOPS DULCIS	TEXAS BLIND SNAKE	Y	G5S1?; STATE SPECIAL CONCERN	LOW	Very secretive and occurring only at the southern edge of the CSP. It is much more common to the south and has no identified threats.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
SISTRURUS CATENATUS	MASSASAUGA	Y	G3G4S2; STATE SPECIAL CONCERN	MED	It appears that the Colorado population may be isolated from other populations. While the taxonomy is debated, there is little doubt that there are few current threats to populations in Colorado at this time. As long as ranching remains the primary land use on the eastern Colorado prairie, it is unlikely to be threatened.
TERRAPENE ORNATA	WESTERN BOX TURTLE	Y		MED	All box turtles are listed by CITES. Collecting of specimens for the pet trade is lucrative. There are also issues surrounding road development/fragmentation. Because the species is very long-lived (>25 years), detection of trends is also a long term task. Populations in sandhills, away from roadways appear robust.
PHRYNOSOMA MODESTUM	ROUNDTAIL HORNED LIZARD	N		MED	This southern species occurs in a single (known) disjunct population in Colorado. Because of its isolated status, it is possible that it could be petitioned for listing. However, there are no identified threats of consequence at this time.
INVERTEBRATES					
CICINDELA LEPIDA	LITTLE WHITE TIGER BEETLE	Y	G4S2	LOW	This species is widespread in the U. S. and remains common in many areas. The rural nature of its habitat in Colorado suggests that there are no threats. However, because the species likes active dunes and sand fields, “good range management” often conflicts with good tiger beetle management.
ERYNNIS MARTIALIS	MOTTLED DUSKY WING	Y	G4S2S3	LOW	This is a common species within its range. It occurs marginally in Colorado and is difficult to identify.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
HESPERIA OTTOE	OTTOE SKIPPER	Y	G3G4S2	MED	This species has declined throughout most of its prairie range. As a tallgrass species, it occurs in a fairly narrow range within the CSP. Most of its CSP range, notably disjunct, is within the urban expansion area.
EUPHYES BIMACULA	TWO-SPOTTED SKIPPER	Y	G4S3	LOW	This species is rare in Colorado, but fairly widespread and common elsewhere. There are several protected populations and more survey is needed.
AMBLYSCIRTES SIMIUS	SIMIUS ROADSIDE SKIPPER	Y	G4S3	LOW	This widespread species is rare in Colorado and the CSP. However there are few indications that its populations are threatened at this time.
CELASTRINA HUMULUS	HOPS FEEDING AZURE	Y	G2S2	MED	This recently described species is notably rare. While feeding on a fairly common plant species, its occurrences are not highly predictable. Numbers observed per occurrence are generally low.
EUPHILOTES RITA COLORADENSIS	COLORADO BLUE	Y	G4T2T3S2	LOW	This species is rare, but not apparently threatened.
BOLORIA SELENE SABULOCOLLIS	SANDHILL FRITILLARY	Y	G5T2S2	LOW	There are taxonomic difficulties with this species. In addition, there are no documented threats.
LIBELLULA COMPOSITA	BLEACHED SKIMMER	Y	G3S1	LOW	This is rare in Colorado, but represented by a much larger range elsewhere.
ANODONTOIDES FERUSSACIANUS	CYLINDRICAL PAPERSHELL	Y	G5S2	MED	This species is extirpated from Colorado. While the range is large outside of our state, there is a risk of all mussels being listed if the zebra mussel should become established in the Mississippi drainage.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
ANODONTA GRANDIS	GIANT FLOATER	Y	G5S1	MED	While the range is large outside of our state, there is a risk of all mussels being listed if the zebra mussel should become established in the Mississippi drainage.
LIBELLULA NODISTICTA	HOARY SKIMMER	?	G3S1	LOW	This large dragonfly is much more common farther south. There is conflicting evidence about its tolerance to disturbance. But the species largely occurs in unthreatened areas.
SPEYERIA IDALIA	REGAL FRITILLARY	Y?	G3S1	MED	This species has dramatically declined in the eastern U. S.; however, it remains common in many areas of the tallgrass and mixed-grass prairies. Only a few populations occur in Colorado. Should declines extend into its last strongholds, there is some possibility of its being listed.
ATRYTONE AROGOS	AROGOS SKIPPER	Y	G3G4S2	MED	Fairly widespread, thought to be somewhat associated with tallgrass prairie. Urban expansion may have some impacts. There is some evidence that the populations in Colorado are disjunct.
DECODES STEVENSI	STEVEN'S TORTRICID MOTH	N	G?S1	LOW	Apparently endemic to Colorado. Only known to occur in vicinity of Owl Canyon, Larimer County, CO. As long as the natural area remains intact there is little risk of listing. It may occur elsewhere with appropriate inventory.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
PLANTS					
ASCLEPIAS UNCIALIS	DWARF MILKWEED	Y	G3?S1S2	MED	This small species is apparently much less common than historically. There are several populations known, largely protected, but most have quite small populations. The worldwide population is low.
AMBROSIA LINEARIS	PLAINS RAGWEED	Y	G2S2	LOW	This species is endemic to Colorado, but tolerant of disturbance. Locations in its natural habitat are rare, but it has colonized mesic sites such as roadsides in its prairie range.
BOLOPHYTA ALPINA	WYOMING FEVERFEW	Y	G3S1	LOW	Although narrowly distributed, most populations are in inhospitable habitats and not under any demonstrable threats. Should residential development become an issue in the Western High Plains, the threats could substantially increase.
BOLOPHYTA TETRANEURIS	ARKANSAS RIVER FEVERFEW	Y	G3S3	MED	Rapid urbanization, economically valuable rock, and several roadside locations make this species susceptible to extinction.
OONOPSIS FOLIOSA	SINGLE-HEAD GOLDENWEED	Y	G3G4T2S2	LOW	This species, while in a restricted range, is apparently tolerant of many disturbances. As long as ranching is the primary land use, the populations should be secure.
OONOPSIS PUEBLOENSIS	PUEBLO GOLDENWEED	Y	G1G2S1S2	MED	This species, while in a restricted range, is apparently tolerant of many disturbances. However, rapid urbanization may threaten this species.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
OREOCARYA CANA	MOUNTAIN CAT'S-EYE	Y	G5S2	LOW	Although narrowly distributed, most populations are in inhospitable habitats and not under any demonstrable threats. Should residential development become an issue in the Western High Plains, the threats could substantially increase.
PHYSARIA BELLII	BELL'S TWINPOD	Y	G2S2	LOW	Highly restricted range co-occurs with urbanization; however, many populations are protected. The species seems to be tolerant of disturbance as long as its soil type (shale) remains. Biology of pollination is unknown, but plants along roadsides are reproducing successfully.
ECHINOCEREUS REICHENBACHII VAR PERBELLUS	LACE HEDGEHOG CACTUS	Y	G5T?S1	LOW	Populations are not currently threatened.
ASTRAGALUS PLATTENSIS	PLATTE RIVER MILKVETCH	Y	G5S1	LOW	Marginally occurs in Colorado, but very common elsewhere.
EUSTOMA GRANDIFLORUM	SHOWY PRAIRIE GENTIAN	Y	G5S3	LOW	Showy and restricted in occurrence, but readily occupies abandoned gravel pits and similar habitats. Common elsewhere outside of Colorado
FRASERA COLORADENSIS	COLORADO GREEN GENTIAN	Y	G3S3	LOW	Endemic to CSP. While restricted to specific soils and geological outcrops, there do not appear to be significant threats. As long as ranching is the primary land use within its range, it is unlikely to be threatened.
RIBES AMERICANUM	AMERICAN CURRANT	Y	G5S1	LOW	There are few populations in Colorado; however, the species has a wide range, and is common. The populations in Colorado are under pressure from expanding urban areas.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
NUTTALLIA CHRYSANTHA	GOLDEN BLAZING STAR	Y	G1G2S1S2	MED	This species, while in a restricted range, is apparently tolerant of many disturbances. However, rapid urbanization may threaten this species.
OXYBAPHUS ROTUNDIFOLIA	ROUND-LEAF FOUR-O'CLOCK	Y	G2S2	MED	
GAURA NEOMEXICANA SSP COLORADENSIS	COLORADO BUTTERFLY PLANT	Y	G23T2S1; FEDERALLY PROPOSED THREATENED	HIGH	Federally-listed as Threatened.
OENOTHERA HARRINGTONII	ARKANSAS VALLEY EVENING PRIMROSE	Y	G2S2	MED	Endemic to Colorado, but with a wider range than most of the "Arkansas River endemics." As long as ranching is a key land use in its range, it should thrive. However, many populations in the vicinity of Pueblo are highly threatened.
VIOLA PEDATIFIDA	PRAIRIE VIOLET	Y	G5S2	LOW	Very wide range, common in many places. It is at the edge of its range in Colorado.
COMMELINA DIANTHIFOLIA	BIRDBILL DAY-FLOWER	Y	G5S1?	LOW	Very wide range and common within most of it. It is marginal in Colorado and occurs in several protected areas.
JUNCUS BRACHYCEPHALUS	SMALL-HEADED RUSH	Y	G5S1	LOW	Not known to be highly threatened.
PELLAEA ATROPURPUREA	PURPLE CLIFF-BRAKE	Y	G5S2S3	LOW	The species is of spotty occurrence in Colorado, but it has a very wide range and does not have many threats.

POTENTIAL TARGET SPECIES FOR CDOT'S CENTRAL SHORTGRASS PRAIRIE PROJECT

LATIN NAME	COMMON NAME	OCCUR W/I 0.5 MILES OF CSP HIWAYS	STATUS	LISTING POTENTIAL	COMMENTS
WOODSIA NEOMEXICANA	NEW MEXICO CLIFF FERN	Y	G4?S2	LOW	Fairly widespread species outside of Colorado. There are few documented threats and many occurrences are remote from possible threats.

APPENDIX B: DATA LAYERS

Base Data

COUNTIES

Description: All counties in Colorado. This coverage was used to clip the Central Shortgrass Prairie ecoregion to produce the ecoregion's extent in Colorado.
Source: Colorado Department of Transportation
Vintage: Current as of January 1, 1999
Feature Type: Polygon
Accuracy: Scale of data is 1:24,000

DIGITAL ELEVATION MODEL (DEM)

Description: 30 meter digital elevation model for Colorado.
Source: U.S. Geological Survey
Vintage: Current as of 1999
Feature Type: Grid
Accuracy: 30 meter resolution (roughly 1:24,000)

ECOREGIONS

Description: Ecoregion lines were originally adopted from Robert Bailey's 1994 province-scale level of ecoregion classification and his original map was drawn at 1:2,000,000. Since then, however, TNC has been refining boundaries where they can. That is, in cases where the ecoregion hasn't been "planned" yet, and where a modification in its boundary will not affect an adjoining ecoregion that has already been planned. TNC is using the USFS updated section lines, where available and appropriate to make these refinements. However, the boundaries for the Central Shortgrass Prairie have not been modified and remain coarse.
Source: The Western Regional Office of The Nature Conservancy
Vintage: Current as of 1994
Feature Type: Polygon
Accuracy: Scale of data is 1:2,000,000

HIGHWAYS

Description: All public highways that are maintained and under the jurisdiction of the Colorado Department of Transportation. Includes Interstates, U.S. Highways and State Highways.
Source: Colorado Department of Transportation
Vintage: Current as of January 1, 1999
Feature Type: Line
Accuracy: Scale of data is 1:100,000

HYDROLOGY

Description: Rivers, streams and creeks in Colorado.
Source: Colorado Division of Wildlife
Vintage: Current as of 1999
Feature Type: Line
Accuracy: Scale of data is 1:100,000

MUNICIPALITIES

Description: This layer contains municipal boundaries extracted from TIGER/Line94 and 95 enhanced with boundary data from the Colorado Department of Transportation. Municipal annexations since January 1, 1990 are included. Annexation plats and ordinances statutorily received by the Division of Local Government were digitally converted using coordinate geometry software.
Source: Division of Local Government
Vintage: Current as of December 1997
Feature Type: Polygon
Accuracy: Scale of data is 1:100,000

PLANT ZONE OF IMPACT

Description: Following expert recommendations, the impact zone for all plant species consisted of all Colorado highways buffered 50 meters (for a total width of 100 meters) or the right-of-way (whichever distance was greater).
Source: Colorado Department of Transportation
Edited by the Colorado Natural Heritage Program, August 2000
Vintage: Current as of January 1, 1999
Feature Type: Polygon
Accuracy: Scale of data is 1:100,000

RIGHT-OF-WAYS (ZONE OF IMPACT FOR REPTILES, BIRDS, AND BLACK-TAILED PRAIRIE DOG)

Description: All public highways that are maintained and under the jurisdiction of the Colorado Department of Transportation. Includes Interstates, U.S. Highways and State Highways. To

account for the right-of-way, based on CDOT's recommendations, CNHP applied the following buffer distances:
1) State and federal highways were buffered 75 feet, or 22.86 meters, to capture a R/W width of 150 feet.
2) I-25 and I-70 were buffered 150 feet, or 45.72 meters, to capture a R/W width of 300 feet.
3) I-76 was buffered 200 feet, or 60.96 meters, to capture a R/W width of 400 feet.
Source: Colorado Department of Transportation
Edited by the Colorado Natural Heritage Program, July 2000
Vintage: Current as of January 1, 1999
Feature Type: Polygon
Accuracy: Scale of data is 1:100,000

SOILS (STATSGO)

Description: STATSGO data are a general soil association map developed by the National Cooperative Soil Survey. It consists of a broad based inventory of soils and non-soil areas that occur in a repeatable pattern on the landscape and that can be cartographically shown at the scale mapped. The soil maps for STATSGO are compiled by generalizing more detailed soil survey maps. Where more detailed soil survey maps are not available, data on geology, topography, vegetation, and climate are assembled, together with Land Remote Sensing Satellite (LANDSAT) images. Soils of like areas are studied, and the probable classification and extent of the soils are determined.
Source: U.S. Department of Agriculture, Soil Conservation Service
Vintage: Current as of 1994
Feature Type: Polygon
Accuracy: Scale of data is 1:500,000

VEGETATION

Description: Colorado GAP vegetation is a habitat/vegetation map of Colorado with 52 habitat types photointerpreted from Landsat imagery. This coverage has never been ground-truthed.
Source: Colorado Division of Wildlife, Habitat Resources Section
Vintage: Current as of March 31, 1998
Feature Type: Polygon
Accuracy: 100 hectare minimum mapping unit, 40 hectares for riparian areas

Biological Data

COLORADO BREEDING BIRD ATLAS (BBA)

Description: The Colorado Breeding Bird Atlas, published at the end of 1998, describes the results of the largest natural history survey ever conducted in Colorado. It reports the results from fieldwork by over 1,200 "atlasers" who spent eight years gathering data on Colorado breeding birds. BBA data were available for certain bird species only. Please refer to 'Process

Steps' to determine whether or not BBA data were used in creating assumed presence maps for any given species.
Source: The Colorado Breeding Bird Atlas
Vintage: Current as of 1998
Feature Type: Polygon
Accuracy: Data were collected in blocks 3x3.5 miles on a side and stored in a tabular database. GIS coverage generated by CNHP used 7.5 minute USGS quadrangle boundaries to represent a single BBA record.

ELEMENT OCCURRENCES (EOS)

Description: An element occurrence (EO) represents a location in which a species or plant community is, or was, present. An EO has potential continued (or historic) presence and/or regular recurrence at a given location and has practical conservation value. Element occurrence data were available for certain species only. Please refer to 'Process Steps' to determine whether or not these data were used in creating assumed presence maps for any given species.
Source: The Colorado Natural Heritage Program
Vintage: Current as of April 14, 2000
Feature Type: Point
Accuracy: CNHP compiles data from a variety of sources, hence, data have variable levels of accuracy. Element Occurrences are lumped into three levels of precision:

seconds – "X" marks the spot; mapable to within approximately 3 arc seconds of latitude and longitude
minutes – mapable within approximately two square miles
general – mapable within approximately two USGS 7.5 minute quadrangles*

*Note: general records were not used in this assessment

POTENTIAL CONSERVATION AREAS (PCAS)

Description: Potential conservation areas represent CNHP's best estimate of the primary area supporting the long-term survival of targeted species and plant communities. Potential conservation area data were available for certain species only. Please refer to 'Process Steps' to determine whether or these data were used in creating assumed presence maps for any given species.
Source: Colorado Natural Heritage Program
Vintage: Current as of July 17, 2000
Feature Type: Polygon
Accuracy: Scale of data ranges from 1:24,000 – 1:100,000

POTENTIALLY SUITABLE HABITAT (PSH)

Description: Potentially Suitable Habitat data were modeled using species-vegetation affinities and elevational range constraints. Vegetation affinities assigned by CDOW include vegetation types used throughout the entire life cycle of the species in question. PSH data were available for certain species only. Please refer to 'Process Steps' to determine whether or not PSH data were used in creating assumed presence maps for any given species.

Source: Colorado Division of Wildlife
Vintage: Current as of 1999
Feature Type: Grid
Accuracy: Vegetation values are from the Colorado GAP vegetation map (refer to vegetation above under base data for more information). The elevation values are from 3 arc second digital elevation model (DEM), roughly 90 meter spacing.

WILDLIFE RESOURCE INFORMATION SYSTEM (WRIS)

Description: Wildlife Resource Information System data represent overall range for a specific species. Overall range is defined as an area that encompasses all known seasonal activities within the observed range. This information was derived from field personnel. WRIS data were available for certain species only. Please refer to Process Steps to determine whether or not WRIS data were used in creating assumed presence maps for any given species.
Source: Colorado Division of Wildlife
Vintage: Current as of 1999
Feature Type: Grid
Accuracy: Scale of data is 1:50,000

APPENDIX C: GIS IMPACT ANALYSIS PROCESS BY SPECIES

Birds

BALD EAGLE, HALIAEETUS LEUCOCEPHALUS

Presumed Presence:

1) As recommended by biologists, CDOW (or WRIS) communal roost sites and roost sites were buffered 15 miles.
2) Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types, within the buffered roost sites, were used to determine presumed presence.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

BURROWING OWL, ATHENE CUNICULARIA

Presumed Presence:

1) Breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Polygons drawn by experts were digitized "heads up" in ArcView 3.2. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types, within the digitized polygons, were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.

4) Highways were intersected with presumed presence to determine the number of highway miles.

CASSIN'S SPARROW, AIMOPHILA CASSINII

Presumed Presence:

1) Breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Polygons drawn by experts were digitized "heads up" in ArcView 3.2. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The vegetation affinities, within the digitized polygons, were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

FERRUGINOUS HAWK, BUTEO REGALIS

Presumed Presence:

1)Vegetation affinities were identified by biologists on the core project team, and reselected from the Colorado Gap vegetation data to determine presumed presence.

Impact Assessment:

1) Right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

LARK BUNTING, CALAMOSPIZA MELANOCORYS

Presumed Presence:

1) No maps were taken to the state experts for Lark Bunting since it was assigned low listing potential; however, experts agreed that it was an important species to add to the list.
2) Based on expert opinion, the entire ecoregion was considered important for this species. However, experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types were used to determine presumed presence.
3) Based on expert opinion, municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

LESSER PRAIRIE-CHICKEN, TYMPANUCHUS PALLIDICINCTUS

Presumed Presence:

1) CNHP element occurrences, CDOW potentially suitable habitat data and breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Polygons drawn by experts were digitized "heads up" in ArcView 3.2. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types, within the digitized polygons, were used to determine presumed presence.
3) Based on expert opinion, municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

Notes:
The transplant area between Highway 94 and Highway 96 was included in the presumed presence coverage. However, this will not affect the number of acres impacted because no highways are in that specific location.

LOGGERHEAD SHRIKE, LANIUS LUDOVICIANUS

Presumed Presence:

1) Breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, the entire ecoregion was considered important for this species. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

LONG-BILLED CURLEW, NUMENIUS AMERICANUS

Presumed Presence:

1) CNHP element occurrences, CDOW potentially suitable habitat data and breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Polygons drawn by experts were digitized "heads up" in ArcView 3.2. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types, within the digitized polygons, were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

McCown's Longspur, Calcarius mccownii

Presumed Presence:

1) CNHP element occurrences, CDOW potentially suitable habitat data and breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Polygons drawn by experts were digitized "heads up" in ArcView 3.2. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types, within the digitized polygons, were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

Notes:
All areas within the polygons drawn by state experts were used, including a wintering area.

Mountain Plover, Charadrius montanus

Presumed Presence:

1) CNHP element occurrences, CDOW potentially suitable habitat data and breeding bird atlas data were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, the entire ecoregion was considered important for this species. Experts determined appropriate vegetation affinities for the breeding life cycle of this species. The selected vegetation types were used to determine presumed presence.
3) Based on expert opinion, all municipalities were removed.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

Mammals

BLACK-TAILED PRAIRIE DOG, CYNOMYS LUDOVICIANUS

Presumed Presence:

1) A complete dataset for distribution of this species was not available. Vegetation affinities were identified by state experts and reselected from the Colorado Gap vegetation data to determine presumed presence.

Impact Assessment:

1) Right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

Notes:
Because prairie dogs are found in many different vegetation types, it was hard to limit those chosen as important for this species. Furthermore, there was not a complete locational dataset available. It is likely that impacts to the black-tailed prairie dog are lower than what is shown by this analysis. It is important to note, however, that this species is frequently found along roadsides.

Reptiles

MASSASAUGA RATTLESNAKE, SISTRURUS CATENATUS

Presumed Presence:

1) CDOW potentially suitable habitat data, CDOW overall range or WRIS data, and CNHP element occurrences were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, all overall range data was included. In addition, all potentially suitable habitat north of Comanche National Grasslands, but below I-70, to the eastern state boundary was included.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.

2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

TEXAS HORNED LIZARD, PHRYNOSOMA CORNUTUM

Presumed Presence:

1) CDOW potentially suitable habitat data, CDOW overall range (or WRIS) data, and CNHP element occurrences were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, all overall range data was included as well as potentially suitable habitat data south of Highway 96. A small portion of potentially suitable habitat data in Pueblo and Huerfano counties, just west of the overall range, was included as well.

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

WESTERN BOX TURTLE, TERRAPENE ORNATA

Presumed Presence:

Specific occurrence data were not available to refine the distribution of this species within the CSP, so the following approach was taken to determine presumed presence.
1) Experts identified sandy soils as being important. CNHP used STATSGO soils data to determine sandy locations (SSURGO data, which are much more accurate, were not available for most of CSP) and pulled out areas with the string "psam." According to STATSGO, there were only entisols, in the suborder psamment, that fit the criteria. In addition, sand dune grassland complex, sand dune shrub complex and sandy areas were selected from the GAP vegetation layer.
2) The data sets were combined and compared to Geoffrey A. Hammerson's distribution of the western box turtle in his 1999 book Amphibians and Reptiles in Colorado, Second Edition. The presumed presence matched Hammerson's small-scale distribution map (except for a few isolated sightings that were missing from the presumed presence files) so the data were not edited further. CNHP verified that all presumed presence locations were below 5,500 feet (or 1,680 meters), the highest elevation suitable for the western box turtle according to Hammerson, by using a 30 meter digital elevation model (DEM).

Impact Assessment:

1) Based on expert opinion, right-of-ways were used as the zone of impact.
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

Plants

ARKANSAS RIVER FEVERFEW, BOLOPHYTA TETRANEURIS

Presumed Presence:

1) CNHP element occurrences were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, all EOs were used to create the presumed presence coverage.
3) In order to capture the spatial extent of the point data, the following procedures were implemented. For any element occurrence with a corresponding potential conservation area, the PCA boundary was used to represent the extent of the occurrence. No occurrences without PCAs had least rectangles (coordinates defining the southernmost, northernmost, easternmost and westernmost extent of the EO). Hence, those EOs without PCAs were buffered based on precision. General records were deleted from the analysis due to very high locational uncertainty. Seconds records were buffered 92.5 meters and minutes records were buffered 1850 meters.
4) Potential conservation areas and buffered points were combined and the boundaries of all overlapping polygons were dissolved.
5) Because the presumed presence coverage for this species extended outside of the Central Shortgrass Prairie, it was clipped to the ecoregion boundary.

Impact Assessment:

1) Based on expert opinion, the zone of impact included the highways, buffered 50 meters, to get a total width of 100 meters, or the right-of-way (whichever was larger).
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

PUEBLO GOLDENWEED, OONOPSIS PUEBLOENSIS

Presumed Presence:

1) CNHP element occurrences were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, all EOs were used to create the presumed presence coverage.
3) In order to capture the spatial extent of the point data, the following procedures were implemented. All element occurrences had corresponding potential conservation areas; hence, PCA boundaries were used to represent the extent of this species.
4) Since the presumed presence coverage for this species extended outside of the Central Shortgrass Prairie, presumed presence was clipped to the ecoregion boundary.

Impact Assessment:

1) Based on expert opinion, the zone of impact included the highways, buffered 50 meters, for a total width of 100 meters, or the right-of-way (whichever was larger).
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

ROUND-LEAF FOUR-O'CLOCK, OXYBAPHUS ROTUNDIFOLIUS

Presumed Presence:

1) CNHP element occurrences were displayed on a 1:424505 scale map.
2) The maps were taken to state experts to further define the boundaries. Based on expert opinion, all EOs were used to create the presumed presence coverage.
3) In order to capture the spatial extent of the point data, the following procedures were implemented. For any element occurrence with a corresponding potential conservation area, the PCA boundary was used to represent the extent of the occurrence. For one occurrence without a PCA, least rectangles (coordinates defining the southernmost, northernmost, easternmost and westernmost extent of the EO) were used to represent its spatial extent. Those species without PCAs and least rectangle coordinates were buffered based on precision. General records were deleted from the analysis due to very high locational uncertainty. Minutes records were buffered 1850 meters. There were no seconds records without least rectangle coordinates or PCAs.
4) Potential conservation areas, buffered points and least rectangles were combined and the boundaries of all overlapping polygons were dissolved.
5) Since the presumed presence coverage for this species extended outside of the Central Shortgrass Prairie, it was clipped to the ecoregion boundary.

Impact Assessment:

1) Based on expert opinion, the zone of impact included the highways, buffered 50 meters, for a total width of 100 meters, or the right-of-way (whichever was larger).
2) Vegetation data were intersected with presumed presence to determine all vegetation types.
3) Vegetation types within presumed presence were intersected with the zone of impact to determine acres of maximum impact per vegetation type.
4) Highways were intersected with presumed presence to determine the number of highway miles.

APPENDIX D: VEGETATION AFFINITIES FOR VERTEBRATE SPECIES

The potentially suitable habitat (PSH) data used in these analyses for vertebrate animals were modeled by CDOW using the Colorado GAP vegetation data, a statewide, coarse vegetation layer. This appendix contains elevation ranges and listings of vegetation types that were identified by CDOW as potential habitat for vertebrate species (where available). These lists have been refined by Chris Pague (Director of Conservation Science for The Nature Conservancy) and Jennie Slater (Grassland Species Coordinator for Colorado Division of Wildlife) to highlight natural vegetation types that occur in the CSP and that represent habitat critical to the life cycle (e.g., breeding habitat) of the species.

Vegetation affinities that were originally identified by CDOW, but that represent habitat types not likely to be critical to species survival, have been deleted from these lists and have not been included in the analysis. CDOW vegetation affinities were not available for a few species. Mr. Pague and Ms. Slater used the statewide GAP vegetation types to create affinity lists for these species.

Complete, detailed metadata for CDOW's Potentially Suitable Habitat are available from the Colorado Division of Wildlife.

Birds

BALD EAGLE

Bare soil
Barren land
Sandy areas
Tallgrass prairie
Shortgrass prairie
Sand dune grassland complex
Sand dune shrub complex
Dryland agriculture
Forest dominated wetland/riparian
Graminoid/forb dominated wetland/riparian
Open Water

BURROWING OWL

Dryland crops
Tallgrass prairie
Sand dune grassland complex
Midgrass prairie
Shortgrass prairie

Foothills and mountain grassland
Desert shrub
Saltbush shrub
Greasewood fans and flats
Sand dune shrub complex
Disturbed shrub
Barren lands

CASSIN'S SPARROW

Midgrass prairie
Sand dune shrub complex
Tallgrass prairie
Sand dune grassland complex
Juniper woodland
Greasewood fans and flats

FERRUGINOUS HAWK

Bare soil
Barren land
Exposed rock
Midgrass prairie
Shortgrass prairie
Sand dune grassland complex
Dryland agriculture
Foothills and mountain grassland

LARK BUNTING

Dryland crops
Tallgrass prairie
Sand dune grassland
Midgrass prairie
Shortgrass prairie
Desert Shrub
Saltbush shrub
Sand dune shrub
Unvegetated playa

LESSER PRAIRIE-CHICKEN

Dryland crops
Irrigated crops
Tallgrass prairie
Sand dune grassland complex

Midgrass prairie
Unvegetated other
Sand dune shrub complex

LOGGERHEAD SHRIKE

Dryland agriculture
Foothills/mountain grassland
Graminoid and forb dominated wetland
Juniper woodland
Midgrass prairie
Pinyon-juniper
Sand dune grassland complex
Sand dune shrub complex
Desert shrub
Shrub dominated wetland/riparian
Tallgrass prairie
Forest dominated wetland/riparian

(Note that shortgrass prairie was not included as a vegetation affinity for Loggerhead Shrike. The thinking was that this species is strongly adapted to homesteads, and really only occurs in the areas of shortgrass prairie that have trees or shrubs. Shortgrass is not a good estimator because these birds use such a small percentage of it.)

LONG-BILLED CURLEW

Dryland crops
Irrigated crops
Shortgrass prairie
Open water
Barren lands
Graminoid and forb dominated wetland
Unvegetated playa
Unvegetated other

MCCOWN'S LONGSPUR

Dryland crops
Sand dune grassland complex
Midgrass prairie
Shortgrass prairie
Barren lands
Unvegetated playa
Sand dune shrub complex

MOUNTAIN PLOVER

Dryland crops
Midgrass prairie (in dry years)
Shortgrass prairie
Barren lands
Unvegetated playa
Unvegetated other

Mammals

BLACK-TAILED PRAIRIE DOG

Bare soil
Midgrass prairie
Shortgrass prairie
Sand dune grassland complex
Dryland agriculture
Foothills and mountain grassland

Reptiles

MASSASAUGA RATTLESNAKE

Midgrass prairie
Shortgrass prairie
Sand dune shrub complex
Sand dune grassland complex

TEXAS HORNED LIZARD

Shortgrass prairie
Bare soil
Midgrass prairie
Pinon-juniper
Sand dune grassland complex
Sand dune shrub complex
Sandy areas
Exposed rock

WESTERN BOX TURTLE

Midgrass prairie
Sand dune grassland complex
Sand dune shrub complex
Shortgrass prairie
Desert shrub