San Luis Valley – Taos Plateau Level IV Ecoregion Landscape Assessment

Phase I Report and
Phase II Work Plan

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Phase I Report and
Phase II Work Plan

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prepared by
Leroy J. Walston, Heidi M. Hartmann, Konstance L. Wescott, Emily A. Zvolanek, Katherine E. Rollins, and Laura R. Fox
Environmental Science Division, Argonne National Laboratory

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NOTATION

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

Argonne	Argonne National Laboratory
BLM	Bureau of Land Management
CA	Change Agent
CE	Conservation Element
LA	Landscape Assessment
MQ	Management Question

UNITS OF MEASURE

km^2	square kilometers(s)
m	meter(s)

UNIT CONVERSIONS

1 km^2	0.39 mi^2
1 m	3.28 ft

San Luis Valley – Taos Plateau Level IV Ecoregion Landscape Assessment

1 Introduction

1.1 Purpose of Rapid Ecoregional Assessments

Rapid Ecoregional Assessments undertaken by the Bureau of Land Management (BLM) provide a broad-scale synthesis of natural resource status and trends within an ecoregion. Fifteen BLM Rapid Ecoregional Assessments have been completed by or are underway in 2014 (http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas.html). The Rapid Ecoregional Assessments characterize the current status of selected Conservation Elements (CEs) and forecast trends and the future vulnerability of these resources to Change Agents (CAs). The Rapid Ecoregional Assessments have received particular emphasis in the BLM's landscape approach to land management, and are excellent tools in implementing U.S. Department of the Interior Secretarial Orders to use landscape approaches in evaluating the impacts of climate change, energy development, and other activities occurring on public lands (USDOI 2010, 2013). The Rapid Ecoregional Assessments are intended to serve several purposes pertaining to natural resource management:

- Understand landscape-level status and trends of Conservation Elements;
- Characterize current and potential influences (Change Agents) in the ecoregion;
- Understand landscape-level impacts of human development activities;
- Inform the development of ecoregion-based conservation strategies;
- Inform landscape planning decisions (including identification of regional mitigation opportunities); and
- Provide baseline for long-term monitoring and adaptive management;

1.2 Purpose of this Landscape Assessment

Following previous Rapid Ecoregional Assessment guidance, the BLM will conduct a Landscape Assessment (LA) of the San Luis Valley –Taos Plateau Level IV ecoregion to document the current status of Conservation Elements at the ecoregional scale and evaluate the trends and vulnerability of these resources to Change Agents over time. This LA approach, as completed for this study, is based on approaches similar but not identical to BLM Rapid Ecoregional Assessment approaches completed for the Colorado Plateau and Mojave Basin and Range Ecoregions (BLM 2012a, 2013a). The main distinctions lie in scope.

Whereas the Colorado Plateau and other BLM Rapid Ecoregional Assessments were analyzed at the scale of a Level III Ecoregion (generally >100,000 km^2 in size), the focus for this LA is a smaller Level IV Ecoregion (approximately 25,346 km^2) of the Upper Rio Grande landscape occurring within the AZ-NM Plateau This smaller LA study area contains three BLM Colorado Solar Energy Zones defined as priority areas for renewable energy (solar) development.

The primary objective of this LA is to inform landscape-based mitigation strategies for solar energy development in Colorado within these priority areas. Additionally, the San Luis Valley - Taos Plateau Landscape assessment is completed in the context of other BLM land use planning activities, including but not limited to planning for the Rio Grande del Norte National Monument, and may have application for other future BLM actions in the region. Management Questions (MQs) and Conservation Elements (CEs) selected for this LA will be developed to inform regional mitigation planning for solar development. Although this LA will be prepared with focus on solar energy development, the assessment is intended to provide broad application to inform other resource and conservation issues and future land management decisions.

In addition, the San Luis Valley – Taos Plateau LA will also include an evaluation of cultural and visual resources within the study area in an effort to inform solar regional mitigation strategies. Previous Rapid Ecoregional Assessments (e.g., BLM 2012a, 2013a) have primarily focused on ecological resources and have not thoroughly evaluated cultural and visual resources. Although some resources with cultural resource values (such as Specially Designated Areas) are typically evaluated in Rapid Ecoregional Assessments, this LA will make greater efforts to assess condition and trends of cultural landscapes, values, and areas of connectivity. The assessment of cultural and visual resources in this LA will utilize results from concurrent Cultural and Visual Resource Assessments being performed for the BLM.

1.3 Overview of the Landscape Assessment Process and Approach

This LA will be developed in two phases: a pre-assessment phase (Phase I) and an assessment phase (Phase II) (Table 1). The pre-assessment phase comprises four main tasks: determination and refinement of MQs, CEs, and Change Agents (CAs) [Task 1]; Development of a general conceptual model for the ecoregion [Task 2]; Development of conceptual models for CEs [Task 3]; and preparation of a work plan report [Task 4]. The LA work plan provides guidance for Phase II, the assessment and reporting phase of the LA. The work plan summarizes key considerations made by the BLM in determining Tasks 1-3 and outlines a framework for the assessment approach in Phase II (assessment). The assessment phase comprises three tasks: compilation and review of literature and source datasets for evaluation [Task 5], conducting assessment and interpreting results [Task 6], and preparation of the final LA and deliverables [Task 7].

Table 1. Overview of Phase I (pre-assessment) and Phase II (assessment) tasks for the Landscape Assessment (LA).

Phase	Task	Task Description
I. Pre-assessment	1	Determine and refine Management Questions, Conservation Elements, and Change Agents.
	2	Develop general conceptual model for the ecoregion.
	3	Develop conceptual models for Conservation Elements.
	4	Prepare work plan report.
II. Assessment	5	Compile and review source information, literature and datasets for resource conditions and trend assessment.
	6	Conduct assessment and interpret results.
	7	Prepare draft and final LA report and deliverables.

1.4 Landscape Assessment Expected Outcomes and Products

One purpose of this Phase I Report and Phase II Work Plan is to document the selection process for final MQs, CEs, and CAs as part of Task 1 efforts. Finalization of this work plan report completes all pre-assessment tasks. In addition, an assessment framework to address MQs is presented (Phase II Work Plan). The assessment approach incorporates conceptual models to organize and document methodology. This work plan report contains examples of how the assessment framework will be applied by providing example methods and results.

At the end of Phase II, a draft LA report will be produced for BLM review; comments will be incorporated and a final report published. The final LA report will include documentation of specific methods, results, and conclusions regarding MQs, CEs, and CAs. All source and derived datasets will be provided to the BLM, and the guidelines of the BLM National Operations Center Data Management Plan will be followed.

1.5 Landscape Assessment Team

The BLM project team consists of a project management and implementation team, a BLM assessment management team, a technical interdisciplinary team of BLM subject matter experts with knowledge of the San Luis Valley & Taos Plateau study area, and LA project support from Argonne National Laboratory (Argonne).

2 San Luis Valley – Taos Plateau Landscape Assessment

2.1 Background on the San Luis Valley – Taos Plateau Level IV Ecoregion

The San Luis Valley – Taos Plateau Level IV Ecoregion (hereafter, "the study area") encompasses approximately 25,346 km^2 and includes portions of southern Colorado and Northern New Mexico (Figure 1). The study area is known for its high cultural and ecological values. The wide variety of vegetation types includes intermountain basins dominated by sagebrush shrublands and semi-desert shrub-steppe communities interspersed with wetlands and riparian areas and piñon-juniper forests, including volcanic cones rising upwards of 2,000-4,000 feet from the pleateau with oak and mixed conifer forests of ponderosa pine, douglas fir, white pine and aspen, and other foothill woodland communities. High elevation mountain ranges around the periphery of the study area support montane and subalpine forests. Networks of basin wetlands within the study area are formed from snowmelt in the surrounding mountains and provide important habitat for over 200 species of migratory waterfowl and shorebirds as well as other wildlife, including many threatened, endangered, and sensitive species (USFWS 2012). The study area also provides important habitat for big game wildlife species – including bighorn sheep, elk, mule deer, and pronghorn – and supports one of the largest elk herds in New Mexico (Smallidge et al. 2003).

The San Luis Valley and Taos Plateau have a rich cultural history beginning with the Paleo-Indian culture approximately 11,000 years ago (USDA 2014). Native American use of the area was primarily nomadic, including hunting, gathering, trading, and other activities, and occurred throughout the region until the late 1800s. Spanish explorers first entered the area in the late 1500s and land grants were established, but the area was largely unsettled until around 1850 when the San Luis Valley became a territory of the United States. Agricultural potential and mining opportunities attracted settlers. Agriculture and stock-raising (sheep and cattle) remains a major base of the present economy (USDA 2014).

2.2 Major Components of the Landscape Assessment

The Phase I objectives were to identify the subjects of the assessment, develop a generalized conceptual model for the ecoregion, and develop conceptual models for the CEs. The major components of the LA are discussed below and summarized in Table 2.

2.2.1 Management Questions

Management Questions (MQs) were identified in 2013-2014 by the BLM interdisciplinary team and assessment management team to identify the information needed for addressing public land management responsibilities as defined in the BLM San Luis Resource Area Resource Management Plan (BLM 1991) and amendments, and BLM Taos Resource Area RMP (BLM 2012b). A list of recommended MQs is provided in **Appendix A**.

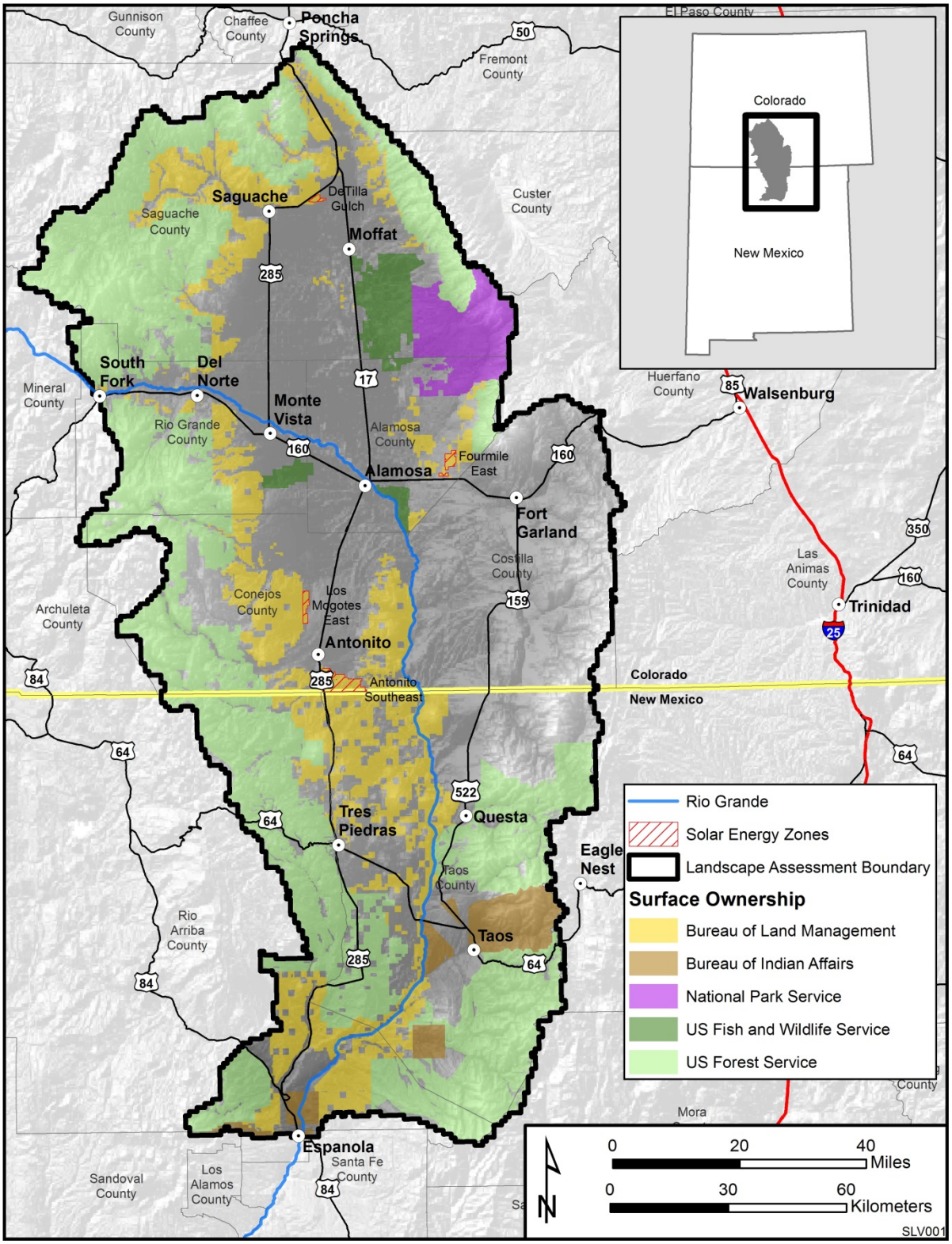

Figure 1. Study area for the San Luis Valley-Taos Plateau Landscape Assessment, located in southern Colorado and northern New Mexico (inset).

Table 2. Major components of the San Luis Valley – Taos Plateau Landscape Assessment.

Component	Description
Management Questions	Questions about important resources and their attributes for addressing land management responsibilities.
Change Agents	Primary drivers that either currently influence or could influence Conservation Elements. The four change agents evaluated in this LA include climate change, human development, invasive species, and wildfire.
Conservation Elements	A limited number of resources with regional conservation importance. These resources could include species, species assemblages, ecological systems, habitats, physical resources (e.g., soils, hydrology), and cultural resources.
Conceptual Models	Illustrative depictions of the interactions between Conservation Elements, the biophysical properties of the environment, and Change Agents. Conceptual Models show the relationships and mechanisms of their interactions.
Key Ecological Attributes (if applicable)	Characteristics of certain ecological Conservation Elements that are important for the long-term viability of the Conservation Element. Primarily applicable only to ecological Conservation Elements.

Management Questions help to focus the LA process and ensure that the most relevant datasets are compiled, analyzed, and summarized. The MQs may pertain to either CEs or CAs. There are also integrative MQs that address the interaction of CAs and CEs. Common aspects of Management Questions include the following:

- What and where are key attributes of Conservation Elements?
- What and where are the Change Agents?
- Where do the Change Agents overlap with key attributes of Conservation Elements?
- How do the Change Agents affect the key attributes of Conservation Elements?

Each MQ will be evaluated to determine whether it can feasibly be addressed in the LA. For each MQ, the data needs and planned methodology to address the questions will be documented. Those MQs for which data are lacking may require extra time beyond the LA schedule. Those that may be redundant with other MQs will be identified for deletion or revision.

2.2.2 Conservation Elements

A regionally significant Conservation Element has attributes that give it more than local significance, especially compared to similar resources. Conservation Elements considered in this LA represented a number of resources with regional conservation importance in 2014. These resources include species, species assemblages, ecological systems, habitats, physical resources

(e.g., soils, hydrology), and cultural and visual resources. Discussions between Argonne and the BLM assessment management team and interdisciplinary team on Conservation Elements began in December 2013 and a recommended list of 24 CEs was identified in April 2014. The process involved the objective of identifying a list of CEs that would provide a broad picture of the general condition of the resources of conservation concern within the study area and could be used to address priority Management Questions. A target of <25 CEs was chosen based on a review of CEs evaluated in previous BLM REAs. Rapid Ecoregional Assessments define core CEs as biotic constituents (wildlife and plant species and assemblages) or abiotic factors (e.g., soils, hydrology, etc) of regional significance in major ecosystems and habitats across the ecoregion. A limited suite of CEs is designed to represent the entirety of resources and values within the ecoregion; as such, it is suggested that the individual CEs may serve as surrogates for other resources across the ecoregion. Ecological CEs may be single species, assemblages of taxonomically similar species (for example, bat assemblage), or species that use similar resources (for example, grassland fauna assemblage). These CEs highlight rare or specialized species that likely would not be assessed adequately by the ecological communities (Poiani et al. 2000), either because they require localized habitats or are already at risk and require active, targeted management to prevent further population declines. Abiotic CEs represent those physical attributes that are biologically important and can be adequately characterized in the landscape.

A workshop was held on February 3, 2014 with the BLM interdisciplinary team, assessment management team, and staff from the BLM National Operations Center. One purpose of this workshop was to gather input on resources and issues of potential conservation interest for consideration as CEs in the Landscape Assessment. During this workshop, the BLM identified a total of 77 resources or elements that, if evaluated individually, would represent 77 unique CEs in the LA.

As a preliminary step in the LA (Task 1), the workshop was held to document a wide and comprehensive set of resource issues, through resource specialist consultation and baseline data review, with the intent to screen and filter these resource issues to those that are the most meaningful CEs in a regional context to inform the LA. Based on Rapid Ecoregional Assessment guidance and LA scope, six criteria were used to determine the suitability of elements for recommendation as final CEs in the Landscape Assessment (Table 3). These include scope (e.g., would assessment of the resource inform solar regional mitigation strategies?), management implications, regional distribution and habitat heterogeneity (for species), vulnerability to anthropogenic disturbances, and socioeconomic importance. In addition, special effort was placed on identifying aggregations of CEs (e.g., Ecological System macrogroups) or indicators that could be used as surrogates for multiple similar elements. Of particular note is scope. The primary focus of this LA is to inform regional mitigation strategies for solar energy development in the study area. Therefore, selection of CEs was based, at least in part, on the potential for the CE to be affected by solar energy development and/or inform the solar regional mitigation strategy.

The selection criteria (Table 3) were considered for each of the originally-proposed 77 CEs to filter those CEs that best met the selection criteria, reduced duplicity and redundancy among CEs, and aggregated elements, where possible. This filtering process narrowed the list of potential CEs to a recommended list of 24 Conservation Elements. The recommended and initial lists of Conservation Elements are provided in **Appendix B.**

Table 3. Conservation Element selection criteria for the San Luis Valley – Taos Plateau Landscape Assessment

	Criteria Description
1.	Scope *Would assessment of this element inform Solar Regional Mitigation Strategies?*
2.	Resource with Management Implications *Would assessment of this element inform future BLM management decisions?*
3.	Regional Distribution and Habitat Heterogeneity (primarily for wildlife species) *Does this element have a landscape-level distribution and occur in both states (CO and NM)?*
4.	Vulnerability to Anthropogenic Disturbance *Would this element be vulnerable to human development such as solar energy?*
5.	Socioeconomic Importance *Examples: charismatic species, game species, resources of socioeconomic conflict*
6.	Potential for Aggregations or Surrogates *Preference for resources that can be aggregated or surrogates*

For this Landscape Assessment, the Ecological Systems from the LANDFIRE Existing Vegetation Types Version 1.2.0 (LANDFIRE 2013) model were examined. One advantage to using LANDFIRE Existing Vegetation Type is that the vegetation types are already aggregated to vegetation macrogroups based on the National Vegetation Classification Standard protocol and consistent with BLM vegetation mapping standards (BLM IM 2013-111 [BLM 2013]). Using the National Vegetation Classification Standard macrogroups (hereafter "macrogroups"), ecological systems macrogoup CEs were identified to represent characteristic vegetation communities in the study area. One assumption for evaluating ecological systems macrogroups is that intact functioning vegetation systems are more resistant and resilient to stressors than non-intact systems and will protect a diverse collection of flora and fauna (Haufler et al. 1996; Poiani et al. 2000; Desmet and Cowling 2004), therefore, priority should be placed on conservation of intact systems. There are 22 ecological systems (i.e., LANDFIRE Existing Vegetation Types) that occur in the study area, of which 18 were considered for Ecological System CEs (**Appendix B**; Table B-3). For this LA, Ecological Systems were aggregated to the four dominant macrogroups of the study area to represent the Ecological Systems CEs. These four macrogroups represent 81.6% of the study area and include:

(1) montane and subalpine conifer forest (35.2% of ecoregion);
(2) basin grassland and shrubland (27.6% of ecoregion);
(3) piñon-juniper woodland (10.2% of ecoregion); and
(4) riparian and wetland systems (8.6% of ecoregion)

The distribution of these macrogroups in the study area is shown in Figure 2. Macrogroups were selected based on an objective of obtaining broad-scale representation of all ecologically important systems in the study area. Using broader vegetation macrogroups can reduce misclassifications that are typically made in finer vegetation classifications. In addition, the macrogroup level is more appropriate for projecting potential impacts of Change Agents (Rehfeldt et al. 2012). Systems not included in the recommended list of ecological systems macrogroups CEs include human disturbances (approximately 12.2% of the study area) and natural systems that do not occur throughout the study area and collectively represent only approximately 6.4% of the study area (e.g., Great Plains grassland, Madrean forest, and chaparral communities).

Twelve focal species or species assemblages are recommended as CEs for this LA. These species (or assemblages) were identified on the basis of the selection criteria described above (Table 3). Preliminary data evaluated to characterize these CEs include SWReGAP habitat suitability models and suitable habitat and range data provided by the BLM and state natural resource agencies. Maps illustrating the preliminary data on distribution of these focal wildlife species are provided in **Appendix C**.

Finally, six ecosystem function CEs and one "sites of conservation concern" CE were characterized (see Tables B-1 and B-2). Ecosystem function CEs defined include soil systems, aquatic systems, riparian areas, hydrologic systems, species richness/biodiversity and big game ranges. The sites of conservation concern CE is an assemblage of sites representing high biodiversity and sites of high ecological and/or cultural value. Maps illustrating sites of conservation concern, soil systems and soils of concern, and areas of high biodiversity are also shown in **Appendix C**. Maps shown in **Appendix C** are draft representations based on data available for this Phase I report. Additional data may be used to characterize the distribution of these CEs in Phase II if additional datasets are identified or criteria are modified.

2.2.3 Change Agents

Four primary CAs will be evaluated in this Landscape Assessment: (1) human development, (2) fire, (3) invasive species, and (4) climate change. Several other factors were considered in the development of CAs. These include grazing, recreation activities, and other agricultural practices (e.g., fallowing). The BLM interdisciplinary team recommended that these factors be included and characterized as human development activities.

2.2.4 Conceptual Models

Two types of conceptual models were developed in preparation of this Landscape Assessment. The first type of conceptual model consisted of a general ecosystem-based model to illustrate the roles of CAs and CEs and their interactions in the ecosystem. An example ecosystem-based conceptual model is provided in Figure 3. In addition, conceptual models for ecological CEs (ecological systems and focal species) were developed to highlight the major processes by which CAs may affect each ecological CE. These more detailed models also identify which mechanisms may be spatially addressed in this Landscape Assessment, as well as data gaps. An example CE-specific conceptual model is provided in Figure 4. Additional conceptual models for remaining ecological CEs are provided in **Appendix D**. Ecological conservation element accounts to inform and support the conceptual models will be provided in the Phase II Assessment Report.

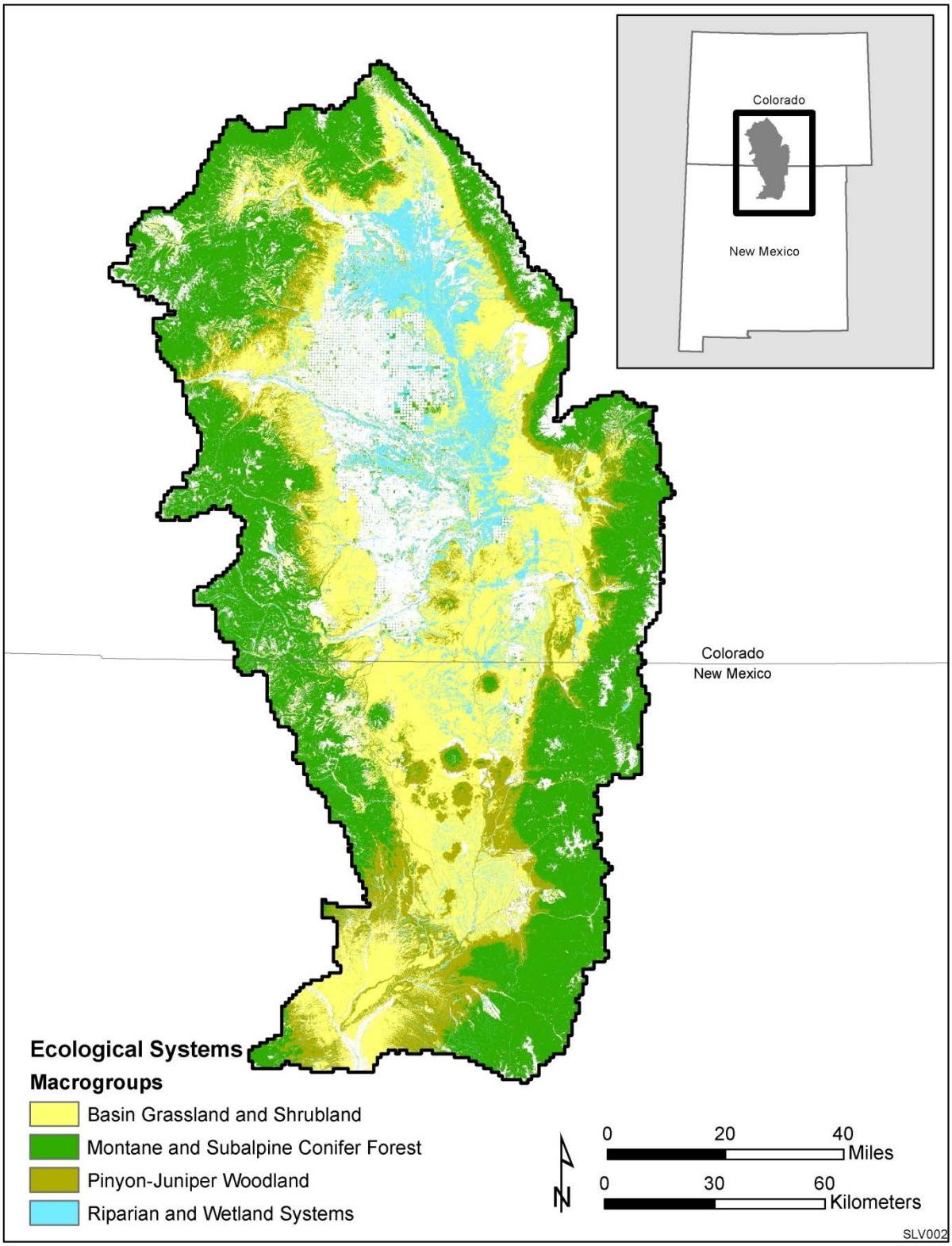

Figure 2. Distribution map of Ecological Systems Macrogroup Conservation Elements in the San Luis Valley-Taos Plateau Landscape Assessment study area.

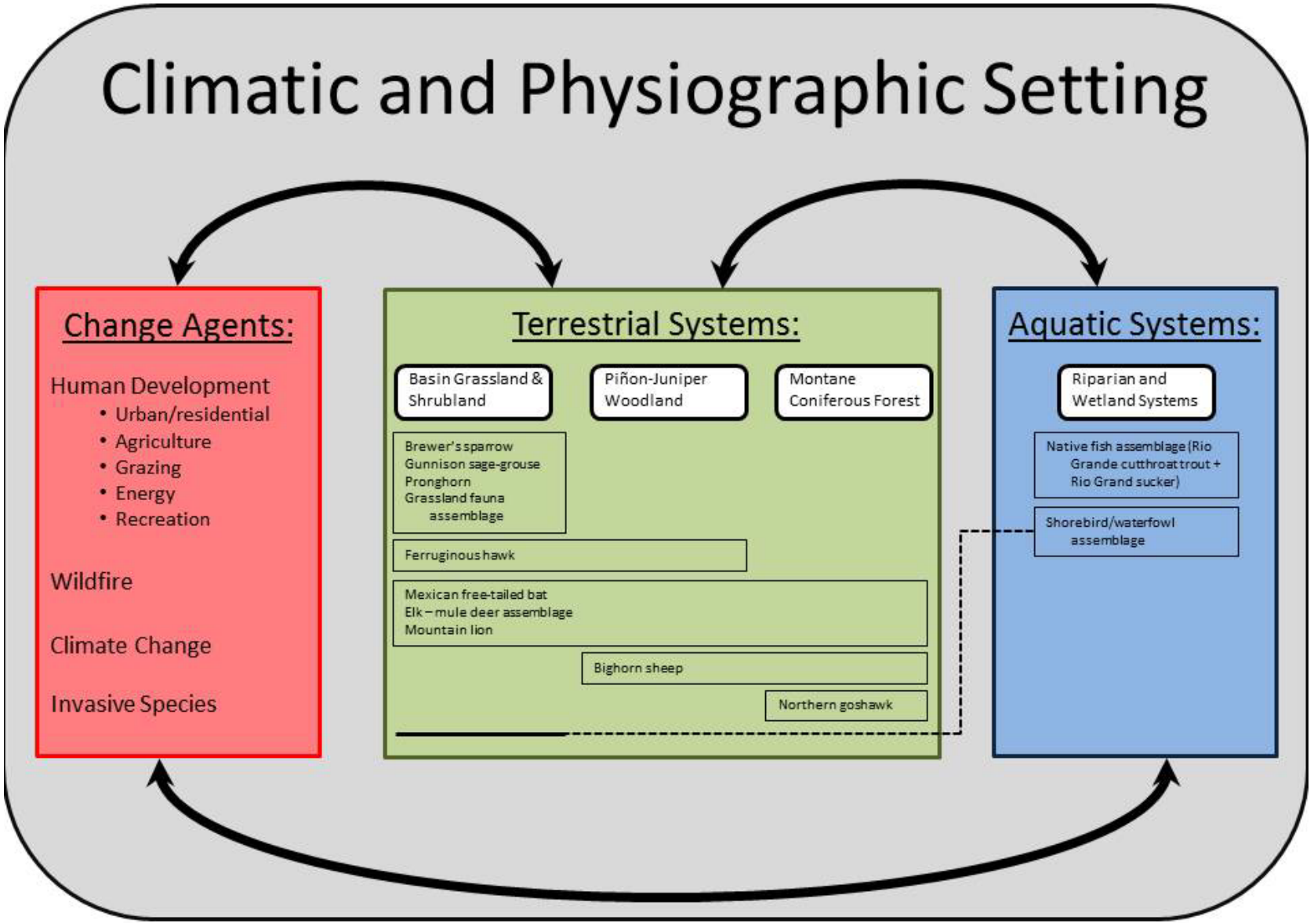

Figure 3. General ecosystem-based Conceptual Model for the San Luis Valley – Taos Plateau Level IV Ecoregion.

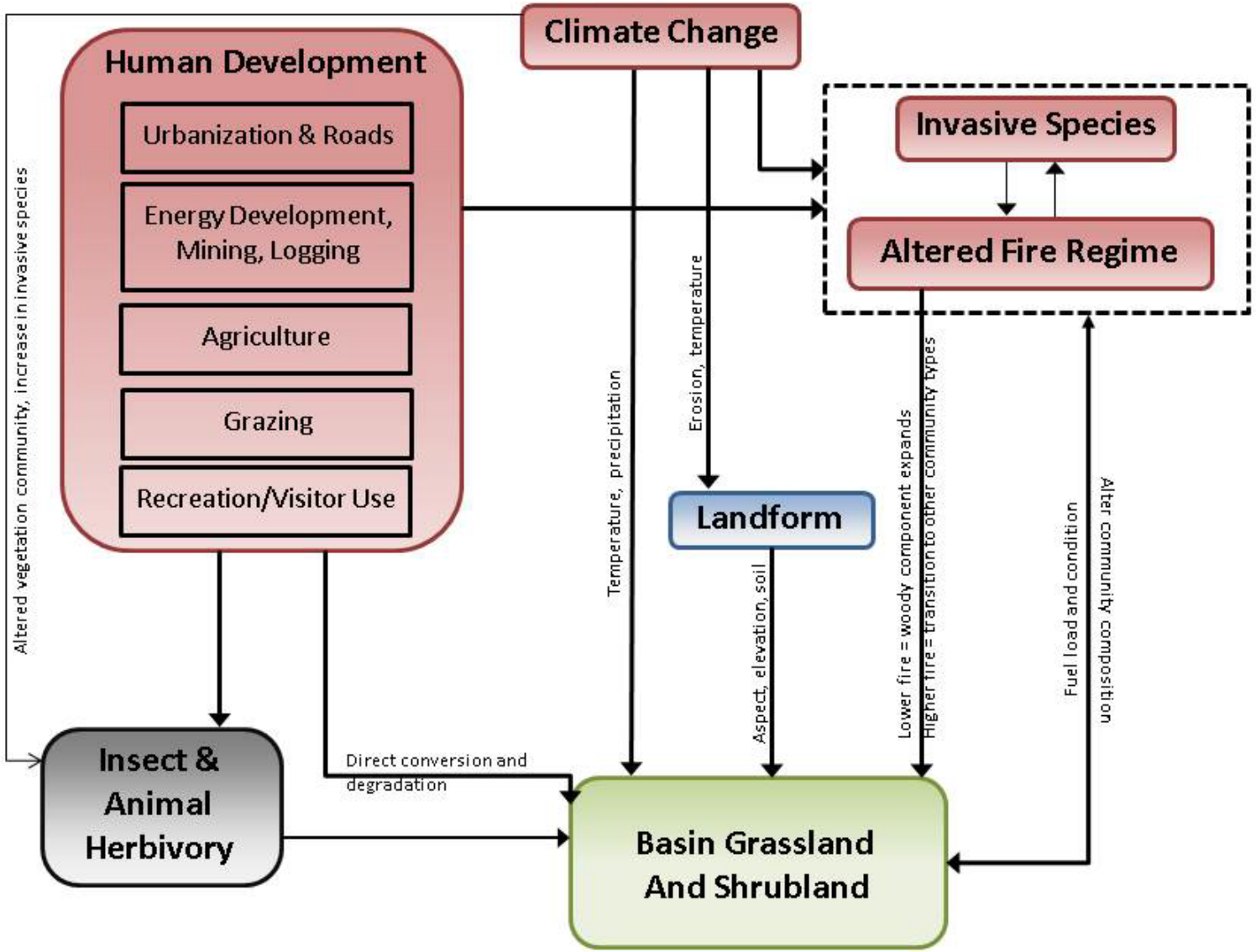

Figure 4. Conservation Element-specific conceptual model for the Basin Grassland and Shrubland Ecological System Conservation Element. Additional CE-specific conceptual models are provided in Appendix D.

3 FRAMEWORK AND METHOD FOR THE LANDSCAPE ASSESSMENT – PHASE II WORK PLAN

A generalized assessment approach was prepared (Figure 5) for addressing MQs for CAs and CEs. Beginning in November 2013, available spatial data were compiled for the project area and reviewed for quality and consistency. Spatial data were managed per the Data Management Protocols developed by the BLM National Operations Center. The presence of metadata for each dataset was verified and, if necessary, augmented to meet BLM data management specifications. The compilation, review, and evaluation of spatial datasets is ongoing; datasets will be finalized and delivered to the BLM and National Operations Center during Phase II.

For each ecological CE, background natural history information will be compiled from existing literature and a standardized key ecological attribute table (Table 4) will be used to summarize the attributes, indicators, or predictor variables, metrics or models, and data sources used to evaluate the status of each CE. The spatially-explicit evaluation of ecological attributes in the LA will depend on the availability of existing spatial data. Spatial data is not expected to be available for all ecological attributes; therefore, the primary purpose of identifying key ecological attributes is to inform and support species-specific conceptual models to understand the status of each species in the study area. Where possible, natural history information from existing Rapid Ecoregional Assessments (e.g., BLM 2012a, 2013), updated with more current or study area-specific information where available, will be used to populate conservation element accounts that will inform and support the development of conceptual models to understand ecological CE roles in the ecosystem and the processes that may influence their attributes.

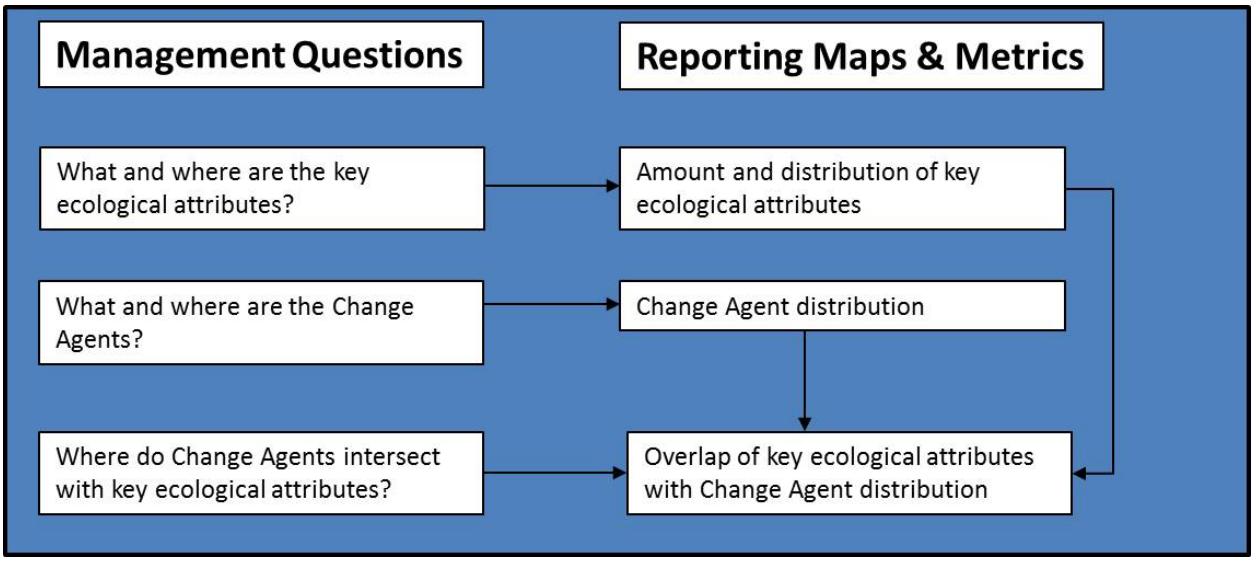

Figure 5. Generalized framework for assessing the status of Conservation Elements, Change Agents and addressing Management Questions. Reporting maps will include source data at native resolutions (e.g., 30 m or 90 m), and Change Agent models and overlap analyses will be summarized to the appropriate reporting unit (e.g., 1 km^2 reporting unit or Hydrologic Unit Code (HUC) boundary).

Ecological attributes are organized into three primary classes: (1) amount and distribution of habitat or biogeophysical variables; (2) landscape structure; and (3) landscape dynamics. Example ecological attributes for the Mexican free-tailed bat CE is provided in Table 5. It is important to note that not all of the CEs evaluated in this Landscape Assessment are ecological CEs; there are additional CEs for human resources and ecosystem function that may not have associated key ecological attributes.

Habitat distribution maps will be developed for each ecological CE (ecological systems and focal species). The habitat maps will be used to quantify the amount and spatial distribution of each CE under current conditions.

For each CE, relevant CAs will be evaluated based on the conceptual models, availability of the data, and relevance to the MQs. Overall CA models will be developed and used to evaluate the relative magnitude or risk of the CA across the entire study area. The CA models will be used to answer such MQs as "Where are areas with greatest long-term potential for climate change?"

Geospatial intersection analyses will be used to observe where CAs overlap with CE attributes. The map overlays will be provided as map products that will be used to evaluate the status of each CE. Such representations are useful for determining where on the landscape a particular CE may be vulnerable to a CA.

Table 4. Summary of key attributes, indicators, metrics, and data sources for assessing the status of each ecological Conservation Element. Note: not all Conservation Elements evaluated in this assessment are ecological Conservation Elements. (Adopted from the Southern Great Plains Rapid Ecoregional Assessment).

Attribute	Indicator	Metrics and/or Models	Data Source[1]
Amount and distribution	Habitat or biogeophysical variables (e.g., habitat distribution, soil, topography, vegetation distribution)	Area per analysis unit	BLM, CDOW, SWReGAP, LANDFIRE, NWI, NHD, NRCS
Landscape structure	Patch size, fragmentation	FRAGSTATS spatial statistics	Conservation Element distribution map
Landscape dynamics	Climate regime, disturbance regime, flow regime, food web, etc.	Current average temperature and precipitation, historical andrecent fire and other disturbances, stream flow and variability	Conservation Element distribution map, PRISM climate data, LANDFIRE

[1] BLM = Bureau of Land Management; CDOW = Colorado Division of Wildlife; SWReGAP = Southwestern Regional Gap Analysis Project; NWI = National Wetlands Inventory; NHD = National Hydrography Dataset; NRCS = Natural Resources Conservation Service; PRISM = Parameter-elevation Regressions on Independent Slopes Model.

Table 5. Example Ecological Attribute Table for the Mexican free-tailed bat. (Adopted from the Southern Great Plains Rapid Ecoregional Assessment).

Attribute	Indicator
Amount and distribution	Bat species current distribution and habitat distribution and acres.
Landscape structure	Size and spatial distribution of habitat; habitat patch size
Landscape dynamics	Habitat productivity (reproductive success), prey availability (food web), drought (impacts to water sources), roosting resources , predator dynamics

Reporting maps will be displayed at a scale of the entire study area (e.g., 1:1,250,000). Maps that depict source input data will be displayed using native resolution (e.g., 30 or 90 m raster pixels). Data derived from process models and other data derived from the LA will be summarized to one or more of the following reporting units prior to display in the final report: 1 km^2, 4 km^2, or 5^{th} level HUC boundary. The default reporting unit size selected for this LA is 1 km^2. Where possible, model output will be summarized to the 1 km^2 reporting units. However, in some cases where source input data are coarser than 1 km^2 (such as climate data) derived model output will be summarized to either 4 km^2 reporting units or 5^{th} level HUC boundaries, as appropriate.

One important model that will be developed to assist in the evaluation of CE status and trends is the Landscape Condition Model. This model builds on a growing body of existing methods that aim to characterize the relative ecological condition of landscapes (Theobald 2001, 2010; Leu et al. 2008; Comer and Hak 2012). This model will use regionally available spatial data to characterize ecological condition in the landscape as a function of the system's ability to support and maintain diverse and functional ecosystems and habitats expressed by the influence of human land uses in the landscape (Parrish et al. 2003). This model utilizes indicators of human modification (or absence thereof), which provide a measurable way to characterize the state of the environment.

Landscape condition modeling approaches involve the parameterization of indicators used to score the level of human influence in the ecosystem. This scoring system is quantified as a degree of human modification, *h*, which is often represented as a function of human modification intensity and the spatial influence of the human activity (Brown and Vivas 2005; Woolmer et al. 2008; Theobald 2013), but it is also regarded as a site impact score. The goal of these modeling efforts is to spatially characterize landscape condition along a relative continuum ranging from low human modification to high human modification.

Indicators and their scores were selected for the Landscape Condition Model based upon knowledge of their amount and distribution in the study area and understood level of impact to natural systems. Estimates of the degree of human modification, *h*, from previous modeling efforts (e.g., Brown and Vivas 2005; Woolmer et al. 2008; Theobald 2013) were used to

parameterize the site impact scores for each indicator in this model. The Landscape Condition Model for this Landscape Assessment consists of a site impact score of human land uses (ranging from 0.015 to 0.95), reflecting the presumed level of ecological stress or impact. Values close to 1.0 imply relatively little ecological impact from the land use. For example, recently logged areas are given a relatively high site impact score (0.7) compared to cultivated agriculture (0.35) or high-density urban development (0.015). This range of values (0 to 1) is similar to the range of landscape condition values modelled in previous landscape modeling efforts (e.g., Brown and Vivas 2005; Woolmer et al. 2008; Comer and Hak 2012; Theobald 2013).

Proximity to human modifications also affects ecological condition and can be spatially characterized in the landscape. Habitat quality and use by wildlife generally decreases with proximity to human developments. For example, Rowland et al. (2000) found there was a measurable decline in elk habitat use up to 1.8 km (1.1 mi) away from roadways. Other example effects of proximity to human development on wildlife and habitat are provided in Table 6. Most reported effects to wildlife have been observed within 4 km (2.5 mi) from human development (Table 6), although there are fewer reports of effects occurring at greater distances. For this reason, the Landscape Condition Model was parameterized with a maximum distance of influence of 4 km (Table 7). For comparison purposes, a maximum distance of 2 km was utilized in the Landscape Condition Model for the BLM's Mojave Basin and Range REA (BLM 2013a).

Table 6. Example effects of proximity to human developments on wildlife and habitat.

Ecological Attribute	Indicator	Distance (km)	Measured Response	Citation
Elk habitat	Distance to roads	1.8	Elk habitat use decreased up to 1.8 km from roadways	Rowland et al. (2000)
Elk habitat	Distance to human disturbances	3	Elk may avoid habitats within 3 km from human disturbances	Preisler et al. (2006), Naylor et al. (2009)
Elk habitat	Distance to roads	>4	Elk habitat use is greatest at distances >4 km away from roads	Montgomery et al. (2013)
Mule deer habitat	Distance from natural gas wells	3.7	Lower predicted probability of habitat use up to 3.7 km away from natural gas well developments	Sawyer et al. (2006)
Bighorn sheep observations	Distance to roads	>0.5	Bighorn sheep observations greatest at distances >500 m away from roads	Papouchis et al. (2001)

Table 7. Landscape Condition Model impacting factors, site impact scores, and distance decay scores for the San Luis Valley – Taos Plateau Landscape Assessment.[1]

Human Land Use or Impact Factor	Site Impact Score[2]	Presumed Relative Stress[3]	Distance of Influence (m)[4]	Function[5]
Transportation				
Dirt roads, OHV trails	0.75	Low	500	linear
Local roads	0.3	Medium	1000	logistic
Primary highways	0.015	High	4000	logistic
Urban and Industrial Development				
Low density development (including rural development)	0.6	Medium	1000	logistic
Medium density development	0.35	Medium	2000	logistic
High density development	0.015	High	4000	logistic
Communication Towers	0.6	Low	200	linear
Powerlines / transmission lines	0.6	Low	200	linear
Mines and oil/gas well pad locations	0.2	High	1000	logistic
Urban Polygons (BLM and U.S. Census Bureau)	0.015	High	4000	logistic
High Impervious Surfaces (NLCD Imperv > 40)	0.3	Medium	500	logistic
Urban Lights (NASA Night Lights > 200)	0.05	High	4000	logistic
Managed and Modified Land Cover				
Low agriculture and invasives (ruderal forest, recently burned, recently logged, etc)	0.7	Low	500	linear
Pasture (landcover)	0.7	Low	500	linear
Grazing allotment polygons	0.7	Low	500	linear
Introduced vegetation	0.6	Medium	500	linear
Cultivated agriculture	0.35	Medium	2000	linear

[1] Modeling approach and parameters are adopted from the Landscape Condition Model prepared for the Mojave Basin and Range Rapid Ecoregional Assessment (BLM 2013).

[2] Site Impact Score ranges between 0 and 1 and provides an indication of presumed ecological stress or impact. Lower values (closer to 0) indicate a greater site impact. Values adopted from previous modeling efforts by Brown and Vivas (2005), Woolmer et al. (2008), Comer and Hak (2012), and Theobald (2013).

[3] Presume relative stress indicates the level of influence the impacting factor has relative to other impacting factors. For example, high-density developments such as urban areas have the highest relative stress scores.

[4] Distance of influence is the minimum distance at which condition values approach 1.0. Values adopted from previous modeling efforts by Comer and Hak (2012), which described the methodology for completing the Landscape Condition Model for the BLM Mojave Basin and Range REA.

[5] Distance decay functions for impacting factors with low or medium relative levels of stress were evaluated with linear or logistic functions. Distance decay functions for impacting factors with high relative levels of stress were evaluated with logistic functions.

To characterize the influence of proximity to human modifications on ecological condition, each input data layer for the Landscape Condition Model was parameterized with a distance decay function that expressed a decreasing ecological impact with distance away from the mapped location of the feature (Table 7). This process involved the use of Euclidean Distance mapping tools and other geoprocesses (e.g., raster calculator) to spatially represent the functional relationship between condition value and distance away from the human land use indicator. Those features with a smaller distance of influence result in a map surface where the impact dissipates within a relatively short distance. Values for each layer approach 1.0 at the distance of influence, symbolizing an area of negligible impact. An example logistic functional relationship for major roadways is provided in Figure 6.

Integrating the mapped distance decay results for all impacting factors, the resulting Landscape Condition Model is a map surface indicating relative scores between 0 and 1. For this Landscape Assessment, the Landscape Condition Model will be developed using datasets for existing development (current Landscape Condition Model) and for a near-term (i.e., 2015-2030) future timeframe using spatial data that project potential future human development. A preliminary draft current Landscape Condition Model, which utilizes existing data and parameters presented in Table 7, has been developed for this LA. For purposes of this LA, the condition values will be summarized to values within 1 km^2 reporting units and may be categorized to enable status assessments. The preliminary draft current Landscape Condition Model, summarized to 1 km^2 reporting units, is shown in Figure 7.

A modified cultural landscape condition model will be developed to address the condition of cultural resources which can include various states of human development from native vegetation for early hunting and gathering areas, to early trail systems for navigating the region, to Hispano agricultural communities to the built environment, such as historically significant buildings and railroads. A similar process as described above using site impact scores and distance decay functions (that reflect stress on cultural resources rather than ecological resources) can be used to address the various levels of significance and condition/trend based on more recent human developments.

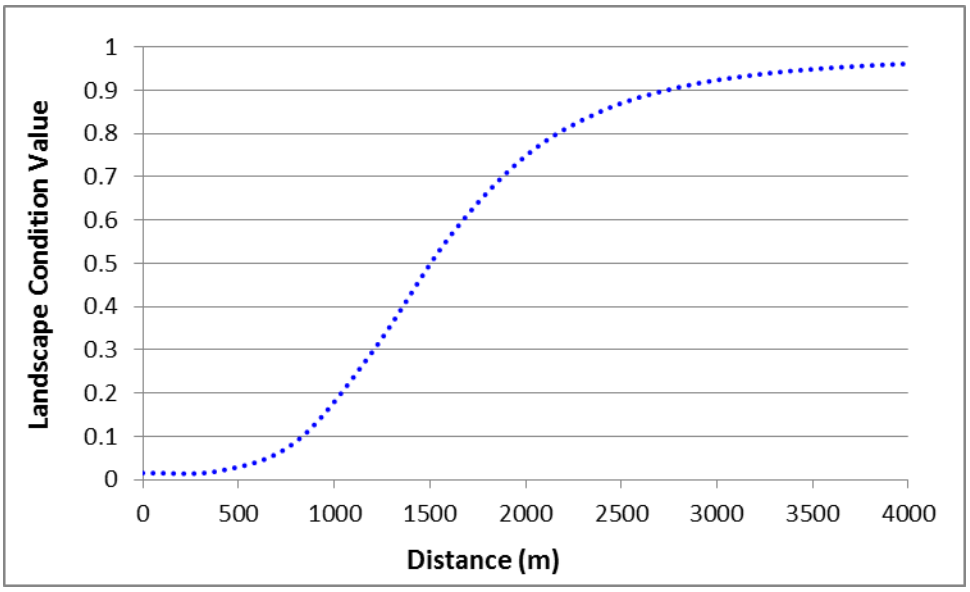

Figure 6. Logistic distance decay function for major roadways in the development of the Landscape Condition Model. Refer to Table 7 for model parameterization.

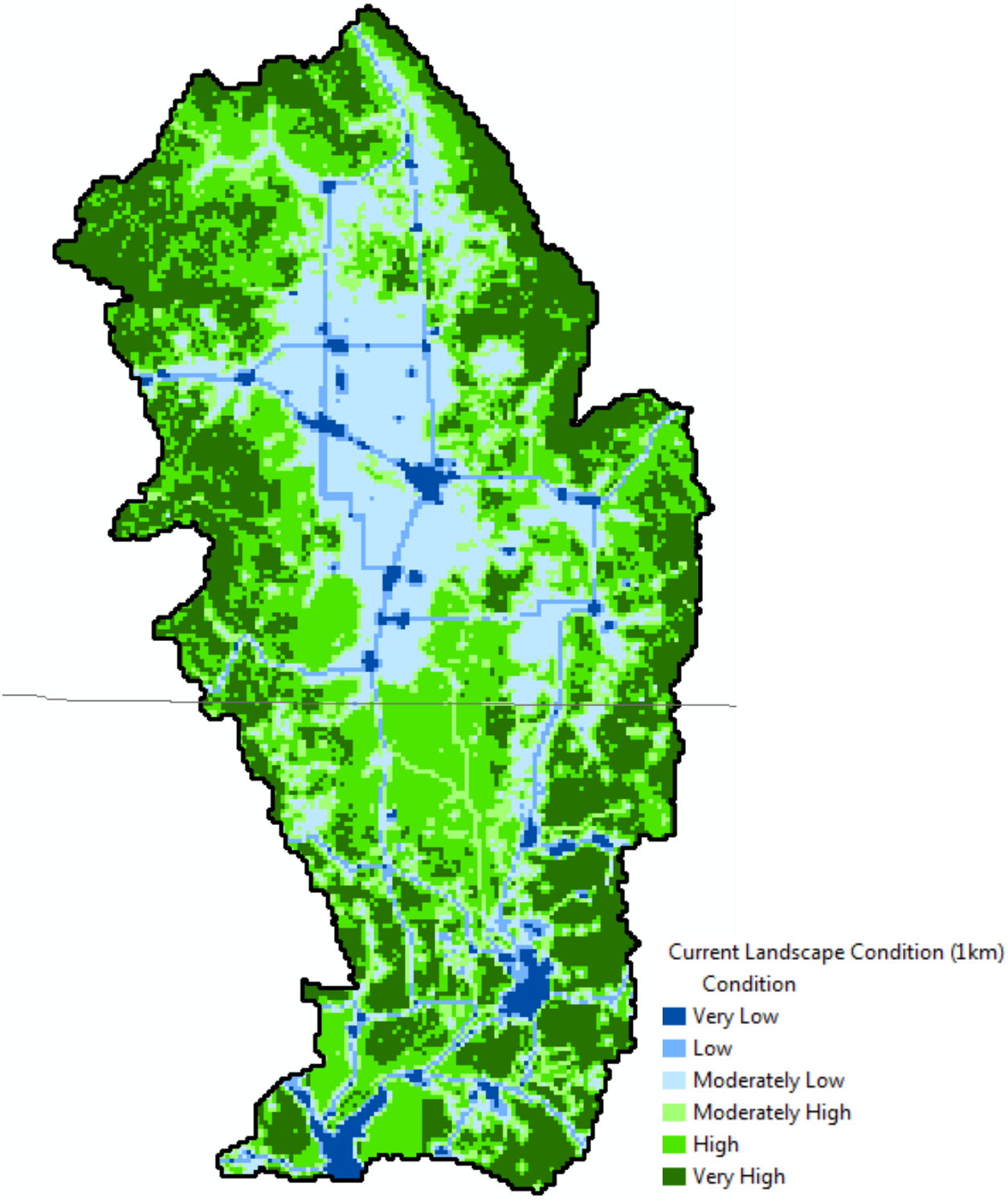

Figure 7. Draft current Landscape Condition Model for the San Luis Valley-Taos Plateau Level IV Landscape Assessment. Landscape condition is summarized to 1 km^2 reporting units and categorized from very low condition (dark blue) to very high condition (dark green).

4 LANDSCAPE ASSESSMENT WORKPLAN AND TIMELINES

This report serves as the transition between Phase I and Phase 2 of the Landscape Assessment. The report summarizes Phase I management questions, conservation elements, and change agents, and proposes the Phase II assessment methodology. This section provides an overview of the Landscape Assessment workplan, with timelines for remaining Phase II tasks. Table 8 shows the workflow and task timelines for this LA. Following completion of this Phase I Report, Phase II assessment tasks will begin, which include the following (Table 8):

1. Development of process models and approach;
2. Development and review of model output;
3. MQ, CE, CA Literature Review and spatial model output validation
4. Delivery of Draft LA report;
5. Presentation of Final LA report; and
6. Final data delivery to the BLM National Operations Center.

Webinars and other work sessions will be held at each of the Phase II steps to present work completed and receive feedback from BLM assessment management team and interdisciplinary team. Argonne expects that a near-final LA report will be available in January 2015, although the date of public release of the report may be postponed to better incorporate public comments.

Table 8. Timeline of Landscape Assessment tasks.

	2013		2014												2015
Landscape Assessment Workflow	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan
1. Preliminary workshops to scope CAs, CEs, MQs, and to discuss data needs															
2. Compilation and review of spatial data; interaction with BLM NOC on data management per Rapid Ecoregional Assessment Data Management Protocols															
3. Workshops to finalize CAs, CES, MQs, and data needs															
4. Development of preliminary assessment approach and conceptual models															
5. Phase I report complete															
6. Process models and approach developed and provided to BLM assessment management and interdisciplinary teams for review															
7. Model output and derived datasets available for BLM assessment management and interdisiplinary team review; present MQs, CEs, and CAs to public															
8. MQ, CE, CA Literature Review and Argonne Model Validation															
9. Draft Assessment Report															
9. Final Assessment Report															
10. Final datasets provide to BLM National Operations Center															

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APPENDIX A:

MANAGEMENT QUESTIONS

Table A-1. Recommended Management Questions for the San Luis Valley-Taos Plateau Landscape Assessment

	Management Question	Model / Assessment Type	Difficulty[1]
A. Soils and Air Quality			
MQA1	Where are Class I PSD areas?	Conservation Element Characterization	1
MQA2	Where are soils of concern (including coarse-textured, calcic, saline, sodic, and shallow soils; salt crusts, low water holding capacity soils, soils susceptible to wind erosion, and biological crusts)?	Conservation Element Characterization	2
MQA3	Where are soil systems of concern vulnerable to change agents (human development (including agriculture), climate change, fire, and invasive species)?	Conservation Element Sensitivity Assessment to Change Agents	2
MQA4	Where are communities and hydrologic basins susceptible and/or sensitive to fugitive dust and dust-on-snow events?	Conservation Element Sensitivity Sensitivity Assessment to Change Agents	2
MQA5	Where are CAA criteria pollutant source areas: PM10, PM2.5, O3, and visibility/regional haze?	Conservation Element Sensitivity Assessment to Change Agents	2
B. Hydrology			
MQB1	Where are and what are the conditions of hydrologic features including lotic and lentic features and artificial surface water bodies (e.g., perennial, intermittent, and ephemeral streams and springs; playas; wetlands; lakes; reservoirs; wells; ponds; livestock and wildlife watering tanks)?	Conservation Element Characterization	2
MQB2	Where are impaired waters and aquatic systems (such as those included in the EPA 303(d) and 305(b) lists)?	Conservation Element Characterization	2
MQB3	Where are mountain snow pack, rainfall, and alluvial aquifers and their recharge areas?	Conservation Element Characterization	2
MQB4	Where are hydrologic features vulnerable to change agents?	Conservation Element Sensitivity Assessment to Change Agents	2

	Management Question	Model / Assessment Type	Difficulty[1]
MQB5	Where are the areas that are susceptible to early snow melt due to dust on snow?	Conservation Element Characterization	3
MQB6	What are seasonal discharge maxima and minima for the Rio Grande, Closed Basin, and major tributaries at gaging stations?	Conservation Element Characterization	4
MQB7	Where are the confined and unconfined recharge or discharge areas?	Conservation Element Characterization	4
C. Ecological Systems Conservation Elements			
MQC1	Where are existing vegetative communities?	Conservation Element Characterization	1
MQC2	Where are vegetative communities vulnerable to change agents in the future?	Conservation Element Sensitivity Assessment to Change Agents	2
MQC3	Where are areas of highest carbon sequestration and what are conditions and trends of carbon sequestration in the study area?	Conservation Element Sensitivity Assessment to Change Agents	3
MQC4	What change agents have affected existing vegetation communities?	Conservation Element Sensitivity Assessment to Change Agents	4
MQC5	How will vegetation communities be altered (e.g. state-in-transition) according to the change agents?	Conservation Element Sensitivity Assessment to Change Agents	4
D. Focal Species Conservation Elements			
MQD1	What is the current distribution and status of available and suitable habitat for focal species Conservation Elements?	Conservation Element Characterization	1
MQD2	What is the distribution of current and potentially suitable habitat, if available, for aquatic, terrestrial, and riparian biodiversity sites, and special status species?	Conservation Element Characterization	2

	Management Question	Model / Assessment Type	Difficulty[1]
MQD3	Where are focal species vulnerable to change agents in the future?	Conservation Element Sensitivity Assessment to Change Agents	2
MQD4	Where are aquatic, terrestrial, and riparian biodiversity sites, and special status species vulnerable to change agents in the future?	Conservation Element Sensitivity Assessment to Change Agents	2
MQD5	What is the current distribution and status of big game crucial habitat and movement corridors (including bighorn sheep, elk, mule deer, and pronghorn)?	Conservation Element Characterization	2
E. Wildfire			
MQE1	Where has wildfire has occurred in the past 20 years?	Change Agent Characterization	2
MQE2	Where are the Fire Regime Condition Classes and what/where are historic fire regimes?	Change Agent Characterization	2
MQE3	Where is fire adverse to ecological communities, features, and resources of concern?	Conservation Element Sensitivity Assessment to Change Agents	2
MQE4	Where are the areas with potential to change from wildfire in the future?	Change Agent Characterization	3
MQE5	Where is fire likely to change in relation to climate change?	Change Agent – Change Agent Assessment	3
MQE6	Where might fire interfere with future human development (e.g., development risk)?	Change Agent – Change Agent Assessment	3
F. Invasive Species			
MQF1	Where are areas that invasive species occur or could potentially occur (e.g. tamarisk, Russian Olive, cheatgrass)?	Change Agent Characterization	2

	Management Question	Model / Assessment Type	Difficulty[1]
G. Human Development and Resource Use			
MQG1	Where are linear recreation features such as OHV roads and trails?	Change Agent Characterization	1
MQG2	Where are Special Recreation Permits (SRPs) and permitted uses such as grazing and wood gathering?	Conservation Element and Change Agent Characterization	1
MQG3	Where are the locations of irrigated lands	Conservation Element Sensitivity Assessment to Change Agents	1
MQG4	Where are high-use recreation areas, (High Intensity Recreation Areas (HIRA's) SRMAs, National Parks, etc)?	Change Agent Characterization	2
MQG5	Where are areas of current and planned development (e.g., plans of operation, urban growth, wildland-urban interface, energy development, mining, transmission corridors, governmental planning)?	Change Agent Characterization	2
MQG6	Where are federally owned water rights that are adjudicated for wildlife and irrigation?	Conservation Element Characterization	2
MQG7	Where are areas of potential future development (e.g., under lease), including renewable energy sites and transmission corridors?	Change Agent Characterization	3
MQG8	Where are areas of potential human land use change (e.g., agricultural fallowing)?	Change Agent Characterization	3
MQG9	What are the conditions and locations of surface and groundwater rights?	Conservation Element Characterization	4
MQG10	Where are current conservation efforts prohibiting human development?	Change Agent Characterization	4
MQG11	Where is the acoustic environment affected by human development?	Conservation Element Characterization	4
H. Climate Change			
MQH1	Where are areas with greatest long-term potential for climate change?	Change Agent Characterization	2

	Management Question	Model / Assessment Type	Difficulty[1]
MQH2	Where have conservation elements experienced climate change and where are conservation elements vulnerable to future climate change?	Conservation Element Sensitivity Assessment to Change Agents	3
I. Human and Cultural Elements			
MQI1	Where do areas of cultural resource management and protection occur (National Monuments, ACECs, National Historic Landmarks, World Heritage Areas, Los Caminos Scenic and Historic Byway, etc)?	Conservation Element Characterization	1
MQI2	Where are known historic properties, traditional cultural properties, and sacred sites and landscapes?	Conservation Element Characterization	2
MQI3	What are the traditional cultural land use patterns?	Conservation Element Characterization	2
MQI4	Where are known historic properties, traditional cultural properties, and sacred sites vulnerable to change agents	Conservation Element Sensitivity Assessment to Change Agents	2
MQI5	Where are high potential areas or high density areas for historic properties that address the highest priority research goals?	Conservation Element Characterization	3
MQI6	Where is cultural landscape connectivity vulnerable to change agents (human development, fire, invasive species, climate change)	Conservation Element Sensitivity Assessment to Change Agents	3
MQI7	Where are sensitive socioeconomic populations and how are they affected by change agents?	Conservation Element Characterization	3
J. Landscape Condition			
MQL1	What is current and future predicted landscape condition?	Terrestrial Landscape Condition Model	3
K. Visual Resources			
MQK1	Where are specially designated/managed areas with associated visual resource considerations/mandates/prescriptions?	Conservation Element Characterization	1
MQK2	Where are visual resource inventoried areas with high scenic quality, public sensitivity for scenic quality, and distance zones where people commonly view the	Conservation Element Characterization	1

	Management Question	Model / Assessment Type	Difficulty[1]
	landscape?		
MQK3	Where are night sky values and where are they vulnerable to change agents (NPS inventory)?	Conservation Element Sensitivity Assessment to Change Agents	2
MQK4	Where are scarce scenic quality values and where are they vulnerable to change agents?	Conservation Element Sensitivity Assessment to Change Agents	2
MQK5	Where are current Visual Resource Inventory (VRI) classes and where are they vulnerable to change agents?	Conservation Element Sensitivity Assessment to Change Agents	3
MQK6	Where are current Visual Resource Management (VRM) classes and where are they vulnerable to change agents?	Conservation Element Sensitivity Assessment to Change Agents	3

[1] Difficulty was ranked based on the level of complexity needed to assess the management question, as follows: 1 = Simple. Source data may be easy to obtain and comprehensive throughout the study area, little processing of the source data may be needed before evaluation, and the assessment does not involve any modeling; 2 = Moderate. Source data may be difficult to obtain or may not be comprehensive throughout the study area, source data may need to be processed before evaluation, or the assessment may involve the some minor geoprocessing or modeling; 3 = Difficult. Source data may be difficult to obtain or may not be comprehensive throughout the study area, source data may need to be processed before evaluation, and the assessment may involve complex geoprocessing or modeling or may be out of scope; 4 = Reconsider. MQs that may be deleted or may need further discussion on the basis of being out of scope or lack of data.

APPENDIX B:

CONSERVATION ELEMENTS

Table B-1. Recommended List of Conservation Elements for the Landscape Assessment

A. Ecological Systems (aggregated by macrogroup)[1]		
	MACROGROUP	**Percent of Ecoregion**
A.1	Montane and Subalpine Conifer Forest	35.2%
A.2	Basin Grassland and Shrubland	27.6%
A.3	Piñon-Juniper Woodland	10.2%
A.4	Riparian and Wetland Systems (playa, marsh, open water, wetland)	8.6%
B. Focal Species		
B.1	Native fish assemblage (Rio Grande cutthroat trout and Rio Grande sucker)	
B.2	Brewer's sparrow (representative migratory bird species)	
B.3	Ferruginous hawk	
B.4	Northern goshawk (representative montane species)	
B.5	Gunnison sage-grouse	
B.6	Waterfowl/shorebird assemblage	
B.7	Mexican free-tailed bat (representative bat species)	
B.8	Bighorn sheep	
B.9	Grassland fauna assemblage (burrowing owl, mountain plover, and Gunnison's prairie dog)	
B.10	Mountain lion	
B.11	Pronghorn	
B.12	Elk-mule deer assemblage	
C. Sites of Conservation Concern		
C.1	Sites of Conservation Concern Assemblage (see Table B-2)	
D. Ecosystem Functions		
D.1	Soil systems of concern (including coarse-textured, calcic, saline, sodic, and shallow soils; salt crusts; low water holding capacity soils; soils susceptible to wind erosion; and biological soil crusts)	
D.2	Aquatic systems (including streams, lake, ponds, reservoirs, wetlands/playas, ponds livestock and wildlife watering tanks, springs, wells, diversions, ditches, canals and other artificial water bodies)	
D.3	Riparian areas (includes data from various sources and scales, such as CPW, NWI, and species-specific data on willow and cottonwood, if available)	
D.4	Hydrologic systems (includes snowpack level, runoff [timing], rainfall patterns, high quality waters, impaired waters, ephemeral drainages, groundwater and aquifers related to quantity (recharge and discharge) and quality (contaminant transport and groundwater pollution)	
D.5	Species Richness / Biodiversity Assemblage (rare/at risk species summed by Natural Resources Conservation Service (NRCS) HUC10 hydrologic reporting unit)	

D.6	Big game ranges (including summer & winter range, fawning, lambing, and calving areas, and migration corridors)
E. Cultural and Historic Conservation Elements	
	Cultural historic CEs will be determined through separate Cultural Landscape Assessment effort.

[1] Macrogroups determined from LandFire EVT associations and compliant with BLM vegetation mapping standards (IM 2013-111 [BLM 2013b] : http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2013/im_2013-111_the_national.html)

Table B-2. Sites of Conservation Concern

	Sites of High Biodiversity
1	TNC portfolio sites
2	Important bird areas (Audubon)
3	Intermountain West Joint Venture (IWJV) Key Sites
4	Areas recognized by State Wildlife Action Plans
	Sites of High Ecological and/or Cultural Value
5	Historic and Nationally Designated Historic and Scenic Trails
6	Wilderness Areas
7	Wilderness Study Areas
8	National Wildlife Refuges
9	National Monuments
10	National and State Parks
11	Areas of Critical Environmental Concern (ACECs)
12	Forest Service Research Natural Areas
13	State Wildlife Management Areas
14	Wild and Scenic Rivers
15	Designated Recreation Management Areas (including SRMAs)
16	National Historic Landmarks and National Natural Landmarks
17	National Heritage Areas
18	Designated and proposed critical habitat sites for ESA-listed species
19	Rio Grande Natural Area
20	FWS Focal Areas
21	Outstanding National Resource Waters in New Mexico
22	Class I Prevention of Significant Deterioration (PSD) areas

Table B-3. Initial List of Proposed Conservation Elements

Conservation Element			Selection Prioritization and Landscape Relationship	Recommended Action
A. Ecological Systems Conservation Elements				
	System Name[1]	**Percent of Ecoregion (%)**		
A.1	Inter-Mountain Basins Semi-Desert Shrub Steppe	14.80%	Basin system, dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible solar impact, possible aggregation system. May be affected by all change agents.	*Consider using LandFire EVT vegetation classes to represent the following Ecological System macrogroups within the study area: (1) montane and subalpine conifer forest; (2) basin grassland and shrubland; (3) piñon-juniper woodland; and (4) riparian and wetland systems.*
A.2	Southern Rocky Mountain Piñon-Juniper Woodland	9.70%	Dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible solar impact, possible aggregation. May be affected by all change agents.	
A.3	Inter-Mountain Basins Big Sagebrush Shrubland	9.40%	Basin system, dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible solar impact, possible aggregation system. May be affected by all change agents.	
A.4	Rocky Mountain Ponderosa Pine Woodland	6.50%	Dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible aggregation system, may be affected by all change agents	
A.5	Inter-Mountain Basins Greasewood Flat	5.10%	Characteristic vegetation community of unique habitats (alkali-saline wetlands). Could be aggregated with wetland macrogroup. May be affected by all change agents.	
A.6	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	4.80%	Dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible aggregation system, may be affected by all change agents.	
A.7	Rocky Mountain Aspen Forest and Woodland	4.60%	Dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible aggregation system, may be affected by all change agents.	

[1] Based on National Vegetation Classification macrogoup using LANDFIRE Existing Vegetation Types.

Conservation Element			Selection Prioritization and Landscape Relationship	Recommended Action
A.8	Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland	4.00%	Dominant system in region (broad-scale habitat surrogate for many plant and animal species), possible aggregation system, may be affected by all change agents.	
A.9	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	3.70%	Not a dominant system in region; however, possible aggregation system with other dominant systems. May be affected by all change agents.	
A.10	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	2.90%	Not a dominant system in region; however, possible aggregation system with other dominant systems. May be affected by all change agents.	
A.11	Inter-Mountain Basins Semi-Desert Grassland	1.90%	Basin system. Not a dominant system in region; however, possible solar impact, and possible aggregation system with other dominant systems. May be affected by all change agents.	
A.12	Rocky Mountain Alpine-Montane Wet Meadow	1.40%	Not a dominant system in region. Characteristic vegetation community of unique habitats (wet meadow). Could be aggregated with wetland macrogroup. May be affected by all change agents.	
A.13	Southern Rocky Mountain Montane-Subalpine Grassland	1.20%	Not a dominant system in region. System represents a unique habitat (playa). May be affected by all change agents.	
A.14	Rocky Mountain Subalpine Mesic Meadow	0.70%	Not a dominant system in region. Characteristic vegetation community of unique habitats (wet meadow). Could be aggregated with wetland macrogroup. May be affected by all change agents.	
A.15	Rocky Mountain Cliff and Canyon	0.50%	Not a dominant system in region. System represents a unique habitat (cliff and canyon). May be affected by all change agents.	
A.16	Rocky Mountain Lower Montane Riparian Woodland and Shrubland	0.30%	Not a dominant system in region. System represents a unique habitat (riparian). Could be aggregated with wetland macrogroup. May be affected by all change agents.	

Conservation Element			Selection Prioritization and Landscape Relationship	Recommended Action
A.17	Inter-Mountain Basins Playa	0.20%	Not a dominant system in region. System represents a unique habitat (playa). Could be aggregated with wetland macrogroup. May be affected by all change agents.	
A.18	North American Arid West Emergent Marsh	0.1%	Not a dominant system in region. System represents a unique habitat (emergent marsh). Could be aggregated with wetland macrogroup. May be affected by all change agents.	
B. Focal Species Conservation Elements				
	Plants			
B.1	Rock loving neoparrya		These 3 plants are special status plant species with management implications. They occupy a small/narrow distribution in the region and have low habitat heterogeneity. They may be affected by solar development and by all change agents.	*Recommend removing these plants from species CE on the basis of small home range size and low habitat heterogeneity. An assemblage (species richness/biodiversity) is recommended as a surrogate for special status plants.*
B.2	Grama grass cactus			
B.3	*Astragalus ripley*			
	Invertebrates			
B.4	Macroinvertebrates		The invertebrates listed here have unique/important ecological functions. Distribution and habitat heterogeneity in the region are limited or unknown. Not generally considered to be landscape species. May be affected by solar development and by all change agents.	*Recommend removing these invertebrate macrogroups from species CE. Little is known on home range size, habitat heterogeneity, and distribution in the region. An assemblage (species richness/biodiversity) is recommended as a surrogate for invertebrates.*
B.5	"Pollinators"			
	Fish			
B.6	Native Fishes		Example species: **Rio Grande Cutthroat Trout.** Characteristic managed species of region watersheds. Special status species. Occurs in both Field Offices. Maybe affected by all change agents.	*Recommend a native fish assemblage (RGCT, RG Sucker)*

	Conservation Element	Selection Prioritization and Landscape Relationship	Recommended Action
	Amphibians		
B.7	Northern leopard frog	Both amphibian species listed here have management implications as special status species. They are characterized by relatively small distribution and habitat heterogeneity in the region. May be affected by all change agents.	*Recommend removing these amphibians from species CE on the basis of small home range size and low habitat heterogeneity. An assemblage (species richness/biodiversity) is recommended as a surrogate for special status amphibian species.*
B.8	Boreal Toad		
	Birds		
B.9	"Migratory birds"	Example species: **Brewer's sparrow** Characteristic managed migratory songbird species of grasslands. Special status species. Occurs in both Field Offices. Maybe affected by all change agents.	*Retain Brewer's sparrow as species CE representative of migratory songbirds.*
B.10	Mountain plover	Grassland inhabiting shorebird with management implications - special status species. May occur in both Field Offices. Moderate habitat distribution and habitat heterogeneity. May be a surrogate for other species. May be affected by solar development and other change agents.	*Recommend aggregating mountain plover in a grassland fauna assemblage with burrowing owl and Gunnison's prairie dog.*
B.11	Sandhill Crane	These species are either special status species or species of concern. They occur in both Field Offices but they do not have large habitat distributions or habitat heterogeneity. All of these species are considered to be aquatic shorebirds/rails or riparian migratory songbirds.	*Recommend a shorebird/waterfowl assemblage CE.* *Riparian habitat for SWWF and YBC can be addressed through fine-scale assessment of riparian/wetlands. An assemblage (species richness/biodiversity) is recommended as a surrogate for special status bird species.*
B.12	Snowy Plover, White-faced ibis, phalarope		
B.13	Southwestern willow flycatcher		
B.14	Yellow-billed cuckoo		

Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
B.15	Golden eagle	Raptor species of conservation interest. Broad scale habitat distribution and high habitat heterogeneity. May occur in a variety of habitats, including shrublands. Possible solar impacts and impacts from all change agents.	*Recommend removing golden eagle from CE list. Broad distribution and greater habitat heterogeneity compared to other raptors. Use ferruginous hawk as surrogate representative for raptors.*
B.16	Goshawk	Raptor species of conservation interest. Habitats are more restricted ot mature coniferous forests. Characteristic forest bird species. Occurs in both Field Offices but distribution reflects the distribution of montane forests. May be affected by all change agents.	*Retain goshawk as species CE for its unique habitat (forest bird species).*
B.17	Peregrine falcon	These raptor species occupy moderately large home ranges and have similar habitat heterogeneity. Similar habitats as golden eagle.	*Recommend removing pairie falcon and peregrine falcon from species CE on basis of similar habitat distribution (redundant) as other raptors.*
B.18	Prairie falcon		*Recommend retaining ferruginous hawk as species CE. Similar distribution and habitat as other raptors. However, ferruginous hawk may be more closely associated with shrublands on the SEZs.*
B.19	Ferruginous hawk		
B.19	Burrowing owl	Species with management implications - special status species. Characteristic raptor species of basin grasslands and shrublands. Widely distributed throughout the region - occurs in both Field Offices. May be affected by solar development and other change agents.	*Recommend aggregating burrowing owl in a grassland fauna assemblage with mountain plover and Gunnison's prairie dog.*

Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
B.20	Gunnison sage grouse	Species with management implications - special status species. Characteristic species of sagebrush communities. Small habitat distribution and heterogeneity. Most habitat is known from SLV FO.	*Recommend including Gunnison sage grouse as individual CE.*
	Mammals		
B.21	Bighorn sheep	Big game species with management implications. Somewhat vulnerable to human disturbance. Occurs in both Field Offices. Moderate habitat heterogeneity - generally inhabits montane regions and riparian corridors. Relatively moderate socioeconomic significance. Potential solar impacts. May be affected by all change agents.	*Include as unique species CE on basis of landscape species with management implications and vulnerability to human disturbances. Habitat distribution is not similar to any other species.*
B.22	Elk	Big game species with management implications (hunting). High habitat heterogeneity (generalist) and large home range size. Low vulnerability to human disturbance. Occurs in both Field Offices. Potential solar impacts. May be affected by all change agents.	*Recommend aggregating elk in an elk-mule deer assemblage ("big game assemblage").*
B.23	Mountain lion	Wildlife species with management implications. Representative of top predator (unique ecological function). Large home range size and high habitat heterogeneity. Moderate vulnerability to human disturbances.Relatively high socioeconomic significance. Occurs in both Field Offices. May be affected by all change agents.	*Recommend including mountain lion as individual CE.*

Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
B.24	Mule deer	Big game species with management implications (hunting). High habitat heterogeneity (generalist) and large home range size. Low vulnerability to human disturbance. Occurs in both Field Offices. Potential solar impacts. May be affected by all change agents.	*Recommend aggregating in an elk-mule deer assemblage ("big game assemblage").*
B.25	Pronghorn	Big game species with management implications (hunting). High habitat heterogeneity (generalist) and large home range size. Relatively low vulnerability to human disturbance. Occurs in both Field Offices. Potential solar impacts. May be affected by all change agents.	*Recommend including pronghorn as individual CE.*
B.26	Canada lynx	Special status wildlife species. Representative of top predator (unique ecological function). Moderate home range size, low habitat heterogeneity - generally only occurs in montane coniferous habitats. High vulnerability to human disturbances. Relatively moderate socioeconomic significance. Primarily only known from the SLV Field Office (no suitable habitat in TP FO). May be affected by all change agents, particularly climate change.	*Recommend removal from list of focal species CE on basis of low habitat heterogenity, isolated or peripheral distribution in the region, and special status (ESA-listed). May be represented by biodiversity/species richness assemblage dataset(s).*
B.27	River Otter	Wildlife species with special management implications. Not a special status species. Small distribution and habitat heterogeneity in the region. Occurs in riparian and riverine habitats. Moderate vulnerability to human disturbances. Not likely to be affected by solar development. May be affected by all change agents.	*Recommend removing river otter from species CE. Low habitat distribution and heterogeneity. An assemblage (species richness/biodiversity) may be used as a surrogate for special status mammal species.*

Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
B.28	Gunnison's prairie dog	Wildlife with management implications - special status species. Moderate distribution and habitat heterogeneity in the region. Characteristic fauna species of grasslands/shrublands. May be affected by solar development. May be affected by all change agents.	*Recommend aggregating Gunnison's prairie dog in a grassland fauna assemblage with mountain plover and burrowing owl.*
B.29	New Mexico meadow jumping mouse (ESA-PE)	Special status wildlife species. Small distribution and habitat heterogeneity in the region. May be affected by all change agents.	*Recommend removing New Mexico meadow jumping mouse from species CE. Small home range size, habitat distribution, and heterogeneity. An assemblage (species richness/biodiverstiy) may be used as surrogate for special status mammal species.*
B.30	Swift Fox (SS)	Special status wildlife species. Small distribution and habitat heterogeneity in the region. May be affected by all change agents, particularly climate change.	*Recommend removing swift fox from species CE. Low habitat distribution and heterogenity. Other species (Gunnison's prairie dog) may better represent grassland/shrubland mammalian fauna. An assemblage (species richness/biodiversity) may be used as a surrogate for special status mammal species.*
B.31	Mexican Free-tailed bat	All bats forage and roost in the region. There is considerable overlap in bat habitat and distribution among species. With exception of spotted bat, all species have large distributions, home ranges, and habitat heterogeneity. Bats may be similarly affected by solar development, particularly to foraging habitats (shrublands). All bats may be affected by all change agents.	*Recommend Mexican free-tailed bat as the surrogate bat species.* *With exception of spotted bat, all bats exhibit similar distribution and habitat heterogeneity in the region. An assemblage (species richness/biodiversity) may be used as a surrogate for all other special status bat species.*
B.32	Big free-tailed bat		
B.33	Western small-footed myotis bat		
B.34	Townsend's big-eared bat		
B.35	Fringed myotis		
B.36	Spotted bat		

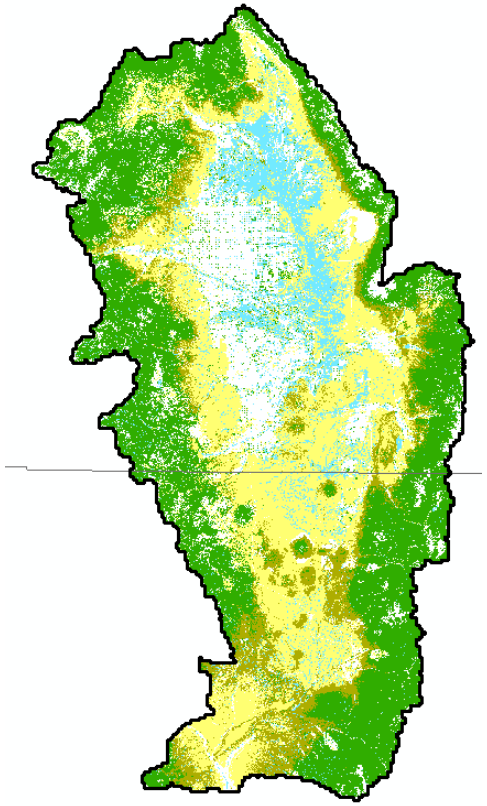
Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
C. Sites of Conservation Concern Conservation Elements			
C.1	Sites of conservation concern (see Table B-2 for list of sites)		*Retain as CE. Combine all sites of conservation concern into one aggregate dataset.*
D. Ecosystem Functions Conservation Elements			
D.1	Biological crusts		*If possible, recommend combining with soils of concern (D.2) below.*
D.2	Soil systems of concern including saline, sodic, calcic, shallow - low water holding capacity soils and soils susceptible to wind and water erosion		*Retain as CE.*
D.3	Surface hydrology (streams, lake, ponds, reservoirs, snowpack level, runoff (timing), rainfall patterns,, wetlands/playas, ponds livestock and wildlife watering tanks, springs, wells, diversions, ditches, canals and other artificial water bodies)		*Combine with playa wetlands to form CE "Aquatic systems"*
D.4	Big game winter range and migration corridors		*Retain as CE, consider moving to Site of Conservation Concern CE.*
D.5	Riparian areas		*Retain as CE. Use as habitat surrogate for other resources. Include data from various sources/scales: NWI, CPW, species-specific data (cottonwood-willow).*
D.6	High quality and impaired waters		*Recommend retaining as an aggregated CE under hydrologic systems.*
D.7	Groundwater aquifers related to quantity (recharge and discharge) and quality (contaminant transport and groundwater pollution)		*Recommend retaining as an aggregated CE under hydrologic systems.*

Conservation Element		Selection Prioritization and Landscape Relationship	Recommended Action
D.8	Night sky a high priority for the NPS in the study area	Possible surrogates using sites of conservation concern (NPS properties, ACECs, WA).	*Recommend removing this from CE list. Night sky values can be indirectly addressed through evaluation of Sites of Conservation Concern (which include all NPS properties).*
D.9	Playa Wetlands		*Combine with surface hydrology to form CE "Aquatic systems" aggregate.*
D.10	Migratory bird flyways – shorebirds, sand-hill crane, bald & golden eagle, raptors 3		*Recommend removing this from CE list on basis of redundancy with other CEs. Broad-scale evaluation of species habitats will be evaluated in focal species assessments. Other important habitats for birds will be addressed through Sites of Conservation Concern (includes Audubon Important Bird Sites and others).*
E. Cultural and Historic Conservation Elements			
E.1	Traditional Cultural Properties: mountains and highpoints		*An assemblage of specific cultural CEs is being identified through a separate Cultural Landscape Assessment process that will be incorporating input from tribes, the general public, and several state and federal agencies.*
E.2	Traditional Cultural Properties: water		
E.3	Traditional Cultural Landscapes		
E.4	Traditional Resource Collection Areas		
E.5	Trails, Passes and Travel Corridors		
E.6	Culturally Modified Trees/Woodlands		
E.7	Hispano Land Grants and Communal Use Patterns		
E.8	Homesteading and Post WWII properties		
E.9	Historic Mining properties		
E.10	Paleoindian Sites		
E.11	Paleontology		
E.12	Eligible Historic Properties		

APPENDIX C:

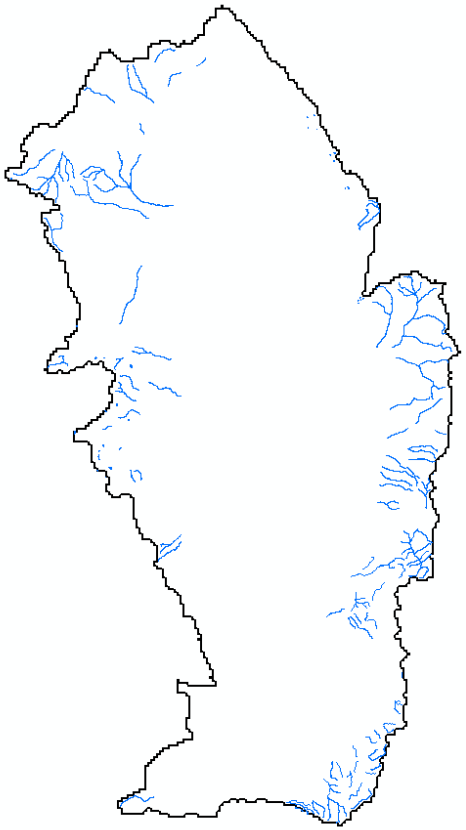
CONSERVATION ELEMENT DISTRIBUTION MAPS

Focal Species Conservation Elements



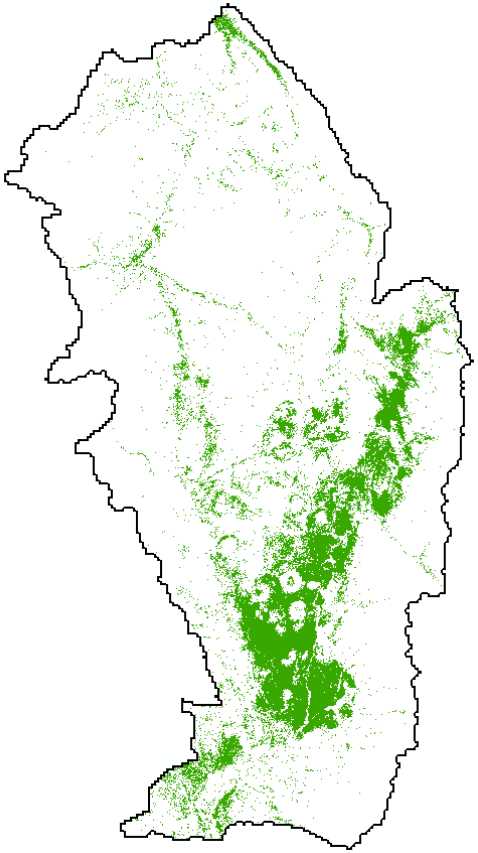
Ecological Systems
(refer to Figure 2 in the text)

Data[1]: LANDFIRE Existing Vegetation Types aggregated to macrogroups



Native Fish Assemblage

Data[1]: fish distribution data provided by BLM and Colorado Division of Wildlife

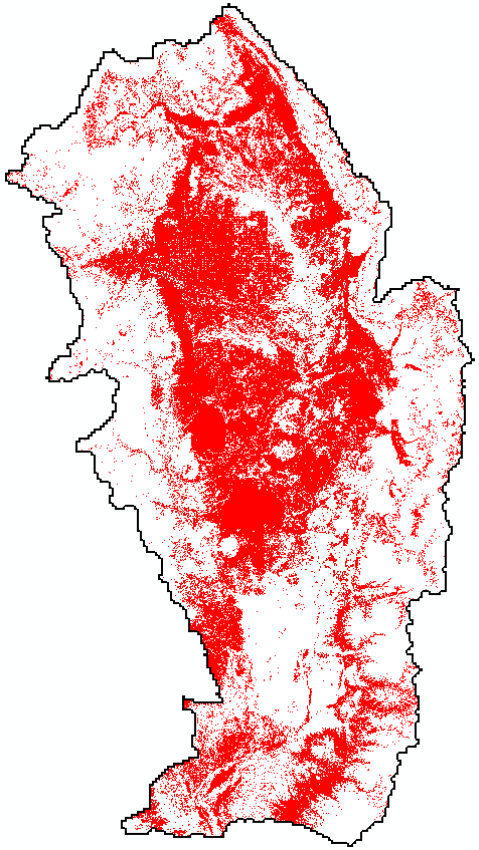


Brewer's Sparrow

Data[1]: Southwest Regional Gap Analysis Project (SWReGAP)

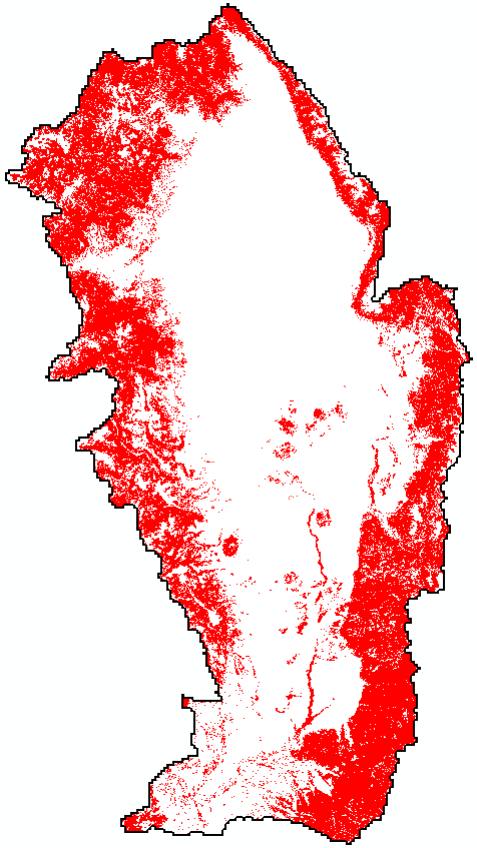
[1] Additional datasets will be considered for the LA as they are identified.

Focal Species Conservation Elements



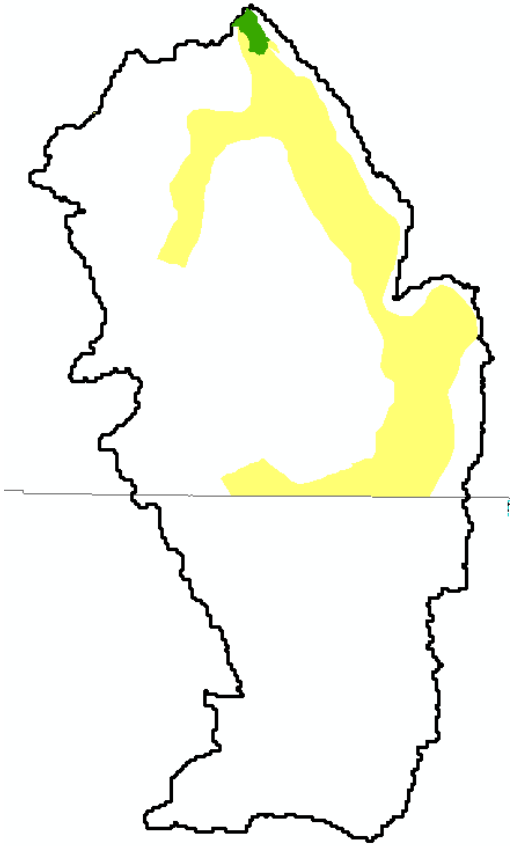
Ferruginous Hawk

Data[1]: SWReGAP



Northern Goshawk

Data[1]: SWReGAP

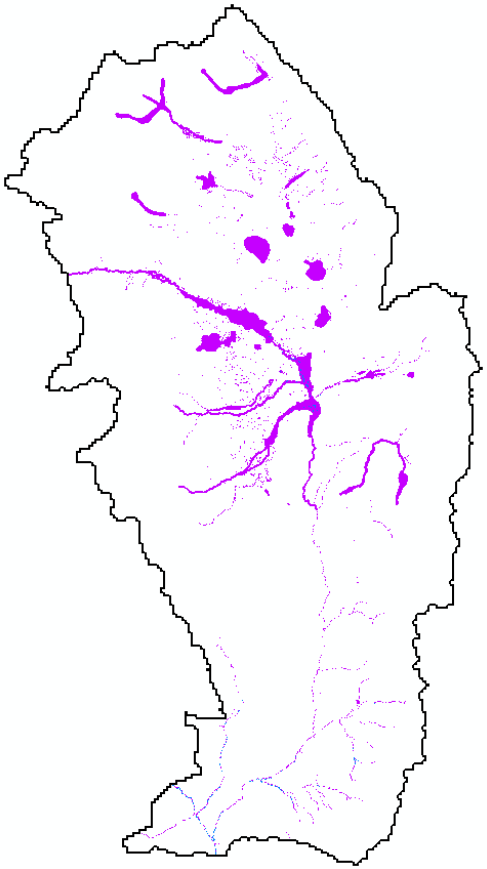


Gunnison Sage-Grouse

Data[1]: U.S. Fish and Wildlife Service proposed critical habitat (green) and historic habitat (yellow)

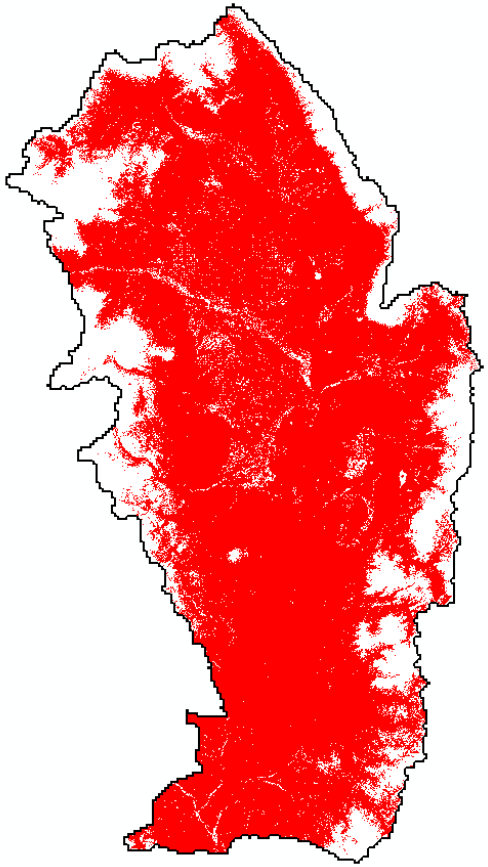
[1] Additional datasets will be considered for the LA as they are identified.

Focal Species Conservation Elements



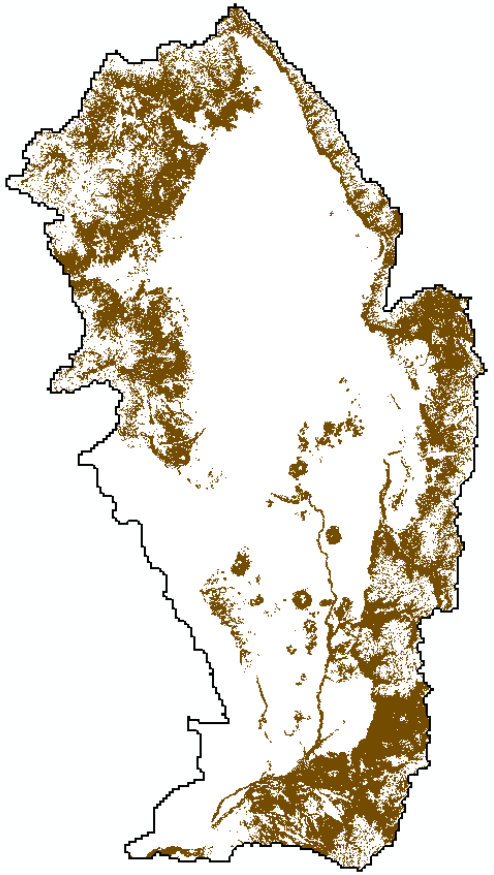
Shorebird Assemblage

Data[1]: Colorado Parks and Wildlife (CPW) habitat for geese, great blue heron, and pied-billed grebe. Riparian and wetland systems included.



Mexican Free-tailed Bat

Data[1]: SWReGAP

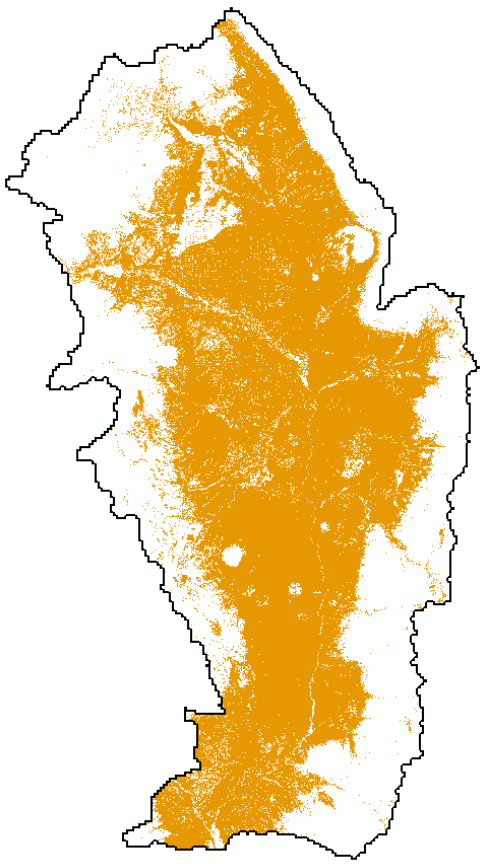


Bighorn Sheep

Data[1]: SWReGAP

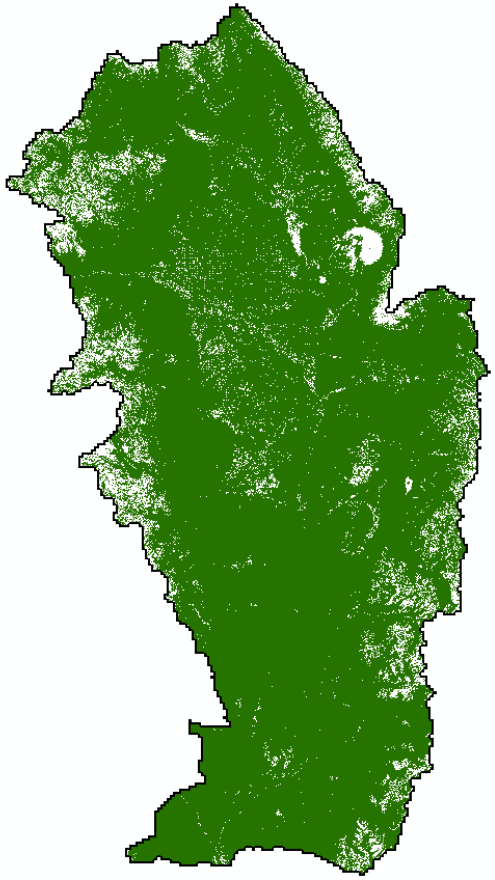
[1] Additional datasets will be considered for the LA as they are identified.

Focal Species Conservation Elements



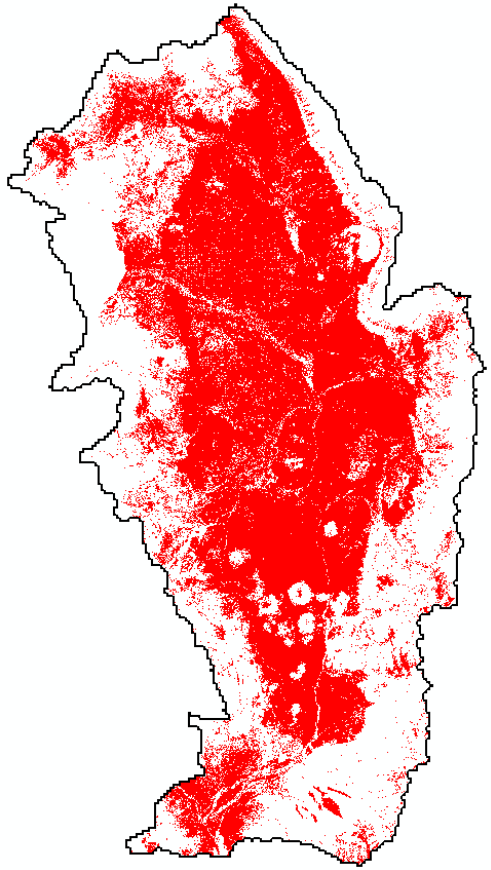
Grassland Fauna Assemblage

Data[1]: SWReGAP



Elk-Mule Deer Assemblage

Data[1]: SWReGAP

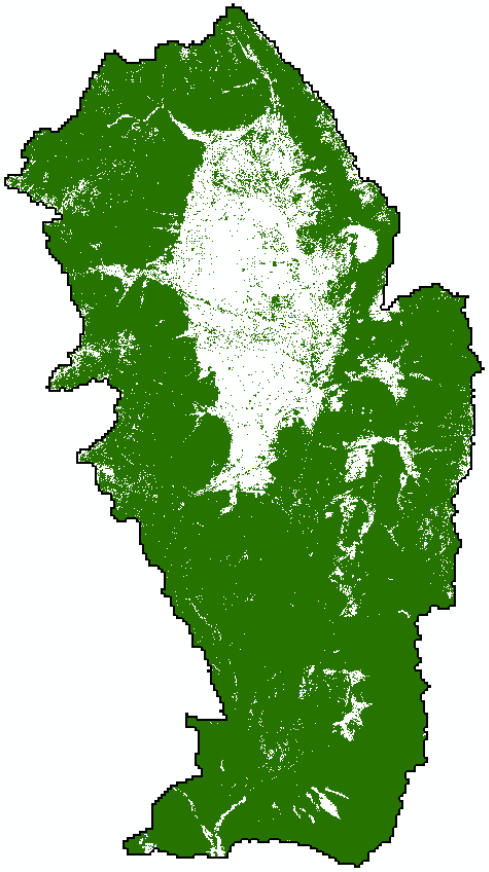


Pronghorn

Data[1]: SWReGAP
(note: may also use data provided by Colorado Parks and Wildlife)

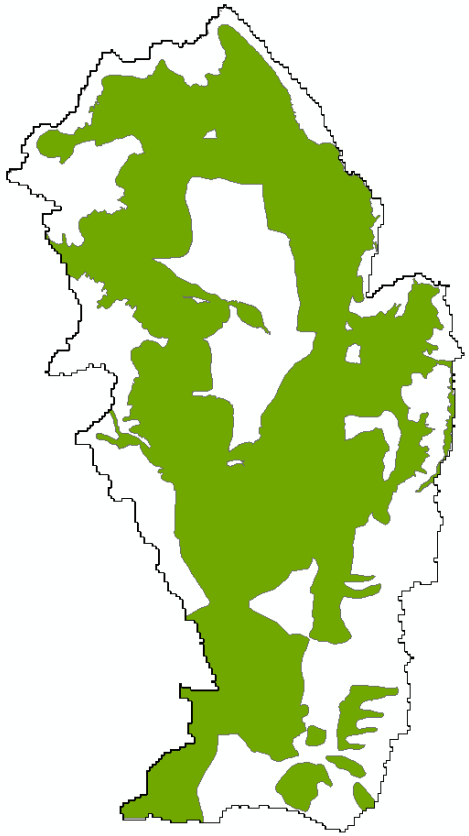
[1] Additional datasets will be considered for the LA as they are identified.

Focal Species Conservation Elements



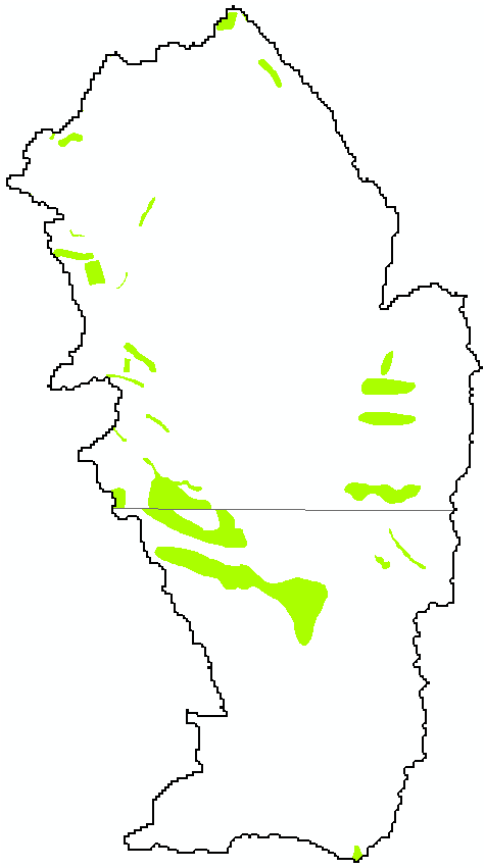
Mountain Lion

Data[1]: SWReGAP



Big Game Winter Range

Data[1]: Colorado Parks and Wildlife, BLM

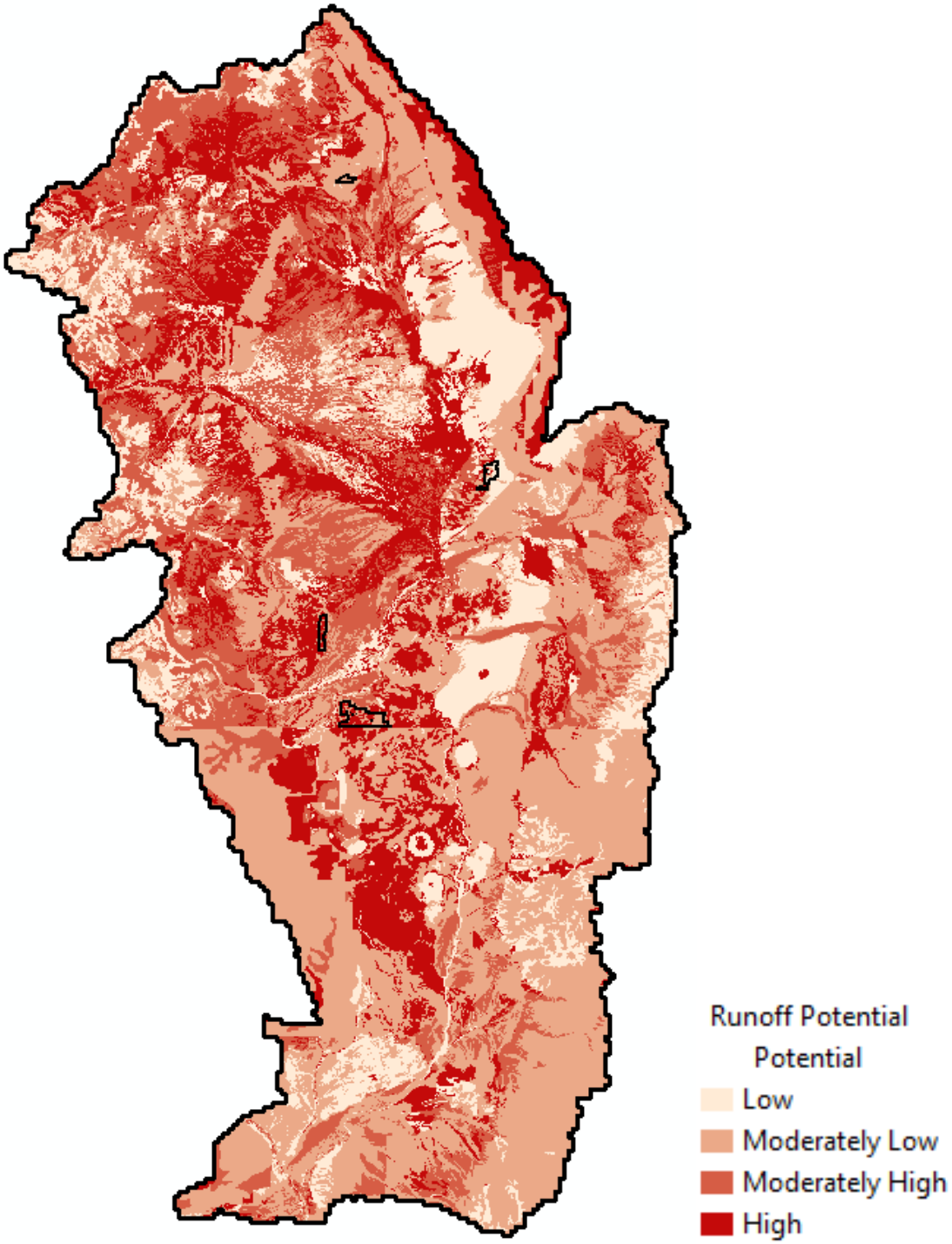


Big Game Migration Corridors

Data[1]: Colorado Parks and Wildlife, BLM

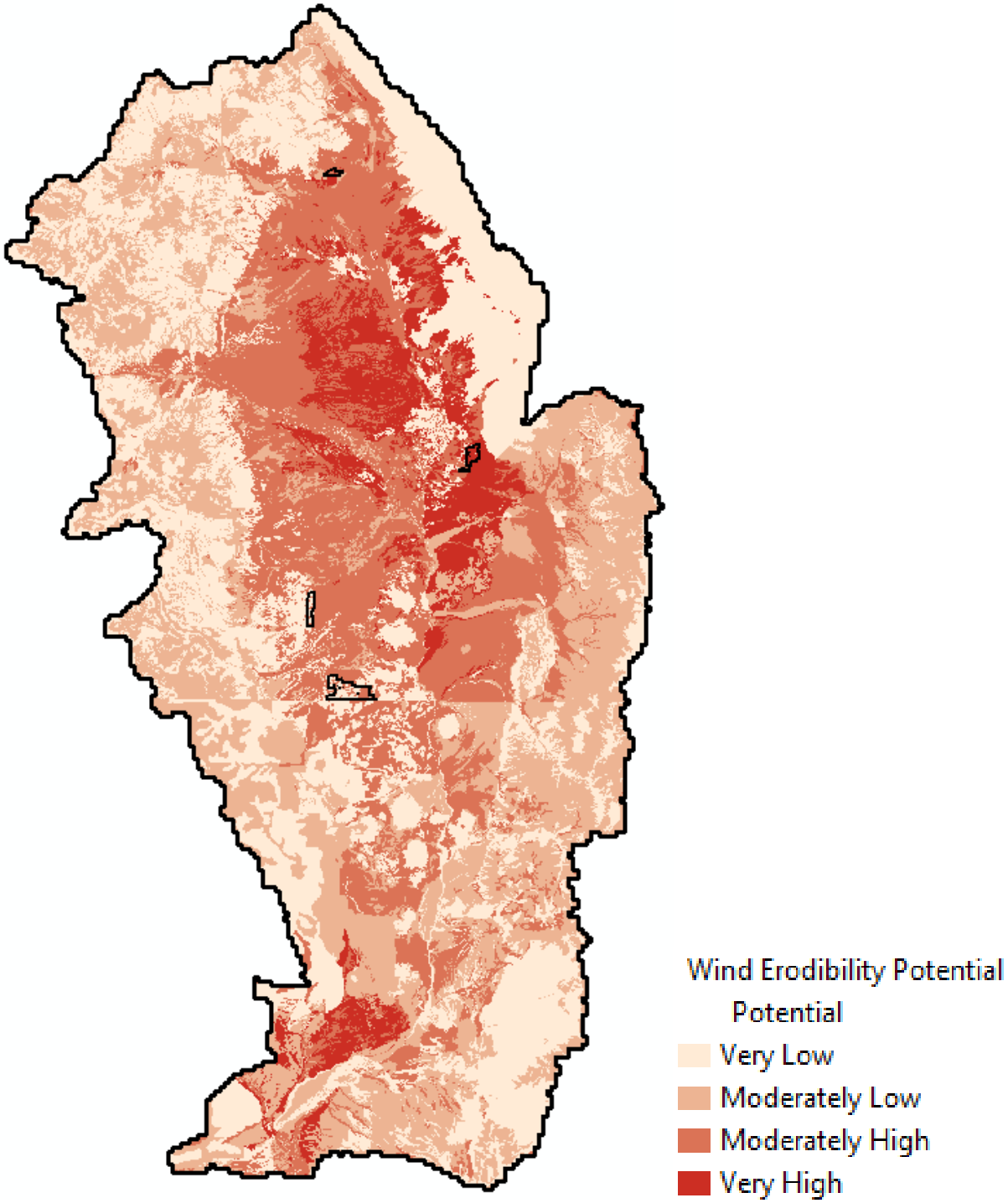
[1] Additional datasets will be considered for the LA as they are identified.

Soil Conservation Elements



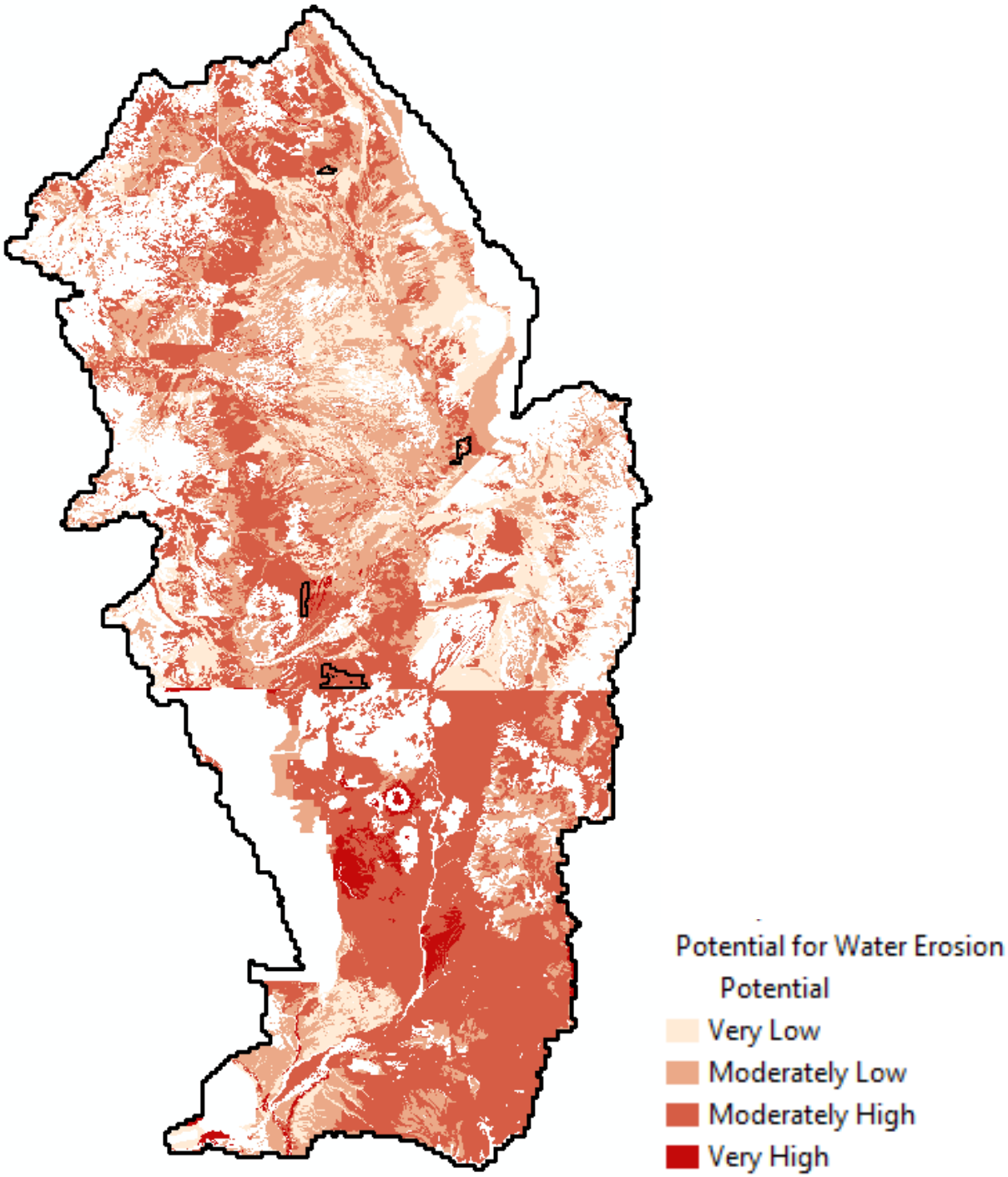
Potential for runoff based on Natural Resources Conservation Service (NRCS) SSURGO and STATSGO soil properties by hydrologic group ("HYDROLGRP")

Soil Conservation Elements



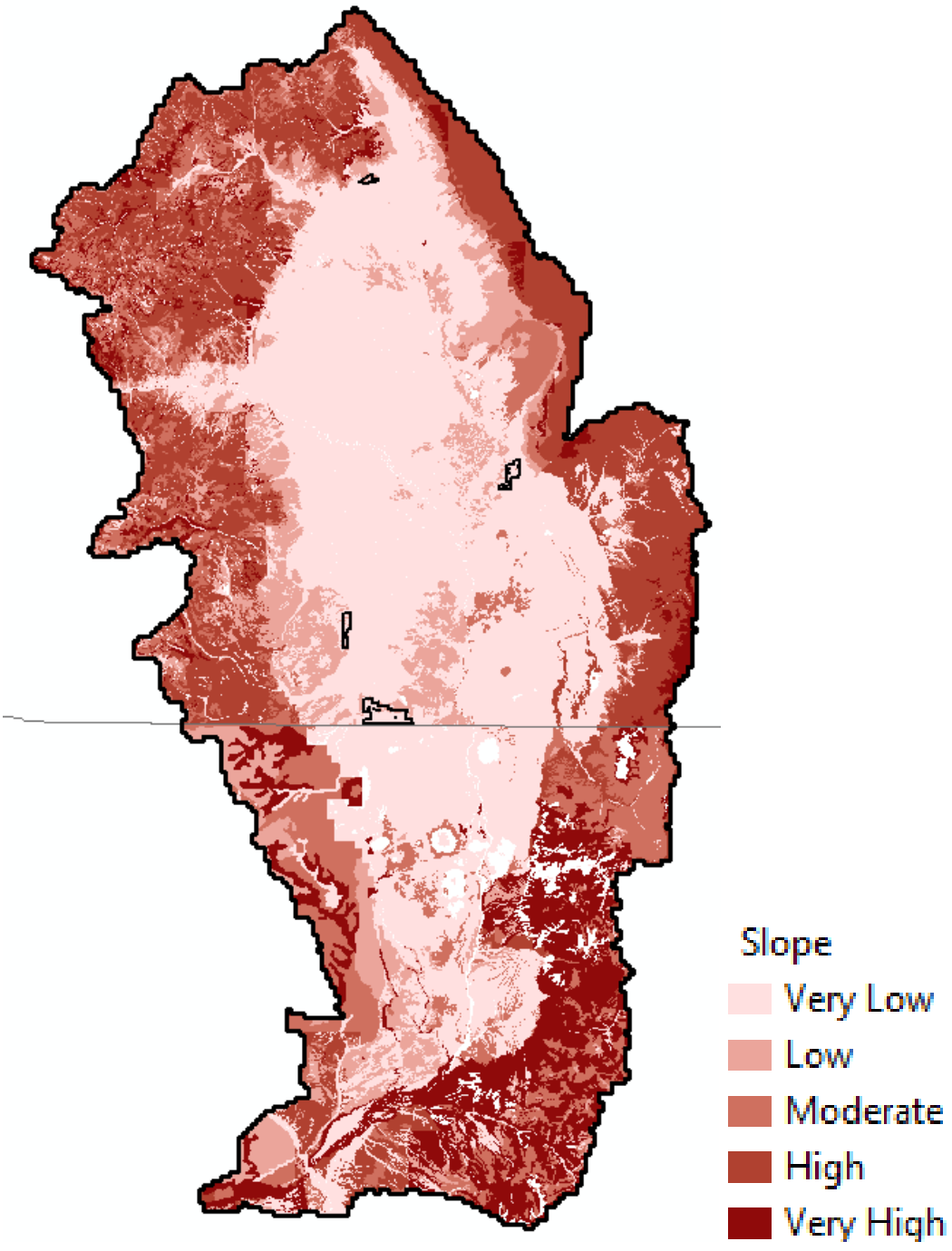
Potential for wind erodibility based on Natural Resources Conservation Service (NRCS) SSURGO and STATSGO soil properties by Wind Erodibility Group (WEG)

Soil Conservation Elements



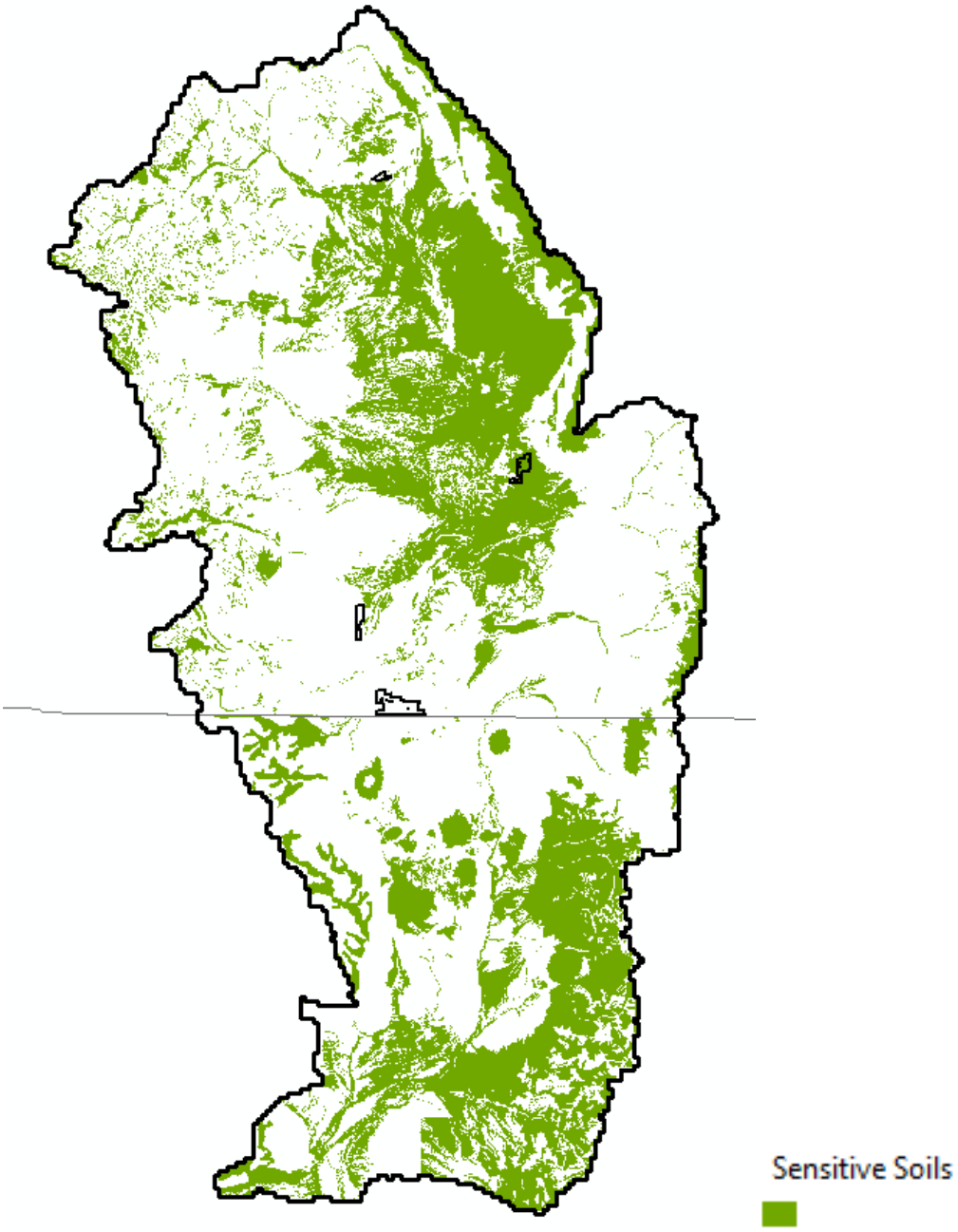
Potential for water erosion based on Natural Resources Conservation Service (NRCS) SSURGO and STATSGO soil properties by K Factor

Soil Conservation Elements



Natural Resources Conservation Service (NRCS) SSURGO and STATSGO soil slope

Soil Conservation Elements

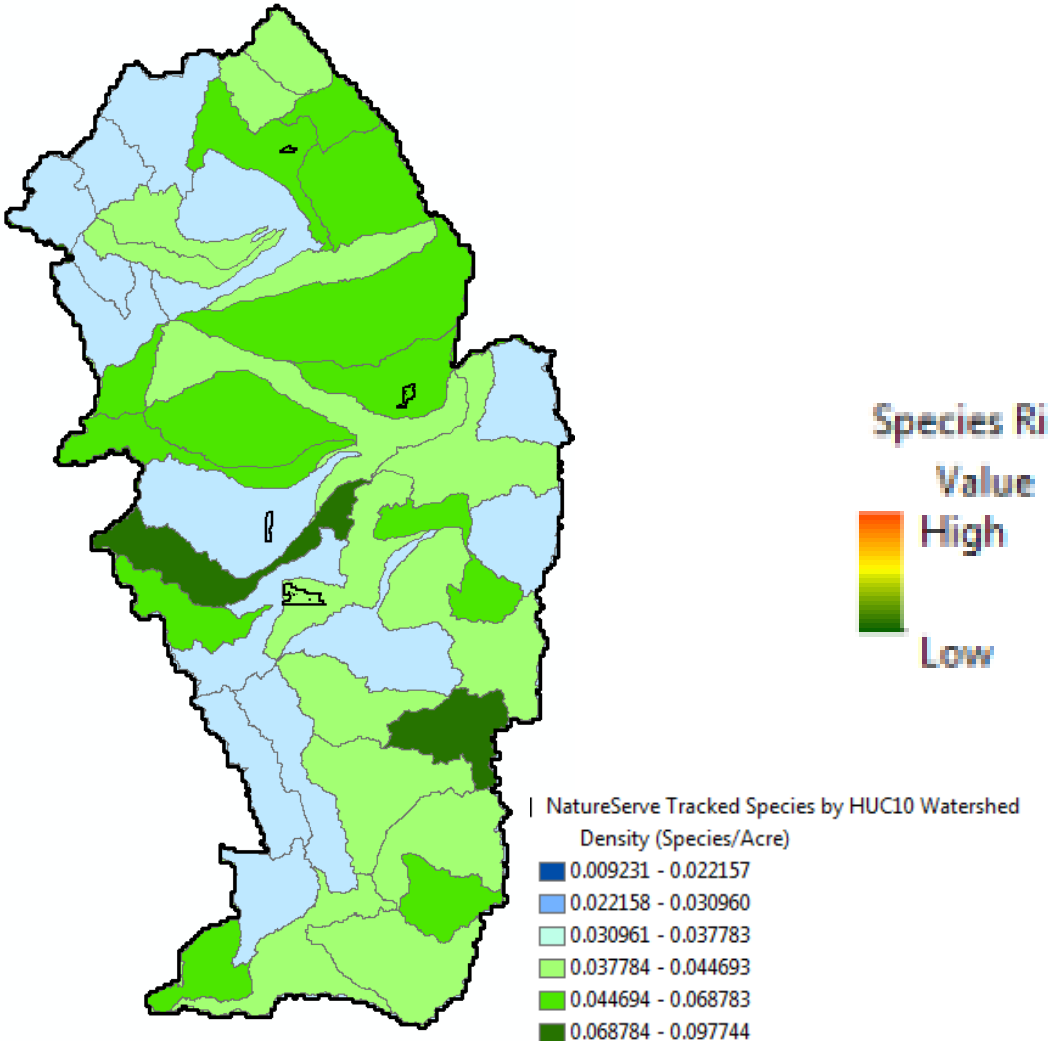


Soil Systems of Concern in the study area based on Natural Resources Conservation Service (NRCS) SSURGO and STATSGO soil properties. See Table C-1 for list of soil systems of concern criteria.

Table C-1. Soil Systems of Concern criteria (NRCS STATSGO and SSURGO data)

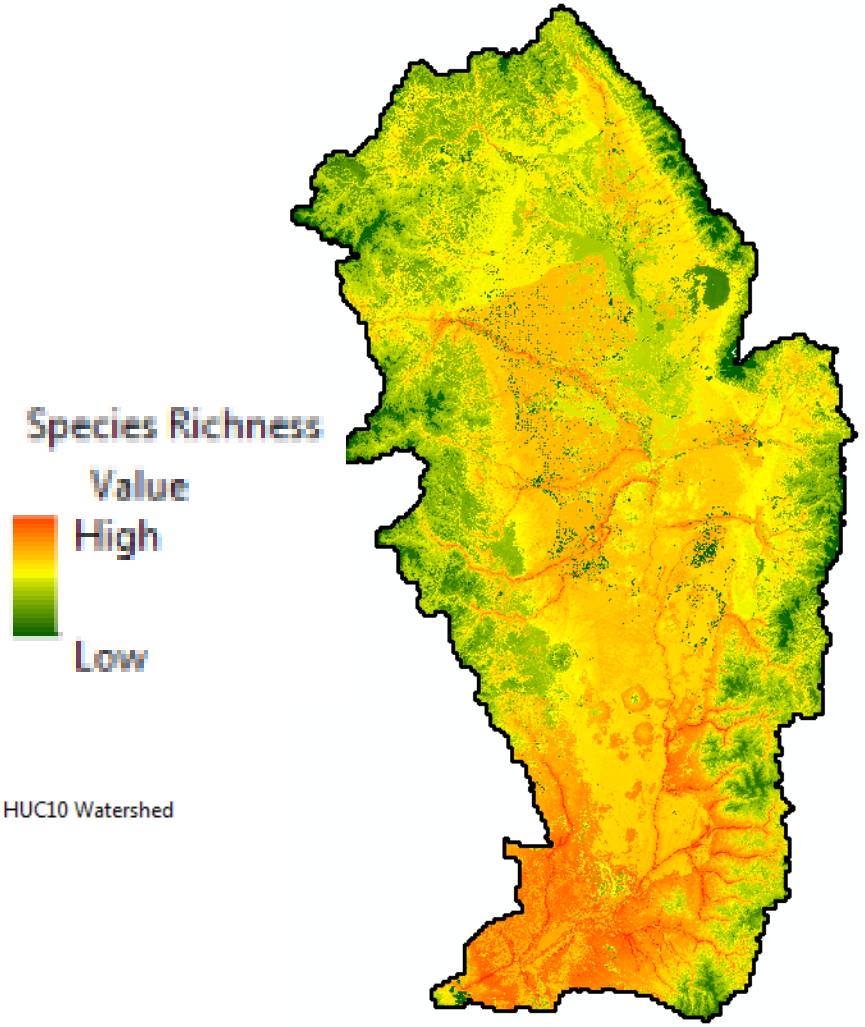
Parameter	Criterion
Available water capacity (AWC)	AWC < 0.05 cm^3/cm^2
Hydric Rating	HydrcRatng >= 63
Electrical conductivity (EC)	EC > 16 mS/cm
Sodium Adsorption Ratio (SAR)	SAR >= 13
pH (pH water)	pH water > 9
Gypsum	Gypsum > 10%
Calcium carbonate (CaCO3)	CaCO3 > 5%
Depth to Soil Restrictive Layer (Dep2ResLyr)	Dep2ResLyr < 25.4 cm
Wind erodibility group (WEG)	WEG = 1 or 2
Water erodibility (KFactor)	KFactor > 0.4
Slope	Slope > 45%

Biodiversity / Species Richness Conservation Elements



Sum of Rare Species by HUC10 Watershed

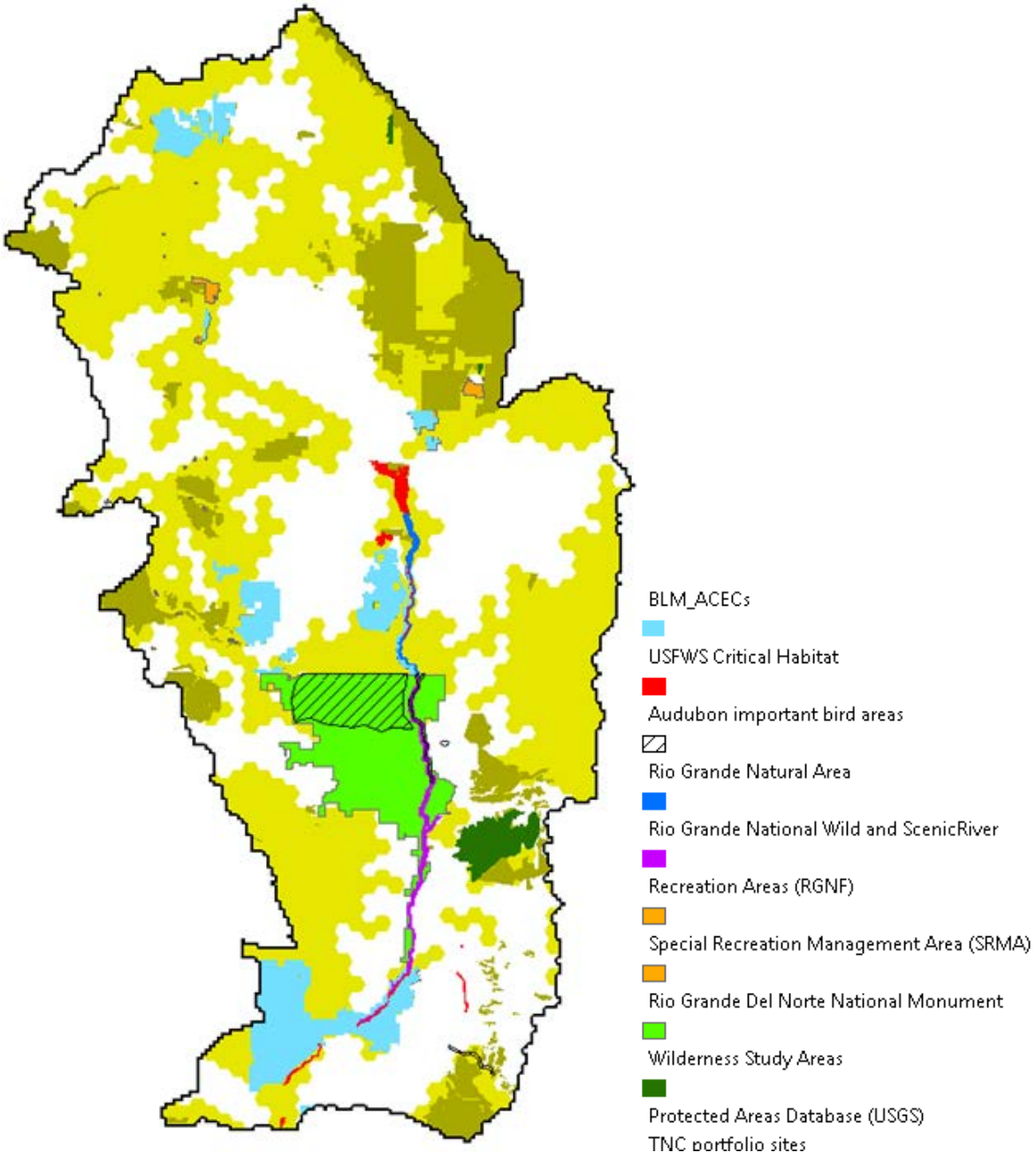
Data: NatureServe



SWReGAP Vertebrate Species Richness

Data: SWReGAP

Sites of Conservation Concern Conservation Element



Sites of Conservation Concern Conservation Element

APPENDIX D:

CONSERVATION ELEMENT-SPECIFIC CONCEPTUAL MODELS

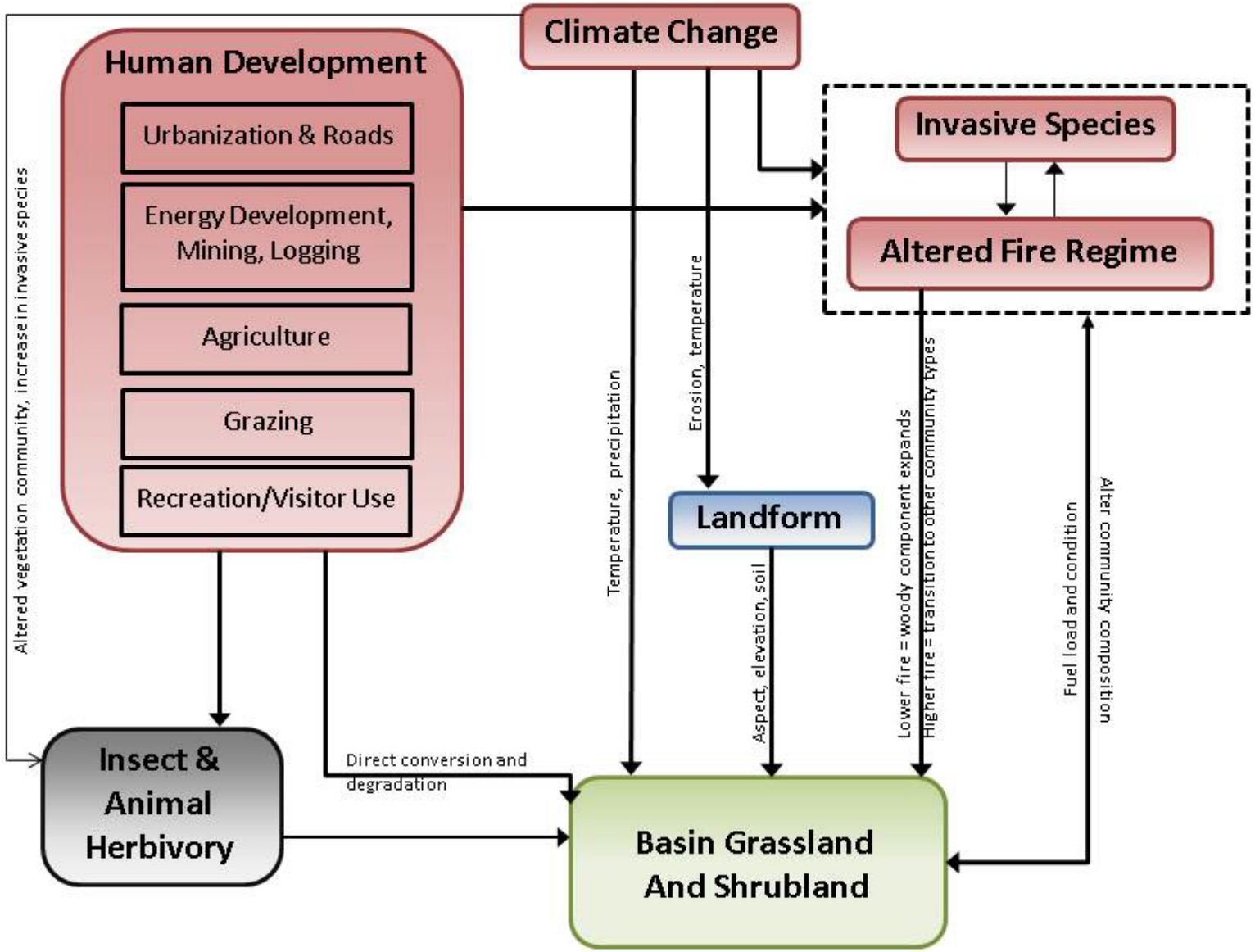


Figure D-1. Conceptual model for the Basin Grassland and Shrubland Ecological System Macrogroup Conservation Element.

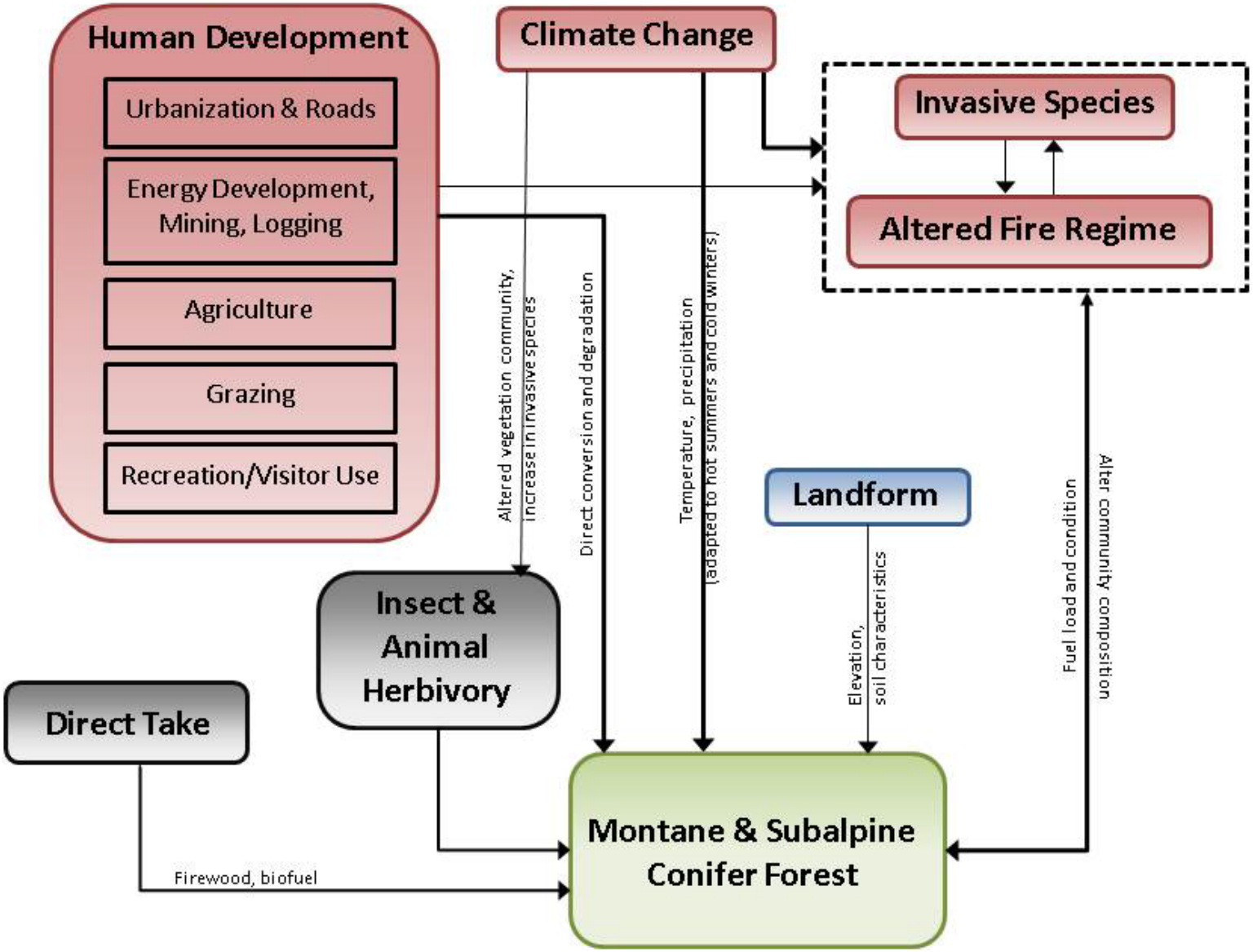


Figure D-2. Conceptual model for the Montane and Subalpine Conifer Forest Ecological System Macrogroup Conservation Element.

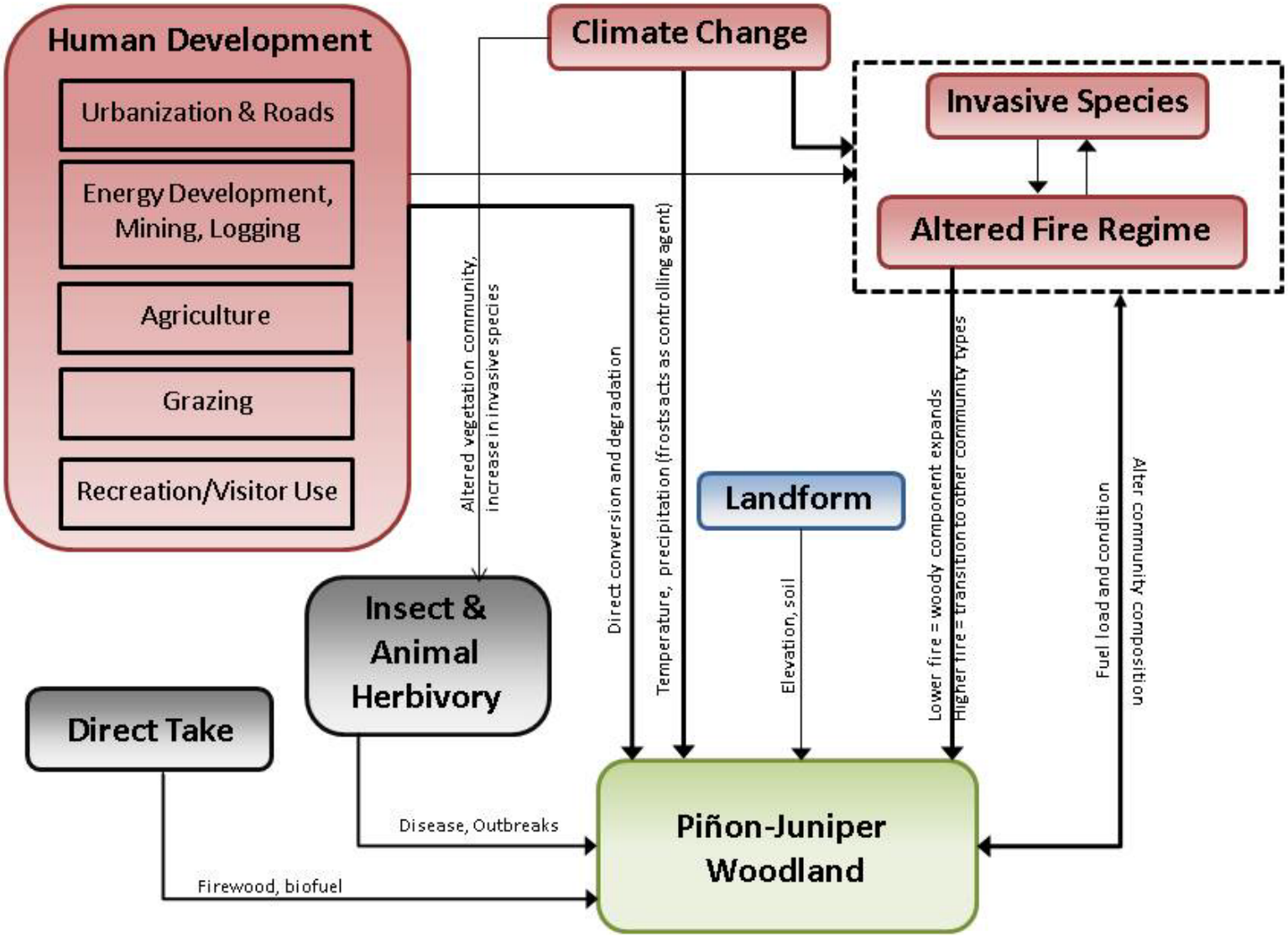


Figure D-3. Conceptual model for the Piñon-Juniper Woodland Ecological System Macrogroup Conservation Element.

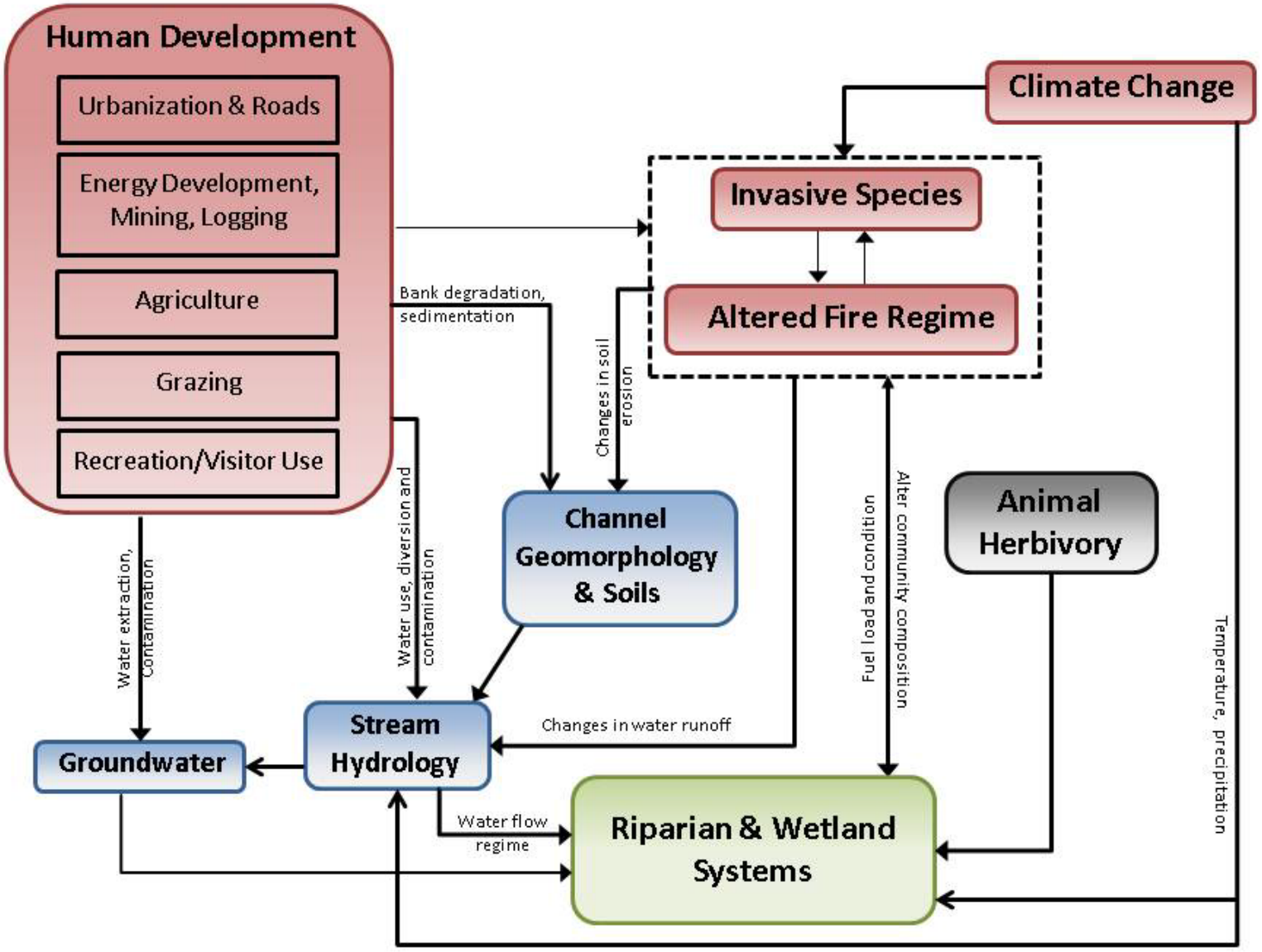


Figure D-4. Conceptual model for the Riparian and Wetland Systems Ecological System Macrogroup Conservation Element.

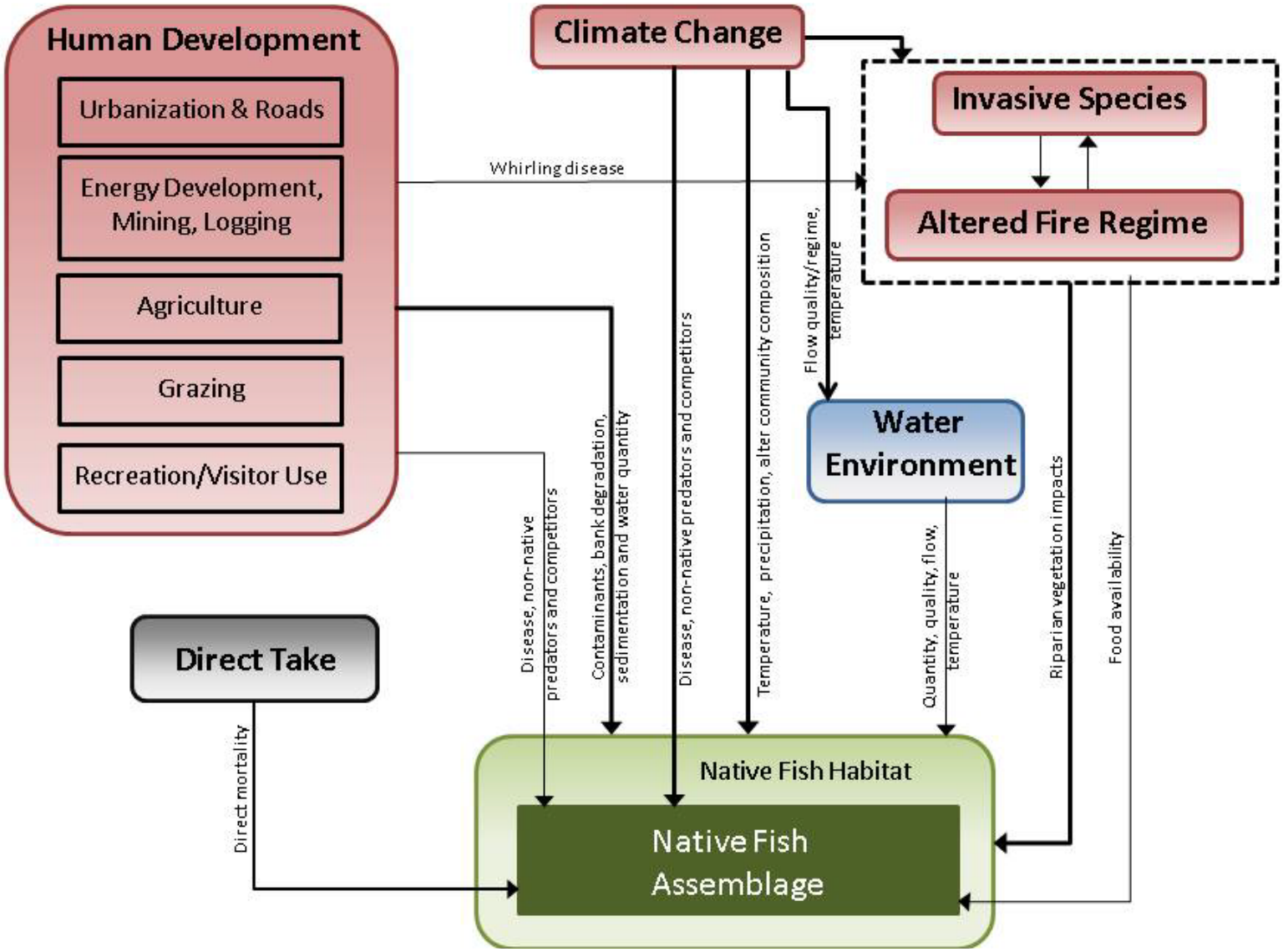


Figure D-5. Conceptual model for the native fish assemblage Focal Species Conservation Element.

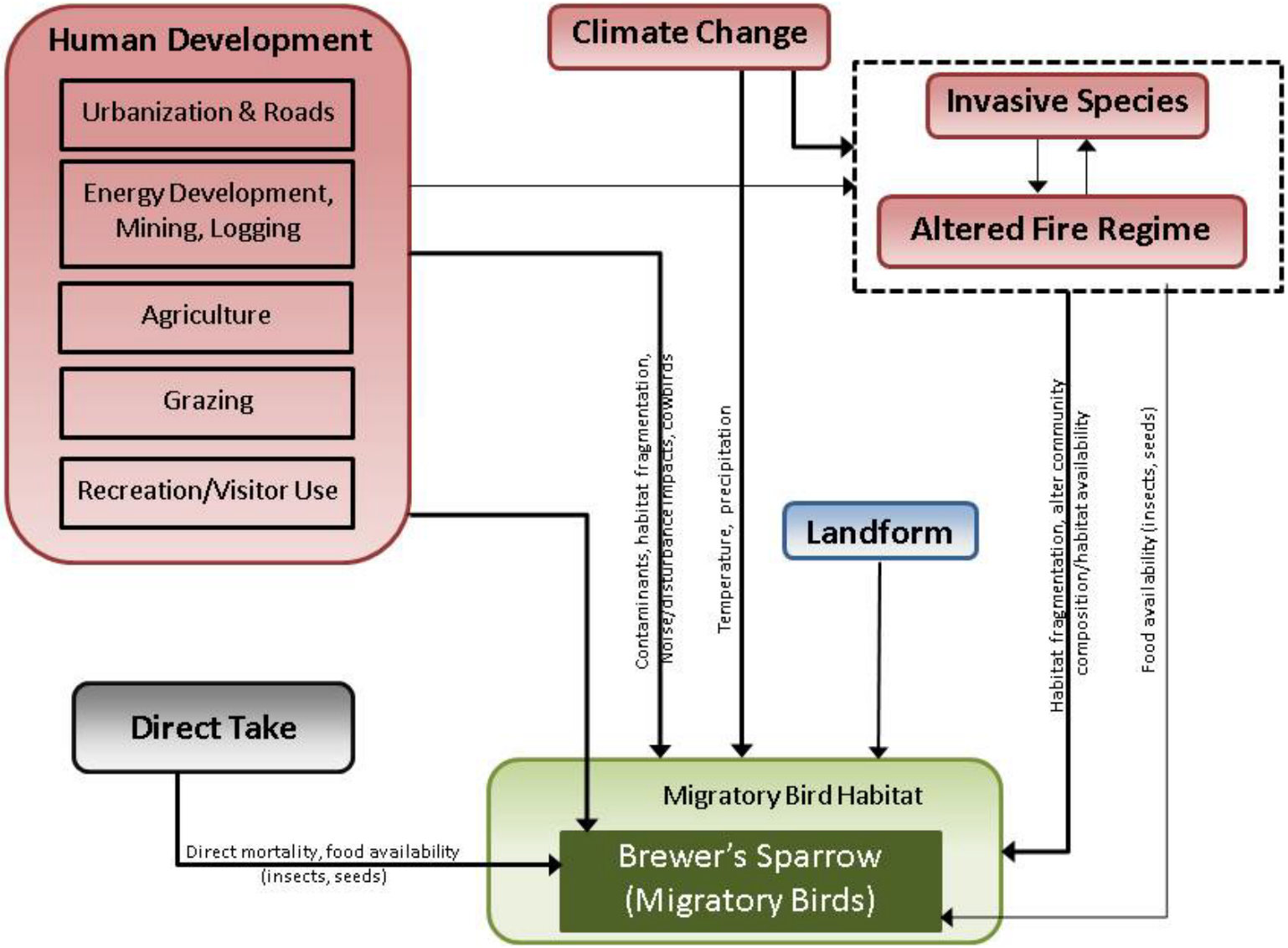


Figure D-6. Conceptual model for the Brewer's sparrow Focal Species Conservation Element.

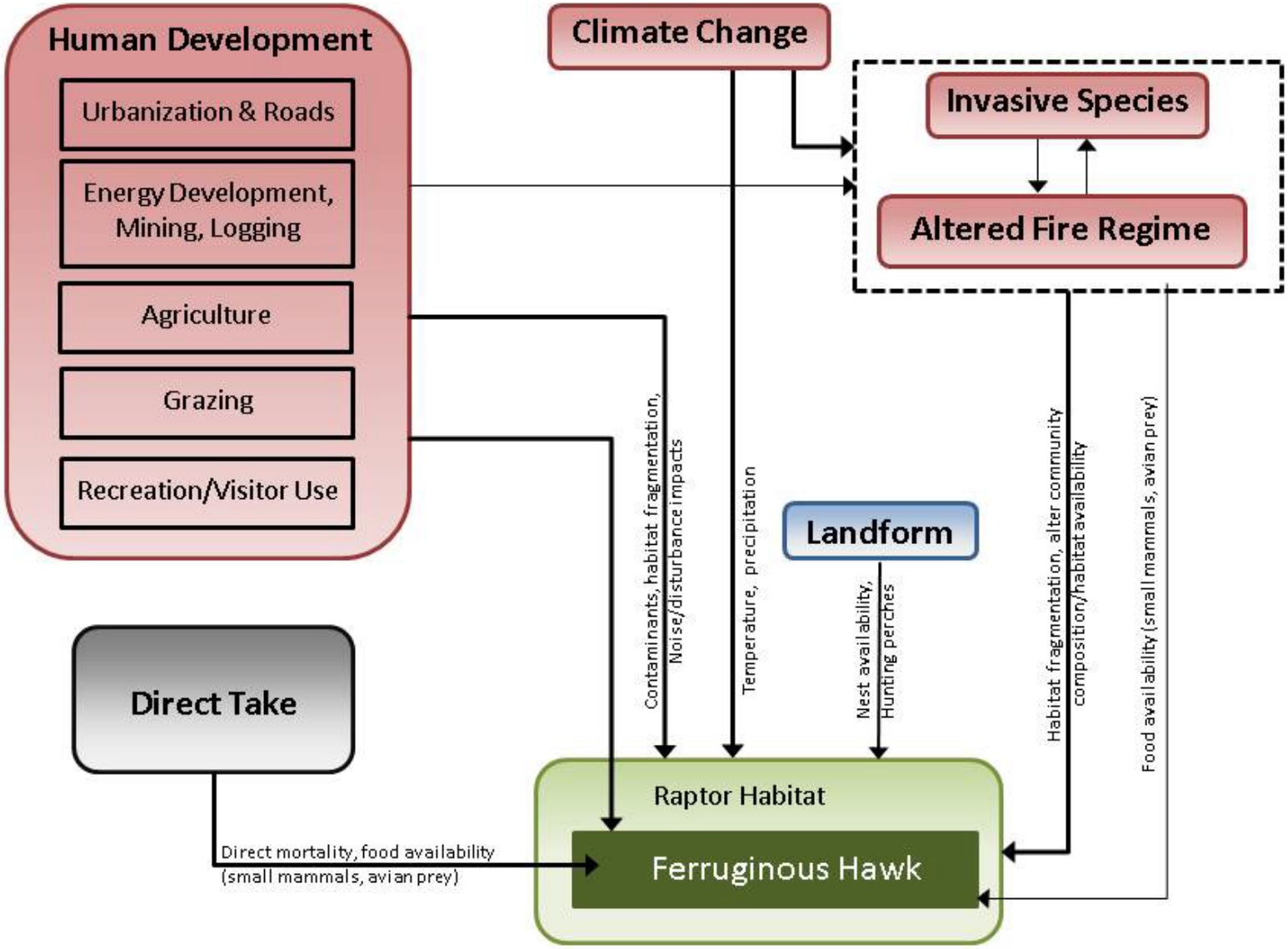


Figure D-7. Conceptual model for the ferruginous hawk Focal Species Conservation Element.

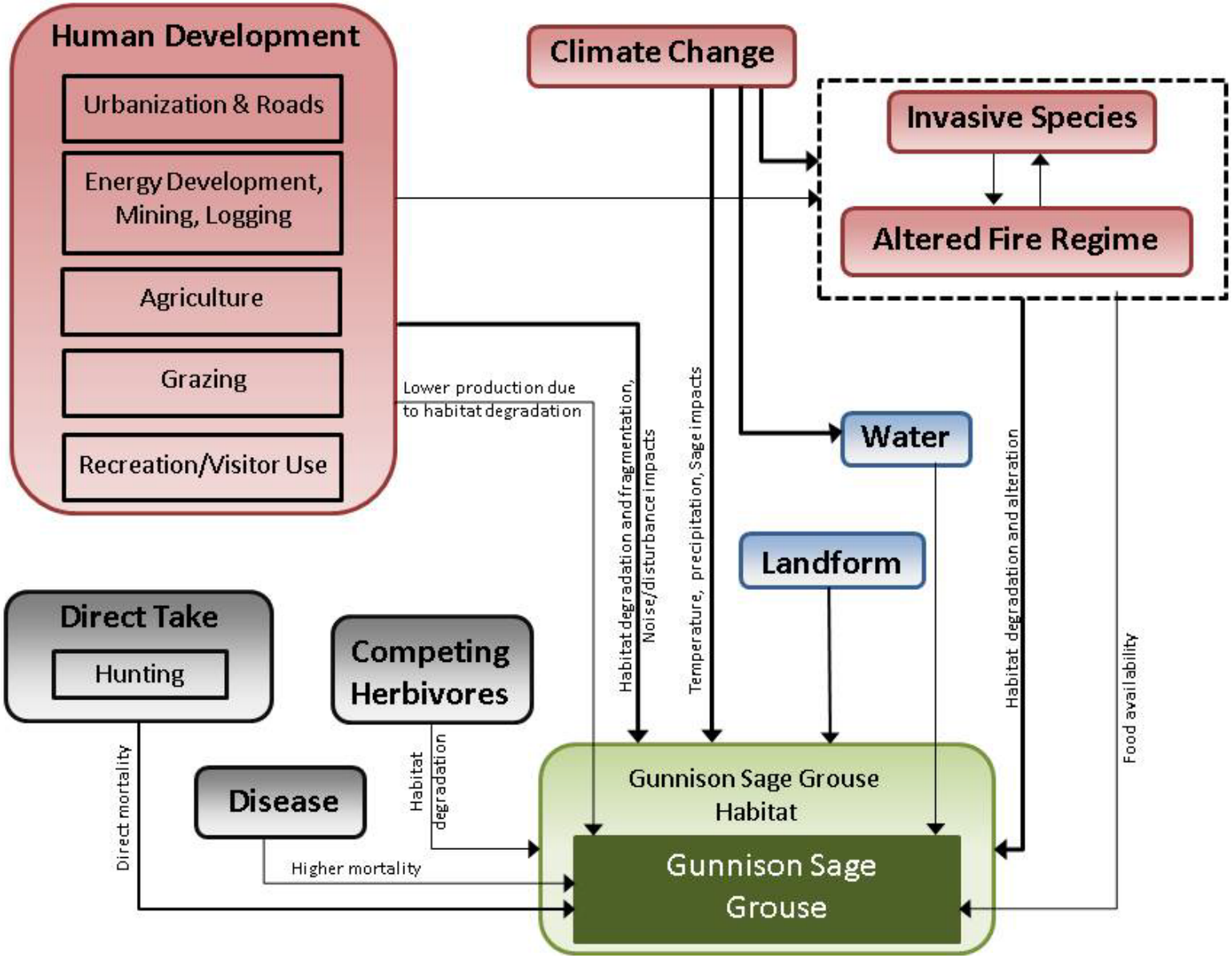


Figure D-8. Conceptual model for the Gunnison sage-grouse Focal Species Conservation Element.

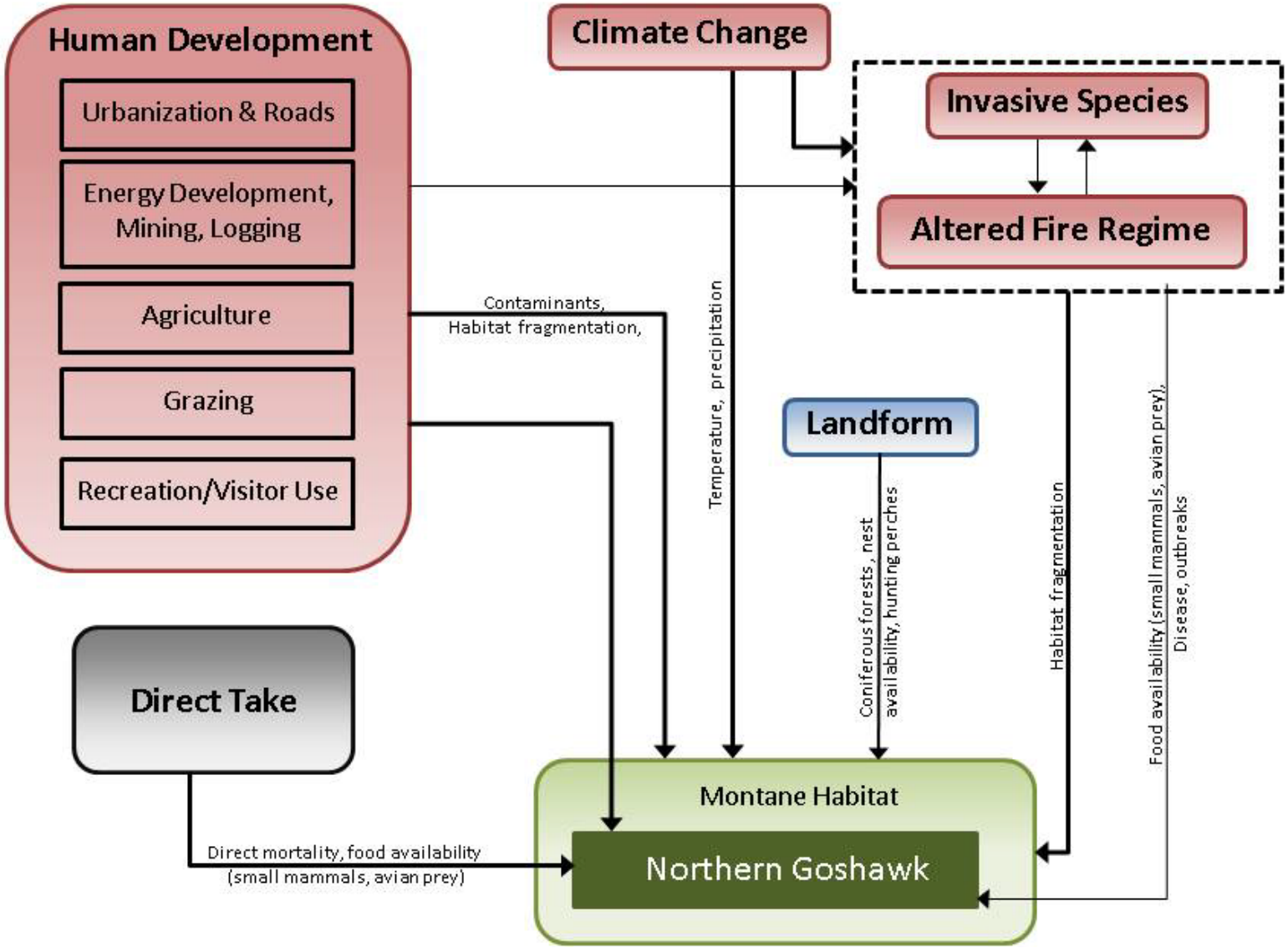


Figure D-9. Conceptual model for the northern goshawk Focal Species Conservation Element.

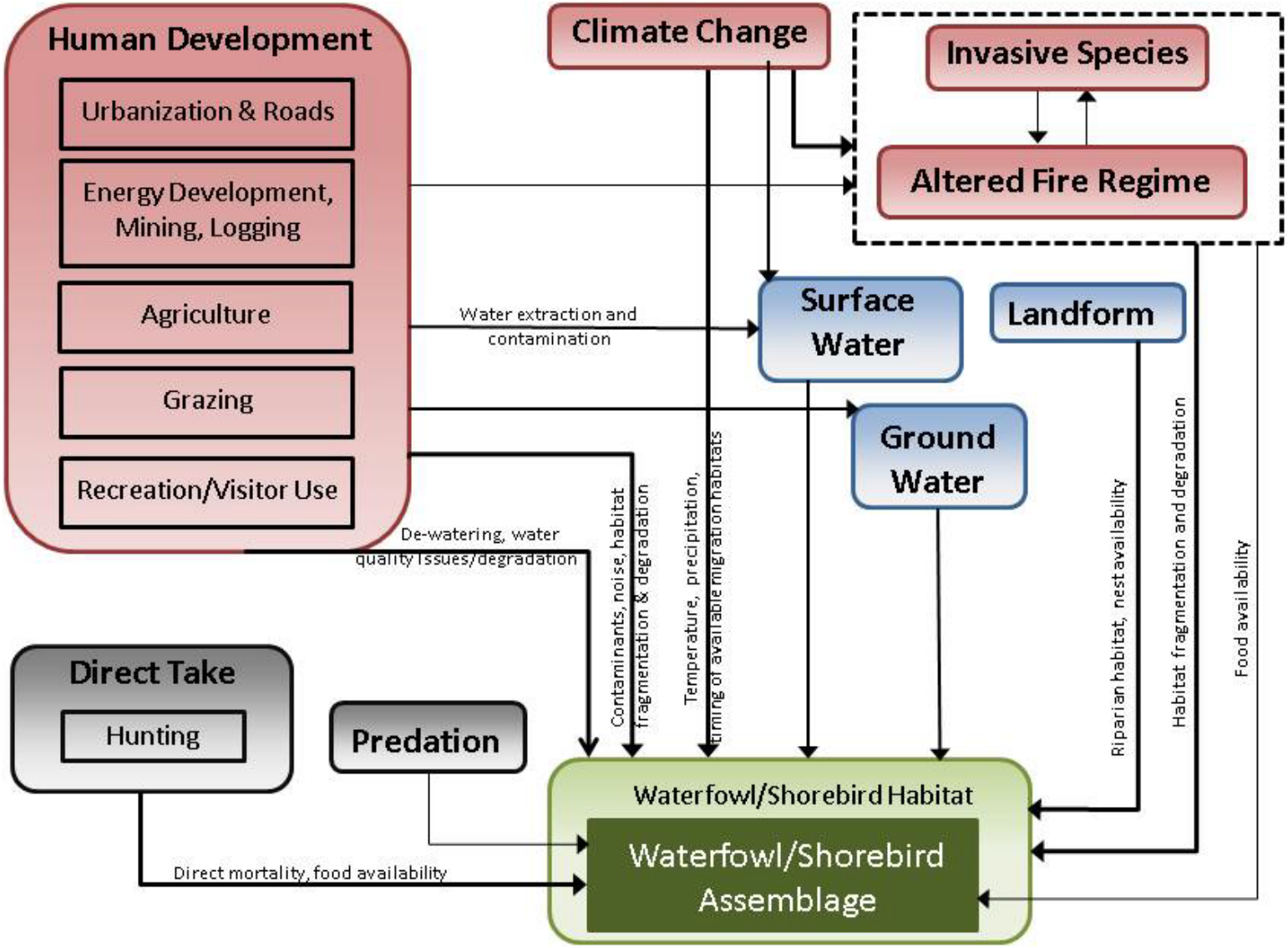


Figure D-10. Conceptual model for the shorebird-waterfowl assemblage Focal Species Conservation Element.

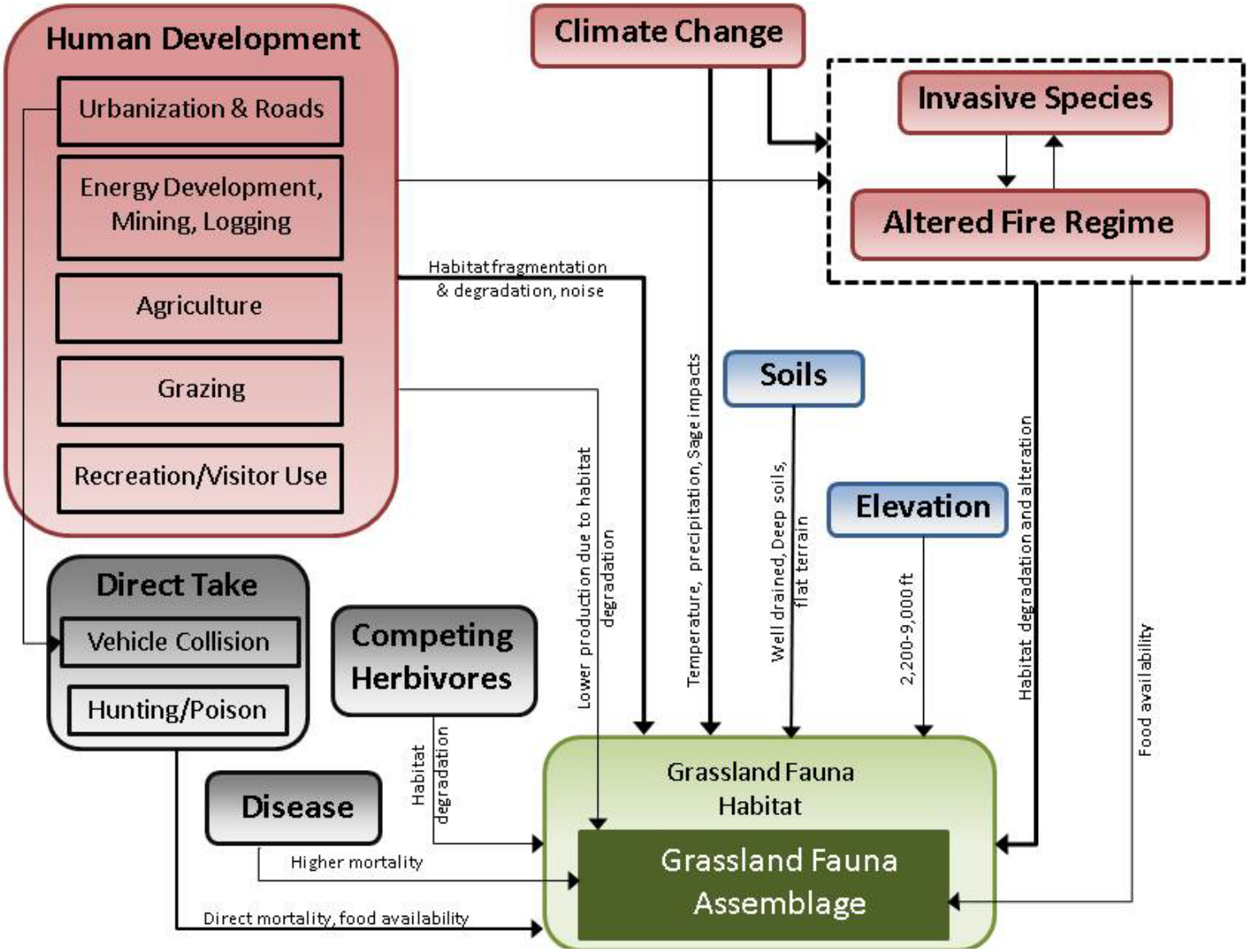


Figure D-11. Conceptual model for the grassland fauna assemblage Focal Species Conservation Element.

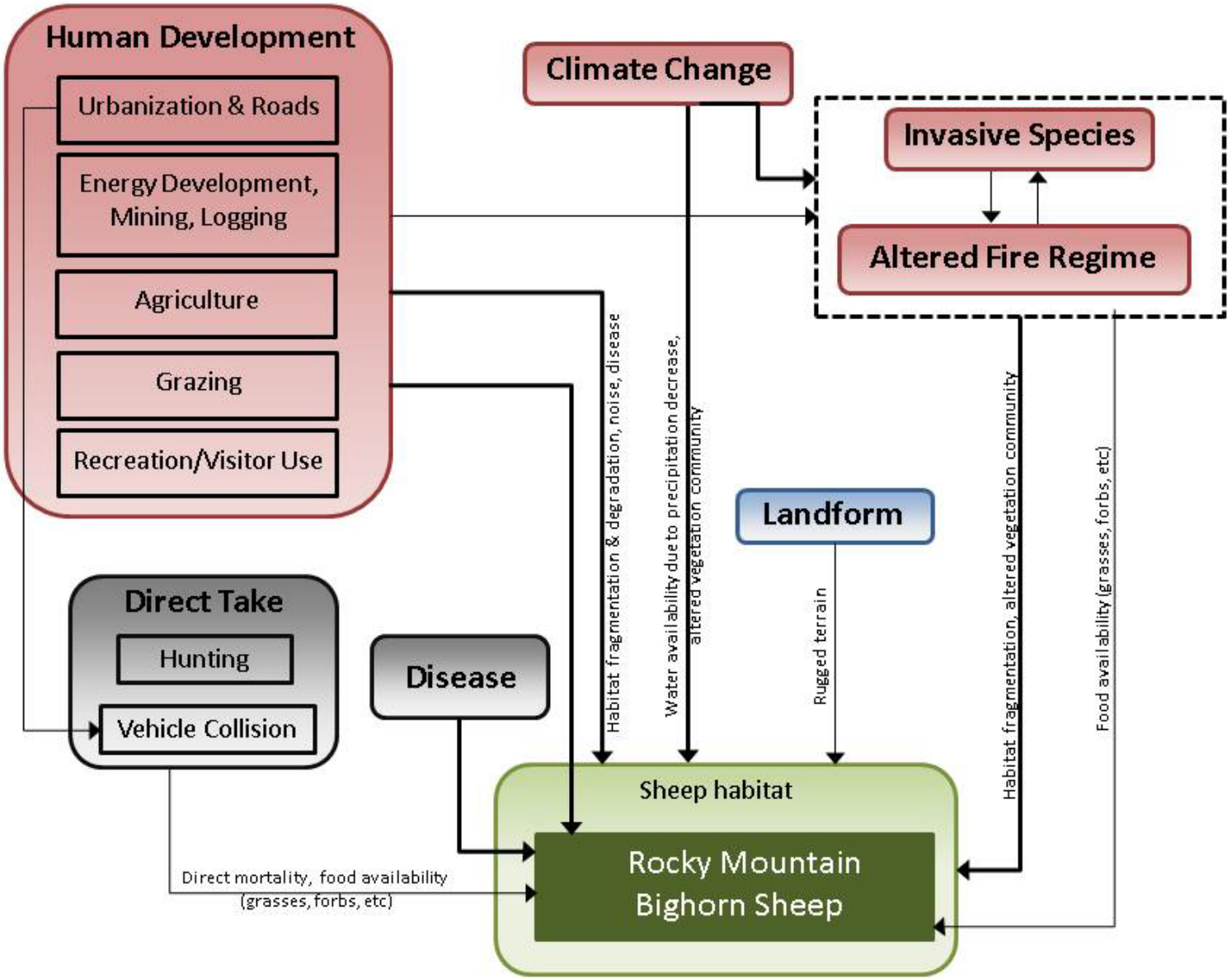


Figure D-12. Conceptual model for the bighorn sheep Focal Species Conservation Element.

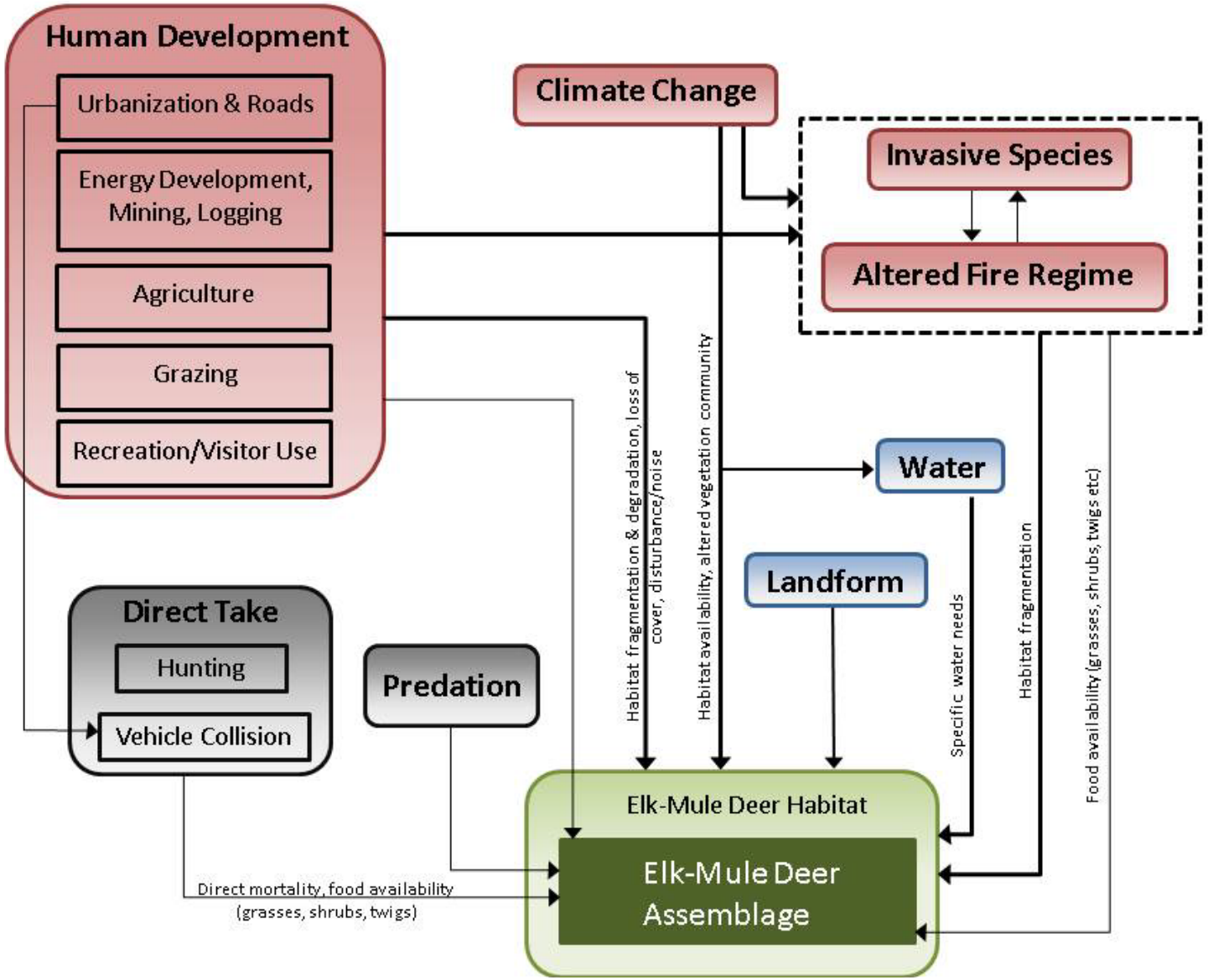


Figure D-13. Conceptual model for the elk-mule deer assemblage Focal Species Conservation Element.

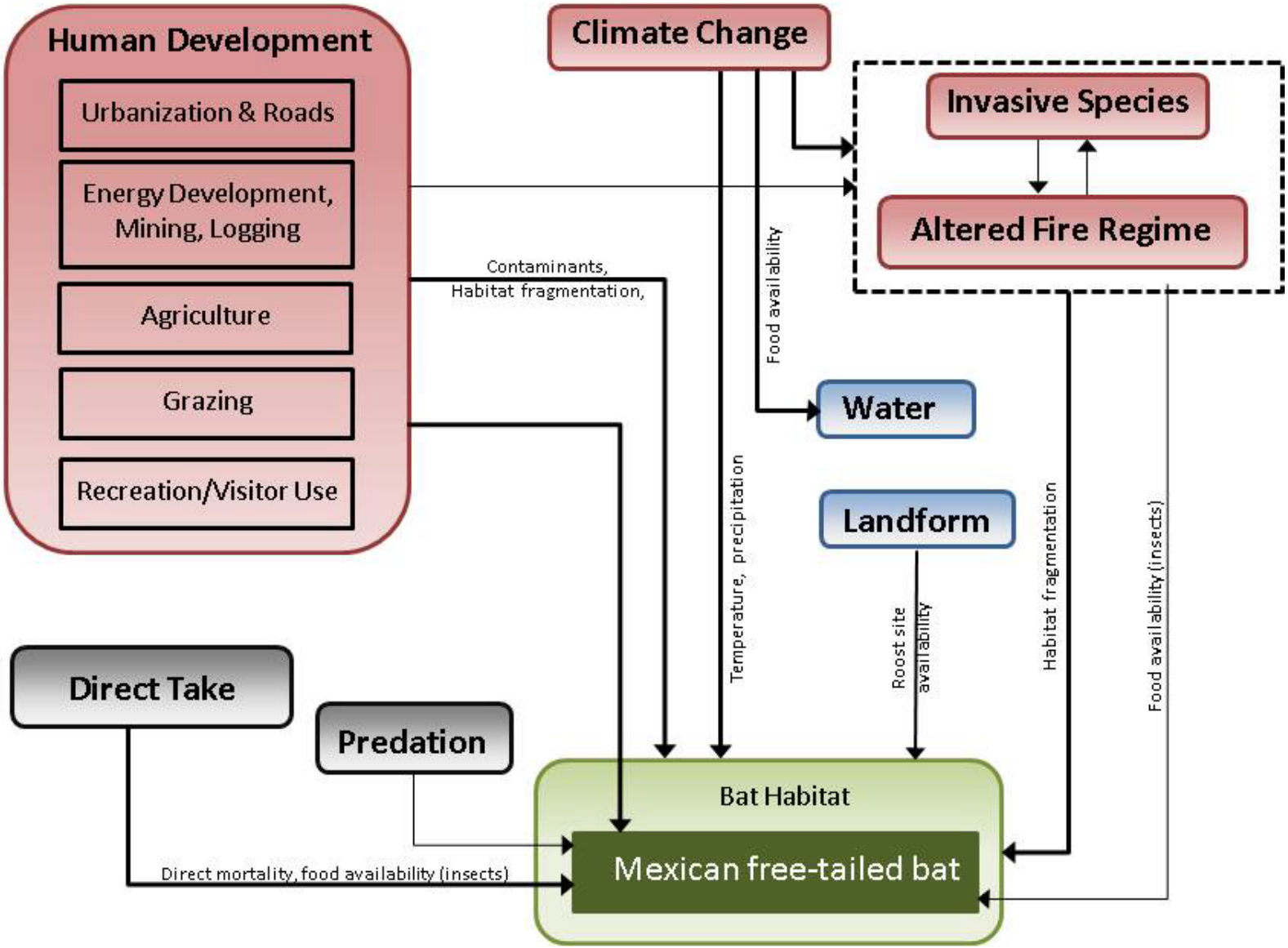


Figure D-14. Conceptual model for the Mexican free-tailed bat Focal Species Conservation Element.

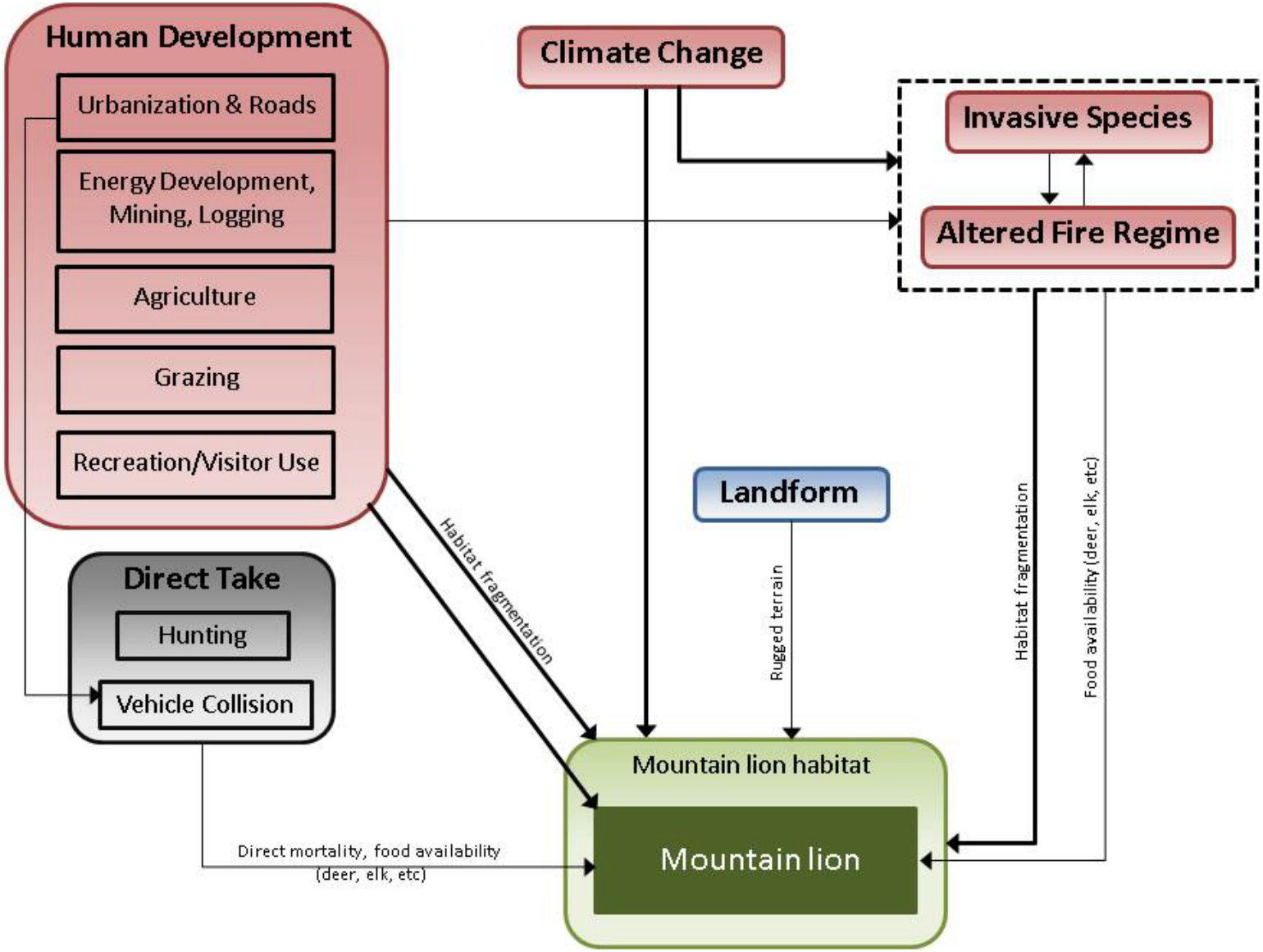


Figure D-15. Conceptual model for the mountain lion Focal Species Conservation Element.

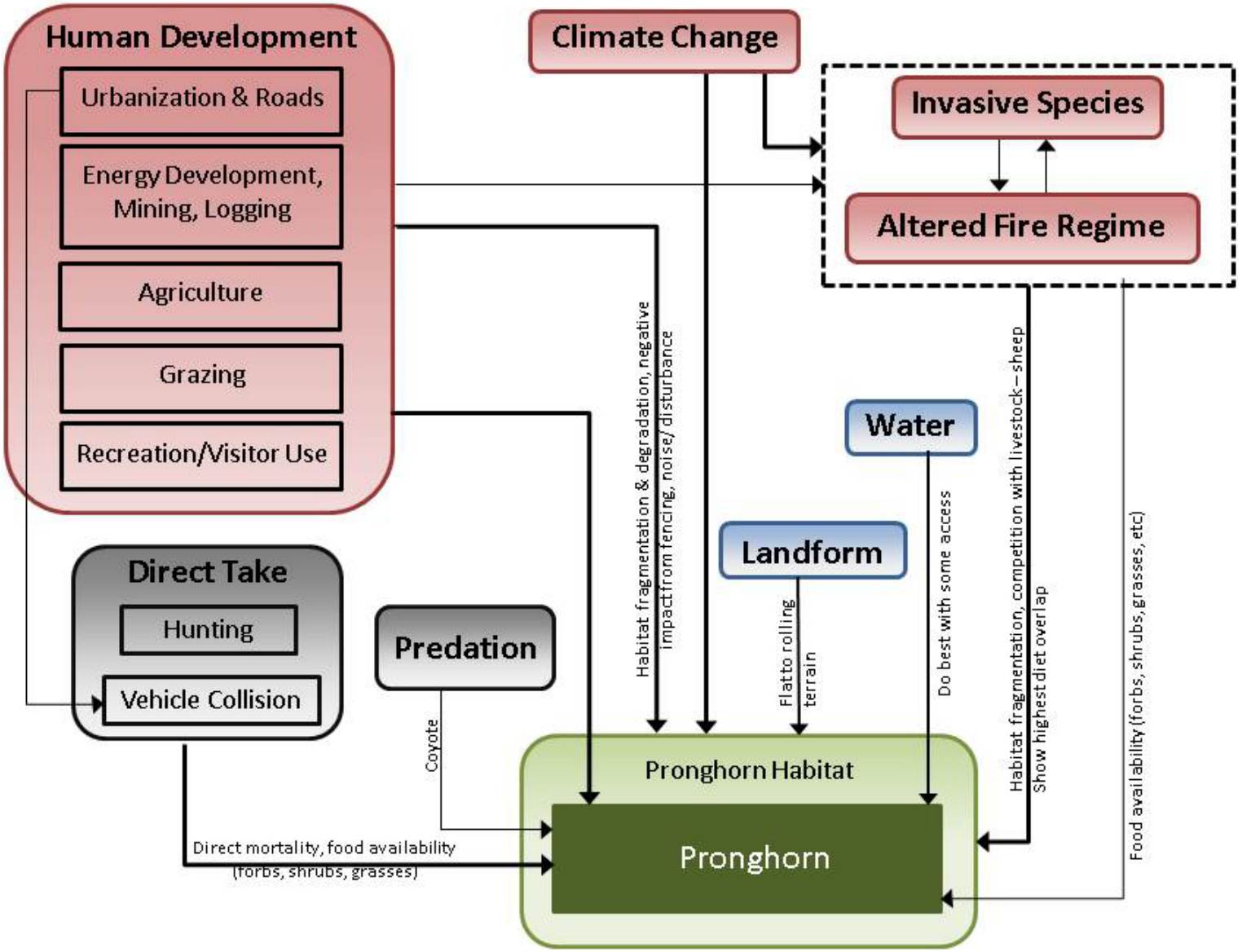


Figure D-16. Conceptual model for the pronghorn Focal Species Conservation Element.