

# Chapter 8: Conservation Opportunity Areas

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This chapter presents a series of maps to help guide conservation efforts across the state. These maps are useful for broad-scale analysis of where conservation efforts might be most warranted and most successful. *It is important to note that these maps take into consideration only those environmental factors that can be mapped at a statewide scale using available data.*

The first six maps indicate relative condition of freshwater, terrestrial upland, and wetland/riparian habitats. This information can be used to identify areas at a broad scale that are likely to be in higher quality condition, and therefore good candidates for land protection strategies, as well as those that are more likely in degraded condition and in need of restoration. The final two maps display SGCN concentration areas for aquatic and terrestrial species, respectively.

## Freshwater Habitats

The freshwater condition map for Colorado, developed by The Nature Conservancy and included here with permission, provides a general indication of the condition of freshwater ecosystems in Colorado (Figure 13). Details on data inputs and methods can be found in TNC (2012). The map displays relative level of impact for each stream reach based on multiple mappable landscape measures, each of which were ranked on a scale of Very Good to Poor (Table 10). A stream reach with a good or very good rank (minimal or low impact) may benefit from prioritized protection efforts. It is important to note that even a stream reach with a poor ranking may provide important habitat and support species of concern. However, the poor ranking indicates that those species may be at risk, and serves as a guideline for identifying places that could benefit from restoration efforts. Map categories range from minimal impact (very good condition) to high impact (very poor condition), according to the definitions in Table 11.

**Table 10. Measures included in the freshwater condition map. All factors are weighted equally.**

Natural Flow Regime	Riparian Condition	Development	Connectivity	Water Quality
<ul style="list-style-type: none"> <li>• Consumptive Use (Agricultural Use, Municipal Use, Trans-basin Diversions)</li> <li>• Reservoir Storage</li> </ul>	<ul style="list-style-type: none"> <li>• Riparian Land Use</li> <li>• Non-native Plants – Tamarisk – in the Riparian Vegetation</li> </ul>	<ul style="list-style-type: none"> <li>• Land Use</li> <li>• Road Density</li> <li>• Road Crossings</li> <li>• Oil and Gas</li> <li>• Mining</li> </ul>	<ul style="list-style-type: none"> <li>• Instream Barriers to Fish Movement</li> </ul>	<ul style="list-style-type: none"> <li>• Streams with a 303d and/or Monitoring and Evaluation Designation</li> </ul>

**Table 11. Definitions of map categories for freshwater condition.**

Level of Impact	Summary Measure
Minimal	All measures in Very Good or Good category
Low	>=1 category is Fair; all others Very Good or Good
Moderate	1-2 categories are Poor; all others Very Good, Good, or Fair
High	>2 categories are Poor

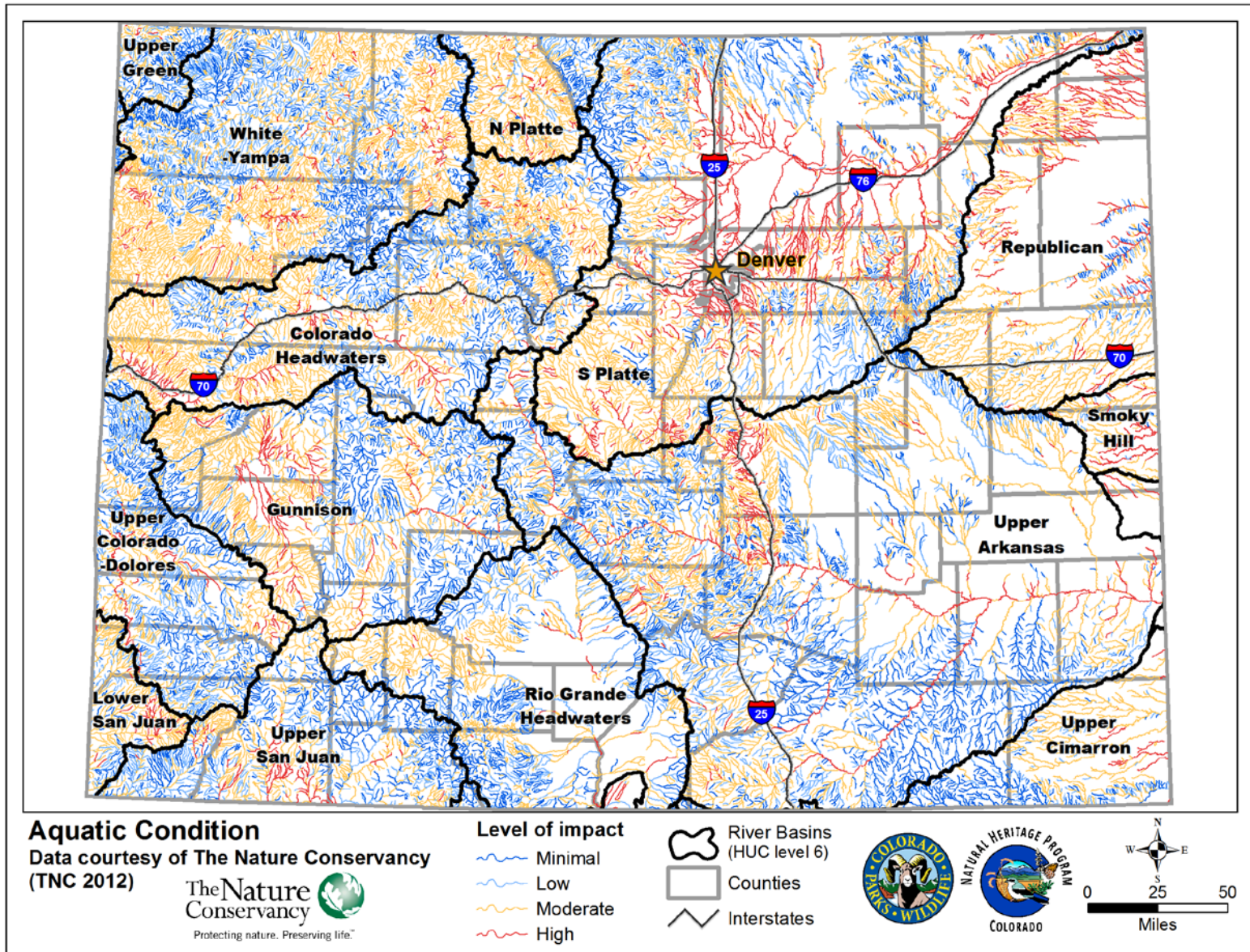


Figure 13. Condition of freshwater habitats in Colorado.

## Terrestrial Landscape Integrity Model

This map is the terrestrial upland counter-part to the aquatic condition map. This model was originally created for Rondeau et al. 2011<sup>23</sup>, but has been updated for inclusion in the SWAP. This model is based on mapped locations of seven land-use impacts: urban development, crop agriculture, roads, oil and gas wells, above-ground transmission lines and pipelines, surface mines, and wind turbines. Data used to map these land uses are listed in Table 12. Distance decay curves representing the area that effects extend beyond the footprint of the land use were incorporated (Figure 14). This was done in recognition that impacts from any particular land-use disturbance extend some distance out from the source of the impact, but lessen over that distance. The resulting model (Figure 15) provides a statewide perspective for location and relative degree of human impact on the landscape. The assumption is that where impacts are higher, general condition of remaining habitat is likely to be decreased, and vice versa. See Rondeau et al. (2011) for detailed analysis methods.

**Table 12. Source data for land uses represented in the landscape integrity model.**

Land Use	Source Data
High/med intensity development	SWReGAP high/medium development types
Low intensity development	SWReGAP low intensity development types
Agriculture*	SWReGAP agriculture
Roads - primary & secondary	2013 TIGER/Line roads
Roads - local & rural	2013 TIGER/Line roads
Oil & gas wells - active	Colorado Oil & Gas Commission (2015)
Oil & gas wells - inactive	Colorado Oil & Gas Commission (2015)
Gas pipelines	2013 TIGER/Line utilities
Transmission lines	Powerline Corridors in the Western United States and Canada (Connelly et al. 2004)
Surface Mines - active	Colo. Division of Reclamation, Mining, & Safety (2013)
Surface Mines - inactive	Colo. Division of Reclamation, Mining, & Safety (2013)
Wind Turbines	USGS Onshore Industrial Wind Turbine Locations for the United States (2014)

\*The agriculture category in SWReGAP includes cropland and irrigated hay fields.

<sup>23</sup> [http://www.cnhp.colostate.edu/download/documents/2011/Scorecard\\_march1\\_2012\\_final.pdf](http://www.cnhp.colostate.edu/download/documents/2011/Scorecard_march1_2012_final.pdf)

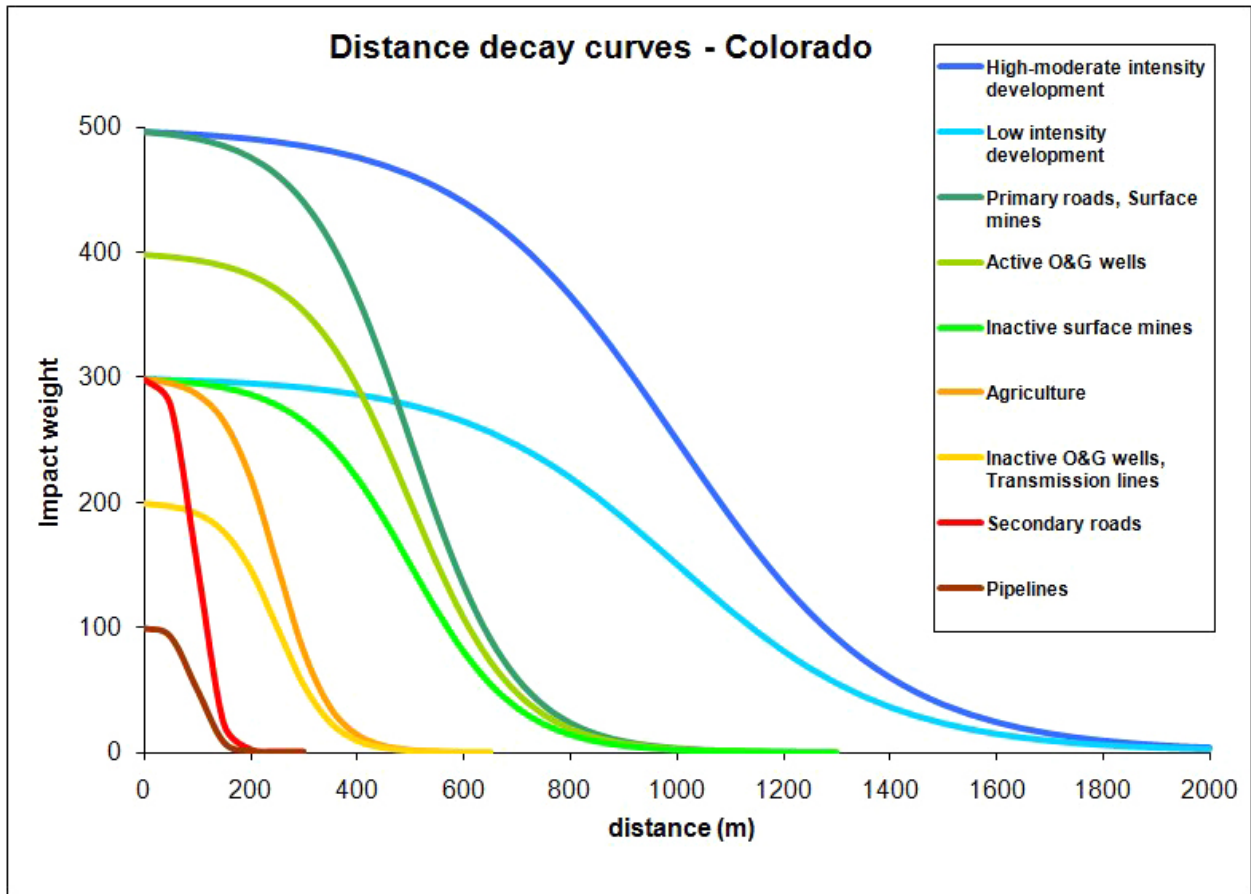


Figure 14. Distance decay curves for land uses represented in the landscape integrity model.

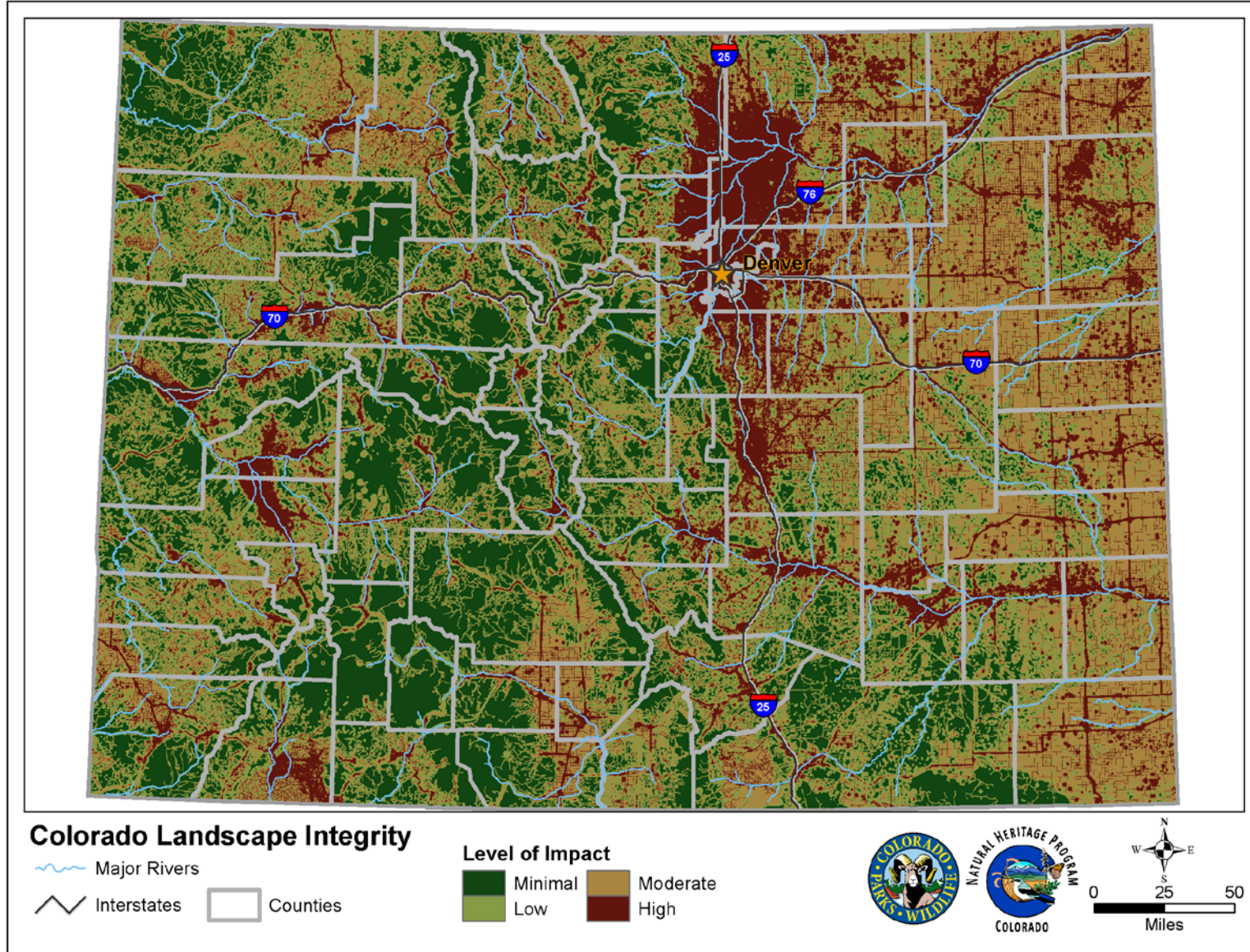


Figure 15. Landscape integrity model for Colorado.

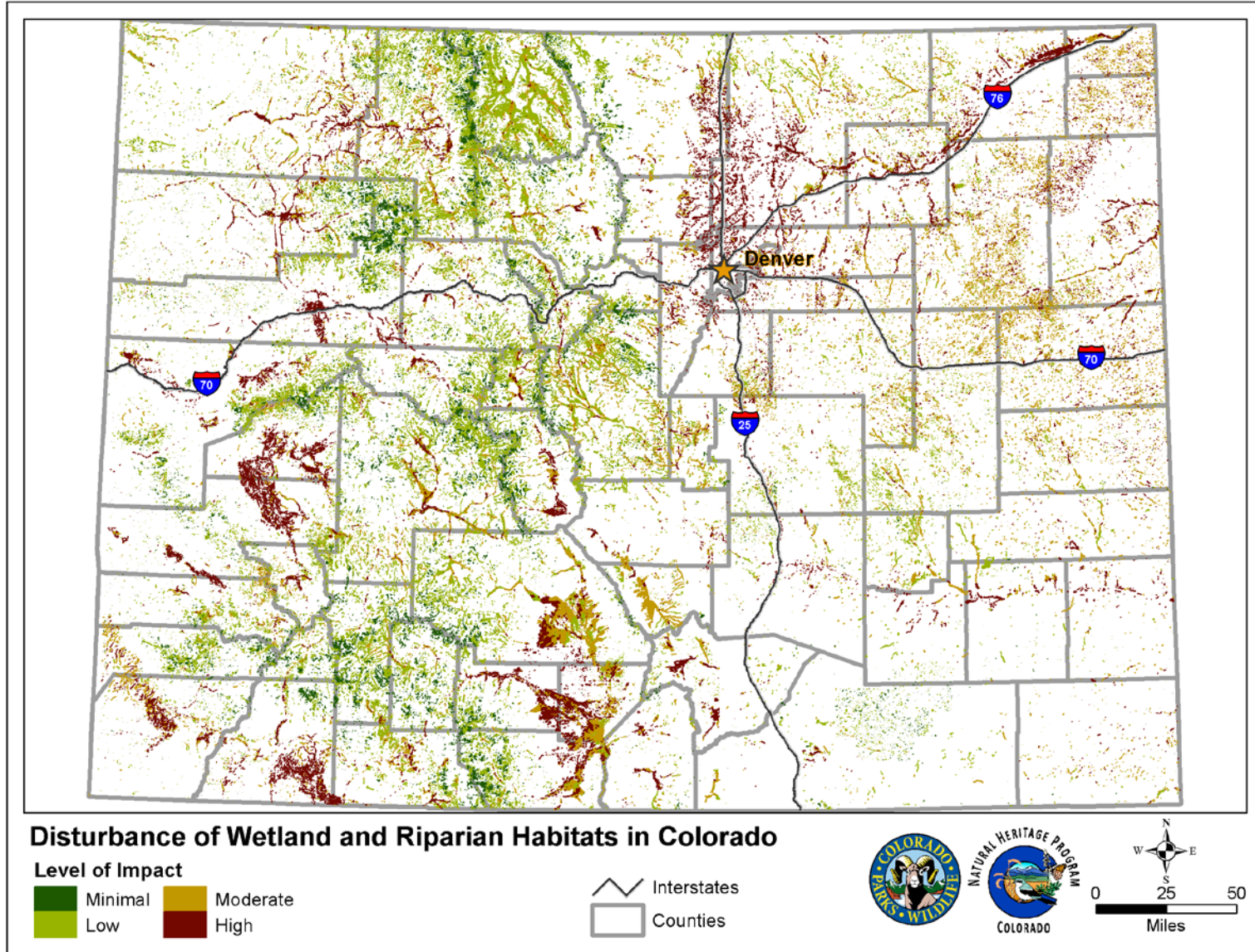
## Wetland and Riparian Habitats

Through a partnership among the USFWS, CPW, and CNHP, fine-scale mapping of wetlands based on the U.S. Fish and Wildlife Service's National Wetland Inventory Program has been completed for Colorado (USFWS 2010, as edited by CNHP in 2014). In addition, the Rocky Mountain Bird Observatory and Playa Lakes Joint Venture have developed a GIS data layer for playas on Colorado's eastern plains (RMBO 2009). These data were used in conjunction with a wetland-specific landscape integrity model to produce Figure 16, which depicts level of human impact on wetland and riparian habitats. For each wetland/riparian polygon, the mean value of the overlapping portion of the wetland landscape integrity layer was calculated to estimate general level of impact for that habitat patch. Work is currently underway to explore field and mapping methods for determining wetland quality (Lemly et al. 2011). This goal is complicated by the fact that quality measures from a floristic standpoint and from a wildlife standpoint are not necessarily equivalent. Results of this exploration were not complete in time for inclusion in this iteration of Colorado's SWAP. Our hope is that the next SWAP revision will include a more robust treatment of condition for these high priority habitats.

The wetland-specific landscape integrity model for Colorado is meant to reflect the impact to wetland and riparian habitats from cumulative, mappable, anthropogenic changes to the land and water. This model is based on the inputs listed in Table 13.

**Table 13. Data sources for the wetland-specific landscape integrity model.**

Land Use	Source Data
Housing & commercial development	LANDFIRE Current Vegetation for Colorado (2006)
Low intensity development	SWReGAP low intensity development types
Agriculture - tilled, fallow tilled, orchards & vineyards	LANDFIRE Current Vegetation for Colorado (2013)
Oil & gas wells	Colorado Oil & Gas Commission (2015)
Wind turbines	CNHP (2011)
Active sand & gravel mines	Colo. Division of Reclamation, Mining, & Safety (2008)
Other active mines	Colo. Division of Reclamation, Mining, & Safety (2008)
Reservoir storage as a proportion of mean annual flows	The Nature Conservancy (2012)
Altered flow as a proportion of mean annual flows	The Nature Conservancy (2012)
Density of dams & diversions	The Nature Conservancy (2012)
Water wells - active	The Nature Conservancy (2012)
Tamarisk infestations	The Nature Conservancy (2012)



**Figure 16. Level of disturbance to wetland and riparian habitats.** Due to the small size of many wetland and riparian habitats, the polygons have been exaggerated to be visible on this statewide map.



## Terrestrial Upland Habitats

Rondeau et al. (2011) developed a map of distinct patches of matrix-forming and large patch ecological systems, derived from Southwest Regional GAP vegetation data layer. These ecological system patches are roughly equivalent to the terrestrial habitats as defined in this SWAP. These maps show comparative condition for discrete patches of each habitat type, according to biodiversity status scores originally developed for Rondeau et al. 2011. Components of biodiversity status are sub-scores for patch size, patch condition, landscape context, and landscape integrity. General methods described below are summarized from Rondeau et al. 2011.

### Habitat Patches

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CNHP used the Southwest Regional Gap Analysis Project (SWReGAP) landcover dataset (USGS 2004) to produce a generalized vegetation map from which we could identify discrete ecological system patches. To the generalized map, we then added current highway data to represent existing fragmentation of the landscape. Of the resulting discrete patches of each ecological system type, we retained only patches larger than the minimum size judged to be viable as an ecological system at the landscape scale, according to methods in Rondeau (2001) and CNHP (2005a).

### Size

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Patches that met minimum size criteria were scored from 5 to 10, depending on size (Table 14). Patches that did not meet minimum size requirements were not included as viable in Rondeau et al. 2011. However, they have been added to these maps (Figures 17 - 19) and ranked as "Poor" without regard to the other sub-scores.

**Table 14. Total acres, minimum patch size, number of patches, and largest patch size for each habitat.**

Habitat Type	Habitat Name	Total acres	Minimum patch size (ac.)	No. patches	Largest patch (ac.)
Forest	Aspen	3,580,854	20,000	1,564	513,422
Forest	Lodgepole	2,199,719	30,000	643	264,169
Forest	Mixed Conifer	881,470	2,500	1,562	39,416
Forest	Pinyon-Juniper	6,753,665	30,000	1,300	512,906
Forest	Ponderosa	3,220,299	30,000	1,153	516,244
Forest	Spruce-Fir	4,880,993	20,000	956	458,277
Grass	Grasslands	3,020,774	5,000	1,551	281,180
Grass	Shortgrass	11,855,161	50,000	1,827	1,072,828
Other	Alpine Tundra	1,681,811	10,000	480	250,971
Shrub	Montane-Foothills Shrub	388,143	1,000	562	43,507
Shrub	Greasewood	443,159	1,000	367	136,846
Shrub	Oak & Mixed Mtn Shrub	2,717,457	5,000	1224	206,256
Shrub	Sagebrush	5,564,595	30,000	1,995	924,242
Shrub	Saltbush	763,237	1,000	356	77,768
Shrub	Sandsage	1,959,449	14,000	672	179,704
Shrub	Semi-desert Steppe	776,043	5,000	243	172,992

## Patch Condition

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Patch condition was scored by using the LANDFIRE Fire Regime Condition Class dataset (USFS 2007) that maps degree of departure from historic fire regime. The fire condition metric is most meaningful for forests, but was included for all habitats except alpine, greasewood, salt shrub, and shrub-steppe. This metric was judged to be not meaningful for these habitats because alpine does not typically burn, and LANDFIRE dataset does not represent these three shrubland types well. The Condition sub-score in Rondeau et al. 2011 only reflected degree of departure from normal fire regime. Since that analysis was completed, Colorado has experienced a number of significant insect outbreaks and wildfires. Thus, for forest habitats, the condition sub-score was updated by incorporating degree of tree mortality due to insect infestation and disease as mapped by the U.S. Forest Service aerial surveys from 2008-2014. While not added to the sub-score, the aerial extents of recent large-scale fires and mud-slides (2012-2014, Rocky Mountain Incident Management data) were overlaid on ecosystem patches as a highly transparent white, so they

would lighten the color (and therefore the apparent condition) just for the footprint of the disaster, and not the ecosystem patch as a whole.

## **Landscape Context and Integrity**

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Landscape context was scored by calculating the proportion of the landscape within ½ mile of a patch that is covered with natural vegetation. Landscape integrity was calculated using a GIS layer that represents the cumulative impacts from oil and gas wells, gas pipelines, surface mines, urban development, agriculture, roads, transmission lines, and wind turbines (i.e., the Landscape Integrity map, Figure 15, in this chapter).

## **Overall Biodiversity Status**

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The four sub-scores were averaged to produce the biodiversity status scores, which are used to represent the overall habitat condition presented on Figures 17-19. These scores, ranging from 0 to 10, have been classified as:

0 - 2.5	Poor
> 2.5 - 5.0	Fair
> 5.0 - 7.5	Good
> 7.5 - 10	Very Good

For these maps, the patch condition and landscape integrity sub-scores from Rondeau et al. 2011 were updated with new information and the biodiversity status score re-calculated.

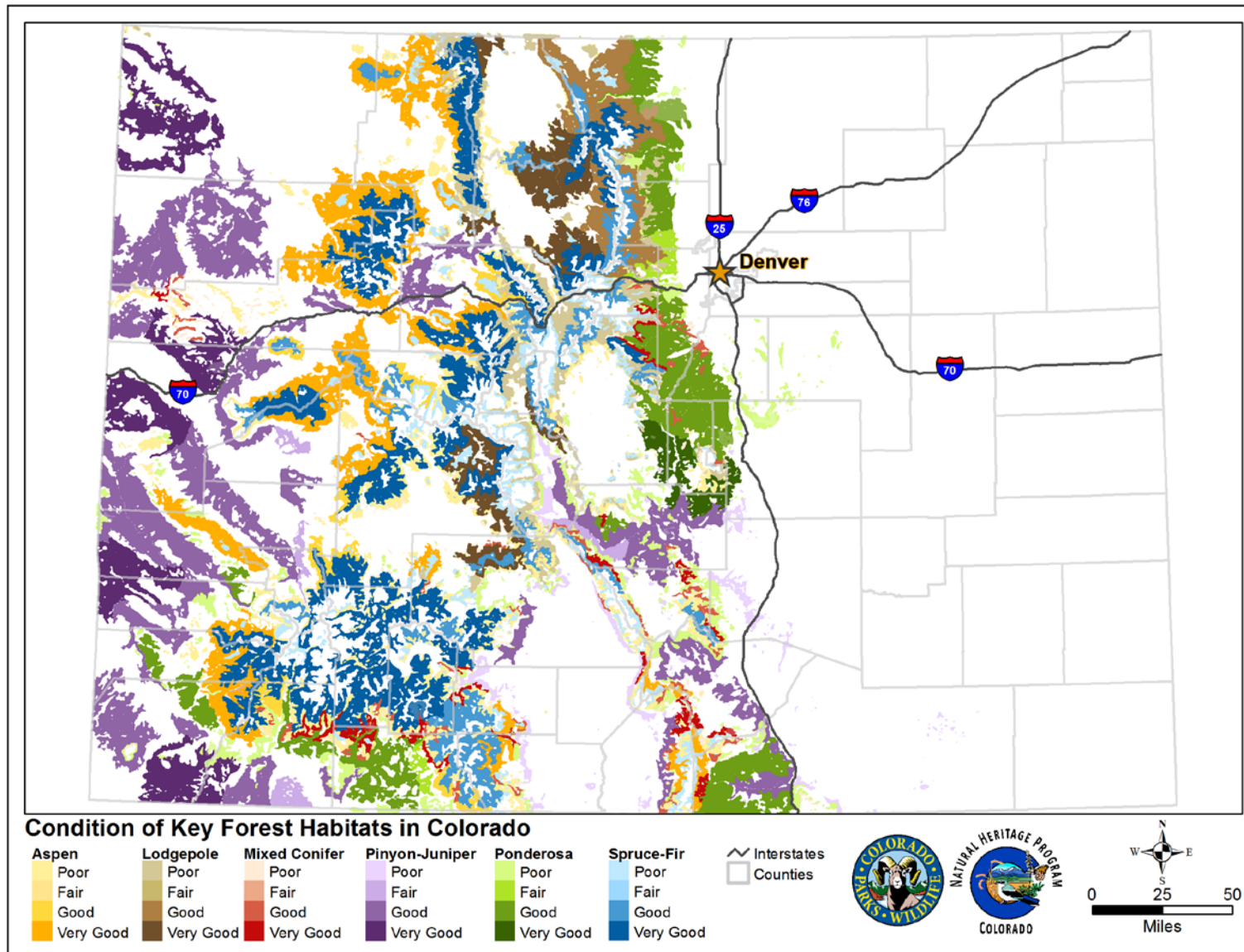


Figure 17. Terrestrial upland habitat condition - Forests.

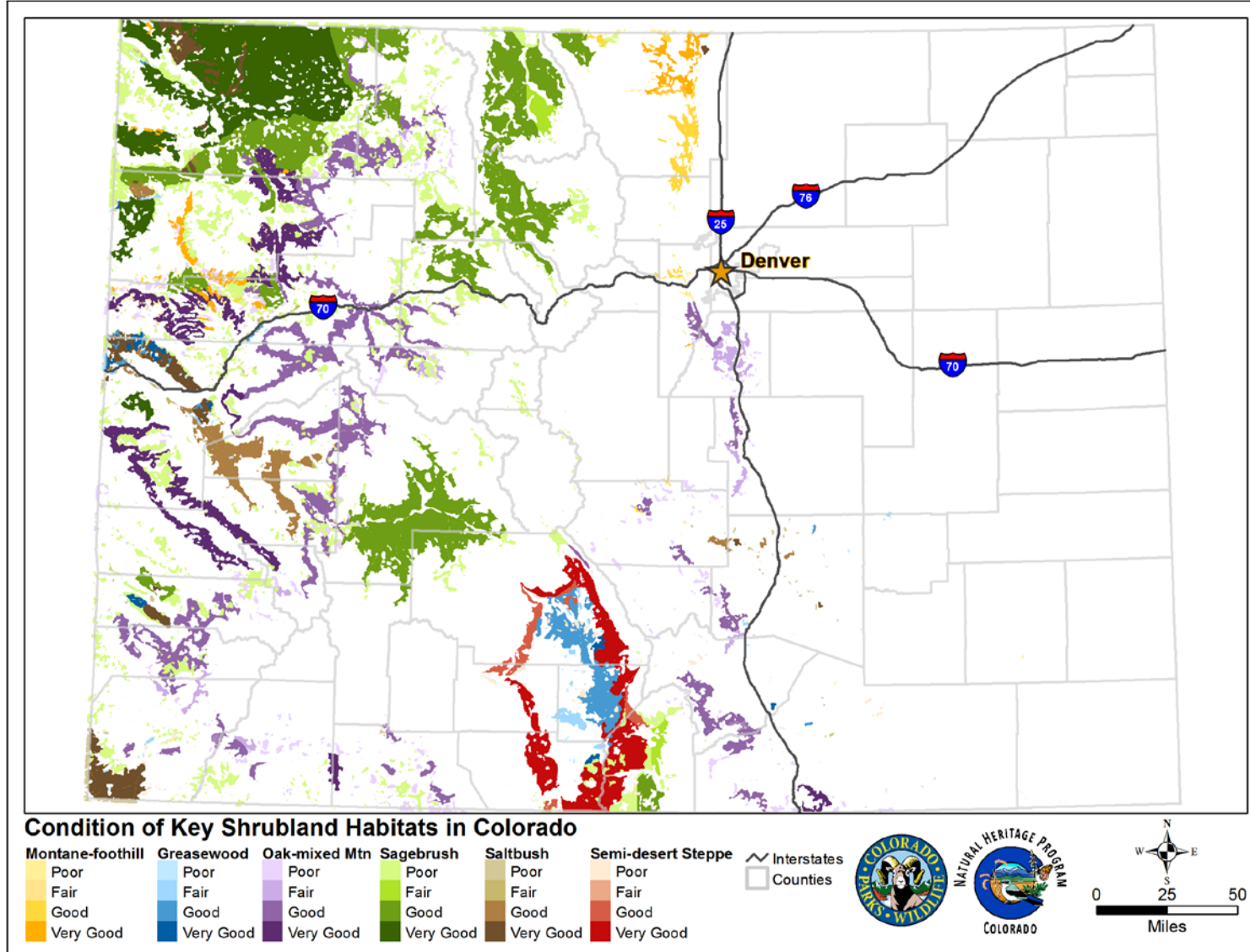


Figure 18. Terrestrial upland habitat condition – Shrublands

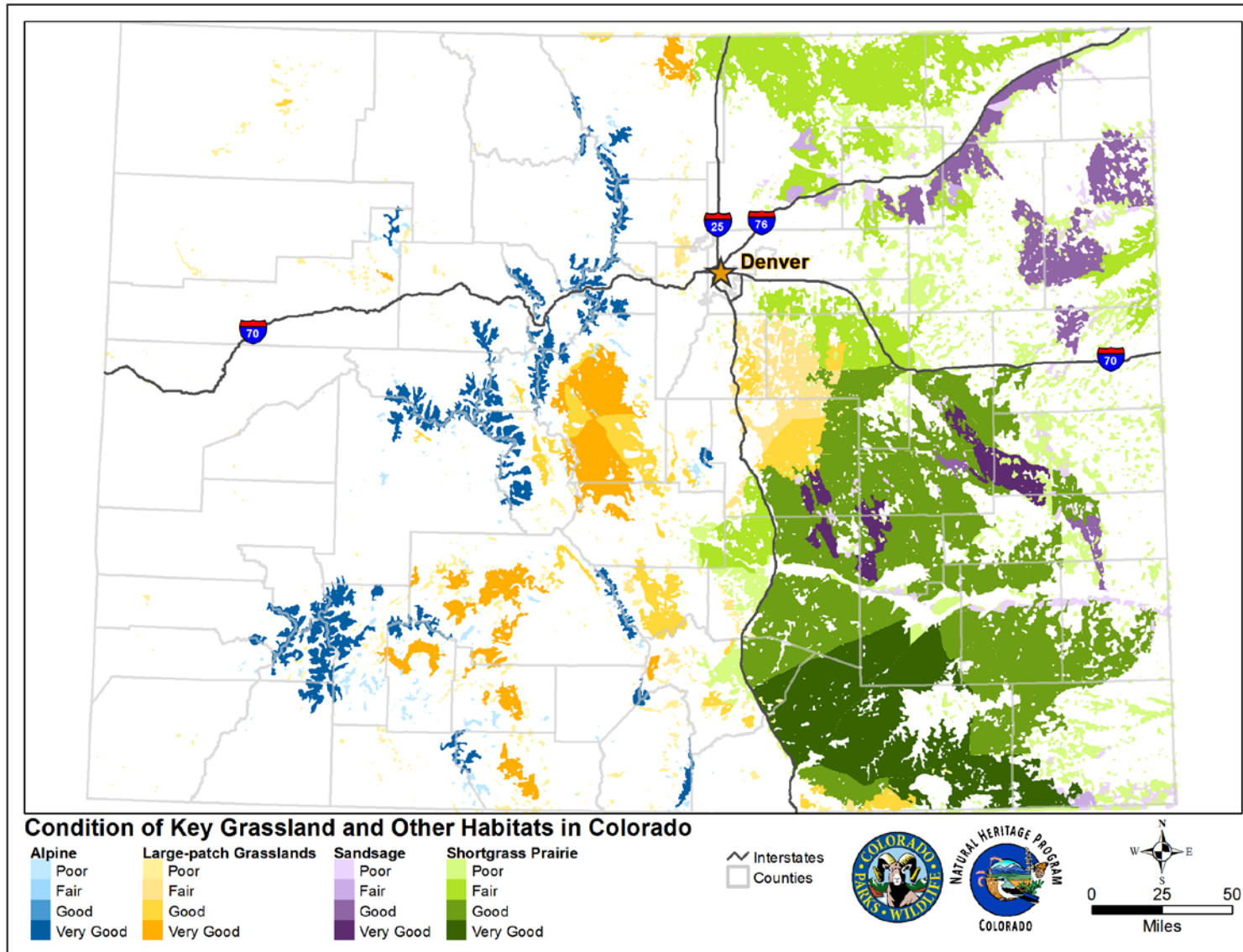


Figure 19. Terrestrial upland habitat condition – Grasslands and Other Habitats

## **High Priority Watersheds for Aquatic SGCN**

This map represents the number of Tier 1 fish species known to occur in each HUC10 watershed in the state, according to data available in CPW's fish database as of December 2014 (Figure 20). There are 25 fish species on the Tier 1 SGCN list; a maximum of eight different species occur in the same watershed. This map is an indicator of species richness only; it does not consider relative habitat quality, or population metrics such as density or abundance, across watersheds.

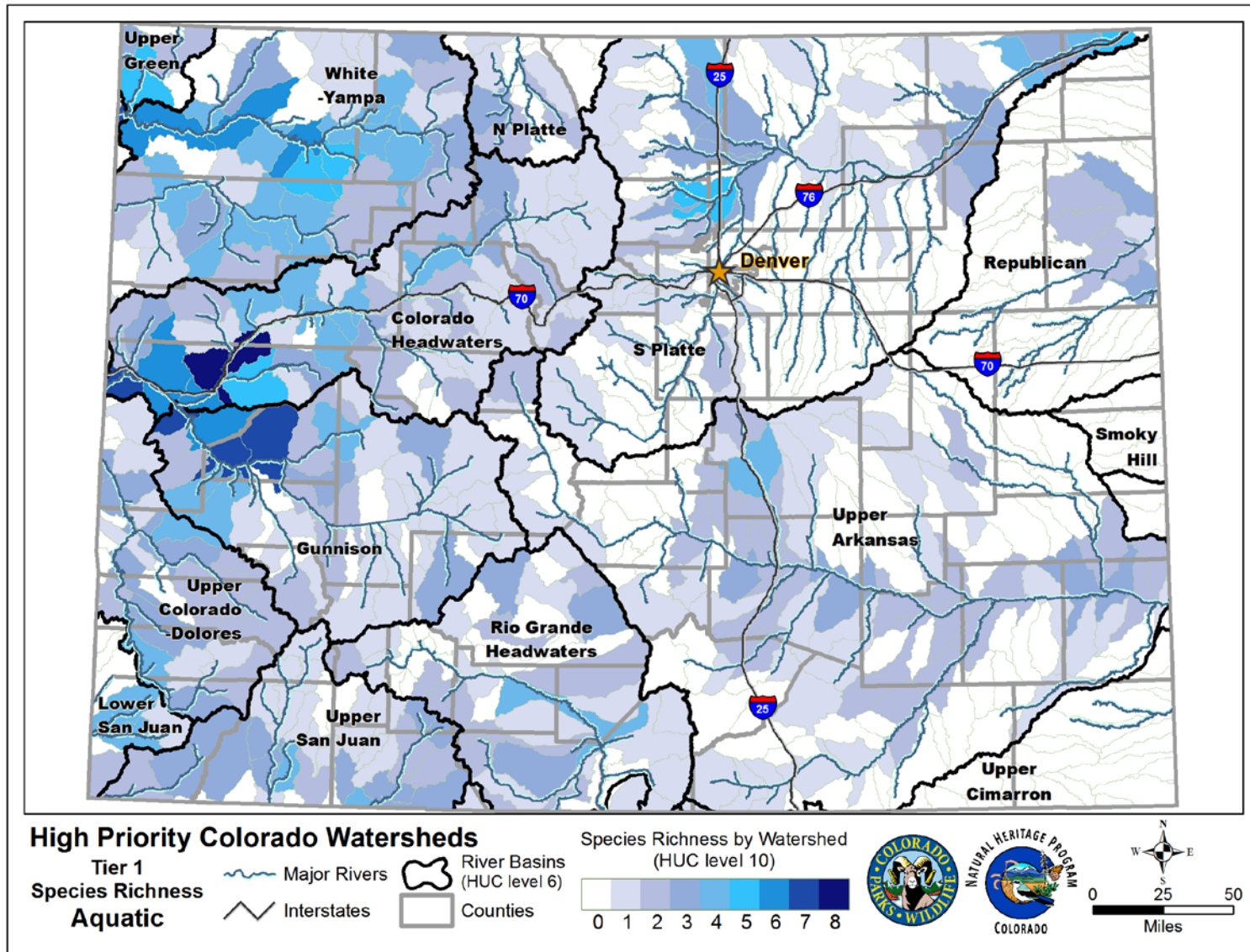


Figure 20. Priority watersheds for aquatic Tier 1 SGCN.



## Crucial Habitat Assessment Tool

The first iteration of the Crucial Habitat Assessment Tool<sup>24</sup> (CHAT) map was developed in 2013, in collaboration with the Western Governors' Association and 18 other states, for the purpose of creating a regional spatial data tool to identify crucial wildlife habitat across the western U.S. As part of Colorado's CHAT effort, a map of Species of Greatest Conservation Need was developed. The original SGCN CHAT layer for Colorado has been updated to reflect the newly revised list of Tier 1 SGCN, and to incorporate improved distribution data for those species (Figure 22). Using State Wildlife Grant funds, we developed species distribution models for 16 Tier 1 SGCN. These newly-developed models, pre-existing species distribution models, and documented distribution data for Tier 1 terrestrial vertebrate and plant SGCN have been combined at the resolution of 640 acre hexagons across the state. Each hexagon was then placed into one of five habitat priority categories based on criteria listed in Table 15.

As defined by the Western Governors' Wildlife Council (2013), crucial habitats are places containing the resources, including food, water, cover, shelter and important wildlife corridors, that are necessary for the survival and reproduction of aquatic and terrestrial wildlife and to prevent unacceptable declines, or facilitate future recovery of wildlife populations, or are important ecological systems with high biological diversity value. Crucial habitats are categorized according to the following definitions using the criteria in Table 15. See Table 16 for criteria as applied for each SGCN.

**Category 1:** Habitats, including wildlife corridors, that are rare or fragile and are essential to achieving and/or maintaining wildlife species viability or exceptional diversity. The habitat contains a unique combination of location or composition or complexity of the habitat or corridor which cannot be duplicated, and is therefore considered irreplaceable.

**Category 2:** Habitat, including wildlife corridors, which is limiting to a fish or wildlife community, population, or metapopulation. Loss of any of this habitat or corridor could result in a significant local or population-level decline in species distribution, abundance, or productivity. The habitat or corridor is essential to achieving and maintaining fish and wildlife target population or management objectives. Restoration or replacement is difficult, or may be possible only in the very long term.

**Category 3:** Habitat, including wildlife corridors, that contributes significantly to the maintenance of fish or wildlife communities, populations, or metapopulations. Loss of a significant portion of the habitat or corridor could result in local or population-level declines in

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<sup>24</sup> <http://westgovchat.org>

species distribution, abundance, or productivity. Impacts can be minimized or reduced, and habitat or corridors restored or replaced by utilizing appropriate best management practices.

**Common Habitat** [represented on map as Category 4]: Habitat which is relatively common, generally less limiting to fish and wildlife communities, populations, or metapopulations, and generally better suited for land use conversion. Large-scale or cumulative impacts to species or habitat could result in declines in species distribution or abundance, however, the loss may be difficult to measure. Impacts from individual projects or land use actions can be minimized, and habitat restored or replaced, so that effective habitat function or species distribution or abundance is maintained.

**Habitat Significance Unknown** [represented on map as Category 5]: Lands likely to have significant wildlife values, but for which there is insufficient data or a lack of information about the importance of the habitat in meeting conservation objectives.

**Table 15. Criteria for CHAT categories.**

Federal listing codes: LE = Endangered; LT = Threatened, C = Candidate; NatureServe conservation status codes: G1= critically imperiled; G2 = imperiled; G3 = vulnerable; G4 = apparently secure; G5 = demonstrably secure.

CHAT Category	Criteria
1	At least one T, E, G1, or G2 species with documented occurrence, or at least two G3 species with documented occurrence
2	At least one document occurrence of a C or G3 species, or at least two documented occurrences of G4 species
3	Modeled distribution of at least one G3 species, or documented occurrence of at least one G4 species
4	Modeled distribution of at least one C or G4 species, or documented occurrence of at least one G5 species
5	Modeled distribution of at least one G5 species

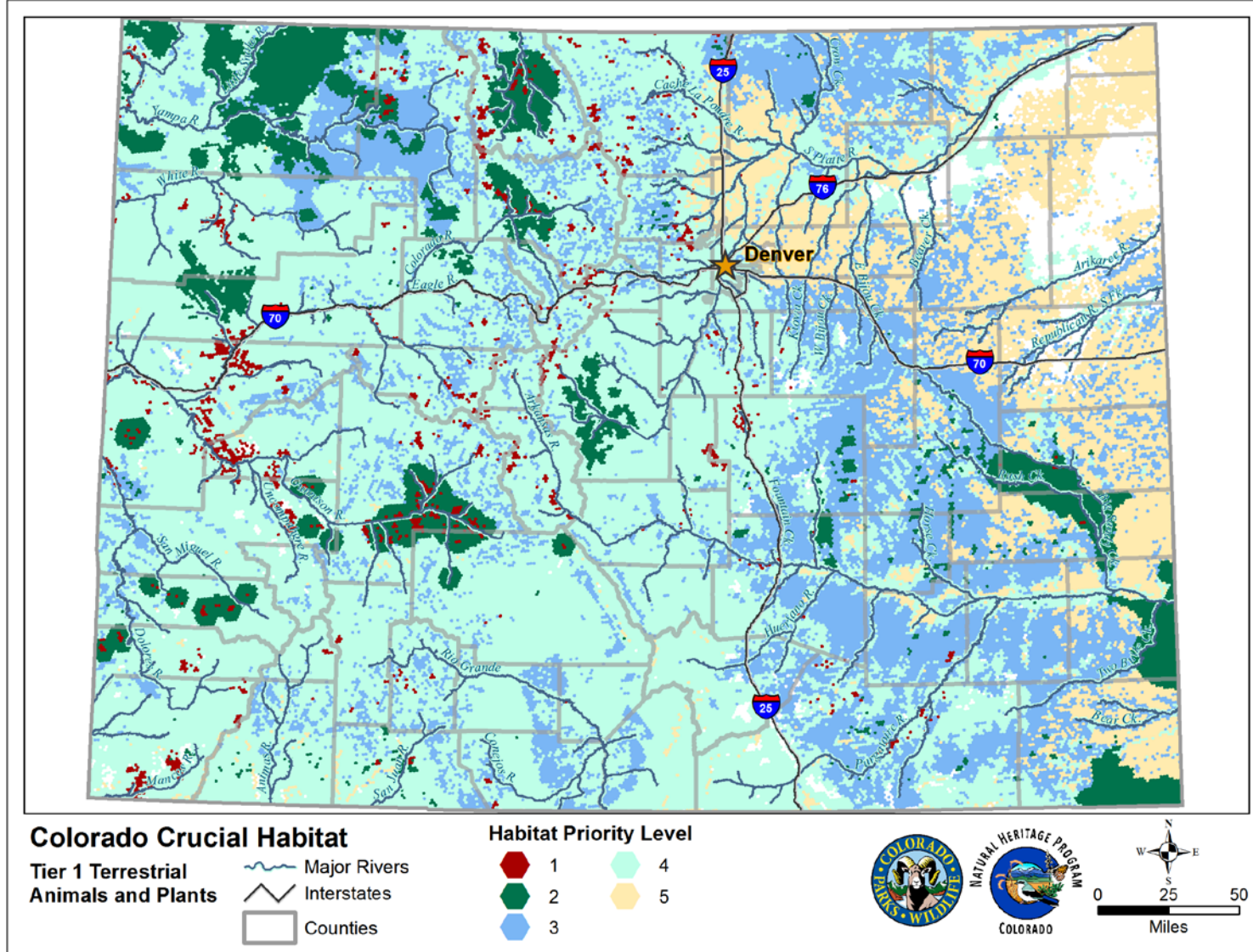
**Table 16. CHAT categorization criteria, by species.**

Species	Federal Listing Status	NatureServe Status Rank	Documented Occurrence	Modeled Distribution
<b>TIER 1 AMPHIBIANS</b>				
Boreal toad		G1	X	X
Northern leopard frog		G5	X	X
<b>TIER 1 BIRDS</b>				
Brown-capped rosy-finch		G4	X	X
Burrowing owl		G4	X	X
Columbian sharp-tailed grouse		G3	X	X
Golden eagle		G5		X
Greater sage grouse	C	G3	X	X
Greater sandhill crane		G4	X	X
Gunnison sage grouse	LT	G1	X	X
Lesser prairie-chicken	C	G3	X	X
Mountain plover		G3	X	X
Plains sharp-tailed grouse		G4	X	X
Southern white-tailed ptarmigan		G5	X	X
Southwestern willow flycatcher	LE	G1	X	X
Western yellow-billed cuckoo	LT	G4		X
<b>TIER 1 MAMMALS</b>				
American pika		G5		X
Black-footed ferret	LE	G4		X
Fringed myotis		G4	X	X
Gunnison's prairie dog	C	G5	X	X
Little brown myotis		G4		X
Lynx	LT	G4		X
New Mexico meadow jumping mouse		G4		X
Olive-backed pocket mouse		G5		X
Preble's meadow jumping mouse	LT	G2	X	X
Spotted bat		G4	X	X
Townsend's big-eared bat subsp.		G3	X	X
White-tailed prairie dog		G4	X	X
Wolverine		G4		X
<b>TIER 1 REPTILES</b>				
Colorado checkered whiptail		G2	X	X
Massasauga	C	G3	X	X
<b>TIER 1 PLANTS</b>				
<i>Aletes latilobus</i>		G1	X	
<i>Aliciella sedifolia</i>		G1	X	
<i>Astragalus deterior</i>		G1	X	
<i>Astragalus humillimus</i>	LE	G1	X	

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Species	Federal Listing Status	NatureServe Status Rank	Documented Occurrence	Modeled Distribution
<i>Astragalus microcymbus</i>	C	G1	X	
<i>Astragalus osterhoutii</i>	LE	G1	X	
<i>Astragalus schmolliae</i>	C	G1	X	
<i>Astragalus tortipes</i>	C	G1	X	
<i>Boechera glareosa</i>		G1	X	
<i>Corispermum navicula</i>		G1	X	
<i>Descurainia kenheili</i>		G1	X	
<i>Draba malpighiacea</i>		G1	X	
<i>Draba weberi</i>		G1	X	
<i>Erigeron wilkenii</i>		G1	X	
<i>Eriogonum brandegeei</i>		G1	X	
<i>Eriogonum pelinophilum</i>	LE	G2	X	
<i>Eutrema penlandii</i>	LT	G1	X	
<i>Gutierrezia elegans</i>		G1	X	
<i>Hackelia gracilentia</i>		G1	X	
<i>Ipomopsis polyantha</i>	LE	G1	X	
<i>Ipomopsis ramosa</i>		G1	X	
<i>Lepidium huberi*</i>		G1		
<i>Lygodesmia doloresensis</i>		G1	X	
<i>Mimulus gemmiparus</i>		G1	X	
<i>Oenothera coloradensis ssp. coloradensis</i>	LT	G2	X	
<i>Oreoxis humilis</i>		G1	X	
<i>Packera mancosana</i>		G1		
<i>Pediocactus knowltonii*</i>		G1		
<i>Penstemon debilis</i>	LT	G1	X	
<i>Penstemon gibbensii</i>		G1	X	
<i>Penstemon penlandii</i>	LE	G1	X	
<i>Penstemon scariosus var. albifluvis</i>	C	G1	X	
<i>Phacelia formosula</i>	LE	G1	X	
<i>Phacelia submutica</i>	LT	G2	X	
<i>Physaria congesta</i>	LT	G1	X	
<i>Physaria obcordata</i>	LT	G1	X	
<i>Physaria pulvinata</i>		G1	X	
<i>Physaria rollinsii</i>		G1	X	
<i>Physaria scrotiformis</i>		G1	X	
<i>Sclerocactus glaucus</i>		G2	X	
<i>Sclerocactus mesae-verdae</i>	LT	G2	X	
<i>Spiranthes diluvialis</i>	LT	G2	X	

\* No locational data for these species exist for Colorado, so they are not represented on the CHAT map.



**Figure 21. Crucial habitat for Tier 1 terrestrial animal and plant SGCN.** Areas in white on the map indicate places where there are no documented occurrences or modeled habitat for any Tier 1 SGCN.